2010-2011
Energy Efficiency Program
Evaluation Report

prepared for

City of Lompoc

energy & resource
solutions

California Regional Office:
152 North Third Street., Suite 520
San Jose, CA 95112

Corporate Headquarters:
120 Water St., Suite 350
North Andover, Massachusetts 01845
(978) 521-2550
Fax: (978) 521-4588

December 6, 2011

Contents

Executive Summary

1

This report documents the evaluation activities undertaken by ERS for the City of Lompoc's electric utility. The evaluation focuses on the energy savings impacts of twenty-six commercial lighting projects. The evaluated projects were completed during the 2010–2011 program year (July 1, 2010 through June 30, 2011).

The objective of the evaluation is to provide independent verification of Lompoc's reported energy savings.

The evaluation consisted of four primary sets of activities: conducting research, developing evaluation plans, collecting data, and estimating energy savings. ERS developed a stratified sample design to randomly select eight projects for evaluation. ERS visited eight sites and collected data to verify the energy saving attributes of each retrofit project.

ERS combined the research and data collection results to analyze and develop energy savings estimates using standard engineering principles and evaluation methodologies.

1.1 RESULTS

The lighting projects achieved 154,603 kWh of annual energy savings. Table 1-1 provides the energy savings reported by Lompoc and compares it to the energy savings verified by ERS.

Table 1-1
Verified Savings

Measure		Energy Savings (kWh)
Twenty-six lighting retrofit projects	Reported	81,004
	Evaluated	154,603
	Realization rate	191%
Precision (at the 90% confidence level)		15.1%

Introduction

2

This report documents the evaluation activities undertaken by ERS for the City of Lompoc and its electric utility. The evaluation focuses on the energy savings impacts of twenty-six lighting projects completed during the 2010–2011 program year (July 1, 2010 through June 30, 2011).

2.1 PROJECT OVERVIEW

Lompoc offers energy efficiency rebates through its electric utility's energy efficiency programs. In addition, Lompoc was awarded funding under the American Reinvestment and Recovery Act through the Energy Efficiency and Conservation Block Grant. Lompoc combined these funds to implement twenty-six commercial lighting retrofit projects.

2.2 EVALUATION OBJECTIVES

The primary objective of the evaluation is to provide independent verification of Lompoc's reported energy savings for the twenty-six commercial lighting projects.

2.3 OVERVIEW OF EVALUATION ACTIVITIES

The evaluation consisted of four primary sets of activities: conducting research, developing evaluation plans, collecting data, and estimating energy savings.

Conduct Research – ERS conducted initial research and review of the following:

- Similar evaluation efforts
- Publicly owned utility compliance reporting requirements and methodologies

Develop Evaluation Plan – ERS developed a sampling plan to randomly select projects for evaluation, and then developed a measurement and verification (M&V) plan[1] for each selected project.

Collect Data – ERS collected rebate documentation and visited eight project sites. ERS interviewed staff and collected data regarding each energy-efficient measure installed at the site.

Estimate Energy Savings – ERS combined the research and data collection results to analyze and develop energy savings estimates per the methodologies described in Section 3.

2.4 REPORT STRUCTURE

The remainder of this report consists of four sections.

[1] The on-site M&V plan is provided in Appendix A of this report.

1. Section 3 describes the evaluation methodologies employed for sampling, data collection, and estimating energy savings. It also provides a discussion on the reliability of the results of the evaluation and provides recommendations for reporting program influence in terms of net-to-gross energy savings.
2. Section 4 provides the results for the sample project evaluated.
3. Section 5 presents the results for all twenty-six projects.
4. Section 6 provides recommendation for T12 lighting retrofits.

Methodology

3

This section describes the methodologies used by ERS for sampling, data collection, and savings verification. It also provides a discussion on the reliability of energy savings estimates and our recommendations for reporting program influence in terms of net-to-gross energy savings.

3.1 SAMPLING

ERS developed a stratified sample design to randomly select projects for site evaluation. Projects were stratified by size (energy savings) and sample projects were optimally selected from each group. One project site was considerably larger than all other sites and was selected with certainty. The sample size was designed to achieve a relative precision of 20% at the 90% confidence level (precision of 90/20), which exceeds the recommendations (precision of 90/30) found in the CPUC evaluation protocols[2] for verification level of rigor.

The initial sample size was eight projects. All projects selected were evaluated; there were no substitutes required.

The sample realization rate was calculated using sample allocation weighting (case weights) and then expanded to the program population to determine the program's verified savings. The resulting realization rate is 190.9%, and the relative precision is 15.1% at the 90% confidence level (see Table 3-1).

Table 3-1
Realization Rate

Realization rate	190.9%
Standard error	17.6%
Error bound (at 90% confidence level)	0.29
Relative precision	15.1%

3.2 DATA COLLECTION

ERS visited each project site selected for evaluation. ERS collected information on-site regarding the retrofit project to determine if lighting measures were installed and operational. Information

[2] 2006 California Energy Efficiency Evaluation Protocols, California Public Utilities Commission

was also gathered to assist with verifying energy savings estimates. Site visits were conducted on October 24, 2011 and October 25, 2011.

3.3 VERIFICATION OF ENERGY SAVINGS

Note: All energy saving calculations performed by ERS will be provided to Lompoc in a spreadsheet file.

3.3.1 ENERGY SAVINGS REPORTED BY LOMPOC

Lompoc did not provide reported energy savings, but informed ERS that savings would be reported using the publicly owned utility's version of the E3 reporting tool (E3 tool). The E3 tool allows utilities to report both deemed and custom measures. The source of the deemed savings values in the E3 tool is the 2009 KEMA Study[3], which is largely based on the 2008 Database for Energy Efficient Resources maintained by the CPUC. Energy savings resulting from custom measures are provided by the utility and are either calculated by the utility or provided by the customer.

For the lighting projects, deemed per-unit energy savings values from the E3 tool were used for all projects, except for one project where the customer provided the energy savings estimates.

3.3.2 PROJECT VERIFIED SAVINGS

For lighting measures, ERS used the same methodology described in the 2009 KEMA study. ERS calculated energy savings as the difference between pre-retrofit (baseline) conditions and post-retrofit conditions. Baseline conditions were determined from the rebate documentation, utility inspections, and information provided by the installation contractor. We used either actual lamp/ballast performance data or typical wattage values for calculating energy use. To estimate lighting run time, we gathered information from the site regarding hours of operation, occupancy hours, and type/use of lighting controls.

3.4 RELIABILITY

Energy savings cannot be measured directly. Energy savings estimates are a predictor of the absence of energy use – they account for the difference between how energy-consuming systems and equipment operated beforehand (baseline conditions) and how they operate after being upgraded (post-retrofit conditions). Therefore, estimating energy savings is challenging under any circumstances. To assess the reliability of the verified energy savings presented in this report, ERS reviewed all potential sources of error associated with our evaluation efforts. Overall, we find the verified savings presented in this report to be a reasonably accurate and precise estimate of the energy savings achieved by program participants.

[3] *2009 Measure Quantification Methodology Statewide Savings and Cost,* prepared for NCPA and SCPPA Members, KEMA, Inc.

The following is a list of the potential sources of error:

Baseline conditions – Although ERS was unable to directly verify baseline conditions, Lompoc pre-inspected each site and provided ERS with the all project documentation. In addition, ERS obtained information about the pre-retrofit lighting fixtures from the installation contractor.

Baseline lighting fixture wattage – The installation contractor reported that all sites used 40 W lamps with magnetic ballasts. ERS also visually confirmed that 40 W lamps were still in use in fixtures that were not retrofitted.

Lighting operating hours – Lighting run time is often the largest variable associated with the estimated energy savings from a lighting retrofit. No time-series measurements were taken in this evaluation effort to assess lighting run time. In lieu of measured data, ERS estimated run time by gathering information from site personnel regarding business hours of operation, occupancy hours, lighting controls, space end use, and seasonal schedule variations. We also factored into our estimate observations made on-site.

3.5 PROGRAM INFLUENCE (NET-TO-GROSS ENERGY SAVINGS)

It is important to understand and properly reflect the influence of utility energy efficiency programs. Program influence is typically reported as net energy savings. Net energy savings is the fraction of the total energy savings that are considered attributable to the program. To determine net energy savings, a net-to-gross (NTG) factor is used to adjust gross energy savings for free ridership and spillover. Free ridership describes program participants who would have implemented energy efficiency in the absence of the program, and spillover describes the program's ability to indirectly influence behavior (customer or market behavior) leading to increased energy efficiency.

Program influence is difficult to assess, and the results of efforts to quantify this influence have a high degree of uncertainty. Given this uncertainty and the relatively high cost to conduct primary research on program influence, ERS recommends that Lompoc use stipulated NTG factors for reporting program net savings.

To assist publicly owned utilities (POUs), the E3 tool includes stipulated NTG factors from large investor-owned utilities (IOU) programs. Although the scale and program delivery for these larger IOU programs can greatly differ from POU programs, there are few other readily available resources. Therefore, ERS recommends using the NTG factors included in the E3 tool. For lighting programs, the NTG factor is 78%.

Site Verification Results

4

ERS evaluated eight project sites. This section provides the results of the site evaluations.

4.1 RESULTS

Table 4-1 summarizes the energy savings for the eight sites evaluated. Energy savings reported by Lompoc are compared to the energy savings verified by ERS.

Table 4-1
Site 1 Results

Measure Name		Energy Savings (kWh)	Demand Reduction (kW)
Site 1: Retail office supply	Reported	23,941	5.0
	Evaluated	23,851	5.4
	Realization rate	100%	107%
Site 2: Appliance store	Reported	1,877	0.46
	Evaluated	3,459	0.99
	Realization rate	184%	216%
Site 3: Fast food	Reported	5,164	0.95
	Evaluated	12,459	2.3
	Realization rate	241%	240%
Site 4: Liquor store	Reported	1,002	0.24
	Evaluated	3,932	0.65
	Realization rate	392%	269%
Site 5: Automotive shop	Reported	2,260	0.68
	Evaluated	4,398	1.6
	Realization rate	195%	230%

Measure Name		Energy Savings (kWh)	Demand Reduction (kW)
Site 6: Woodworking shop	Reported	5,040	1.5
	Evaluated	7,541	3.5
	Realization rate	150%	230%
Site 7: Retail	Reported	3,648	0.89
	Evaluated	7,570	2.0
	Realization rate	208%	223%
Site 8: Dentist's office	Reported	3,559	0.98
	Evaluated	6,277	2.1
	Realization rate	176%	210%

4.2 SITE VISIT

Date of site visit: October 24 & 25, 2011

The eight sites visited consisted of an office, retail, grocery, restaurant, and light industrial use. The largest site was a retail office supply store. All projects were lighting retrofits, primarily consisting of replacing T12 lamps and magnetic ballasts with T8 lamps and electronic ballasts.

ERS visited each site and counted each fixture retrofitted. The fixtures were visually inspected to verify installation of new lamps and ballasts. Site personnel were interviewed to determine lighting baseline and operating characteristics.

4.2.1 KEY FINDINGS

- ERS found that all sites were accurately represented in the utility's rebate documentation.
- The T8 lamps installed were 700 series lamps. These are considered first-generation or standard lamps. Often, utilities require that the latest generation of lamps (high-performance lamps) be installed; however, Lompoc has no such requirement.
- For five sites, lighting run time hours determined by ERS closely match the typical run time hours found in the KEMA study. One site had significantly longer run time and one site has significantly less. For the retail office supply store, lighting run time determined by ERS was slightly lower than the run time estimated by the installation contractor (which was used for reported savings).
- At the retail office supply store, ERS found more fixtures than reported in the customer-supplied spreadsheet. The vendor's equipment invoice also indicated that more fixtures were retrofitted than reported.

- At the liquor store, one retrofitted two-lamp fixture was not operating and appeared not to be electrically connected. Also, ERS determined that one installed 2-foot lamp was reported as a 4-foot lamp in the rebate documentation.
- The woodworking shop had five fixtures installed in a storage area with low operating hours.
- At the appliance store, the installation of an occupancy sensor was reported, but none was identified during the site visit.

4.3 SAVINGS ANALYSIS

As outlined in Section 3 of this report, ERS used the energy savings and demand reduction methodologies described in the KEMA study. Baseline fixture wattages were confirmed to be 40 W T12 lamps with magnetic ballasts. The wattage for the installed lamps and ballast combination were obtained from manufacturer data.

To estimate lighting run time, ERS gathered information from site personnel regarding business hours of operation, occupancy hours (e.g., how early does staff arrive at work), lighting controls (e.g., manual switches, bi-level switching), space end use, and seasonal schedule variations (e.g., holiday schedules). We also factored into our estimate observations made while on-site (e.g., is all lighting on during the day, are sections of lighting turned off, are space end uses as described).

4.3.1 EXPLANATION OF DEVIATION FROM REPORTED SAVINGS

For sites 2 through 8, there are significant differences between the reported savings and those verified by ERS. Almost all of the difference is due to the differences between lamp wattage reduction assumed in the KEMA study (the basis of the E3 tool savings values) and the actual wattage reductions verified by ERS.

The verified demand reductions are based on the actual number of lamps per fixture found at the site. Baseline lamps were determined to be 40 W T12 lamps and replacement T8 lamp/ballast wattages were determined from the installed lamp's manufacturer data sheets.

Reported savings are based on values provided in the E3 tool. These values are taken from the KEMA study, which provide average values weighted by assumed percentages of typical lamps per fixture. In addition, the baseline lamps are referenced as "typical industry values" and generally equate to the wattage of a 34 W, energy-saver T12 lamp. In some instances, the baseline wattage is even lower. The source of the baseline wattage is not identified. Table 4-2 shows the data for 4-foot lamp fixtures from the KEMA study (Table 130, page 118) used to determine the average wattage reduction per lamp used in the E3 tool.

Table 4-2
KEMA Study Baseline Savings per Lamp Assumptions

Fixture Configuration	Base Fixture Wattage	Retrofit Fixture Wattage	Demand Savings per Fixture (kW)	Demand Savings per Lamp (kW)	Weight Percentages
4-foot lamps					
4-foot, four-lamp	144	104	0.04	0.010	36%
4-foot, three-lamp	103	87	0.016	0.005	16%
4-foot, two-lamp	72	58	0.014	0.007	32%
4-foot, one-lamp	43	34	0.009	0.009	16%
Weighted average (used for all fixture configurations)				**0.008**	

For comparison, Table 4-3 shows the values from the evaluated projects and compares them to the KEMA/ E3 savings values.

Table 4-3
Verified Savings per Lamp

Fixture Configuration	Base Fixture Wattage	Retrofit Fixture Wattage	Demand Savings per Fixture (kW)	Demand Savings per Lamp (kW)	As a Percent of KEMA Study Weighted Average
4-foot lamps					
4-foot., four-lamp (40 W T12)	188	112	0.076	0.019	238%
4-foot., three-lamp (40 W T12)	135	86	0.049	0.016	204%
4-foot., two-lamp (40 W T12)	96	59	0.037	0.019	231%
4-foot, one-lamp (40 W T12)	57	30	0.027	0.027	337%

Results for All Projects

5

To determine the verified savings for all twenty-six projects, ERS expanded the results of the eight sample sites (see Section 3 regarding sampling methodology) to all projects using a weighted average realization rate. Table 5-1 shows the verified savings results.

Table 5-1
Verified Savings

Measure		Energy Savings (kWh)
Twenty-six lighting retrofit projects	Reported	81,004
	Evaluated	154,603
	Realization rate	191%
Precision (at the 90% confidence level)		15.1%

As discussed in Section 4, the primary driver for the high realization rate is the differences between the underlying assumptions used for reported savings and the actual conditions found at the sample sites.

Recommendations

6

Based on the finding of this evaluation effort, ERS offers the following recommendations to Lompoc regarding T12 lighting retrofits:

- Use the verified energy savings for reporting the energy savings results of the twenty-six lighting retrofit projects. We suggest that all projects be reported as a single custom measure in the E3 tool.
- Continue to target T12 lamps for replacement until the federal deadline arrives. Federal legislation on general-service fluorescent lamps becomes effective on July 14, 2012, which essentially eliminates the availability of most T12 and first-generation T8 lamps as replacements. At that time, utilities may no longer be able to claim savings for a standard T12-to-T8 lighting retrofit.
- Capture baseline T12 lamp characteristics during project pre-inspections by taking a digital picture of the lamp's standardized code, which can be found near one end of the lamp. Most digital cameras have zoom features that will allow you to obtain lamp information without using a ladder.
- Specify high-performance or the latest generation of T8 lamps as a requirement for rebate eligibility. The latest generation of lamps has superior performance characteristics to that of first-generation T8 lamps.
- For future efficiency program offerings, consider providing rebates for T12/first-generation T8 lamps replaced by reduced wattage (25 W or 28 W) high-performance T8 lamps and premium-efficiency ballasts.
- Also consider offering rebates for lighting redesign efforts that take advantage of the performance of the latest generation of fixtures, lamps, and ballasts.

Appendix A

A

On-site Measurement and Verification Plan

1. Objectives and Methodology

1.1 M&V Objectives

- ❑ Determine if the energy saving measures are installed and operating properly.
- ❑ Verify energy savings, using best available information.

1.2 Sampling Methodology

- ❑ Census – count all measures installed.

2. Lighting Retrofit Projects

- ❑ To determine the number of lamps installed, count and verify the quantity of lighting fixtures retrofitted.
  - 3 ft., X-lamp, T8 lamps and electronic ballasts
  - 4 ft., X-lamp, T8 lamps and electronic ballasts
  - 8-ft., X-lamp T8 lamps and electronic ballasts
  - Occupancy sensors
- ❑ Verify lamp and ballast type installed by inspecting at least one lamp and ballast of each retrofit type at each site.
- ❑ Interview staff to determine:
  - If fixtures were de-lamped (what was original lamp count?)
  - Type of lamp replaced (T12?)
  - Type of lighting control (time clock, manual switch, etc)
  - Operating hours (occupancy hours, lighting control schedule, etc)
  - End use type served by lighting (office, retail, etc)

- Determine energy savings:
  - Use KEMA study energy savings formula: kwh = delta watts x operating hours x interactive effects
  - Based on baseline and retrofit data obtained from site visit
  - Lamp wattage: use either standardized lamp/ballast wattages for both baseline and retrofit measures, or actual lamp/ballast wattages for both baseline and retrofit measures (Source: IOU statewide customized offering program, ERS database, actual lamp ratings)
  - Operating hours: use KEMA study/E3 Reporting Tool end use operating hours, adjusted as necessary based on operating schedule data obtained on site