





Measurement and Verification In Energy Savings Performance Contracts

Jim Smith

Applied Energy Management



GovEnergy
www.govenergy.gov



Benefits of Proper M&V

- Accurately assess energy savings for a project
- Allocate risks to the appropriate parties
- Reduce uncertainties to reasonable levels
- Monitor equipment performance
- Find additional savings
- Improve operations and maintenance (O&M)
- Verify cost savings guarantee is met
- Allow for future adjustments



Savings Verification Steps

- Verify the baseline conditions
- Develop Project Specific M & V Plan
- Verify proper equipment/systems were installed and are performing to spec
- Verify equipment/systems continue to have the potential to achieve predicted savings



Risk & Responsibility Matrix

- Required part of ESPC process
- Prepared by ESCO, approved by Customer
- Determines which party assumes which risks and responsibilities for parts of the project
- ESCO responsible for areas it controls: quality of equipment and installation and performance of equipment installed
- Customer responsible for parameters it controls: operating hours, occupancy, operating conditions
- Parameters not controlled by either (weather, utility rates) usually stipulated by agreement
- Drives selection of specific M&V options



Categories Covered in the Risk & Responsibility Matrix

1. Financial	2. Operational	3. Performance
a. Interest Rates	a. Operating Hours	a. Equipment Performance
b. Energy Prices	b. Load	b. Operations
c. Construction Costs	c. Weather	c. Maintenance & Repair
d. M&V Costs	d. User Participation	d. Equipment Replacement
e. Delays		
f. Major Changes to Facility		



M&V Plan Options (FEMP)

- Option A: Based on measured equipment performance, measured or stipulated operational factors, and annual verification of “potential to perform”
- Option B: Based on periodic or continuous measurements taken throughout the term of the contract at device or system level
- Option C: Based on whole building or facility level utility metering or sub metering adjusted for weather and/or other factors
- Option D: Based on computer simulation of building or process, calibrated with measured data



Option A Features

- Usually simplest, least cost option
- Appropriate where risk or uncertainty of performance is low
- Uses standard tables of values, such as lighting fixture wattages, motor efficiencies
- Savings established by engineering calcs
- Annual verification that equipment is in place, operable, capable of performance



Option A Examples

- Lighting retrofit/replacement
- Motor replacement
- Rate changes
- Operations & Maintenance changes



Option B Features

- More effort and cost than Option A
- Appropriate where uncertainty or risk is high, or where performance is variable
- Some parameters are measured continuously or periodically
- Specific to end-use device or system
- Savings established by engineering calcs using measured data



Option B Examples

- Boilers and boiler plants
- Chillers and chiller plants
- Variable speed drives on fans and pumps
- Energy Management and Control Systems
- Industrial processes



Option C Features

- Looks at whole building or facility, not individual devices or processes
- Can adjust for weather, occupancy
- Best used for multiple, interactive ECMs with significant (20%+) savings
- Savings established by analysis of utility bills, and/or building meter data – adjusted for weather, occupancy, facility changes



Option C Examples

- Facilities with constant usage and good historical data
- Multiple interactive measures, such as HVAC optimization with free cooling, chilled water reset, hot water reset, CO2 controlled ventilation, VAV conversion, etc.
- Weather dependent projects



Option D Features

- Uses computer model of building, calibrated by utility bills
- Typically weather is stipulated, using historical (TMY) data in model
- Labor intensive to set up and calibrate
- Flexible, handles multiple ECMs
- Savings is difference between model runs of baseline vs. runs with one or more ECMs implemented
- Verify ability to perform with annual inspections



Option D Examples

- Building envelope measures: insulation, shading, door, window, roof replacement
- New construction
- Energy management & control systems
- Major renovations: lighting, boiler, chiller, HVAC and controls



Option D Modeling Software

- eQuest, DOE-2, PowerDOE - <http://www.doe2.com/>
- Visual DOE - <http://www.archenergy.com/products/visualdoe//>
- Trace 700, SystemAnalyzer - <http://www.trane.com/Commercial/Dna/View.aspx?i=899>
- EnergyPlus - <http://gundog.lbl.gov>
- Market Manager - <http://www.optimumenergy.com/>



Summary of M&V Options

- A & B are *retrofit isolation* methods – for single individual ECMs. Relatively simple, low cost.
- C&D are *whole building* methods – for multiple interactive ECMs, projects making major changes and generating large % savings, or new construction



Commissioning and Post-Verification

- Post-implementation report required
- Documents any changes in installed versus planned project
- Includes commissioning results and result of any pre- and post-implementation measurements
- Validates construction-period savings (if any)
- Provides estimate of first year savings



Performance Period

- ESCO collects and records data as required
- O&M performed and documented by responsible party (may be ESCO or Customer as determined by Risk & Responsibility Matrix)
- Annual inspection and performance measurements (if required by M&V Plan) of installed equipment (typically by ESCO, witnessed by Customer)
- Annual Report prepared by ESCO, approved by Customer



Useful Links

- M&V Guidelines from FEMP – “the Bible” -
<http://ateam.lbl.gov/mv/docs/26265.pdf>
- SuperESPC info
<http://www1.eere.energy.gov/femp/financing/superespcs.html>
- M&V documents and resources
<http://ateam.lbl.gov/mv/>



Questions

- **Jim Smith**
- **Applied Energy Managementg**
- **jsmith@appliedenergy.com**
- **704-516-4355**

Don't forget to fill out and drop off your session evaluations

