



ENERGY SAVINGS PERFORMANCE AND MEASUREMENT & VERIFICATION

ONLINE TRAINING COURSE

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ENERGY SPECIALIST CURRICULUM





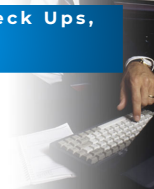
MEASUREMENT AND VERIFICATION FOR ENERGY PROFESSIONALS

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WHAT SHOULD YOU LEARN



Energy Savings Measurement & Verification

EVO IPMVP Guidelines and Measurement Methods

M&V Terminology, Check Ups, and Determining Best Approach for an ECM

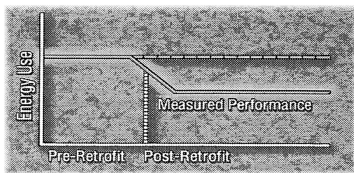
MEASUREMENT AND VERIFICATION

- ✓ Definition
- ✓ Established Guidelines
- ✓ Approach Options Audit & Reconciliation
- ✓ Value



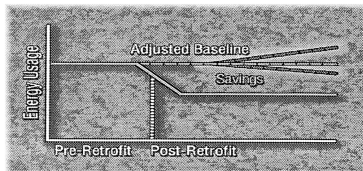
M&V DEFINITION

... the process of measuring and verifying energy consumption, energy demand (if needed) and energy cost savings produced as a result of the implementation of an energy conservation measure ...



M&V DEFINITION

$\text{Savings} = \text{Baseline} - \text{Post Retrofit Energy Use}$
... what would have been (if not for the retrofit) ...



M&V DEFINITION

- ☑ Weather normalization – typically based on CDD and HDD - is common and is usually needed
- ☑ We also typically normalize for size of our facilities using square metres of space
- ☑ Other uses of normalization can be to:
 - ➔ Handle missing data
 - ➔ Handle changing occupancy
 - ➔ Handle changing operating hours



WHAT IS MEASUREMENT AND VERIFICATION AND WHY IS IT IMPORTANT?

Measurements are useful when they provide accurate feedback of a result. In the case of energy savings improvements where a capital outlay has been made, there is usually an expectation of a return on that investment.

Verification is the goal, and measurement is really just the means to the end. Did the savings come to pass? Better or worse than expected? Are the savings persistent this year like last year? For the business side of energy savings, the need for such verification is obvious.

Measurement and Verification is the glue that holds together contracts based on guaranteed savings, because it is the basis of who pays who. In support of the guaranteed savings contract industry, standards of protocol (how to do business) have been developed for M&V.



WHAT IS MEASUREMENT AND VERIFICATION AND WHY IS IT IMPORTANT?

The experience of thousands of projects and input from businesses on both sides of the guarantee pledge has contributed to these standards. The M&V standard most often used today:

- ☑ International Performance Measurement and Verification Protocol (IPMVP)
- ☑ American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE®) Guideline 14. Note: the ASHRAE Standard 14 is intended as the technical document for the IPMVP.

One reality check for the M&V process is the cost of doing it. If, for example, the M&V purpose is to verify that the cost of the project was warranted by the achieved savings, adding cost to the project through M&V makes the economic payback worse even if the savings turn out to be exactly as predicted. This makes M&V a 'necessary evil' that should be used wisely and sparingly.



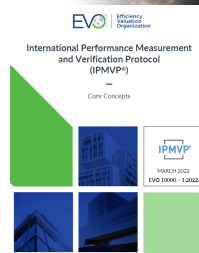
ESTABLISHED GUIDELINES

- ✓ IPMVP
- ✓ ASHRAE Guidelines



IPMVP

- ✓ Approach to measuring and verifying efficiency investments to facilitate a scaled-up global engagement into energy efficiency.
- ✓ The purpose of the IPMVP is to reduce barriers to the energy and water efficiency industries.
- ✓ The IPMVP is owned and maintained by Efficiency Valuation Organization (EVO®) is a non-profit organization whose products and services help people engineer and invest in energy efficiency projects.



ASHRAE GUIDELINES

- ✓ ASHRAE, founded in 1894, is a global society advancing human well-being through sustainable technology for the built environment.
- ✓ ASHRAE was formed as the American Society of Heating, Refrigerating and Air-Conditioning Engineers by the merger in 1959 of American Society of Heating and Air-Conditioning Engineers (ASHAE) founded in 1894 and The American Society of Refrigerating Engineers (ASRE) founded in 1904.

APPROACH OPTIONS

- ✓ **A: Spot Measurement**
- ✓ **B: Continuous Measurement**
- ✓ **C: Utility Bill Comparison**
- ✓ **D: Simulation**



A: SPOT MEASUREMENT

- ✓ **Applicable ECMs:**
 - ➔ Constant Load (i.e. lighting, electric motor replacements)
- ✓ **Well Suited for:**
 - ➔ Small Projects (M&V cost hard to justify)
 - ➔ Fast Track Projects
 - ➔ Installation Verification is Most Important
 - ➔ Owner Willing to Assume Savings Risk



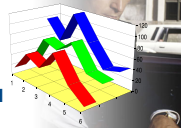
B: CONTINUOUS MEASUREMENT

- ✓ **Applicable ECMs:**
 - ➔ Variable Load (i.e. HVAC, controls)
 - ➔ Device/System can be Isolated
 - ➔ Few Measurement Points Needed (i.e. chiller, boiler)
- ✓ **Well Suited for:**
 - ➔ Large Projects (can absorb M&V cost)
 - ➔ Time Available for Baseline Measurement
 - ➔ Owner Not Willing to Assume Savings Risk



C:UTILITY BILL COMPARISON

- ✓ Applicable ECMs:
 - ➔ Any/All Within a Metered Building or Group
- ✓ Well Suited for:
 - ➔ Projects with No Available Metered Data
 - ➔ Large Projects (can absorb simulation cost)
 - ➔ Aggregation of Various ECMs Within a Metered Building or Group
 - ➔ Somewhat Fast Track Projects Projects with Anticipated Future Baseline Adjustments
 - ➔ New Construction
 - ➔ Owner Willing to Assume Savings Risk



D:CALIBRATED SIMULATION

- ✓ Applicable ECMs:
 - ➔ Any/All
- ✓ Well Suited for:
 - ➔ Projects Where Savings are Projected to be > 10-20% of Baseline
 - ➔ Aggregation of Various ECMs Within a Metered Building or Group
 - ➔ Fast Track Projects
 - ➔ Owner Not Willing to Assume Savings Risk



PERIODIC AUDIT & RECONCILIATION

- ✓ Verification Intervals
 - ➔ Single Post-Installation Verification
 - ➔ Regular Interval Verification
- ✓ Baseline Adjustments
 - ➔ Can "Re-Open"
 - ➔ Scenarios
 - When a change occurs
 - At least annually
- ➔ Negotiation



VALUE

M&V Cost Affects Project Economics

How Much M&V is Worthwhile?

Cost

Accuracy



COST

M&V Approach	Typical Costs (% of ECM Cost)
Option A, Spot Measurement: <small>Key performance factors (e.g., lighting wattage or chiller efficiency) are determined with spot or short-term measurements. Operational factors (e.g., lighting operating hours or cooling ton-hours) are stipulated. Performance is verified annually.</small>	1 - 5% <small>Primarily dependent on quantity of measurement points.</small>
Option B, Continuous Measurement: <small>Savings are determined by continuous measurements taken throughout the term of the contract at the device or system level. Performance and operations factors are monitored.</small>	3 - 10% <small>Primarily dependent on qty. & type of system(s) measured, and the duration of metering & analysis.</small>
Option C, Utility Bill Comparison: <small>Savings are determined at the "whole-building" or facility level using current year and historical utility meter or sub-meter data.</small>	1 - 10% <small>Primarily dependent on qty. & complexity of parameters in analysis.</small>
Option D, Calibrated Simulation: <small>Savings are determined through simulation of facility components and/or the whole facility.</small>	3 - 10% <small>Primarily dependent on qty. & complexity of systems being evaluated.</small>



BEYOND

SMART CITIES

THANK YOU



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