Developing an Evaluation, Measurement and Verification Plan For Municipal Building Energy Efficiency Projects

Feb. 9, 2011, 2-3pm EST
Julie Michals, Northeast Energy Efficiency Partnerships, Inc.
Jonathan Kleinman, CLEAResult
What is TAP?

DOE’s Technical Assistance Program (TAP) supports the Energy Efficiency and Conservation Block Grant Program (EECBG) and the State Energy Program (SEP) by providing state, local, and tribal officials the tools and resources needed to implement successful and sustainable clean energy programs.
How Can TAP Help You?

TAP offers:

- One-on-one assistance
- Extensive online resource library, including:
  - Webinars
  - Events calendar
  - TAP Blog
  - Best practices and project resources
- Facilitation of peer exchange

On topics including:

- Energy efficiency and renewable energy technologies
- Program design and implementation
- Financing
- Performance contracting
- State and local capacity building
The TAP Blog

Access the TAP Blog!
http://www.eereblogs.energy.gov/tap/

Provides a platform for state, local, and tribal government officials and DOE’s network of technical and programmatic experts to connect and share best practices on a variety of topics.
Accessing TAP Resources

We encourage you to:

1) Explore our online resources via the Solution Center

2) Submit a request via the Technical Assistance Center

3) Ask questions via our call center at 1-877-337-3827 or email us at solutioncenter@ee.doe.gov
Who We Are: Team 4

ACEEE, NRDC: National Support

VEIC
NEEA
Sweep
MEEA
NEEP
VEIC/NRDC

VEIC

Vermont Energy Investment Corporation
EF Group Futures Energy
MEEA
VEIC

NRDC
Neep
Sweep

ACEEE
NRDC

American Council for an Energy-Efficient Economy
OVERVIEW

1. Distinguishing between Evaluation, Measurement & Verification (EM&V); Energy Performance Management (EPM); and Reporting

2. DOE Guidance on EM&V, EPM and Reporting

3. Developing a plan for Municipal Building EE projects:
   - *Energy Performance Management* – basic steps and tools
   - *EM&V* – simple or more comprehensive
   - *Case Studies* – EM&V Planning, coordinating with local utility program versus without
   - *Helpful Resources*

4. Q&A
What is EM&V & EPM?

**EM&V** of Energy Efficiency projects/programs includes:

- **Measurement & Verification**: The *collection of data* (pre- and post installation of an efficiency measure, project or facility) *to support energy savings calculations* using e.g., site surveys, metering of energy consumption, and monitoring of certain variables.

- **Evaluation**: The *analysis of the performance of efficiency programs, or collections of projects* (which can include M&V for a statistically significant sample of individual projects).

**Energy Performance Management (EPM)** for energy efficiency projects:

- Like EM&V, also involves establishing a baseline and collecting data.
- *Compares* the performance of your buildings to others – to help identify opportunities for improvement.
- *Prioritizes* the buildings, systems, technologies, and techniques on which to focus efficiency efforts.
- *Verifies and Tracks Progress* of improvement projects by monitoring long-term energy performance of buildings.
DOE Reporting Requirements

Reporting required on:

- Job Impacts
- Energy Savings
- Energy Costs and Savings
- Renewable Energy Capacity and Generation
- Emission Reductions
- Process Metrics: # buildings retrofitted, square footage, efficiency measures purchased, etc.

- EEBCG Program Guidance 10-07B - Reporting: 
  [http://www1.eere.energy.gov/wip/pdfs/eebchg_reporting_program_guidance_10_007b.pdf](http://www1.eere.energy.gov/wip/pdfs/eebchg_reporting_program_guidance_10_007b.pdf)

- SEP Program Guidance 10-006BA – Reporting: 
DOE EM&V and EPM Guidance

• DOE requires reporting of energy savings, but does not require specific EM&V as part of Grantees award agreement.

• Estimates can be calculated using *Recovery Act Benefits Calculator*, but not intended to replace more rigorous EM&V techniques. See:
  

• *NEW* Updated DOE Guidance on EM&V and EPM:
  

• Grantees with resources to conduct more sophisticated EM&V are encouraged to conduct studies in accordance with Program Notice 10-017, and to share results with DOE through Project Officers. See
  
  http://www1.eere.energy.gov/wip/pdfs/eecbg_evaluation_guidelines_10_017.pdf
Useful tool, available at no cost to grantees: [www.energystar.gov/benchmark](http://www.energystar.gov/benchmark)

**Whole Building** approach for commercial retrofit projects:

- Uses basic building data - square footage, building type, hours of operation, zip code, and utility bill energy use (12 month pre-installation, at least 4 months post-installation)
- Measures and tracks pre- and post-installation energy performance at whole building level, with automatic adjustments to weather normalize
- For M&V, provides platform for IPMVP Option C approach
- Refer to earlier TAN Portfolio Manager webinars

*Trainings available at [www.energystar.gov/businesstraining](http://www.energystar.gov/businesstraining)*
EM&V offers quantitative analysis of collected data and precise measurement and persistence of savings achieved, which can help you better:

- Track cost-effectiveness of efficiency projects, and how much energy and $$ is actually being saved
- Plan for future projects/investments
- Develop estimates of jobs created, emissions reduced, and other economic benefits

Developing an EM&V Plan helps to:

- Standardize EM&V monitoring and reporting throughout the municipality
- Outlines EM&V expectations
- Promotes ongoing success and achievements
EPM involves benchmarking buildings by comparing utility bills before and after measure installations.

Benefits include:

- Low-Cost way to prioritize buildings for assessment using Key Performance Indicators:
  - High energy use (kBtu/Sq.ft)
  - Low percentile rankings and/or low Portfolio Manager scores
  - Large floor areas (Sq.ft)
- Can use utility bill data pre- and post-installation
- Can satisfy IPMVP Option C (*more later*)
- Complement with EM&V to get more rigorous/precise savings results and verify project savings
What is needed to benchmark facilities?

- At least 12 months of utility energy data
  - per meter
  - if an EE project has been implemented try to obtain data 12 months prior to in-service date

- **Basic Data Collection** (at a minimum, e.g., Portfolio Manager, data varies depending on building type):
  - Gross floor area (SF)
  - Weekly operating hours
  - # rooms
  - # computers
  - % of floor area that is cooled
  - % of floor area that is heated
Detailed Data Collection - DOE Guidance for SEP Grantees:

- Contact information of people served/impacted (name, company, address of contact, phone, email)
- Detail descriptions of services received: address of actions taken, recommendations from audits, measures taken, installation dates etc.
- e.g., CA Evaluation Protocols (April 2006, pg 205)

[Link](http://www.calmac.org/events/EvaluatorsProtocols_Final_AdoptedviaRuling_06-19-2006.pdf)
Develop a Successful EPM Strategy

Key Components:

1. Establish priority for data gathering and reporting in energy performance across all departments
2. Establish an energy baseline for your buildings and benchmark your buildings to assess your performance
3. Define scope of overall energy savings opportunity
4. Identify high-level strategies for achieving energy efficiency
5. Include an M&V Plan
6. Allow for senior management endorsement
An EM&V Plan should be written before you start a project. Generally, the plan should:

- Be adaptable and continuously evolving
- Identify personnel/departments accountable for energy data
- Establish data gathering and reporting timelines
- Include facilities overview/description
- Outline EE projects
  - Implemented
  - Identified
- Outline process, if applicable, for leveraging Utility EE Programs and associated EM&V resources
EM&V Plan – Approaches

Approach #1: Coordinate with your Utility Company

Approach #2: Use of Publicly-Available Deemed Savings Values, or Engineering Estimates

Approach #3: Conduct some EM&V, and/or combine with Approach #2
Approach #1: Coordinate with your Utility Company – ask about:

- **Free services**
  - Electronic historic usage data
  - Online bill analyzers and graphs
  - Training workshops – energy accounting

- **Incentive programs / rebates**

- **Developing EE project savings calculations (and what data collection is needed to support utility EM&V)**

- **If you have an assigned utility Account Manager, work through him or her to engage services**

- **Upcoming Case Study – City of Grand Prairie**
### Key EM&V Plan Elements

#### Approach #1

<table>
<thead>
<tr>
<th>Element</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline data collection and benchmarking</td>
<td>Beginning of process, 1-2 months</td>
</tr>
<tr>
<td>Contact utility company to request support of energy efficiency programs</td>
<td>Beginning of process</td>
</tr>
<tr>
<td>Work with utility company to identify project opportunities</td>
<td>1-2 months after benchmarking</td>
</tr>
<tr>
<td>Determine EM&amp;V approach with utility for projects – deemed savings, simple M&amp;V, or full M&amp;V – that specifies data to collect and timing</td>
<td>During project identification</td>
</tr>
<tr>
<td>Collect pre-project data: count equipment and document nameplate data for deemed savings; conduct simple metering (e.g., light loggers) for simple M&amp;V</td>
<td>According to project EM&amp;V requirements: weeks to months before project</td>
</tr>
<tr>
<td>Contractors or staff implement project</td>
<td>Weeks to months</td>
</tr>
<tr>
<td>Collect post-project data</td>
<td>According to project EM&amp;V requirements; weeks to months after project</td>
</tr>
<tr>
<td>Re-benchmark building(s) to verify savings realization</td>
<td>Up to 12 months after project</td>
</tr>
</tbody>
</table>
If no opportunity to coordinate with local utility EE program

Approach #2: Use of Deemed Savings Values, Engineering Estimates

- Can use DOE Benefits Calculator
- Other Deemed Savings values/algorithms available
- With complement use of benchmarking tool

Approach #3: Conduct some EM&V, and/or combine with #2

- Complement use of benchmarking tool (e.g. Portfolio Manager Tool) with some EM&V
  - Upcoming Case Study – Natural Gas Efficiency Project
## Key EM&V Plan Elements
### Approaches #2 or #3

<table>
<thead>
<tr>
<th>Element</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline data collection and benchmarking</td>
<td>Beginning of process, 1-2 months</td>
</tr>
<tr>
<td>Work with staff and/or contractor (e.g., energy services company) to identify project opportunities, solicit bids</td>
<td>After benchmarking</td>
</tr>
<tr>
<td>Establish EM&amp;V approach for projects – researching deemed savings, use EECBG calculator, or M&amp;V plan – independently, or contact TAC for assistance</td>
<td>During project identification</td>
</tr>
<tr>
<td>Establish project-specific M&amp;V plans – data collection to used deemed savings or calculator, supplemental data collection (e.g., light loggers), or whole building utility bill analysis (IPMVP Option C)</td>
<td>1-2 months after project identification</td>
</tr>
<tr>
<td>Collect pre-project data</td>
<td>According to project EM&amp;V plan</td>
</tr>
<tr>
<td>Contractors or staff implement project</td>
<td>Weeks to months</td>
</tr>
<tr>
<td>Collect post-project data</td>
<td>According to project EM&amp;V plan</td>
</tr>
<tr>
<td>Re-benchmark building(s) to verify savings realization</td>
<td>Up to 12 months after project</td>
</tr>
</tbody>
</table>
Key EM&V Plan Steps

Step 1: Define baseline conditions accurately

Step 2: Develop project-specific M&V plan
- Project description
- Proposed calculation methodology (e.g., formulas, data to be collected)
- Proposed data requirements (e.g., physical, equipment, and field data collection)
- Supporting documentation

Step 3: Commission systems to ensure proper equipment was installed

Step 4: Post-installation verification

Step 5: Regular-interval verification

Detailed steps at: http://www1.eere.energy.gov/femp/pdfs/intro_mv.pdf
Energy Performance Management Framework

1. **Establish Baseline**
2. **Benchmark Cost & Use**
3. **Establish Performance Metrics**
4. **Prioritize Buildings/Equipment**
5. **Identify project at priority facility**
6. **Call utility to find EE program**

**Does utility program support project?**

- **Yes** – Work with Utility’s Savings Calculation (Approach #1)
  - **Deemed Savings or M&V?**
    - **Yes** – Work with utility to identify needed field data to collect
    - **No** – Proceed with own EM&V Plan (Approaches #2 or #3)
    - **M&V**
      - **Hire contractor to draft M&V plan with utility support; collect data**
  - **Deemed savings approach**
    - **Obtain claimed project savings**
    - **Report Savings**

- **No** – Proceed with own EM&V Plan (Approaches #2 or #3)
  - **Engineering Estimates, M&V and/or Deemed Savings Values**
  - **Determine calculated savings**
Process continued...

- Report Savings
  - Does savings show up in ongoing cost monitoring?
    - Yes: Keep monitoring
    - No: Confirm installation and operations & maintenance according to project requirements
      - Issue?
        - Yes: Assess the facility for explanation
        - No: Contact contractor to correct problem
Common Obstacles

- Cost (varies depending on extent of EM&V)
- Available Personnel
- Access to energy data
- Understanding and organizing energy data
  - kWh vs. kW Demand
  - Rate structures
  - Meters and corresponding equipment/facilities
- Choosing an accounting/tracking software e.g.,
  - Excel
  - ENERGYSTAR Portfolio Manager
  - Utility Manager Pro
  - Other
CASE STUDY #1
City of Grand Prairie, TX

- Participated in ONCOR’s Government Facilities Program and City Grants Program

- **Step 1:** Define baseline conditions accurately
  - Benchmarked 42 City Owned Buildings at no cost (*2 months*)
  - Provided 12 months of utility data for all associated meters

- Participated in an Energy Master Planning Workshop
  - Developed Energy Master Plan (*additional 2 months*)

- Identified several EE opportunities, including:
  - Lighting retrofits
  - HVAC equipment replacements, including rooftop units and chilled water systems
Step 2: Develop Project-Specific M&V Plan (Approach #1)

- Oncor programs have deemed savings methodologies for lighting and HVAC projects approved by Public Utility Commission of Texas
- Program staff, municipal staff, and energy services company (McKinstry) complete full equipment inventories of existing light fixtures and HVAC equipment, including photo-documentation of HVAC equipment (2-3 months)
- Oncor sends inspector to verify accuracy of submitted equipment data (1 month)

Step 3: Project installation and system commissioning
Step 4: Post-installation verification

- Program staff, municipal staff, and energy services company (McKinstry) complete full equipment inventories of existing light fixtures and HVAC equipment, including photo-documentation of HVAC equipment (2-3 months)
- Oncor sends inspector to verify accuracy of submitted equipment data (1 month)

Step 5: Regular-Interval verification

- Re-benchmarking of facilities under discussion

- All projects estimated to have saved 250 kW and over 1.2 million kWh per year
- Financial incentives from utility also received
CASE STUDY #2 - Natural Gas Project
No Coordination with Local Utility

• Sample Project
  – Replacement of old steam boiler with its distribution system (i.e., radiators) with a high-efficiency hot water boiler and the existing distribution system
  – Re-piping where necessary

• Assumptions
  – There is no local utility natural gas energy efficiency program
  – There are no changes to the building’s energy use (e.g., no window replacements, weatherization)
Step 1: Define baseline conditions

- Track fossil fuel use over past 12 to 24 months, and compare with other facilities’ weather-normalized consumption (per square foot) if possible (e.g., through Portfolio Manager) (**2 months**)

Step 2: Project-specific M&V Plan

- Option 1: ask contractor to estimate existing system efficiency with proposed system efficiency, and determine % savings estimate by efficiency ratios – have contractor verify all existing equipment efficiency levels (**1 month**)

- Option 2: hire local engineering firm or other energy expert to develop project savings estimate based upon project specifications and utility bill history – have engineering firm verify all existing equipment efficiency levels (**3 to 6 months, depending on bid process for engineering firm**)

Step 3: Project installation and Commissioning

CASE STUDY #2 – Natural Gas Project
Step 4: Post-installation verification

• Municipal staff confirm installation of project according to project specifications, and verify system efficiency with nameplate data (1 month)

Step 5: Regular interval verification

• Track utility bill consumption for additional 12 months to confirm system performance (12 months)
• If expected savings do not materialize, contact contractor and/or engineering firm to re-commission system
Forthcoming Support Documents

• Information from this webinar will be expanded into a Technical Assistance guidance document with more detail  *March 2011*

• Upcoming EM&V TAN webinar to address Energy Management and EM&V for *Residential Retrofit* projects  *March 2011*

• Final guidance document to cover Energy Management and EM&V Planning for *Municipal Buildings and Residential Retrofit*, with supporting case studies  *May 2011*
Questions?
ADDITIONAL BACKGROUND INFO AND RESOURCES
DOE Guidance on EM&V – for Grantees Conducting 3rd Party Evaluations

Guidelines for States Conducting or Contracting Evaluations of ARRA Funded SEP Activities (using 3rd party contractors):

High level guidelines/standards on:

- **Evaluation Metrics** – energy/demand savings, carbon emission reductions, job creation
- **Independent Evaluations** – by 3rd independent party
- **Attribution of Effects** – net effects due to SEP funds, with guidance on allocation of effects for jointly funded projects
- **Evaluation Budgeting** – recommends 5% or less of project budget
- **Timing of Evaluation** – evaluation planning to start at same time as when projects are initiated, determine baseline approach, data collection and analysis efforts

Continued...
High level guidelines/standards cont:

- **State of the Art Analysis** – evaluation approach should use current state of the art evaluation approaches and analysis methods
- **Evaluation Rigor and Reliability**: Study should be as reliable as possible within study approach and budget limits
- **Study Design and Study Plan**: Study methods/approach, tasks to be conducted, detailed data collection approach, detailed analysis approach for energy and demand savings
- **Sampling and Statistical Significance**: minimize bias and maximize representativeness of the population. Sample to be no less rigorous than 90% confidence level with +/- 10% precision
- **M&V Approaches**: analytic approach, baseline and post-installation operation assessments should use IPMVP field data collection frameworks (discussed later)
Grantees can refer to existing state energy efficiency program administrator data assumptions and algorithms if project data is not all available/colllected. These “Technical Reference Manuals” (TRMs) include a mix of stipulated data, prior EM&V data and/or manufacturer specs. Existing resources include:

- California DEER Database: [http://www.energy.ca.gov/deer/](http://www.energy.ca.gov/deer/)
- Other state TRMs
Savings Estimate Example
Commercial Lighting Retrofit

*Algorithms for Energy and Demand Savings:*

\[
\text{kWh Saved} = (\text{Quantity}_{\text{baseline}} \times \text{Watts}_{\text{baseline}}) - (\text{Quantity}_{\text{installed}} \times \text{Watts}_{\text{installed}}) / (1000 \times (\text{Annual Operating Hours}))
\]

\[
\text{kW Saved} = (\text{Quantity}_{\text{baseline}} \times \text{Watts}_{\text{baseline}}) - (\text{Quantity}_{\text{installed}} \times \text{Watts}_{\text{installed}}) / (1000 \times (\text{Coincidence Factor}))
\]

*Where:*

- **Baseline Fixture Quantity** = number of existing fixtures
- **Baseline Fixture Wattage** = connected wattage of the existing fixture for C&I retrofit
- **Installed Fixture Quantity** = number of installed fixtures
- **Installed Fixture Wattage** = rated wattage of the installed fixture, inclusive of both lamp and ballast. Obtained from nameplate data
- **Annual Hours** = number of operating hours for the fixture in a typical year, either site-specific or assigned by building type (assumed to remain constant)
- **Summer Coincidence** = ratio of peak demand at the same time as a “summer” period to the peak demand across all periods
- **Winter Coincidence** = ratio of peak demand at the same time as a “winter” period to the peak demand across all periods
Which EM&V Approach to Use?

1. Approaches/methods range from simple/direct to complex/indirect where more complex methods require more detailed data and higher cost.

2. Guidelines for EM&V measurement/analysis include:

- CA Evaluation Protocols: http://www.calmac.org
- NW Regional Technical Forum Protocols http://www.nwcouncil.org/energy/rtf/
- Most of the above refer to IPMVP: The International Performance Measurement & Verification Protocol (IPMVP Vol 1, 2010 www.evo-world.org)
Team 4 Contacts

CONTACTS

VEIC: Dan Quinlan, dquinlan@veic.org, 802-488-7677 (Team 4 Lead)
MEEA: Jay Wrobel, jwrobel@mwalliance.org, 312-784-7245
NEEP: Ed Londergan, elondergan@neep.org, 781-860-9177
NEEA: Elaine Blatt, eblatt@neea.org, 503-827-8416
SWEEP: Curtis Framel, cframel@swenergy.org, 303-447-0078
SEEA: Jolyn Newton, jolyn@seealliance.org 615-612-9592,
ACEEE: Eric Mackres, emackres@aceee.org, 202-507-4038
NRDC: Lara Ettenson, lettenson@nrdc.org, 415-875-6100
EFG: Richard Faesy, rfaesy@energyfuturesgroup.com, 802-482-5001
Upcoming Webinars

Please join us again:

- **Title:** Financing Programs: RFP & Contract Terms and Conditions
  - Date: February 15, 2011
  - Time: 1:00 – 2:30 Eastern

- **Title:** Energy Savings Performance Contracting: Savings Measurement and Verification (M&V)
  - Host: Meg Giuliano, ICF/SRA
  - Date: February 24, 2011
  - Time: 1:30 – 2:30 Eastern

- **Title:** Integration of Renewables and Efficiency: Leveraging Interest and Funding
  - Host: Cheryl Jenkins, VEIC
  - Date: February 17, 2011
  - Time: 2:00 – 3:00 Eastern

- **Title:** Optimizing Solar Installations – Tools and Strategies
  - Host: Sarah Busche, NREL
  - Date: February 23, 2011
  - Time: 3:00 – 4:15 Eastern

For the most up-to-date information and registration links, please visit the Solution Center webcast page at [www.wip.energy.gov/solutioncenter/webcasts](http://www.wip.energy.gov/solutioncenter/webcasts)