



# Measurement & Verification Guide

The complete guide to measuring and verifying energy efficiency projects





## Measurement & Verification

Measurement & verification (M&V) is the process of quantifying the energy and cost savings that result from energy conservation measures (ECM). When investing in new equipment or a new operational strategy for your business, it is imperative to measure & verify your savings. However, when doing so, it is not enough to just review year-over-year utility bills, as several factors (occupancy, production levels, operating schedules, weather, etc.) may have changed that could be affecting these numbers. Rather, savings must be determined by comparing measured use before and after implementation of a project, making appropriate adjustments for changes in conditions. Often times, efficiency projects will have ambiguous outcomes that do not directly lower the energy bill, thus needing further analysis through M&V. This guide will go over the different guidelines and standards to M&V, when and where it is necessary, and what benefits it may have for your organization.

## Measurement & Verification Guidelines

Due to the many components that go into proper M&V analyses, building a standardization process and guidelines to follow was necessary. The International Performance Measurement and Verification Protocol (IPMVP) provides a framework and standard for M&V, while ASHRAE Guideline 14 provides specific procedures for using measured billing data (kWh, kW, etc.) for the calculation of savings, as well as benchmarks for analysis of model fit and uncertainty.

### IPMVP

The Department of Energy partnered with the Efficiency Valuation Organization to develop the IPMVP. Through IPMVP, energy use before the ECM (the baseline period) is compared against energy use after (the performance reporting period), with routine and non-routine adjustments to account for factors such as, occupancy, production, and weather.

### ASHRAE Guideline 14

ASHRAE developed Guideline 14-2014, a Measurement of Energy, Demand, and Water Savings to “provide guidelines for reliably measuring the energy, demand, and water savings achieved in conservation projects.” To determine savings through ASHRAE Guideline 14, measurements of post-retrofit energy use are compared to pre-retrofit use and adjusted to show a representation of the conditions had the retrofit not been implemented.

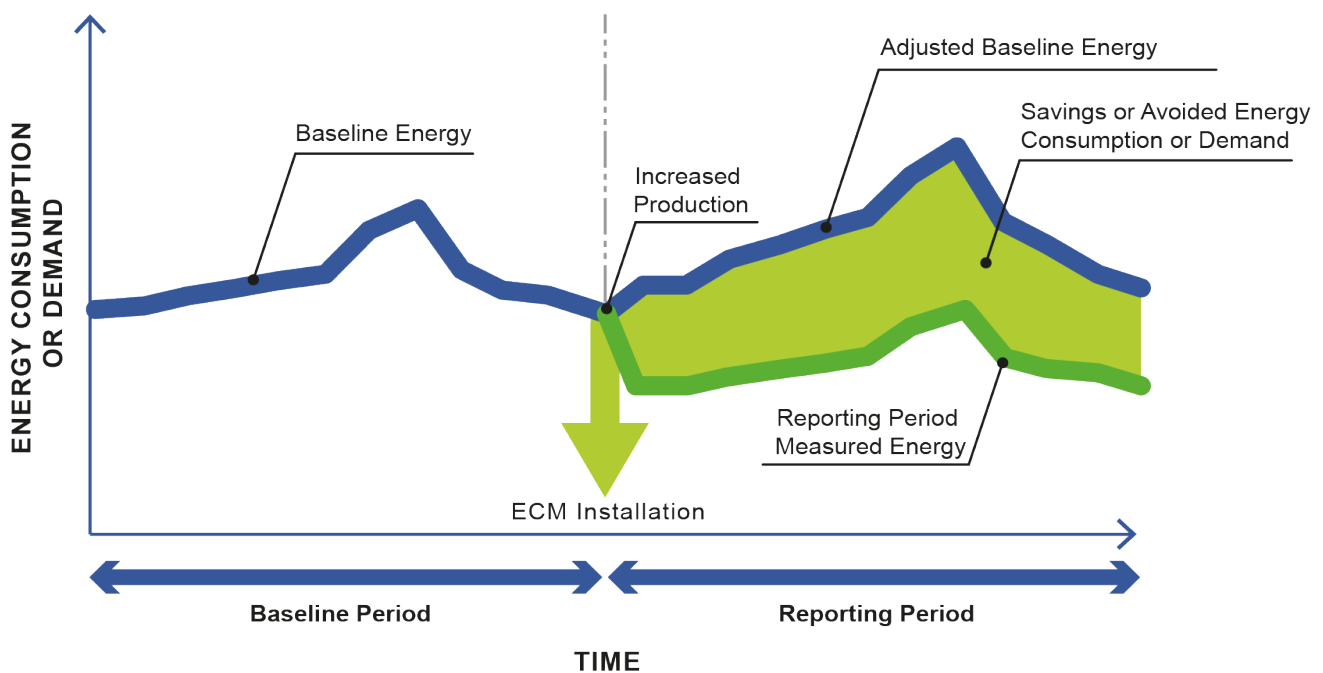


# IPMVP Explained

The adjustments IPMVP uses to calculate savings can be routine or non-routine:

**Routine Adjustments** – for any energy-governing factors, expected to change routinely during the reporting period, such as weather or production volume. A variety of techniques can be used to define the adjustment methodology. Techniques may be as simple as a constant value (no adjustment) or as complex as a several multiple parameter non-linear equations each correlating energy with one or more independent variables.

**Non-Routine Adjustments** – for those energy-governing factors which are not usually expected to change, such as: the facility size, the design, and operation of installed equipment, the number of weekly production shifts, or the type of occupants. These static factors must be monitored for change throughout the reporting period.



To quantify savings, IPMVP uses four options (A, B, C, D) pertaining to the needs of the M&V analysis and reporting. For facility level, option C or D is favorable. If only the isolated ECM retrofit needs to be analyzed, options A, B, or D are suitable. The 4 options explained are as follows:

- **Option A: Retrofit Isolation (Key Parameters)**

Savings are quantified by field measurement of only the key performance parameters which define the energy use of the systems affected by the retrofit. Parameters not selected are estimated.

- **Option B: Retrofit Isolation (All Parameters)**

Savings are quantified by the field measurement of the actual energy use of the systems affected by the retrofit.

- **Option C: Whole Facility**

Savings are quantified by measuring energy use at the whole facility or sub-facility over a given reporting period.

- **Option D: Calibrated Simulation**

Savings are determined through a simulation of the energy use of the whole facility or sub-facility. The simulation aims to demonstrate actual projected energy performance.





## ASHRAE Guideline 14 Explained

ASHRAE Guideline 14-2014 provides three different engineering approaches to M&V and savings determination. To ensure validity, reaching compliance with each approach requires that the overall uncertainty of the savings estimates is below the prescribed thresholds. The three approaches to determining savings use similar concepts in computing savings, but differ in how they measure energy use and demand quantities. The approaches are:

- **Retrofit Isolation Approach**

Measures the energy use and relevant independent variables of the individual systems and equipment actually affected by the retrofit. Baseline and post-installation measurements are required and for a specific duration that will illustrate the full range of impact.

- **Whole Facility Approach**

Uses the measured energy use of the building or an entire facility to determine savings. This approach requires the collection of utility meter or specific submetered data and independent variables such as weather.

- **Whole Building Calibrated Simulation Approach**

Involves the use of a computer simulation tool to create a model of energy use and demand of the building. This approach is typically used in pre-retrofit analysis and uses actual measurements of energy usage and demand to project post-retrofit conditions.

### When should you use M&V?

In the unlikely case that there is no need to prove results to another party, then M&V may not be necessary. However, the results of an ECM are normally required to at least be discussed, and more commonly need to be proven within an acceptable level of certainty. The larger and more costly the project, the more necessary M&V becomes.

### Where should you use M&V?

Anytime performance/savings are guaranteed by a contractor or technology, then M&V should be required. Here are some examples:

- Federal Energy Savings Performance Contracts – M&V is required on an annual basis
- Efficiency financing and shared savings arrangements – if a company is providing “no cost” upgrades and is paid a percentage of measured savings/cost avoidance, then there should be an agreed upon M&V plan that allocates risk appropriately
- Utility incentive money – when doling out taxpayer or ratepayer efficiency funds, M&V should be required to ensure the performance and achievement of reduction goals

### Why should you use M&V analysis?

Whether recommended or required, M&V processes provide benefits well beyond their costs, which are typically 2-5% of projected annual savings. Some benefits include:

- Allocating risks between the contractor and customer
- Accurately assessing energy savings and persistence of savings for a project
- Reducing uncertainties to reasonable levels
- Aiding in monitoring the performance of equipment
- Identifying additional savings
- Improving operations and maintenance (O&M)

### Wrap-up

The measurement and verification of efficiency projects is part science, part art, and is critical in determining the energy, water, and cost savings that result from the installation of ECMs. The actual implementation of an energy efficiency project is just the first step. An M&V process that is compliant with IPMVP and ASHRAE Guideline 14 provides reliability and reduces the struggle of reporting that often comes when implementing a project.

Even with the installation of sensors, advanced meters, and building control systems, the data provided is often in different (or unusable) formats and multivariate regression models are beyond the scope of most internal energy teams. eReveal's M&V service integrates all meter, weather, occupancy, or any other trackable independent variable to present easily accessible M&V performance via the cloud to all interested parties. We will handle the analytics so you can ensure that your energy efficiency projects are meeting their goals. And if they aren't, we will catch it early enough so adjustments can be made.

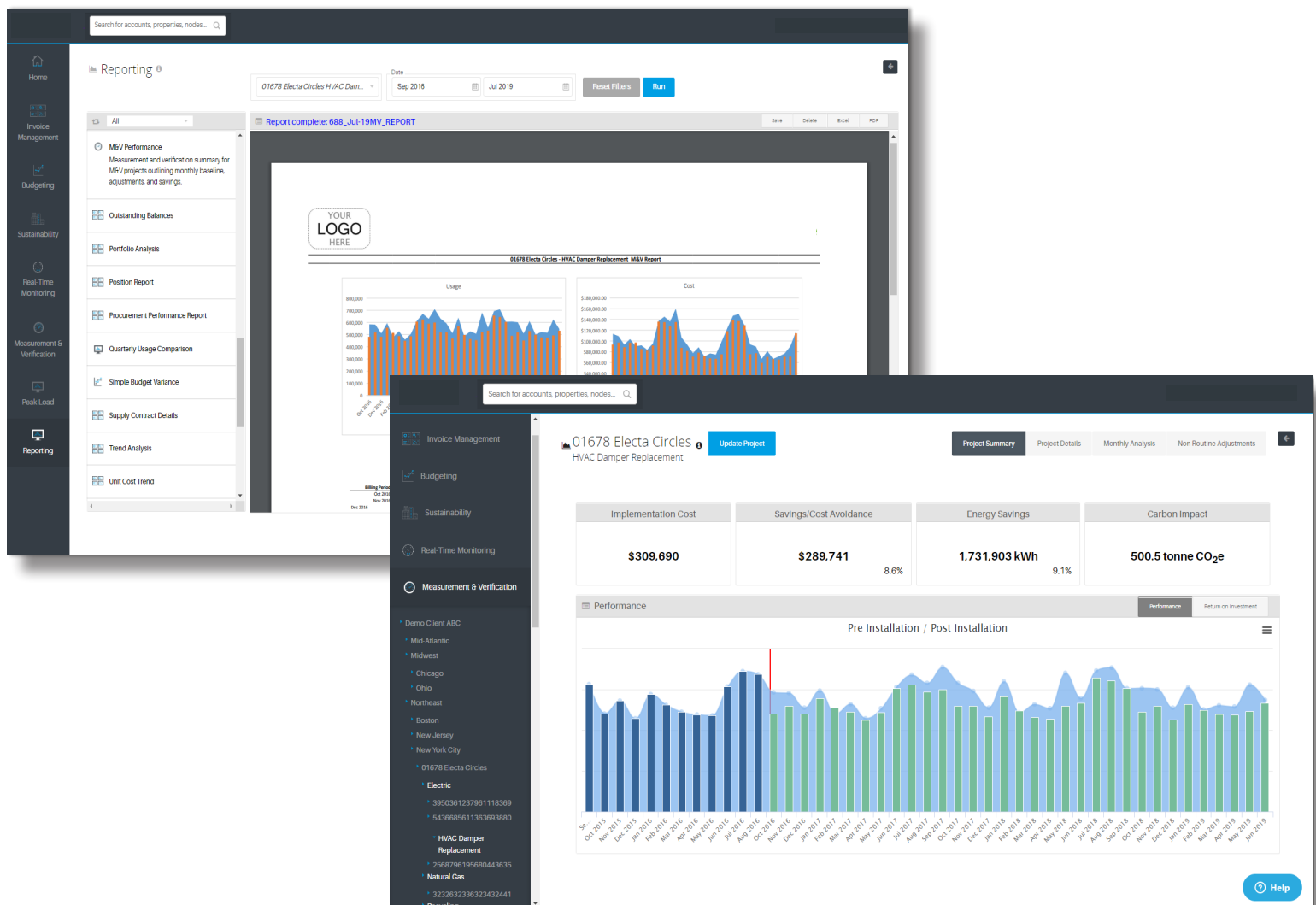
### How can eReveal help?

eReveal offers M&V services to its clients and partners through our platform, where meter readings and any necessary independent variable(s) data are integrated and analyzed to automate your M&V calculations and simplify your energy savings reporting.

# M&V Case Study

## No Cost Operational Strategy Adjustment Yields \$285,000 Net Savings Annually

What should you do when steam rates are increasing, electricity rates have decreased, and there's spare capacity on a supplemental electric chiller? One of our clients and one of the world's largest commercial real estate companies switched load from the steam absorber to the electric chiller. The platform measured and verified this operational change to support their decision. While electricity usage/demand increased, the net annual savings from the reduced steam consumption totaled more than \$285,000 and 2,200 tonnes CO<sub>2</sub>e.



## About Efficient Power Tech

Efficient Power Tech was formed in 2015 to provide all commercial and industrial businesses with the same high quality advanced energy technologies available to their mega-large competitors at affordable price points. Our products and services can make an immediate positive impact on a business's ability to control and manage how they buy and use energy. Measurement, Verification, Low Capex, Services (Design, integration, Procurement, Installation, Financing) all combine to give your facility the resources necessary to finally move the electric meter in your direction.

## Where Energy Technology Drives Better Business – Welcome To The Energy Future

To learn more, visit our website: [www.efficientpowertech.com](http://www.efficientpowertech.com)