

Documenting Plan Requirements for Measurement and Verification of Demand Resources in New England's Forward Capacity Market

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ISO New England Inc.
Demand Resources

Today's Agenda

- Introduction
- M&V Requirements
- Overview → 5) M&V Approach
- Break
- 6) Baseline → 11) Measurement Equipment
- Break
- 12) Data → 17) Plan Format
- Questions and Answers
- Adjourn



The Market Rules

- All Demand Resources that participate in the Forward Capacity Market are required to demonstrate performance during specified operating hours in a manner that provides electrical capacity to the New England Control Area.
- Market Participants shall prepare and have an ISO-NE approved Measurement and Verification Plan which complies with the applicable Measurement and Verification standards defined in M-MVDR.
- The measured and verified electrical energy reductions during performance hours are the basis of FCA Payments to Market Participants participating in the Forward Capacity Market.

Objectives

Your M&V Plan should.....

- Document the quantitative methods used to develop Demand Reduction Values from your Demand Resources with the required level accuracy and precision.
- Demonstrate how your company or organization will comply with all required quality assurance and quality control requirements established in the M&V Standards.

What this Training does not Provide

- While this training will inform participants of ISO-NE M&V standards and acceptable methods:
 - This training and the Manual are not intended to provide instruction to Project Sponsors in classifying a Project into one of the Demand Resource types in the Forward Capacity Market.
 - This training and the Manual do not provide instruction or assistance on Measurement and Verification methods, procedures, equipment, data analysis, statistical design, or data validation, quality assurance or quality control.

M&V Standards vs. Plan

- The M&V Standards Manual describes the **minimum requirements** that all Project Sponsors of Demand Resources shall comply with.
- The Project Sponsor's M&V Plan describes ***what*** the Project Sponsor will do and ***how*** they will meet or exceed the minimum requirements set forth in the M&V Standards Manual.

M&V Plan vs. Impact Evaluation

- The Project Sponsor's M&V Plan describes **what** the Project Sponsor will do and **how** they will meet or exceed the minimum requirements in the M&V Standards Manual, but does not necessarily provide the actual Demand Reduction (MWh) from the Demand Resource.
- Data from past Impact Evaluations may be used to justify assumptions in the M&V Plan, provided they meet the statistical accuracy and precision requirements.
- On-going Impact Evaluations, conducted consistent with the M&V Plan, should be the basis for reported Demand Reduction Values where applicable – eg.g, EE projects).

How will ISO-NE use the M&V Plan?

- **From 6/15/2007 to 10/1/2007:**
 - The M&V Plan will be used to qualify the Project Sponsor's Demand Resource project and what they can offer in FCA#1 being held in February 2008.
- **From 8/1/2008 to 5/31/2010:**
 - The M&V Plan will be used to verify project Performance Milestones or Critical Path Schedule for New Capacity.
- **After 6/1/2010 to End of Commitment Period:**
 - The Project Sponsor will be expected to comply with their M&V Plan in determining Demand Reduction Values (MWh) for monthly reporting to ISO-NE.

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Section 1: Overview

Purpose of Manual

The Manual for Measurement and Verification of Demand Reduction Value from Demand Resources (M-MVDR) establishes the criteria required for qualified Market Participants to verify and report electrical energy reductions (MWh) for Demand Resources participating in the Forward Capacity Market for all Demand Resource types defined in Market Rule 1.

- 1) Demand Resource On-Peak Hours,
- 2) Demand Resource Seasonal Peak Hours,
- 3) Demand Resource Critical Peak Hours,
- 4) Real-Time Demand Response Event Hours, and
- 5) Real-Time Emergency Generation Event Hours.

Scope of Manual Compliance

- To be eligible to receive FCA Payments, Demand Resources shall comply with all requirements set forth in this Manual in addition to any other relevant **Market Rules, Operating Procedures and Manuals** established by the ISO.
- Project Sponsors of Demand Resources shall conform to Market Rule 1 and **provide an Annual Certification** that the Demand Resource Projects for which the Project Sponsor is requesting compensation, continue to perform in accordance with the submitted Measurement and Verification Documents reviewed by the ISO.
- The **Manual applies to all Demand Resource Types** which may be comprised of a variety of measures, systems, technologies, and strategies.

Scope of Manual Compliance continued

- Compliance with this Manual is required for all Project Sponsors wishing to:
 - (i) qualify a Demand Resource for a Forward Capacity Auction or Reconfiguration Auction and
 - (ii) receive FCA Payments shall prepare and submit a Measurement and Verification Plan and provide other Measurement and Verification Supporting Documents, where applicable, which comply with the standards and criteria specified in this Manual.

Compliance with Standards

- Failure to comply with the requirements of this Manual during the FCM qualification process will result in rejection of the Project Sponsor's Demand Resource Qualification Package.
- Failure to comply with the requirements of this Manual after a Project is qualified by the ISO may result in the forfeiture of Financial Assurance, reduced or no FCA Payments, or sanctions as provided for in Market Rule 1 Appendix B.
- Compliance failures due to circumstances beyond the reasonable control of the Project Sponsor, such as transmission, distribution or communication outages that are external to the Demand Resource project, are excluded.
- The ISO will determine the Resource's ability to perform in the markets when not in compliance with the requirements of this Manual.

Section 2: Project Information

Project Information

1. Project Name.
2. Project Sponsor's Market Participant Status.
3. Demand Resource Type
4. Load Zone within which the Project will be located.
5. Project Location
6. Facility Type
7. Customer classes and End-Uses served.
8. Measure Type
9. Estimated Demand Reduction Value (kW) per measure and/or per customer facility
 1. Must provide supporting documentation

Project Information continued

- 10. Estimated total Demand Reduction Value of the Project;
- 11. Commercial Operation Date
- 12. Status under ISO generation interconnection procedures (if applicable);
- 13. Existing Capacity Treatment (FCA#1 only)
- 14. Project Team qualifications and experience

Additional Information Requirements for Distributed Generation

1. The aggregate nameplate capacity of the Distributed Generation resource;
2. The most recent annual non-coincident peak demand (absent Distributed Generation output) of the end-use metered customer at the location where the Distributed Generation resource is directly connected;
3. An estimate of the monthly average hourly load for each month of the Capacity Commitment Period (absent Distributed Generation output) of the end-use customer to which the Distributed Generation resource is directly connected; and
4. An estimate of the Distributed Generation resource's monthly average hourly output for each month of the Capacity Commitment Period

Section 3: Project General Assumptions

Project General Assumptions

- **Variables:**
 - Describe all variables that will be measured or monitored to determine the Demand Reduction Value. For example, outside temperature, time of day, process changes, occupancy, etc
- **Assumptions:**
 - Describe all substantive assumptions for the Project's Demand Reduction Value, including but not limited to, baseline energy consumption, post measure installation energy consumption, process changes, and measure life.

Project General Assumptions continued

- **Unknown Variables and Assumptions:**
 - If one or more of the variables that will be measured or monitored and/or assumptions that will be used are not known the Project Sponsor may:
 - provide alternative information and/or forecasts and
 - indicate the portion of the Demand Reduction Value associated with such measurement and monitoring variables and/or
 - assumptions and explain the basis for such forecasts.

Section 4: Equipment, Measure, and Practice Detail

Equipment, Measure, and Practice Detail

- **Equipment Specifications**

- The Project Sponsor shall provide in its Measurement and Verification Plan specifications of the equipment or types of equipment for projects being installed and/or modified.

- **Engineering Analysis**

- 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.

Equipment, Measure, and Practice Detail

- **Change in Business Practices**
 - For Projects involving changes to business practices or strategies, the Project Sponsor shall provide a description of the practice or strategy that will effect the facility's energy consumption during the relevant Performance Hours relative to Baseline Conditions.

Section 5: Measurement and Verification Approach

Measurement and Verification Approach

- The Project Sponsor shall describe which of the methodologies described in Section 5.2 it plans to use to determine its Project's Demand Reduction Value.
- Acceptable Methodologies Include:

Option A: Partially Measured Retrofit Isolation/Stipulated Measurement

Option B: Retrofit Isolation/Metered Equipment

Option C: Whole Facility/Regression

Option D: Calibrated Simulation

Option A: Spot or Short-Term Measurement with Stipulated Values



- Description:
 - The approach is intended for DR projects where either performance or operational factors can be measured on a spot or short-term basis during pre and post-installation periods.
 - Demand Reduction Value is stipulated based on engineering assumptions, analysis of historical data, or manufacturer's data.
- Requirements:
 - Stipulated factor shall not be subject to fluctuation over the Performance Hours or Measure Life of the Demand Resource.
 - Requires baseline measurement calculations
 - Supplier shall demonstrate a correlation between the metered proxy variables and energy consumption (MWh) during Performance Hours.
- Example:
 - Measuring HVAC system temperatures and flow rates to calculate MWh consumption using manufacturer's equipment data.

Option B: End-Use or System Interval Metering



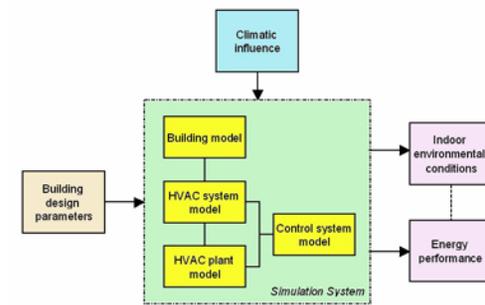
- Description:
 - Demand Reduction Value is measured at the component or system level using interval meters installed on the affected end-use.
- Requirements:
 - The Supplier shall measure factors continuously during the performance period and Measure Life of the resource.
 - Requires baseline measurement calculations
 - Consideration shall be given to the possibility of interactive effects that may significantly alter loads on other end-use equipment.
- Examples:
 - Measuring the MWh output of a Distributed Generator during Performance Hours.
 - Measuring the MWh consumption of a large electric motor

Option C: Whole Facility Metering and Analysis



- Description:
 - Demand Reduction Value is determined by studying overall energy use in a facility and identifying the impact of the implemented measure on total building or facility energy use patterns.
- Requirements:
 - Interval metering of facility MWh consumption during Performance Hours.
 - Requires baseline measurement calculations
 - Approach may not be appropriate if the Demand Reduction Value is expected to be small relative to the total facility load, due to the small “signal-to-noise ratio,
- Example:
 - Residential weatherization measures reducing air-conditioning load

Option D: Calibrated Simulation



- Description:
 - Demand Reduction Value is determined using calibrated computer simulation models of either a system or whole building energy consumption to determine measure energy savings.
 - Engineering simulation models (such as DOE-2) can model both residential buildings (homes, apartments and condominiums) as well as more complex commercial buildings.
- Requirements:
 - Simulation models shall be calibrated to actual kW and kWh data from the site or process being examined.
 - Requires baseline measurement calculations or simulation
- Example:
 - Installation of high efficiency HVAC and control systems in new construction project.

Measurement and Verification Approach

- **Why is the Proposed Approach the Best Approach?**
 - Describe why the methodology or combination of methodologies selected is the most appropriate.
- **References to Best Practices**
 - Provide references to engineering best practices in the Measurement and Verification literature, reference reports, or state of the art to demonstrate that its proposed Measurement and Verification approach is appropriate for the Demand Resource type and will produce accurate and reliable Demand Reduction Values.
- **Project Team**
 - Describe the technical capabilities of the Project team and subcontractors to implement its proposed methodology.

Additional M&V Approach Requirements

- **Simulation Model Calibration**
 - For existing buildings, systems, processes or equipment, calibrate the simulation model to actual kW or kWh data from the buildings, systems, processes or equipment being modeled.
- **Meter Output of Distributed and Emergency Generation**
 - Follow Option B and directly measure the electrical demand (MW) output of the Distributed Generation or Emergency Generation.

Additional M&V Approach Requirements

- Projects involving multiple Distributed Generation or Emergency Generation installations may use Option B in conjunction with statistical sampling as described in Section 7 of this Manual.
- If statistical sampling is used to determine any variables, factors, parameters, engineering factors, or load shapes used in the calculation of Demand Reduction Values, the statistical sampling shall satisfy the requirements described in Section 7.

Appendix A: Requirements for RTDR or RTEG

- Must follow Method B
- Must be willing and able to interrupt load within 30-minutes after receiving the instruction from the ISO through its IBCS Provider.
- Interval meters for all resources or ISO approved Measurement and Verification Plans that comply with the requirements defined in this Manual.
- Resources shall be able to provide data in the format and frequency required to interface with the IBCS Open Solution.
- Project Sponsors shall utilize the services of an ISO certified IBCS Provider to provide such data services.

Appendix A: Requirements for RTDR or RTEG

- Must be able to submit required meter reading data to the IBCS Open Solution by 1300 on the third business day after the Operating Day.
- Revised metering data may be submitted up to 90 days following the dispatch day for inclusion in the Monthly Services Invoice.

Section 6: Establishing Baseline Conditions

Baseline Requirements

- **Variable Load / Weather Dependent**
 - Baseline Conditions shall be calculated for each hour across the Performance Hours.
- **Active Controls / Energy Management**
 - Where Baseline Conditions are calculated based on historical hourly load or output data from measures with variable load equipment or equipment whose operation is time-dependent or weather-dependent the Project Sponsor shall demonstrate that the variance in the historical hourly load or output data used in the calculations of Baseline Conditions comply with the statistical reliability criteria (Section 7)

Baseline Requirements continued

- **Active Controls / Energy Management**
 - Where Baseline Conditions are calculated using a rolling average of historical hourly load or output data over some period prior to the Performance Hours the Project Sponsor shall exclude historical hourly loads or output coincident with the Performance Hours from the Baseline Conditions calculations.
- **Existing or Removed Equipment**
 - Baseline Conditions shall be the kW load of that operating equipment across the Performance Hours prior to such equipment removal or reduced use.

Baseline Requirements continued

- **Replaced Failed Equipment**
 - 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.
- **Replaced operating equipment**
 - Baseline Condition is the kW load of that operating equipment across the Performance Hours.

Baseline Requirements continued

- **Emergency Generation Projects Meter on Unit**
 - For DG metered at the generator output, (resources whose operation is limited to loss of external power to the facility or the implementation by the ISO of voltage reduction of 5% requiring more than 10 minutes to implement), the Baseline Condition electricity output shall be zero.

- **Emergency Generation Projects Facility Metered or on a Submeter**
 - For DG metered at the customer billing meter or a sub-meter within the facility, the Baseline Condition electricity output shall be zero.

Baseline Requirements continued

- In the absence of a measured baseline, the baseline values shall be level of efficiency required by applicable state code or Federal product efficiency standard or standard practice if there is no applicable state code or federal standard.
- If standard practice is used as the basis for establishing Baseline Conditions it shall be documented in the Measurement and Verification Plan.
- The Project Sponsor shall describe the method by which the Baseline Condition may be adjusted over the Measure Life.

Baseline Requirement Specific to New Construction and Major Renovation

- Applicable state code or Federal product efficiency standard, or
- Standard practices if there are no applicable state codes or Federal product efficiency standards, or
- Standard practices that are less stringent than applicable state code or Federal product efficiency standards, shall be documented and meet statistical accuracy and precision, or
- Standard practices that are more stringent than applicable state code or Federal product efficiency standards, shall be documented.

Appendix A: Requirements for RTDR or RTEG Customer Baseline

- For RTDR and RTEG resources, ISO New England will calculate the resource's Customer Baseline using the methodology in the Open Solution software.
- The methodology used to calculate the Customer Baseline will be identical to that currently used for the Real-Time Demand Response Program, with the exception of **Baseline Adjustments**

RTDR and RTEG Baseline Adjustments

- One or more Demand Resource Shortage Hours and no Demand Resource Forecast Peak Hours were forecasted for the Event day, then the Customer Baseline will be increased or decreased to reflect the actual usage for the two hours preceding the start of the Event.
- One or more Demand Resource Forecast Peak Hours were forecasted for the Event day, then the Customer Baseline will be adjusted to reflect the actual usage for the two hours preceding the start of the Event, provided, however, that no adjustment will be applied that would reduce the Customer Baseline.
- If the Event coincides with a scheduled shutdown of the facility or scheduled maintenance of energy consuming equipment associated with the Demand Resource, then no adjustment will be applied to the Customer Baseline and the Customer Baseline as originally computed is used to determine the amount of interruption.

RTDR and RTEG Baseline Adjustments

- If the actual usage for the two hours preceding the start of the Event is equal to or less than 10% of the Customer Baseline, the ISO will deem the Demand Resource to be on scheduled facility shutdown or scheduled equipment maintenance on the Event day.
- If the actual usage for the two hours preceding the start of the Event is greater than 10% of the Customer Baseline, the Customer Baseline as originally computed may be used to determine the amount of interruption provided that the Project Sponsor submits evidence that demonstrates, to the ISO's satisfaction, that the facility or equipment was on scheduled shutdown or maintenance on the Event day.

RTDR and RTEG Baseline Adjustments

- If there are multiple, consecutive Event days for a specific resource type, the Customer Baseline for those resources will be the Customer Baseline from the last non-Event day.
- The adjustment to the Customer Baseline to reflect the actual usage for the two hours preceding the interruption will be calculated separately for each Event day, and the adjustment for consecutive days will be the higher of the previous Event day's adjustment or the present day's adjustment.

Section 7: Statistical Significance

Statistical Significance

- Must describe how M&V will meet or exceed the required statistical precision and accuracy standards.
- Must demonstrate that the techniques utilized to calculate sample accuracy and precision are consistent with the methods described in the Manual.
- Must describe how the M&V 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.
- Must describe how accuracy and precision will be achieved on Demand Reduction Value and sampling during the measure life.

Statistical Significance Requirements

- Must describe how M&V 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 Demand Reduction Value.
- Must justify use of M&V Reference Documents relative to M&V methodology
 - engineering estimates,
 - load profiles,
 - measure life, and
 - coincidence factors.

Statistical Significance Bias Control

- Demand Reduction Value calculations include engineering-based direct measurement, measurement of proxy variables or simulations,
- Must describe methods to control relevant types of potential bias including, but not limited to:
 - (a) accuracy and calibration of the measurement tools
 - (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.

Statistical Significance Bias Control

- Demand Reduction Value calculations include regression or statistical analyses,
- Must 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.

Statistical Significance Requirements

- Demand Reduction Value calculations including any form of survey or interview data,
- Must 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;
 - (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.

Statistical Sampling

If sampling will be conducted, the Project Sponsor shall describe in its Measurement and Verification Plan each of the following general sampling conditions:

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

Statistical Sampling Requirements

- If the Demand Reduction Value is estimated from one or more samples, the required sample size(s) shall be based upon targeting 10% relative precision at an 80% confidence level.
- If the Demand Reduction Value is estimated from a sample drawn from 2 or more strata the overall test sample size shall be based upon targeting 10% relative precision with an 80% confidence interval.

Statistical Sampling Requirements continued

- All Sampling calculations shall incorporate a plan to compensate for potential data loss through,
 - Over sampling
 - Sample site replacement in the course of the study,
 - Demonstration that precision and confidence targets will still be met with a smaller sample size.
- The Project Sponsor 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.

Statistical Sampling Requirements continued

- 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.
- The Project Sponsor shall demonstrate the method for controlling bias attributed to the c.v. as it relates to sample size determination.

Statistical Sampling Requirements continued

- 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 Project Sponsor 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.

Sample Size Recalibration

- In the absence of a reliable c.v. the Project Sponsor may use a default c.v.
- Once performance data has been collected, the Project Sponsor shall demonstrate that the level of Precision and Accuracy is met in the sampling methodology by calculating the relative precision with a new estimate of C.V.

Requirements for Sampling Over Load Zones

- The Project Sponsor shall demonstrate that the accuracy and precision requirements apply to the overall population of Demand Resources being studied, rather than to the Project or Projects within each individual Load Zone.
- The Project Sponsor shall demonstrate the method for controlling any bias attributed to sampling across Load Zones.

Section 8: Demand Reduction Value Calculations

Demand Reduction Value

- Must describe Demand Reduction Value calculations.
- The following factors may be used in the Demand Reduction Value calculations:
 - Equations and Formulas
 - Assumptions
 - Manufacturers Equipment Specifications
 - Direct Measurement Data
 - Indirect Measurement Data
 - Engineering Factors, Parameters and Other Variables

DRV Calculation Requirements

- Achieve at least a 10% relative precision at an 80% confidence level.
- Document adjustments to the Baseline Conditions to reflect operating conditions during Performance Hours.
- Show formulas used and any modifying factors, such as:
 - coincidence appropriate for the specified Demand Resource type and the relevant Performance Hours,
 - realization rate,
 - measure life, and
 - equipment failure rate.

DRV Calculation Requirements continued

- Demand Resource Projects consisting of multiple sites and/or measures,
 - may calculate the aggregated Demand Reduction Value during the Performance Hours in each Load 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 an 80% confidence level, or the aggregated Demand Reduction Value achieves at least a 10% relative precision at an 80% confidence level.
- Where sampling is performed, aggregated Demand Reduction Values shall be calculated from the measured data of the sample, except where sampling across load zones meets the M&V requirements.

Appendix A: Requirements for RTDR and RTEG Demand Reduction value Calculation

- ISO New England will continue to calculate Demand Reduction Values for RTDR and RTEG resources using the Open Solution, with the following change:
 - Demand Reduction Values will be based on the Average Hourly Load Reduction over the Event Hours.

{ The current method for calculating capacity value for RTDR and RTEG resources will be retained through the end of the Transition Period. }

Section 9: Monitoring Parameters and Variables

Monitoring Parameters and Variables

- Shall describe variables that will be measured, monitored, counted, recorded, collected, and maintained to determine the Project's Demand Reduction Value.
- Shall describe how each of the variables will be measured, monitored, recorded, collected and maintained.

Monitoring Parameters and Variables Requirements

- For Projects affecting **HVAC Systems**, the Project Sponsor shall, at a minimum, collect and maintain, the following information:
 - On HVAC equipment: equipment capacity, quantity, manufacturer, model and serial numbers, and age.
 - On HVAC system controls: location of zones, temperature set-points, control set-points and schedules, and any special control features.
- For Projects affecting **Building Envelope**, the Project Sponsor shall, at a minimum, collect, maintain and report on all key variables effecting savings associated with the measures.
- For Projects affecting **Interior or Exterior Lighting Systems**, the Project Sponsor shall, at a minimum, collect and maintain the following information: number and types of lamps and ballasts, with nameplate data.

Monitoring Parameters and Variables Requirements continued

- For Projects affecting **Major Electric Consuming Equipment**, the Project Sponsor shall, at a minimum, collect and maintain the following information: equipment capacity, quantity, manufacturer, model and serial numbers and age.
- 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 Project Sponsor 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 shall satisfy the requirements described in Section 15.0.

Monitoring Parameters and Variables Requirements continued

- For **Distributed Generation or Emergency Generation**, the Project Sponsor shall measure and record the electrical output of the generator during Performance Hours using an interval meter that satisfies the requirements in section 10.
 - Report to the ISO the most recent annual non-coincident peak demand (absent Distributed Generation output) of the end-use metered customer for each year that the Distributed Generation resource participates in the Forward Capacity Market; and
 - Report the monthly average hourly load of the end-use customer separately from the Distributed Generation resource's monthly average hourly output for each month of the Capacity Commitment Period.

Appendix A: Requirements for RTDR or RTEG Monitoring Parameters and Variables

- Describe variables that will be measured, monitored, counted, recorded, collected, and maintained to determine the Project's Demand Reduction Value during Performance Hours.
- Describe how each of the variables will be measured, monitored, recorded, collected and maintained.
- Same requirements as any M&V Plan.

Section 10: Measurement Equipment Specifications

Measurement Equipment Specifications

- Describe each measurement, monitoring and/or data recording device type that will be used to measure, monitor and record data for each parameter and variable described in the M&V Plan.
- Describe 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.

Measurement Equipment Specification Requirements

- American National Standard Institute (“ANSI”) or equivalent standard applies to:
 - All solid-state measurement, monitoring and data recording equipment.
 - 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.
 - 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.

Measurement Equipment Specifications Requirements continued

- Data recorders that are recording pulses from measurement and monitoring devices shall utilize a pulse rate within the resolution capabilities of the recorder.
- All measurement, monitoring and data recording equipment installed on electric circuits with significant harmonics shall meet the relevant standards provided by the Institute of Electrical and Electronics Engineers (“IEEE”).
- Any measurement or monitoring equipment that directly measures electrical demand (kW) shall be a true RMS measurement device with an accuracy of no less than $\pm 2\%$.
- Interval metering devices shall collect electricity usage data at a frequency of 15 minutes or less.

Measurement Equipment Specifications Requirements continued

- Any measurement or monitoring equipment that directly measures electrical demand from three-phase devices shall 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.
- Any measurement or monitoring equipment that directly measures electrical demand on circuits with significant harmonics shall have a digital sampling rate of at least 2.6 kHz as defined in the relevant IEEE Standards.
- Any measurement or monitoring equipment of proxy variables that do not directly measure electrical demand, including but not limited to voltage, current, temperature, flow rates and operating hours, shall have an accuracy rating such that the overall accuracy of the calculated demand (kW) using the proxy variables is not less than $\pm 2\%$.

Measurement Equipment Specifications Requirements continued

- Any measurement or monitoring equipment of current (amps) and nominal voltage used to calculate electrical demand shall include the power factor of the end-uses in the demand (kW) calculations.
- Data recorders shall be synchronized in time, within an accuracy of +/- 2 minutes per month, with the National Institute of Standards and Technology (“NIST”).
- All measurement, monitoring and data recording equipment shall be calibrated by the Project Sponsor or its independent calibration contractor in such a way to meet or exceed the Federal Energy Management Program M&V Guidelines, applicable American Society of Heating, Refrigeration and Air Conditioning Engineers (“ASHRAE”) standards, NIST, or equivalent standard.

Measurement Equipment Specifications Requirements continued

- All measurement, monitoring and data logging equipment shall be maintained in such a way as to meet or exceed industry and manufacturer standards.
- Maintain documentation on all measurement, monitoring and data logging equipment maintenance and calibration activities in accordance with Section 12.0.
- The Project Sponsor shall provide to ISO, upon request, measurement equipment maintenance, calibration and testing records to demonstrate that the Project Sponsor's measurement equipment is calibrated and maintained in accordance the requirements described in this Manual.

Measurement Equipment Specifications Requirements continued

- The Project Sponsor must describe any proposed alternative methods to demonstrate the measurement, monitoring and data recording equipment used in the determination of Demand Reduction Value satisfies the accuracy, calibration and maintenance standards described in the Manual.
- Requirements for RTDR or RTEG:
 - Same requirements as above.

Section 11: Monitoring Frequency and Duration

Monitoring Frequency and Duration

- The Project Sponsor shall describe in its Measurement and Verification Plan the monitoring frequency and duration for each monitoring parameter and variable described in Section 9.0.

Monitoring Frequency and Duration Requirements

- The duration and frequency of metering and monitoring shall be sufficient to ensure an accurate representation of the amount of electrical demand consumed or generated both without and after Project installation and during Performance Hours.
- For Projects using Option B methodology, the direct measurement of electrical demand or generation shall be made using an interval meter.
- All measurements shall be taken at typical system conditions within the time periods and frequency that shall demonstrate coincidence with the Performance Hours as defined in the Market Rules.
- Describe methods to ensure measurement is performed over a duration and frequency sufficient to accurately represent Demand Reduction Value during Performance Hours if independent parameters, such as but not limited to: temperature, humidity, or heating degree days are used.

Appendix A: Requirements for RTDR or RTEG Monitoring Frequency and Duration

- Sufficient to ensure accurate representation of the amount of electrical demand consumed or generated both with and without interruption during Performance Hours.
- All measurements shall be taken at typical system conditions within the time periods and frequency that shall demonstrate coincidence with the Performance Hours.
- Describe processes and methods employed to:
 - validate any and all data used in determining Demand Reduction Value during Performance Hours.
 - estimate any missing measurement data used in determining Demand Reduction Value during Performance Hours.
 - maintain any and all data used in determining Demand Reduction Value during Performance Hours.

Section 12: Data Validation, Retention and Management

Data Validation, Retention and Management

- Describe the systems, processes and methods that will be employed to validate any and all data.
- Describe the systems, processes and methods that will be employed to estimate any missing measurement data.
- Describe the systems and processes that will be used to maintain any and all data.

Data Validation, Retention and Management Requirements

- Demand Resource Projects ≥ 10 kW per facility, the Project Sponsor shall maintain the following:
 - Retail customer's address,
 - The retail customer's utility distribution company,
 - Utility distribution company account identifier such as account number or meter number,
 - Measures installed, and
 - The corresponding monthly Demand Reduction Values until the end of the Measure Life, or until the Demand Resource is permanently De-Listed or retired from the Forward Capacity Market.

Data Validation, Retention and Management Requirements

- Projects < 10 kW per facility, the Project Sponsor shall have option of maintaining records as described above or maintaining records of aggregated Demand Reduction Value and measures installed by Load Zone and Meter Domain.

Data Validation, Retention and Management Requirements continued

- Data shall be validated. Data that has failed validation may not be used in any Demand Reduction Value calculation.
- Projects involving an individual facility, generator or energy consuming equipment, the Project Sponsor shall conduct the following validation checks on any interval data from an individual facility:

Data Validation, Retention and Management Requirements continued

- Time Check: measurement devices time clock is within plus or minus two minutes of the true time as defined by the National Institute of Standards and Technology (“NIST”).
- Sum Check: difference between the sum of the values recorded over the intervals and the value recorded by the meter over the same time period is within plus or minus two percent. This check may be done on either consumption or pulse data, provided the data scaling is consistent throughout the period.

Data Validation, Retention and Management Requirements continued

- High/Low Check: minimum and maximum expected values for each Demand Resource Project. The minimum and maximum values shall be based on equipment ratings or historical equipment and/or facility consumption data. The Project Sponsor shall identify any and all interval data that is greater than the maximum expected value or less than the minimum expected value. Any such interval data shall be deemed to fail validation.
- Zero Value Check: identify any and all interval data with a value equal to zero. The Supplier shall verify whether or not the zero value is the correct value for that interval. If the Project Sponsor determines that the zero value is incorrect, the Project Sponsor shall substitute a corrected or estimated non zero value for the zero value. Under no circumstances shall the Project Sponsor substitute a zero value for missing interval data.

Data Validation, Retention and Management Requirements continued

- Identify any and all estimated data used in the Demand Reduction Value calculations, as well as the methodology used to develop the estimate.
- Classify all data that has passed validation and is used in the Demand Reduction Value calculations as either:
 - (i) actual data,
 - (ii) estimated data or
 - (iii) missing data.
- The data classification shall be stored along with the data values in the Project Sponsor's data retention and management system.

Appendix A: Requirements for RTDR or RTEG

- For large scale aggregations of small Demand Reduction Values per facility, the following information shall be maintained:
 - Retail customer's address,
 - Retail customer's utility distribution company,
 - Utility distribution company account identifier such as account number or meter number, and
 - Measures installed.
- Validate all measured data **before it is submitted to the IBCS OS** and used in the Demand Reduction Value calculations.

Section 13: Performance Reporting

Performance Reporting

- Describe how reports will be prepared which are required to comply with ISO monthly data reporting requirements

Performance Reporting Requirements

continued

- On a monthly basis, report for each Demand Resource Asset registered with ISO the total Demand Reduction Value (MWh) during the Performance Hours applicable to the Demand Resource in the Obligation Month.
- Report the Demand Reduction Values (MWh) for each Demand Resource Project according to the ISO's published Settlement schedule.
- The Project Sponsor may report revised Demand Reduction Values (MWh) for each Demand Resource Project according to the schedule defined by ISO

Performance Reporting Requirements

continued

- Demand Reduction Values (MWh) for each Asset shall be reported in a format defined by the ISO.
- Demand Reduction Values (MWh) for each Asset shall be reported using a software application and electronic interface as defined by the ISO.
- Provide to the ISO on a monthly basis work sheets, engineering calculations, reference materials, meter readings and any other data necessary to support the Demand Reduction Values for each of its Demand Resource Projects.

Performance Reporting Requirements

continued

- For Demand Resource Projects using Statistical Sampling, provide to the ISO on a monthly basis certification that the samples used in the calculation of the Demand Reduction Value comply with the minimum statistical significance requirements.
- Describe any deviations from minimum statistical significance requirements and any and all actions taken to correct deviations.
- Describe any and all adjustments made to Baseline Conditions where Demand Reduction Values (MWh) are derived using Baseline Conditions.

Appendix A: Requirements for RTDR or RTEG Performance Reporting Requirements

- Report near Real-Time data to IBCS OS
 - Using ISO specified format
 - Report every 5 minutes (where Customer Baseline required)
- Perform quality control on data submitted to IBCS OS
- Correct data errors within initial 2.5 business days or before 90 day resettlement window closes

Verification, Errors and Fraud

- Prepare for ISO periodic audits of Project Sponsor performance reports and other data.
- Prepare for disputes concerning erroneous performance reporting which shall be resolved through the ISO's existing dispute resolution procedures.

If, in review of the Project Sponsors performance reports or other data, the ISO determines that the Project Sponsor has committed fraud to extract excess Capacity Payments, the ISO will have the right to ban the Project Sponsor or its customers from participation in the wholesale electricity markets, as well as pursue other legal options at the sole discretion of the ISO.

Section 14: Independence and Auditing

Independence and Auditing

- Describe the aspects of the Measurement and Verification process that will be conducted by independent third-parties.

For purposes of this manual, an independent third-party is a party that does not have a direct financial interest in the FCA Payments resulting from the Project Sponsor's reported Demand Reduction Values.

Independence and Auditing Requirements

- Annual Certification of Accuracy of Measurement and Verification Documents, verified by an independent third-party auditor, certifying projects continue to perform in accordance with the submitted Measurement and Verification Documents reviewed by the ISO in accordance with the Market Rules.
- Cooperate in any and all unannounced audits or tests of a Demand Resource conducted by the ISO to verify its compliance with the requirements as set forth in Market Rule 1 and in this Manual.

Audits may be conducted on a periodic basis, or at the ISO's discretion should the ISO have a reason to suspect a deficiency in the Project Sponsor's compliance with any of the requirements in this Manual or the Market Rules. On site audits will be coordinated with the Project Sponsor and scheduled during normal business hours.

Independence and Auditing Requirements

- The Project Sponsor shall allow the ISO to audit testing and calibration records, and order and witness the testing of metering and measurement equipment installed pursuant to the Demand Resource's approved Measurement and Verification Plan
- The Project Sponsor will be responsible for all expenses associated with installing, maintaining, calibrating and testing the metering, data recording and measurement equipment installed pursuant to the Demand Resource's approved Measurement and Verification Plan.

Appendix A: Requirements for RTDR or RTEG Independence and Auditing Requirements

- M&V Plan shall describe the process to be used by an independent third-parties.
 - An independent third-party is a party that does not have a direct financial interest in the FCA Payments resulting from the reported Demand Reduction Values.
- ISO may periodically audit reported performance and other data to insure that it is consistent with the requirements described in this Manual.
- All information submitted is subject to audit by ISO.

Section 15: Measurement and Verification Supporting Documents

M&V Supporting Documents

- Describe any and all reports, studies, specifications and other documents referenced in its Measurement and Verification Plan.

M&V Supporting Document Requirements

- All reports, studies, specifications and other documents referenced in the Project Sponsor's Measurement and Verification Plan shall have been prepared and published within five years of the Measurement and Verification Plan's submission date.
- Older supporting documents must be demonstrated to have continued relevance to the Demand Resource.
- Provide copies of any and all reports, studies, specifications and other documents referenced in its Measurement and Verification Plan upon request.

Section 16: Responsible Parties

Responsible Parties

- Identify the parties and skills involved in various aspects of the Project.
 - Project Management
 - Measure Implementation
 - Measure Operation and Maintenance
 - Measurement Equipment Calibration and Testing
 - Monthly Demand Reduction Value Calculations
 - Data Validation, Retention and Management
 - Monthly Performance Reporting
 - Independent Project Auditing
 - Quality Assurance

Section 17: Measurement and Verification Plan Format

Required M&V Plan Format

Section 1: Project Information

Section 2: Project General Assumptions

Section 3: Equipment, Measure and Practice Detail

Section 4: Measurement and Verification Approach

Section 5: Methodology for Establishing Baseline
Conditions

Section 6: Statistical Sampling Plan

Section 7: Demand Reduction Value Calculations

Section 8: Monitoring Parameters and Variables

Required M&V Plan Format (Continued)

Section 9: Measurement Equipment Specifications

Section 10: Monitoring Frequency and Duration

Section 11: Data Validation, Retention and Management

Section 12: Performance Reporting

Section 13: Independence and Auditing

Section 14: Measurement and Verification Supporting Documents

Section 15: Responsible Parties

Questions

