Introduction to Energy Measurement & Verification (M&V)

Association of Energy Engineers

NC Piedmont Chapter Meeting

August 20, 2013

Introductions

- Affinity Automation – Power and Energy Management Systems Integrator.
- Member of AEE since 1999.
- Energy Management Diploma, NC State University, 2011.
- CMVP, 2012.

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Agenda

- Define M&V
- M&V Plan
- IPMVP and M&V Options
- Cost & Level of M & V
- Process & Benefits
- Q&A

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What is M & V?

Measurement and Verification (M&V) is a **process** of using **measurement calculation** and/or **modeling** to **reliably** determine **actual** energy/utility **savings** achieved within a facility by an energy management, energy conservation or energy efficiency project or program.[1]

What is a M&V Plan?

A M&V plan provides the basis for documenting performance in a transparent manner that can be subject to independent, third party verification. A good M&V plan balances the savings uncertainty associated with energy improvement projects against the cost to execute the plan.[2]

M&V Plan Elements

Project Level Components
- Project Description and M&V Overview
- Project Savings and Costs from contract
- Schedule
- Reports to be Prepared
- Risk and Responsibility Matrix

ECM Specific M&V Components
- Measure Description
- Objectives
- Parameters to be Monitored
- Sampling Plan
- Data Collection Plan
- Pre-Installation Energy and Performance Baseline
- Post-Installation Facility Conditions
- Determination of Energy Savings
- Plan for Future Measurements
- Plan for Resolving Disputes

The project specific M&V plan is developed during contract negotiations. The M&V plan is the single most important item in an energy savings "guarantee."[3]

Standard Measurement and Verification Plan for Lighting Retrofit Projects for Buildings and Building Sites

SAMPLE LIGHTING RETROFIT M&V PLAN

M & V Guidelines

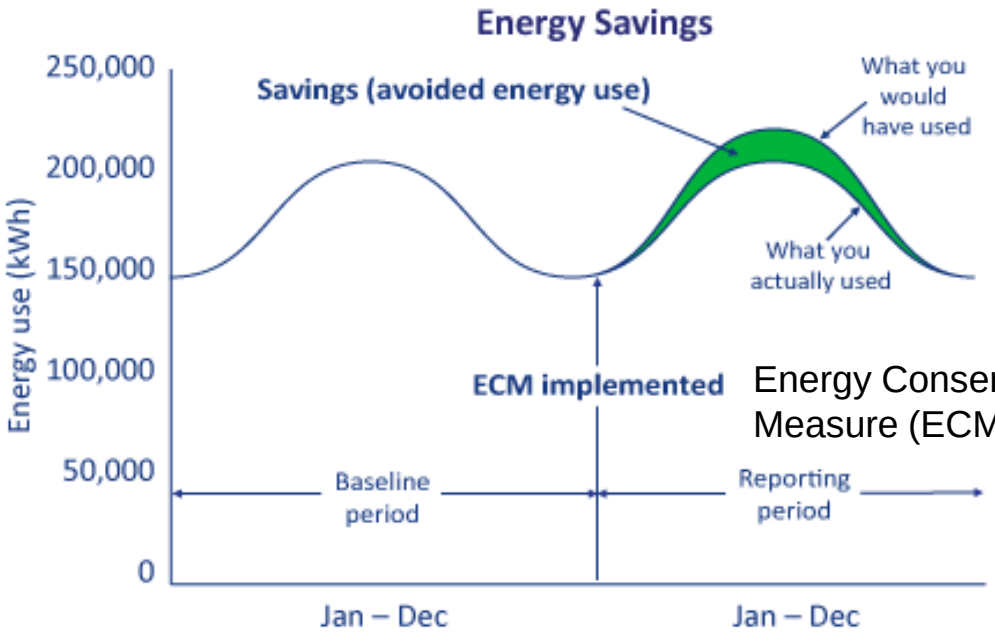
Guideline	Organization
International Performance Measurement and Verification Protocol (IPMVP)	EVO World http://www.evo-world.org/
FEMP M&V Guidelines Version 3.0	US DOE http://www1.eere.energy.gov/femp/financing/superespcs_measguide.html
ASHRAE Guideline 14 – 2002	ASHRAE http://www.ashrae.org
CCC– Guidelines for Verifying Existing Building Commissioning Project Savings	California Commissioning Collaborative http://resources.cacx.org/

4

International Performance Measurement and Verification Protocol (IPMVP)

The IPMVP provides an overview of current best practice techniques available for verifying results of energy efficiency, water efficiency, and renewable energy projects in commercial and industrial facilities.[5] It is published by the Efficiency Valuation Organization (EVO).

Let's Talk About Savings



Energy Conservation Measure (ECM)

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Calculation of Savings

Savings = (Baseline Energy – Reporting-Period Energy) ± Routine Adjustments ± Non-Routine Adjustments[5].

The IPMVP provides four different **Options** for measuring and verifying savings. All four options use the above fundamental formula.

IPMVP Options

IPMVP Option	Description
Option A – Retrofit Isolation Key Parameter Measurement	Field measurements of key performance parameters
Option B – Retrofit Isolation All Parameter Measurement	Field measurement of energy use or proxies
Option C – Whole Facility	Analysis of utility meter data
Option D – Calibrated Simulation	Simulation of whole building energy use, calibrated to measured energy data

5

Energy Efficiency Measures

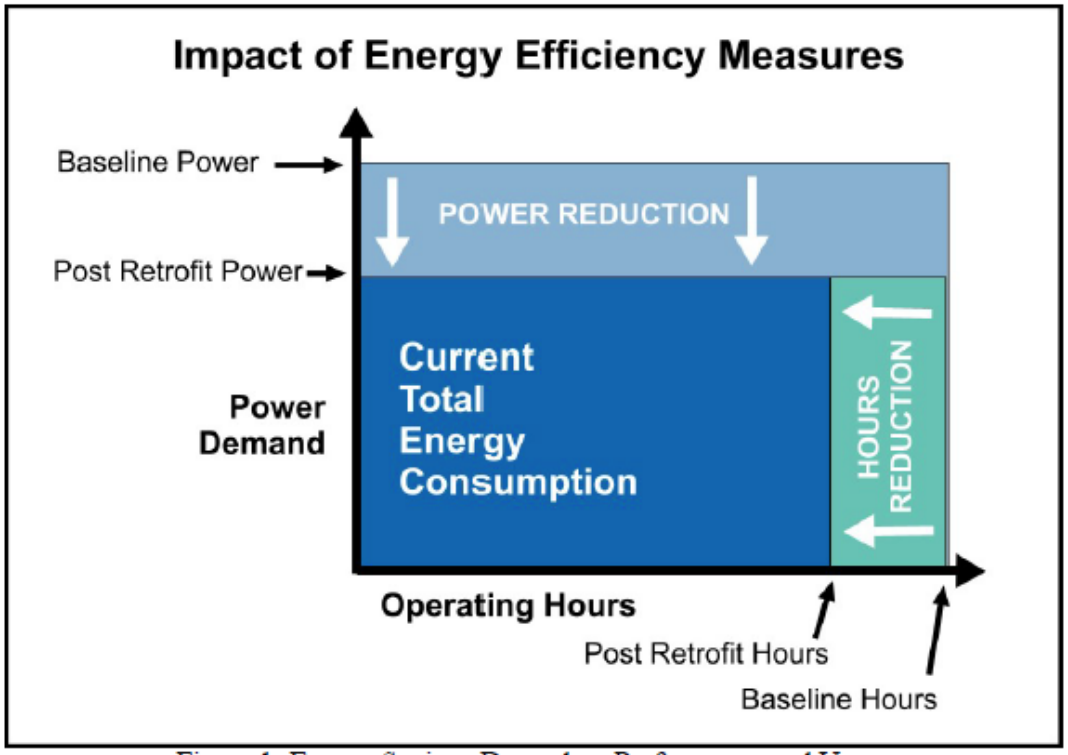


Figure 1: Energy Savings Depend on Performance and Usage

3

IPMVP Options A & B

Often referred to as “Isolation Retrofit Approach”

Options A and B focus on the performance of specific ECM’s such as items of equipment and installed retrofits that can be measured in isolation from the rest of the building. Before and after measurements are taken and compared to determine the savings. A lighting retrofit is a good example for Option A. Installation of variable speed drives is a good example for Option B[3].

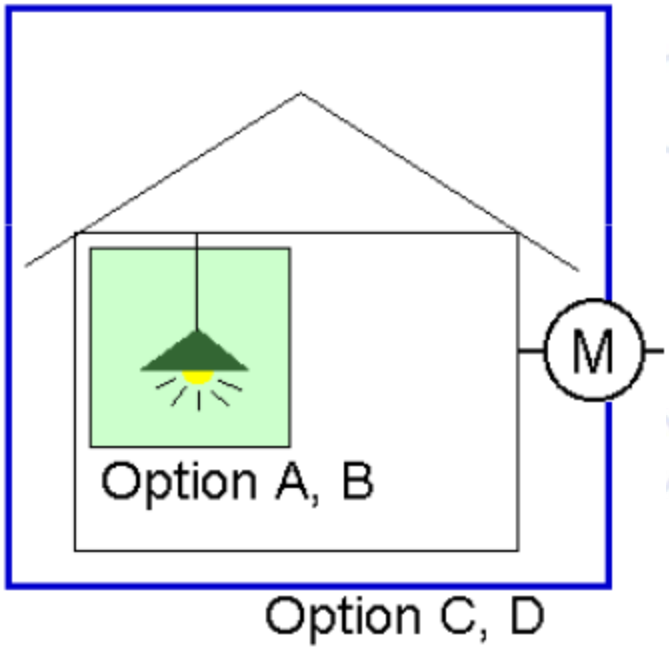
IPMVP Options C & D

Often Referred to as "Whole Building Approach"

These options are used when the nature of the ECM is not easily measured in isolation from the rest of the building operations. This could be typical of operational and control changes that affect many areas of the building.

- The Option C approach assesses savings at the whole-facility level by analyzing utility bills before and after the implementation of the ECM's.
- Option D uses computer simulations and modeling of the whole facility, usually when base year energy data is not available or reliable.
- Installation of energy management control systems (EMS) and training/awareness programs are good examples for Option C^3.

Retrofit Isolation Vs. Whole Facility



Options A and B are retrofit isolation methods
Options C and D are whole facility methods
The difference is where the measurement boundary is drawn[4]

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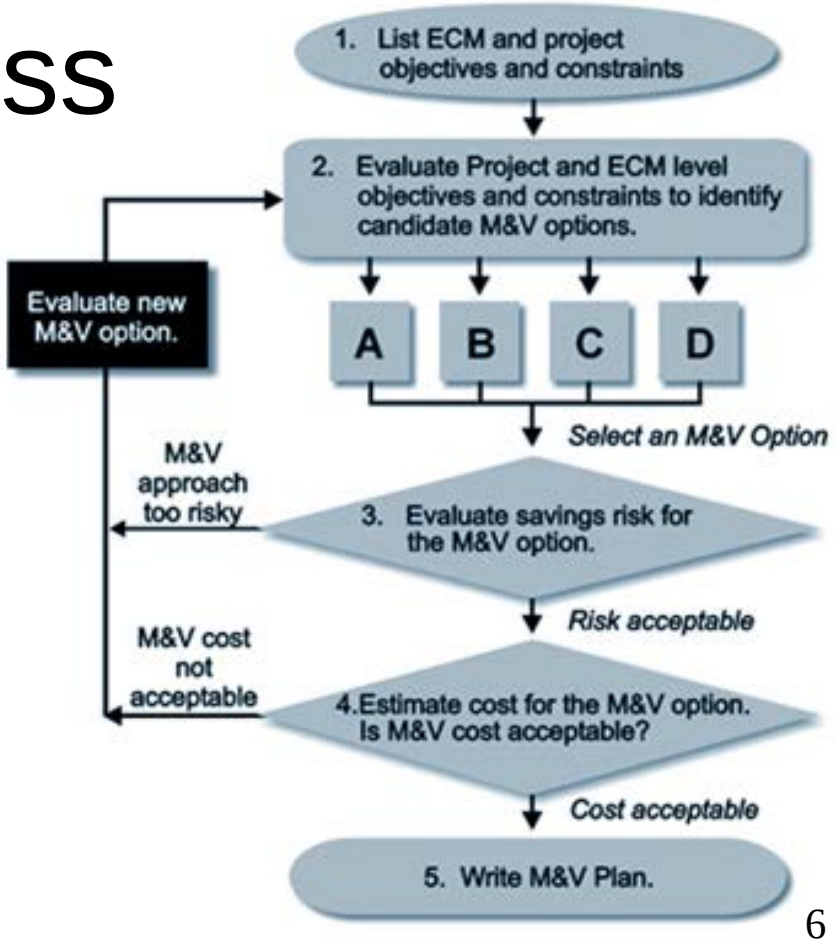
Energy Modeling Software

http://apps1.eere.energy.gov/buildings/tools_directory/alpha_list.cfm

M & V Process



6

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The M & V Process

Regardless of the M&V strategy used, similar steps are taken to verify the potential for the installed energy conservation measures (ECMs) to generate savings. Verifying the potential to generate savings can also be stated as confirming that:

Step 1: The baseline conditions were accurately defined,
Step 2: A suitable project specific M&V plan was developed,
Step 3: Proper equipment/systems were installed and are performing to specification, and
Step 4: The equipment/systems continue to have the potential to generate the predicted savings[3].

Cost of M&V

IPMVP guides that typically M&V costs are less than 10% of total project costs but the costs of the various Options will vary with Options A and C being less costly than Options B and D[1].

Factors That Influence The Level of M&V

- Value of projected savings
- Complexity of efficiency upgrades
- Total amount of equipment
- Number of interactive effects among resource consuming systems
- Level of uncertainty of savings
- Risk allocation for achieved savings between the client and the implementing Company
- Other valuable uses of M&V data (e.g. optimizing O&M, selling carbon credits)
- Availability and capability of an energy management system[1]

Benefits of M & V

Facility owners or energy efficiency project investors can use M&V techniques to mitigate the various risks that can arise after project completion. Energy efficiency practitioners are using M&V for the following purposes:

- Improve engineering design and project costing
- Increase energy savings through proactive adjustments in facility operations and maintenance
- Document financial transactions
- Enhance financing for efficiency projects
- Manage energy budgets
- Enhance the value of emission-reduction credits
- Support evaluation and development of broader efficiency programs
- Increase public and marketplace understanding of energy management as a public
- policy tool[1]

References

[1]Measurement and Verification (M&V) Primer, Merv Chapman, MCCONSULTANTS (UK) LTD, On behalf of the London Better Buildings Partnership.

[2]Lawrence Berkley National Laboratory, Measurement & Verification Portal, http://mnv.lbl.gov/keyMnVDocs/mnvplan.

[3]EPC Watch, Guide, Measurement & Verification of Energy Efficiency Projects, January 2007.

[4]Measurement and Verification Using Energy Simulations: IPMVP and LEED, Lia Webster, PECI, May 2011.

[5]International Performance Measurement & Verification Protocol (IPMVP), Volume I, 2007

[6]US Department of Energy, Energy Efficiency & Renewable Energy – Federal Energy Management Program web site.

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Austin, TX / November 20-22, 2013
Crowne Plaza Austin: (877) 270-1393

Orlando, FL / December 9-11, 2013
The Florida Hotel: (407) 859-1500

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