

# **E, M & V Best Practices: Lessons Learned from California Municipal Utilities**

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## **1 ABSTRACT**

On September 29, 2005, Governor Schwarzenegger signed Senate Bill 1037 (Kehoe) into California law, establishing several important policies regarding energy efficiency. Among the provisions of the law is a statewide commitment to developing cost-effective and feasible energy efficiency programs and the expectation that all utilities consider energy efficiency before investing in any other resources to meet growing demand. SB 1037 – with supplemental provisions added by the passage of AB 2021 - required for the first time that publicly owned utilities had to report on their energy efficiency programs to the energy commission. The Northern California Power Agency<sup>1</sup> (NCPA) developed a collaborative framework to help guide its municipal and rural cooperative members in developing the Evaluation, Measurement, and Verification (E, M&V) plans necessary to meet the new regulatory requirements.

This paper will summarize the ways in which 12 smaller California utilities are enhancing their DSM programs through evaluation, measurement, and verification approaches. This paper will highlight the innovative ways in which these smaller utilities are pooling their resources to meet these E, M&V requirements while also maximizing the value of the DSM programs offered to their customers. This paper will also describe cost-effective approaches used in both process and impact evaluations.

Traditionally, E, M&V activities are viewed as costly and labor-intensive. This paper will provide attendees with strategies on ways in which they too can monitor and improve their DSM programs in a cost-effective manner while still meeting regulatory goals. This paper is especially applicable to mid-size and smaller utilities that often face resource and staffing constraints.

## **2 Introduction**

California Senate Bill 1037 (Kehoe), signed into law in September 2005, established several important policies regarding energy efficiency. Among the many provisions of the law is a statewide commitment to cost-effective and feasible energy efficiency, with the expectation that all utilities consider energy efficiency before investing in any other resources to meet growing demand. Assembly Bill 2021 (Levine) added supplemental provisions in 2006, including the need to verify energy efficiency program results.

NCPA is a joint powers agency that provides support for the electric utility operations of seventeen member communities and districts in Northern and Central California. This paper summarizes the ways in which 10 NCPA member utilities (and 2 non-NCPA utilities) are enhancing their DSM programs through

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<sup>1</sup> NCPA members include the cities of Alameda, Biggs, Gridley, Healdsburg, Lodi, Lompoc, Palo Alto, Redding, Roseville, Santa Clara, and Ukiah, as well as the Bay Area Rapid Transit District, Port of Oakland, the Truckee Donner Public Utility District, and the Turlock Irrigation District, and whose Associate Members are the Plumas-Sierra Rural Electric Cooperative and the Placer County Water Agency.

evaluation, measurement, and verification approaches. The participating utilities<sup>2</sup> in the E, M&V approach described in this paper are:

- Alameda Power & Telecom
- City of Biggs
- City of Gridley
- City of Healdsburg
- City of Lompoc
- City of Ukiah
- Lodi Electric Utility
- Plumas-Sierra Rural Electric Cooperative
- Redding Electric Utility
- Turlock Irrigation District
- City of Shasta Lake (Non-NCPA member)
- Lassen (Non-NCPA member)

To comply with this new legislation, the California public municipal utilities were required to identify all potentially achievable cost-effective electricity efficiency savings and to establish realistic annual savings targets. The reporting requirements were as follows:

- Annual reporting of energy and demand targets to all stakeholders, including customers and the California Energy Commission.
- Cost effectiveness reporting using standard tests defined in the California Standard Practices Manual.

### 3 Overview of Energy Efficiency: A Public Power Perspective

Publicly-owned utilities (POU) have had a long-standing commitment to energy efficiency that is an extension of fundamental principles dedicated to social and environmental responsibility, ensuring reliability, and keeping rates low for the communities they serve. Energy efficiency is a critical element of the resource planning process, generation, transmission and distribution. Public power commitments to energy efficiency are guided by four important concepts:

- **Social and Environmental Responsibility.** POU's place a high priority on energy efficiency, investments in renewable power supplies, low-income programs, and economic development. Local elected officials govern and regulate public power to ensure direct accountability on these important issues to customers.
- **Operational Energy Efficiency.** Public power has important energy efficiency programs that optimize power generation, transmission, and ensure more optimal operation of the grid.
- **Demand-side Energy Efficiency.** This is a major focus of POU's. It includes, but is not limited to: lighting, appliances, air-conditioners, building codes and standards, education,

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<sup>2</sup> Other NCPA members – City of Santa Clara, City of Roseville, City of Palo Alto, and Truckee Donner Public Utility District - have implemented E,M&V plans as well. Although they participated in managing and advising this collaborative effort, their E,M&V work is not detailed in this paper.

electricity management, and weatherization, all coordinated with customer-specific programs.

- **Cost-effective Energy Efficiency.** Cost-effective energy efficiency lowers the cost of providing electricity to our communities. POU customers are “shareholders” and benefits related to energy efficiency are realized by all customer-owners.

The 15 NPCA members’ 2006-2007 demand side management programs<sup>3</sup> are varied in funding, from slightly under \$50K funding in the City of Lompoc, to approximately \$3.7 million in Silicon Valley Power (SVP), with the average funding level of \$249,000 annually.<sup>4</sup> Some NCPA utilities have maintained energy efficiency programs for years with both residential and commercial components while others are just starting new services. The overriding goal of this project was to develop an E, M&V framework to properly document the results achieved through these programs. This framework focused on developing plans that include process and impact evaluations, and properly documenting the results through careful measurement and verification activities.

#### 4 Successful and Cost-Effective Elements of a Process Evaluation

The first step in conducting these process evaluations was to prioritize the types of data collection activities that would be conducted based on the utility’s specific needs and objectives. Since process evaluation was a new activity to many of these utilities, the team began by first conducting a process evaluation that gathered data in a low-cost manner, before moving on to higher cost activities such as surveys and site-visits. Figure 1 displays the data collection activities associated with process and impact evaluations ranging from “low cost” to “high cost.”

**Figure 1: Summary of Data Collection Activities**



The NPCA process evaluations were designed to provide a more detailed understanding of the utility’s overall DSM goals and objectives, while helping to identify the most cost-effective programs to target for impact evaluations. The process evaluations included completing the following tasks:

<sup>3</sup> While there are 17 NCPA members, two members are not retail electric energy providers and thus do not have DSM programs.

<sup>4</sup> Data from *Energy Efficiency in California’s Public Power Sector. A Status Report.* CMUA, December 2006.

## **Review Tracking Systems**

The Summit Blue Team completed a process evaluation of the NCPA efficiency programs which consisted of the following activities:

- A review of the database tracking system to streamline program reporting and enhance comparison between and among programs.
- A review of the measures targeted in utility's residential and commercial energy efficiency program portfolios to determine cost-effectiveness and identify potential alternative measures.

This step included downloading and examining the current status of program data, the ways in which the data were tracked, and ways to identify areas for program improvement. The process evaluation also identified ways to streamline the data tracking process currently used which would provide a more expedient way to measure program impacts and streamline the regulatory compliance reporting process.

## **Review Program Procedures and Inter-Relationships**

The NCPA process evaluations also included a review of the materials and events currently used for recruiting customers to participate in the energy efficiency programs. The review identified additional messages that the NCPA utilities may want to include in future program marketing efforts. This information was also supplemented by interviews with program staff, focusing on the following topics:

- Program process flow and inter-relationships
- Program metrics including current enrollment, customer satisfaction, and savings estimates
- Marketing and outreach activities
- Areas for improvement

## **5 Successful and Cost-Effective Elements of an Impact Evaluation**

Conducting an impact evaluation is often very costly. To develop both cost-effective and reliable impact evaluation efforts, the project team implemented the following strategies.

### **Establish Good Quality Participation Data**

The evaluation team worked closely with the NCPA participating utilities to assess the quality of the data that was available through a coordinated review of the program files and databases. The review would identify the type (deemed or custom calculated) and source (DEER, utility work papers, and/or engineering calculations) of the energy savings of the claimed energy savings. This data would provide estimates of impacts by site and the review would also identify contact information at each site. Assessment of this information would help in determining the appropriate evaluation methodology to be employed and would provide the population for sample draws.

### **Match the Data Collection Strategy to the Data Needs of the Project or Measure**

On-site data collection is expensive and time consuming, and not everything can or should be

measured or monitored. Most of the energy saving estimates used by the NCPA members for their planning and reporting are derived from the deemed saving values of the DEER database. These savings are used by the members in the NCPA version of the E3 benefit/cost calculator used for reporting to the California Energy Commission (CEC). For measures that utilize deemed energy savings estimates, the deemed saving estimates are reviewed to insure correct values are used, but no field work involving metering or billing analysis is needed. However, some form of installation verification is always needed; either on-site, by telephone, or through invoice reviews.

More complex measures, especially those installed under non-residential custom program, sometimes require more rigorous evaluation techniques. This may include an engineer reviewing the submitted custom calculations and assumptions, short term metering, or with some specific weather sensitive measures, a billing analysis.

### **Apply the Appropriate Analytic Approach to the Measure being Analyzed**

There are a variety of analytic methods including but not limited to engineering analysis, hourly building energy simulation models, algorithm-based models, and regression modeling tools. In conjunction with the chosen data collection strategy, it is important to apply the appropriate tool to the analysis at hand, recognizing that the appropriate level of effort and economy must be observed.

When approaching a multiple program evaluation with a wide range of efficiency measures and diverse set of applications of those measures it is helpful to have a systematic context in which to make decisions about the selection of measurement and verification methods. Figure 2 presents a listing of the four International Performance Measurement and Verification Protocols (IPMVP)<sup>5</sup> protocols, the nature of the performance characteristics of the measures to which M&V options typically apply, and an overview of the data requirements to support each option.

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<sup>5</sup> *International Performance Measurement and Verification Protocol*, US DOE, Revised March 2002.

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**Figure 2: Overview of IPMVP M&V Options**

IPMVP M&V Option	Measure Performance Characteristics	Data Requirements
<b>Option A:</b> Engineering calculations using spot or short-term measurements, and/or historical data	Constant performance	<ul style="list-style-type: none"> <li>• Verified installation</li> <li>• Nameplate or stipulated performance parameters</li> <li>• Spot measurements</li> <li>• Run-time hour measurements</li> </ul>
<b>Option B:</b> Engineering calculations using metered data.	Constant or variable performance	<ul style="list-style-type: none"> <li>• Verified installation</li> <li>• Nameplate or stipulated performance parameters</li> <li>• End-use metered data</li> </ul>
<b>Option C:</b> Analysis of utility meter (or sub-meter) data using techniques from simple comparison to multi-variate regression analysis.	Variable performance	<ul style="list-style-type: none"> <li>• Verified installation</li> <li>• Utility metered or end-use metered data</li> <li>• Engineering estimate of savings input to SAE model</li> </ul>
<b>Option D:</b> Calibrated energy simulation/modeling; calibrated with hourly or monthly utility billing data and/or end-use metering	Variable performance	<ul style="list-style-type: none"> <li>• Verified installation</li> <li>• Spot measurements, run-time hour monitoring, and/or end-use metering to prepare inputs to models</li> <li>• Utility billing records, end-use metering, or other indices to calibrate models</li> </ul>

The team selected the appropriate E,M&V by collaborating with each NCPA member and then selected the appropriate E,M&V option that best matched the level of rigor required for each project verified and each program’s budget constraints. Figure 3 provides an example of how these E,M&V options map to the measures that are typically found in many of in the NCPA member programs.

**Figure 3: Assignment of IPMVP EMV& Protocols to a Sample of Program Measures**

Measure Category	IPMVP Option				Comments
	A	B	C	D	
High-Efficiency lighting equipment	✓				Constant performance, low uncertainty in performance parameters
Lighting controls (occupancy sensors)	✓				
Lighting controls / daylighting		✓		✓	Can be analyzed with either end-use metered data set or simulation model
High-Efficiency HVAC equipment		✓		✓	Pre-/post-installation metering can be used alone or to prepare inputs to simulation models
HVAC Diagnostics		✓		✓	Datasets such as outputs from diagnostic tools may be used as analysis inputs
HVAC Quality Installation		✓		✓	Datasets such as outputs from diagnostic tools may be used as analysis inputs
High-efficiency motors	✓				
Variable speed drives		✓			
Building envelope measures				✓	
Weatherization			✓	✓	Billing record analysis is often used; since measures are envelope, simulation modeling is also effective
New construction whole house performance			✓		
Refrigeration measures		✓	✓		
Process measures			✓		
Appliances	✓	✓			
Water heaters and hot water measures	✓				

## 6 Key Lessons Learned/Best Practices

The result of this team effort provides several key lessons and highlights best practices that other utilities can use to cost-effectively implement E, M&V:

- **Don't Reinvent the Wheel**

The resurgence of interest in the development, deployment, and evaluation of DSM programs has led to a greater standardization of industry requirements. This has also led to development of accepted practices and guidelines such as the National Action Plan Guidelines (reference) and the IMPVP E,M&V protocols as well as California Energy Efficiency Evaluation Protocols<sup>6</sup> (TecMarket Works et al 2006). The evaluation team consulted and incorporated these guidelines in developing both the process and impact evaluation plans for the NCPA participating members including the recently developed National Action for Energy Efficiency Impact Evaluation Guidelines<sup>7</sup>.

<sup>6</sup> <http://www.cpuc.ca.gov/PUC/energy/electric/Energy+Efficiency/EM+and+V/>

<sup>7</sup> <http://www.epa.gov/cleanenergy/energy-programs/napee/index.html>

- **Target the Most Important Programs**

The evaluation team also recognized that, given the limited resources, none of these smaller utilities would be able to complete comprehensive program evaluations in time to meet the reporting guidelines. Therefore, the team reviewed each NCPA member’s current level of activity for each DSM program and targeted those energy efficiency programs that represented the largest budget expenditures and/or energy savings. For some utilities, such as the City of Roseville and Redding Electric Utility, the largest emphasis was placed on residential programs, specifically focusing on residential lighting and heating and cooling systems. However, other utilities, such as Turlock Irrigation District, the emphasis was on commercial and industrial energy programs, since they represented the largest component of the energy efficiency costs and savings benefits. These priorities for each E,M&V program activity are summarized in the following table.

**Table 1: Summary of Evaluation Priorities by Market Segment**

<b>Evaluation Priorities by Utility</b>	<b>Residential Programs</b>	<b>Commercial Programs</b>
Alameda Power & Telecom		√
City of Biggs	√	
City of Gridley	√	
City of Healdsburg	√	
City of Lompoc	√	
City of Ukiah	√	
Lassen	√	
Lodi Electric Utility		√
Plumas-Sierra Rural Electric Cooperative	√	
Redding Electric Utility	√	
Shasta Lake	√	
Turlock Irrigation District		√

- **Allow Time in the Process for Mutual Education and to Build Trust**

Small utilities face a steep learning curve when tackling program evaluation for the first time. If possible, the evaluation team needs to allow time to work with the utilities in order provide education on the benefits of evaluation and to build trust.

To help utilities overcome this steep learning curve, NCPA and the Summit Blue team developed a series of workshops and planning meetings. This allowed the utilities to learn about evaluation concepts while helping the evaluation team to understand the unique aspects of each individual utility. The result was mutual education and a better understanding by all on how to develop effective evaluation plans.

- **Review, Streamline, and Integrate Data Collection and Data Tracking Systems.**

Utility data collection and data tracking systems are typically set up to meet program administrator needs for internal reporting. Therefore, an essential first step in any evaluation effort is to review and make recommendations for integrating evaluation-specific data collection into the program implementation process. Not only will this streamline and reduce the cost of future program evaluations, it also very likely to streamline and reduce cost of program implementation.

- **Being Small Doesn't Mean You Have to Sacrifice Quality**

Small utilities with resource and staffing constraints can effectively work together to collaboratively implement E, M&V for their energy efficiency programs. NCPA and its members pursue joint action when it produces consistency, provides for economies of scale, and allows enough flexibility to tailor solutions to meet individual utility needs. Following these principles for effective collaboration allowed NCPA members to implement E, M&V in a cost-effective manner without sacrificing quality.

A common misconception in developing E,M&V programs is that the process has to be expensive. For this collaborative effort, the evaluation team was able to identify cost-effective alternatives for several utilities that would best meet their needs without sacrificing the overall quality of the work completed or the validity of the results. These activities included relying on secondary sources to supplement the staff interviews and document reviews as a way to identify and estimate free ridership levels.

Another approach was to compare the current program requirements against the new ENERGY STAR<sup>®</sup> standards and qualifications. Since these standards have recently changed, this provided the evaluation team with recommended program improvements based on current market conditions. Moreover, this approach ensured that the NCPA member utilities would be targeting the equipment and appliances that would help them achieve the most energy savings impacts. This approach was incorporated in the E,M&V plans for all of the participating NCPA utilities.

NCPA, in collaboration with the California Municipal Utilities Association (CMUA) and the Southern California Public Power Authority (SCPPA), develop a comprehensive database<sup>8</sup> of program impacts with appropriate deemed savings for each measure type. This pooling of resources provided a higher degree of accuracy in preparing program impacts and also effectively leveraged the combined strength and resources of all California publicly-owned utilities.

Several of the utilities in this effort will use a multi-year approach in implementing their evaluation plans. Each year, one or more elements of the evaluation plan will be implemented until all of the plan's recommendations have been completed. The initial efforts consist of a strategic evaluation plan, including a timeline for implementing the various recommendations. This helps the utilities to keep their annual evaluation budget within reason while still comprehensively evaluating their programs.

- **Conduct Evaluations Across Multiple Utility Territories**

NCPA utilities will consider pursuing a collaborative effort across their entire service territories as a way to cost effectively evaluate the following energy efficiency program measures that are not large enough to warrant separate E,M&V efforts. This collaboration will help to standardize the estimated impacts that

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<sup>8</sup> *Measure Quantification Methodology*, KEMA, Revised February 2008.

each NCPA utility reports and will provide a way to identify savings that may otherwise not be possible to attribute to each program. Measures under consideration for this effort are residential CFLs and audits.

- **Residential CFL Lighting:** Many NCPA member utilities currently either provide compact fluorescent lamps (CFLs) either through give-aways or discounts. In both cases, the savings attributed to these activities are not verifiable since there is no information available regarding how and where the bulbs were installed. These utilities plan to conduct a joint CFL lighting impact evaluation study to better assess current CFL installation rates, measure persistence, hours of use, free ridership, and free drivership rates. These findings will then be calibrated for each NCPA member to use when reporting its savings estimates to the CEC.
- **Residential Audits:** Several NCPA utilities also offer free home energy audits. However, savings from some of these audits do not get reported because they are not verifiable. Thus, some NCPA utilities may be under-reporting program-induced savings. As a way to better determine program savings, several NCPA member utilities are considering participating in a larger impact evaluation. This impact evaluation across several NCPA members will determine reasonable savings estimates for each NCPA member to use in Program Years 2009 and 2010.
- **Report Findings Consistently to Facilitate Information Sharing:**

These E, M&V reports needed to offer reporting consistency for NCPA as a whole, while also allowing for some customization to reflect the specific programs that were the subject of each E, M&V report. Since some program evaluations focused only on one market segment, such as residential, commercial, or industrial markets, and given the disparity of the spending levels for these member utilities, the team developed a consistent, albeit somewhat generic, outline that was then modified for each utility report.

## Conclusion

This paper illustrates how small utilities can effectively implement program evaluation that is both cost-effective and comprehensive. NCPA and the Summit Blue Consulting team worked together to develop an evaluation, measurement, and verification framework to properly document the results achieved through their energy efficiency programs. The key lessons learned and best practices developed from this effort include:

- Utilize readily available and industry-accepted resources to optimize evaluation efforts
- Prioritize and target programs for evaluation
- Allow time to educate and build trust
- Review, streamline, and integrate data collection and data tracking systems
- By working together to collectively implement E, M&V utilities can produce consistent results and achieve economies of scale, while still allowing for tailored solutions to meet individual utility needs.
- Report findings in a consistent manner to facilitate information sharing

Program evaluation is no longer just for large utilities. Creative solutions for assisting small utilities

through evaluation efforts are needed and will continue to evolve in the near future as the demand for this service grows nationally.

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