

**Measurement and Verification Plan**

**Template**

**Version 1.0**

# Introduction

This Measurement and Verification (M&V) plan template provides a framework and outline for creating a project-specific M&V plan adherent to the IPMVP Option C, *Whole Facility* approach. The M&V plan can be used directly to describe the M&V process to support [Investor Confidence Project](http://www.eeperformance.org/) (ICP) compliant projects. Various sections will require the user to customize the language to fit project-specific details.

This M&V Plan template was developed with contributions by David Jump of Quantum Energy Services & Technologies, Inc. (QuEST), and the [EVO IPMVP Committee](http://www.evo-world.org/index.php?option=com_content&view=article&id=274&Itemid=409&lang=en).

# 1.0 Introduction

This Measurement and Verification (M&V) plan describes in detail how energy savings will be quantified for NAME OF PROJECT. The M&V plan presented here adheres to the specifications set forth in the International Performance Measurement and Verification Protocol (IPMVP) Core Concepts - 2014.

M&V involves the process of using measurements to reliably quantify actual energy savings from an energy savings project within a facility, a process, a building, or a building subsystem. M&V may be used to verify that an energy efficiency project is achieving its intended savings. Energy savings represents the absence of energy use and cannot be directly measured. M&V describes how savings are determined from measurements of energy use before and after implementation of an energy or water savings project, with appropriate adjustments made for changes in conditions. Such adjustments may be routine and expected, while others are non-routine and due to factors unrelated to the project.

This M&V Plan describes how baseline energy use is documented, how it varies, and what factors are its primary drivers. The M&V plan also describes how adjustments to baseline energy use are made for unexpected events, such as added equipment or loads, or other unforeseen events that materially affect energy use and savings.

The M&V Plan is required to document and describe the approach to quantifying savings, the key measurements required and computation methods, the timing of these activities, roles and responsibilities of involved parties, and the quality assurance requirements associated with the process.

# 2.0 Project Description

[[Provide a general description of the project. This can be copied from an Energy Audit Report or similar document.]]

## 2.1 Energy Conservation Measures

[[Add a table listing the ECMs and estimated savings in energy units and dollars.]]

[[OPTIONAL: add brief descriptions of each ECM.]]

# 3.0 Measurement and Verification

## 3.1 IPMVP Option and Measurement Boundary

IPMVP Option C, *Whole Facility* will be used for savings determination. Option C was selected because multiple energy conservation measures (ECMs) are included in the project, and may have interactive effects. This approach conforms with the Investor Confidence Project (ICP) Large and Standard Energy Efficiency Protocols.

The main building utility meters will be used to determine savings: the natural gas meter and the main electricity meter. These meters account for all energy use of the facility.

## 3.2 Baseline Period Energy and Conditions

The baseline period selected involves the 12 months immediately before the decision to implement the ECMs (BASELINE PERIOD DATES). The baseline energy data for each meter are shown in Appendix A. Key conditions during this baseline period that may change in the reporting period were recorded as shown in Appendix B. These conditions, if different in the reporting period from these baseline conditions, may necessitate non-routine adjustments to the baseline energy use.

## 3.3 Reporting Period

Annual reporting of cost avoidance will be performed.

## 3.4 Basis for Adjustment

Savings are to be reported as “cost avoidance,” under reporting period conditions. Baseline period energy will be adjusted to reporting period conditions, using the following IPMVP equation:

**Equation 1**

Avoided Energy Use (or Savings) = Baseline Energy (+/- Routine Adjustments to reporting-period conditions +/- Non-Routine Adjustments to reporting-period conditions) - Report Period Energy

## 3.5 Analysis Procedures

The energy and demand relationships with heating degree days were examined for the heating season, and cooling degree days for the cooling season, on all utility accounts using regression analysis. For gas and electrical consumption, the base temperatures selected for counting heating and cooling degree days were the outdoor temperatures which yielded the best R-squared in the regression analysis.

Appendix A shows the baseline analysis of the utility meters.

**Table 1 Regression Analysis Summary**

[[Include a summary table, illustrating items such as the HDD or CDD base, R-squared values, standard error of regression, t-statistic of the HDD or CDD coefficients, etc]]

[[Include any discussion here, if appropriate, of the results of the regression analysis.]]

**Table 2 Recalculation of Baseline with Regression Coefficients**

|  |  |  |
| --- | --- | --- |
|  | **Gas consumption (therms)** | **Electric consumption (kWh)** |
| **Total baseline annual energy use** |  |  |

## 3.6 Energy Prices

Reporting of cost avoidance will use the then current rate from each utility account. Prices will be modified each time the utility price schedules change.

## 3.7 Meter Specifications

Utility company meters used for billing are the only meters used.

## 3.8 Responsibilities

**Table 3 M&V Roles and Responsibilities**

|  |  |  |
| --- | --- | --- |
| **Role** | **Responsibility** | **Contact** |
| Facility management | Collect utility bills and send to M&V agent.  Identify any static factors that have changed since the baseline period, and report these to the M&V agent. |  |
| M&V agent | Perform interviews and site visits as appropriate to assess routine / non-routine adjustments.  Calculate the effects of any applicable non-routine adjustments.  Perform regression analysis using baseline and reporting-period data, applying all applicable adjustments.  Report results via an annual M&V report. |  |
| Investor | Approve application of all routine and non-routine adjustments. |  |
| Quality assurance provider | Review M&V activities and analysis, and work with M&V agent to ensure results are reliable.  Provide input to Investor regarding M&V-related issues to be resolved, and their resolution. |  |

## 3.9 Expected Accuracy

Since there is no error in the utility data for the reporting period, the standard error of savings reports using Equation 1 will be represented by the standard error of the regression of the baseline model (assuming no non-routine adjustments).Savings reporting is for long term performance evaluation, not month by month control of the facility. Building automation system logs will be used for day to day control of building operations. Therefore the precision over the long term is adequate for the monthly computations, using the regression analyses.

## 3.10 Budget

[[Present the expected budget here.]]

## 3.11 Report Format

M&V reports will be developed annually, presenting the results of the analysis, and descriptions of any adjustments applied to the baseline period. The report format will adhere to the IPMVP Core Concepts-2014, Section 8.0.

## 3.12 Quality Assurance

The primary risks in this M&V process are listed below with specific quality assurance steps that will be used to address each.

* *Utility companies estimate meter readings instead of actually reading the meter*. Any such estimate will be self-corrected by a subsequent month when the meter is actually read, except in the case of electrical demand on the main meter. When an estimate is detected, the engineering department will hold distribution of savings reports until an actual reading is made, and then adjust data to smooth out anomalies created by estimates.
* *Unexpected changes happen to the building, its operation, or to its use*. The procedures described regarding application of non-routine adjustments, to account for these unexpected changes, will attempt to account for the impact significant non-routine adjustments have on the building’s energy performance..
* *Data entry staff put incorrect data into the analysis spreadsheets*. The responsible engineer will review the utility data before delivery to the M&V agent. The report is given to the engineer with the supporting file containing all input data, including utility bills, and a log of all changes made to raw data or baselines. The engineer will examine all data as he/she sees fit.

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# Appendix A: Baseline Utility Data

[[Insert table of baseline utility data / regression analysis]]

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# Appendix B: Baseline Conditions (Static Factors)

The full set of static factors for the baseline period are not shown in this example. The actual information included the following facts: [[These are examples]]

* a lighting level survey, with a count of the number of burned out lamps in January
* and June;
* a survey of typical space temperatures and humidities during occupied and unoccupied periods in each of four seasons;
* a count of the number and size of all computers, monitors and printers, along with an estimate of the operating hours of each;
* a record of the number of day pupils and evening courses each month of the year;
* a record of the number of public rental hours of the gym, cafeteria, classrooms, auditorium and pool each month;
* a count of the number of window air conditioning units installed;
* the temperature setting of pool water, and domestic hot water serving the pool showers, the gym showers and the rest of the school;
* the volume of makeup water supplied to the pool each month, as recorded by a separate un-calibrated sub-meter;
* the kitchen hot water temperature and the number and rating of all kitchen equipment; and
* the open hours of the kitchen and the value of food sales each month.