Helping Massachusetts Municipalities Create a Cleaner Energy Future

COMMONWEALTH OF MASSACHUSETTS

Charles Baker, Governor
Matthew Beaton, Secretary
Judith Judson, Commissioner

Energy Management Services

Energy Saving Performance Contracting

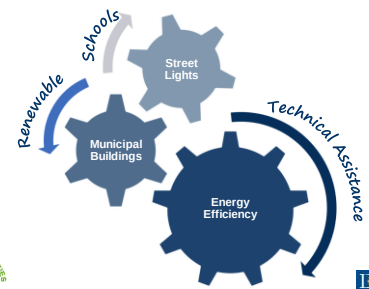
Measuring and Verifying Energy Savings

Green Communities Division Webinar

September 7, 2016

Green Communities Division

The energy hub for ***all*** Massachusetts cities and towns, not just designated "Green Communities."



Outreach - Regional Coordinators

- Regional Coordinators act as direct liaisons with cities and towns on energy efficiency and renewable energy activities
- Located at each of the DEP Regional Offices:

WERO – SPRINGFIELD: Jim Barry
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NERO – WILMINGTON: Joanne Bissetta
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Green Communities Division - Programs & Resources for Municipalities

- Green Communities Designation and Grant Program
- MassEnergyInsight energy tracking and analysis tool
- Municipal Energy Efficiency Assistance
- Energy Management Services Procurement Oversight
- Mass Municipal Energy Group (MMEG)
- Website filled with tools & resources: www.mass.gov/energy/greencommunities

Email updates via e-blasts – Sign up by sending an email to:
join-ene-greencommunities@listserv.state.ma.us

Recording & Presentation

- The webinar is being recorded and will be available on our website in approximately 48 hours at: http://www.mass.gov/eea/energy-utilities-clean-tech/webinars.html
- Click on the camera icon top right of your screen to save any slides for future reference
- Use the Q & A icon on your screen to type in questions
- The slide presentation will also be posted at: http://www.mass.gov/eea/energy-utilities-clean-tech/webinars.html

Presenters

Eileen McHugh
Senior Program Coordinator
Department of Energy Resources

Bob Slattery
Program Manager
Energy and Transportation Sciences Division
Oak Ridge National Laboratory

Question #1

Who in the audience? Are you:

A. in some stage of a performance contract
B. considering a performance contract
C. just interested in learning about M&V
D. none of the above

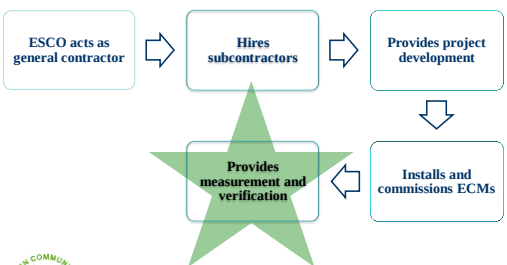
EMS Overview

Eileen McHugh
Senior Program Coordinator

Energy Management Services (EMS)

- Energy Saving Performance Contracting (ESPC)
- Install energy efficient and/or renewable facility improvements
- Provides ***guaranteed energy cost savings*** or ***guaranteed onsite energy generation***

ESCO Services



Guaranteed Energy Cost Savings

- Guarantee - ESCO must warrant annual guaranteed energy cost savings for the term of the contract
- Shortfall – ESCO must reimburse owner
- Excess savings – Excess savings remain the property of the owner. ESCO prohibited from "banking" to cover future or past shortfalls

Requirements

- Must Use Most Recent Version of FEMP M&V Guideline
- Measurement and Verification for the Full Term of Contract
- ESCO Report M&V at least Annually
- DOER Annual Report

DOER Resources

- EMS Web Page
- Model Documents
- In-house Expertise
- Regional Coordinators
- Education and Presentations

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(Supporting U.S. Dept. of Energy)

Measurement & Verification (M&V)

What you don't measure, you can't manage.

M&V is a Factor Throughout the ESPC Process

- Acquisition Planning
- Preliminary Needs Assessment
- Request for Proposal or Request for Qualification
- Evaluation of Respondents
- ESCO Selection
- Investment-Grade Audit
- Negotiations and Acceptance of Final Audit Report
- Final Design and Construction
- Project Acceptance
- Post-Acceptance Performance Period

What is M&V, and why do you need it?

- M&V refers to any activities aimed at determining whether the savings guarantee is being met
  - The guarantee and annual M&V are legally and contractually required
- M&V is needed to ensure that the guaranteed savings are delivered
- When M&V is done well, it will:
  - Reduce uncertainty of the savings estimates to a reasonable level
  - Allocate risks appropriately
  - Manage risk
  - Potentially identify operations & maintenance issues

Basic M&V Concepts

- M&V methods should balance savings assurance against added cost
- The degree of M&V should be proportional to
  1) the ECM's savings; and
  2) the ECM's performance risk
- Good M&V plans require ESCOs to measure the key performance parameters of ECMs
- If the M&V plan is weak, the guarantee may be met only on paper

M&V in the ESPC Process

Baselines	• Defined in IGA and Proposal
M&V Plan	• Developed as part of Proposal
Post-Installation M&V Report	• Verification of ECMs' ability to perform
Annual M&V	• Activities per M&V Plan • Findings documented in M&V reports

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Baselines

- Typically proposed for each ECM by ESCO as part of investment-grade audit; customer reviews/approves
- Baselines are compared to post-installation energy use to determine savings
- Once project is installed, it's difficult or impossible to revisit baselines, so properly defining them is important
- Baselines may vary with changes in weather (or other factors, potentially)
  - e.g., gas usage = 2,500 MMBtu + 46 × (Heating Degree Days)

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Savings Guarantee

- Savings must be guaranteed
  - Annual verification of savings (at minimum)
- Annual payments vs. savings
  - Federal projects require that savings must exceed payments in each year
  - In Massachusetts, savings do not need to exceed payments
- Savings that may be used to pay the ESCO:
  - Energy and water cost savings
  - Energy/water-***related*** cost savings

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Energy and Water Cost Savings

- Reductions in system use
- Efficiency improvements
- Reductions in peak demand
- Reductions in energy rates
- Shifting time of use to lower-cost periods
- Switching to less expensive fuels
- Self-generation (including cogeneration/CHP and renewables)
- Reduced water and sewer use
- Reduced sewer charges (e.g., due to irrigation)

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Energy/Water-*Related* Cost Savings

- Most commonly, reduced O&M expenses
  - Parts and repair costs
  - Equipment replacement costs
  - O&M contracts and other labor
- Cost savings must be "real"
  - If labor savings are claimed, customer should demonstrate contract or staff reductions
  - Reducing tasks of existing staff does not count

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Other Sources of Savings (and thus payments)

- Cost avoidance provided by the project
  - Example: Including chiller replacement funds in project where funds were planned to be paid out of repair & replacement budget in early year of project
- Construction-period energy savings
  - Savings accrued from ECMs that are installed and performing in advance of project acceptance
- More info on acceptable sources of savings:
  - *Practical Guide to Savings and Payments in Federal ESPC Task Orders*, on FEMP ESPC Resources web page.

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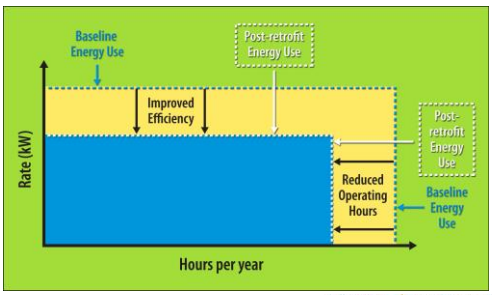
Calculating Savings

- The two components of energy use
  - Rate of energy use (e.g., wattage) – or Performance
  - Usage (hours of use)
- Energy use is the product of the two
  - Example: 4 kW × 2 hours = 8 kWh
- Reducing the rate of energy use or the usage (hours) reduces the total energy use

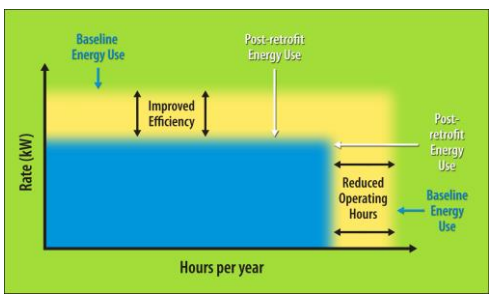
Achieving Energy Savings



Savings Uncertainty

- We can't measure savings directly
  - Because it's the absence of something – i.e., it's energy use that's not there any more!
- We measure energy use before and after the ECM – the savings is the difference (roughly)
- We usually don't know the exact energy use before and after
  - There is almost always some uncertainty in each
- And even when we do, we can't know for sure what's responsible for all of the change

Achieving Energy Savings: The Real Picture



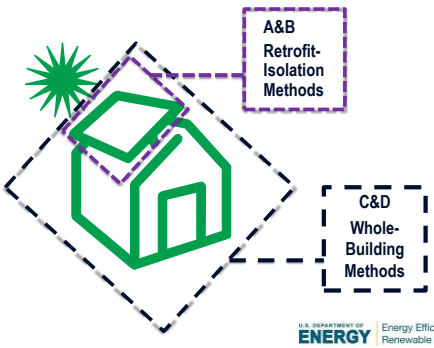
Uncertainty can be reduced, but never eliminated

- Claimed savings are always estimates because savings cannot be measured directly
- Uncertainty is introduced through:
  - Measurement and modeling uncertainty
  - Sampling uncertainty
  - Simplifying assumptions
  - Other changes at facility
- These factors are inherent in M&V

M&V Method Options: A, B, C, and D

- Each ECM is assigned an M&V option
- Measurements differ by:
  - Level – individual system vs. whole building
  - Duration – spot, short-term, periodic, continual
  - Frequency
  - Whether key values are held constant without performance period measurement
    - Example: Hours of lighting operation may be determined in IGA and then fixed for purposes of savings calculation
  - Expense
    - Up-front – averages about 3% of project investment
    - Annual – averages about 3% of annual savings
    - More complex, interactive ECMs justify more M&V effort

Options A/B vs. Options C/D



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Option A Example

M&V Option	How savings are calculated
Option A: "Retrofit Isolation, Key Parameter" – Based on measurement of *key* parameter, either equipment performance or operational factors (usually equipment performance)	Engineering calculations using measured and estimated data

ECM	Baseline and Post Installation	Performance Period (Annual)
Lighting Upgrade	**Measurements:** • Fixture wattage (sample) • Operating hours (data logging or est.) • Lighting levels (sample) **Savings Calculation:** kwh before vs. after @ electricity rate	**Measurements:** None • Inspection of equipment - lamps still low wattage? • Lighting controls still functional? **Savings Calculation:** None, inspections only
Boiler Upgrade	**Measurements:** • Boiler load (baseline) – logs/EMCS/meter • Measure boiler efficiency **Savings Calculation:** baseline load @ efficiency before vs. after @ natural gas rate	**Measurements:** • Boiler efficiency **Savings Calculation:** None, verify that efficiency is still above post-install calculation assumption

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Option B Example

M&V Option	How savings are calculated
Option B: "Retrofit Isolation, All Parameters" – Based on measurements (usually periodic or continuous) taken of *all* relevant parameters; often entails long-term metering.	Engineering calculations using measured data

ECM	Baseline and Post Installation	Performance Period (Annual)
Chiller Upgrade	**Measurements:** (all key parameters) • Chiller demand (kW) and energy use (kWh) • Chilled water load (tons), • Chilled water supply/return water temps • Pump/cooling tower kW/kWh (if affected) • Document assumptions: weather, operating schedule, peak building demand **Savings Calculation:** Chiller performance (kW/ton) across range of operating conditions, extrapolate short term measurements to annual profile for baseline conditions	**Measurements:** • Same measurement of all key parameters as performed at post installation **Savings Calculation:** Savings calculated using same measurements as post install and applied to baseline profile

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Option C Example

M&V Option	How savings are calculated
Option C: Based on *whole-building* or facility-level utility meter data adjusted for weather and/or other factors.	Analysis of utility meter data

ECM	Baseline and Post Installation	Performance Period (Annual)
Central Heating Plant Expansion	**Measurements:** • Utility billing data • Specify independent variables: weather, occupancy, building schedule, set points • Post Install – verify efficiencies **Savings Calculation:** Model developed, correlates base year utility with the factors that caused the consumption.	**Measurements:** • Collection of meter data or utility bill data • Collection of data on independent variables **Savings Calculation:** Typically a regression analysis is performed to adjust the baseline consumption to show what consumption would have been without ECMs (adjust for weather, schedule, etc.)

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Option D Example

M&V Option	How savings are calculated
Option D: Based on *computer simulation* of building or process; simulation is calibrated with measured data.	Comparing different models

ECM	Baseline and Post Installation	Performance Period (Annual)
Building Envelope Upgrades	**Measurements:** • Utility billing data • Collection of building parameters: weather, occupancy, building schedule, set points • Post Install – verify efficiencies **Savings Calculation:** Baseline model developed and calibrated to utility data. ECMs applied to performance period model and compared to baseline model	**Measurements:** • Collection of meter data or utility bill data • Collection of data on independent variables **Savings Calculation:** Calibrate performance period model and subtract results from baseline model using same conditions. After year 1, typically revert to option A approach

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FEMP Guidance on M&V – Newly Revised v 4.0

- New Title*: M&V Guidelines: Measurement and Verification for Performance-Based Contracts Version 4.0*
  1. No longer specific to federal projects
  2. Strengthens Option A by defaulting to annual measurement of key parameters (may not be necessary for all ECMs)
  3. Refocuses Option C to stress short-term applicability
  4. Clarifies Option D approach in performance period
  5. Provides recommended M&V approaches for most ECMs
  6. Modifies M&V annual report template for added clarity in documenting agency impacts to savings
  7. Adds requirement to enter annual M&V report findings in eProject Builder
- The M&V Guidelines and other resources are available on FEMP ESPC Resources web page (see M&V section)

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M&V Guideline 4.0 Provides Approaches for 19 ECMs

	Energy Conservation Measure	M&V OPTION
1	LIGHTING	A
2	LIGHTING CONTROLS	A
3	BUILDING ENVELOPE IMPROVEMENTS	D
4	ENERGY MANAGEMENT CONTROL SYSTEM	D
5	PREMIUM EFFICIENCY MOTORS	A
6	VARIABLE AIR VOLUME CONVERSION	D
7	VARIABLE SPEED PUMPING	A
8	STEAM TRAP REPLACEMENT	A
9	DISTRIBUTED HIGH EFFICIENCY BOILERS	A
10	STEAM/HOT WATER/CHILLED WATER EQUIPMENT REPLACEMENT	D
11	RENEWABLE GENERATION	B
12	RENEWABLE OFFSET	D
13	HEAT RECOVERY SYSTEMS	D
14	THERMAL ENERGY STORAGE	B
15	AIR COMPRESSOR AND VACUUM PUMP IMPROVEMENTS	B
16	REPLACE SELF-CONTAINED AIR CONDITIONING WITH CHILLED WATER	D
17	WATER CONSERVATION MEASURES	A
18	COOLING TOWER WATER METER	B
19	RETROCOMMISSIONING/RECOMMISSIONING	D

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★ M&V Best Practices During Project Development

- Understand that ESPCs are long-term contracts, and change over this period is inevitable
  - Long-term performance is ensured through continuing close engagement of agency with ESCO
- Recognize that the goal is to reduce uncertainty in savings … but that adding M&V adds cost
- The degree of M&V should be proportional to
  1. the amount of savings contributed by the ECM
  2. the performance risk of the ECM

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Key Questions to Ask When Reviewing M&V Plan

- What would have to occur for the ESCO to not meet the guarantee?
- If an ECM does not perform, what happens, and how will savings be restored?
- What is the expected life of the ECM? How is R&R to be handled?
- Does the plan define the agency's role in witnessing of M&V activities?

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★ M&V Best Practices

- Make sure that ESCO-proposed baselines and fixed parameters for ECMs are sound
  - Because they are cornerstones of the savings calculation
- Stay involved throughout performance period
  - Witness ESCO's annual M&V activities
  - Review annual M&V reports, stay in touch with ESCO, etc.

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Questions?

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