

LEED Measurement & Verification

Credit EA 5

NoCo USGBC
Green N Grub

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Overview

- What Is Measurement and Verification?
 - IPMVP
 - ASHRAE Guideline 14
- LEED-NC 2009 and M&V
 - Two Options
- Why Measure and Verify?
 - Some Lessons Learned
- What Is Measured?
- General Costs and Tradeoffs

What Is Measurement and Verification?

- Specifically relates to the energy systems in a building
- Measure the electricity usage, gas usage, and/or water usage

What Is Measurement and Verification?

- International Performance Measurement and Verification Protocol (IPMVP)
 - Volume III, 2003
 - Defines baseline, processes, and methods
- ASHRAE Guideline 14
 - Referenced in IPMVP
 - Statistical issues and instrumentation

What is Measurement and Verification?

- A. Partially Measured Retrofit Isolation
 - Lighting retrofit with spot measurement of kW
- B. Retrofit Isolation (ECM)
 - Variable speed drive with kW measurement through building automation system (BAS)
- C. Whole Facility
 - Facility utility bill comparison
- D. Calibrated Simulation

What is Measurement and Verification?

- Energy model baseline defined
 - Usually part of project through EAc1
 - ASHRAE 90.1 Appendix G, California Title 24
- Calibrate baseline model
 - Use first year utility data, metering information
 - Adjust for:
 - Weather variations
 - Occupancy variations
 - Occupant behavior variations

What is Measurement and Verification?

- *“Most suited to buildings with numerous ECMs that are highly interactive or where the building design is integrated and holistic, rendering isolation and M&V of individual ECMs impractical or inappropriate.” (IPMVP 2003)*

LEED-NC 2009 and M&V

- Intent:
 - “To provide for the ongoing accountability of building energy consumption over time.”
- Requirements:
 - Option 1 – Whole Building
 - Calibrated Simulation
 - Option 2 – Selected ECMs
 - Retrofit Isolation

Why measure and verify?

One can't manage that which one doesn't measure.

Why measure and verify?

- *Increase energy savings*
- Operations and Maintenance troubleshooting
- Performance contracting
- Encourage better project engineering
- Help demonstrate and capture the value of reduced emissions from energy efficiency and renewable energy investments
- Help national and industry organizations promote and achieve resource efficiency and environmental objectives
- Incentive-based design fee structures
- *Documentation of the performance of new buildings*

Why measure and verify?

- Some lessons learned
 - Study by the New Buildings Institute, Cathy Turner and Mark Frankel, 2008
 - Commissioned by USGBC
 - Surveyed all 552 LEED-NC v2.x buildings certified through 2006
 - Requested 12 months of measured post-occupancy energy usage data to participate
 - Only 121 were able to provide this data (22%)

Why measure and verify?

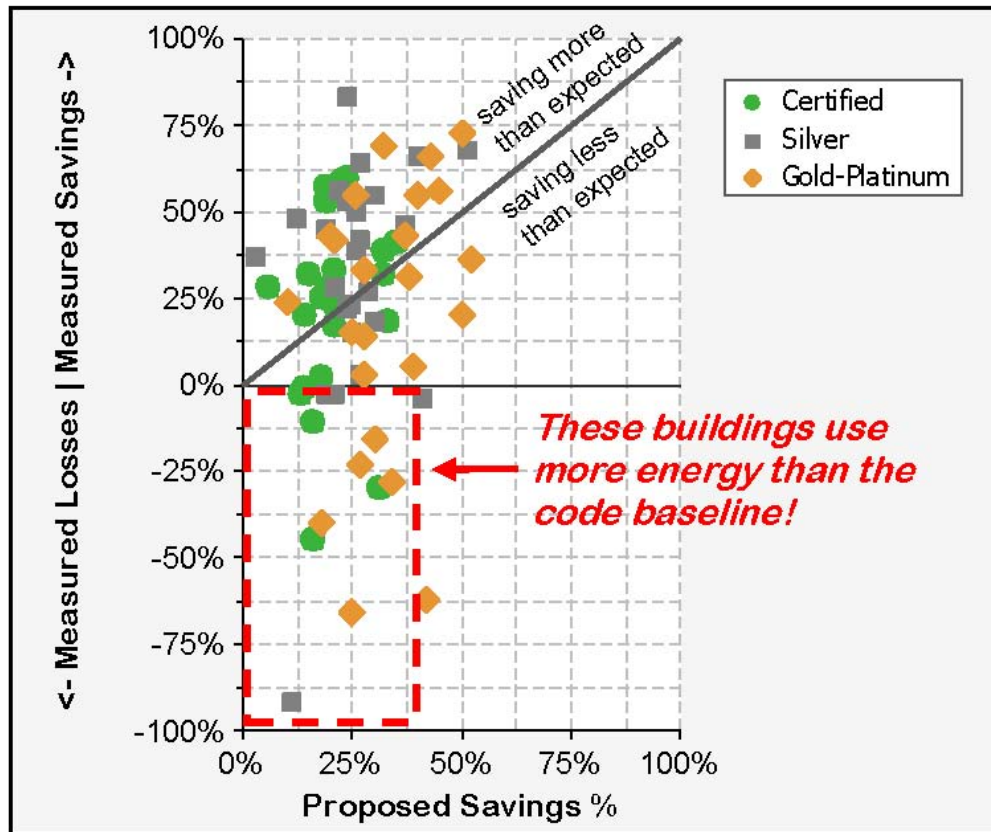


Figure ES- 5: Measured versus Proposed Savings Percentages

Why measure and verify?

- Seven Generations Office Park
 - LEED Platinum Core and Shell
 - LEED Gold tenant

What is measured?

- Electricity
 - Main incoming service
 - Lighting systems
 - HVAC motors, central plant equipment
 - Process/receptacle feeders



What is measured?

- Natural Gas
 - Main gas supply
 - Boiler gas supply
 - Domestic water heater
 - Gas-fired air heaters
 - Gas-fired radiant heaters
 - Lab benches gas supply



What is measured?

- Water
 - Main water supply
 - Irrigation water supply
 - Potable water supply
 - Process water supply
 - Make-up water supplies to systems



What is measured?

- Strategically placed meters, combined with extensive controls monitoring points, provide the data required to verify system and building performance
 - Premier California hotel resort included 50 unique monitoring items with hundreds of control data points, and several individual energy meters

What is measured?

- LEED requires corrective action plans to remedy failing systems or equipment usage
 - Occupant overrides
 - Controls failures
 - Valve leaks
 - Disabled economizer cycles
 - Miscalibrated sensors

General costs and tradeoffs

- Design team/engineering services fees
 - M&V period typically extends well beyond the standard duration of professional design services contracts
 - More complex systems and buildings may require more design team calibration, analysis, and “tweaking” time
 - Simpler buildings may require more design team time due to less robust BMS data, metering

General costs and tradeoffs

- BMS system
 - Smaller buildings may not otherwise have included this level of controls and monitoring
 - More complex or larger buildings generally will have a BMS, so incremental cost of some added control points

General costs and tradeoffs

- Metering
 - Smaller buildings may not have otherwise included separate lighting, mechanical, and process/receptacle panels for individual metering
 - Most buildings may not have included sub-meters for natural gas and water to individual equipment

General costs and tradeoffs

- Benefits
 - Buildings are v1.0
 - Initial year of post-occupancy tuning
 - Potentially small investment to ensure designed energy savings are realized
 - More data supports initial building commissioning, as well as future recommissioning
 - Document compliance with energy codes

General costs and tradeoffs

- Rule of thumb: 4-10% of the typical project cost savings based on IPMVP Option B
 - Walker, et al 1999
- Cost for the meters can add \$2-\$4 per square foot
- Cost for the studies can range from \$50,000 to \$200,000
 - Morris and Matthiessen 2008

References and Acknowledgements

- USGBC LEED 2009
- IPMVP Volume III, 2003
- “Energy Performance of LEED for New Construction Buildings” Turner and Frankel, 2008
- “Energy and Atmosphere EA Credit 5” Presentation by Geoff McDonnell, Omicron, 2007
- “Measurement & Verification: Resource Accountability and Performance Verification in Sustainable Buildings” Stoker & Twohig, Enermodal Engineering, 2009
- “Measurement & Verification: Turning Proposed Savings Into Real Performance” Morrison & Kaufman, Ambient Energy, 2009
- Seven Generations Office Park and Big Grins Dental

Closing Summary

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- *Questions? Comments?*

Thank you!



Brian G. Robertson II, PE, LEED AP