NAVIGANT CONSULTING

ENERGY EFFICIENCY PROGRAM EVALUATION, VERIFICATION, AND MEASUREMENT STUDY

FY 2010- Energy Efficiency Programs

Prepared for:

The City of Lompoc

NAVIGANT CONSULTING

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Introduction

Two legislative bills (SB1037 and AB2021) were signed into law a year apart. SB1037 requires that the Publically Owned Utilities (POUs), similar to the Investor Owned Utilities (IOUs), place cost effective, reliable, and feasible energy efficiency and demand reduction resources at the top of the loading order. Additionally, SB1037 (signed September 29, 2005) requires an annual report that describes the programs, expenditures, expected energy savings, and actual energy savings.

Assembly Bill 2021, signed by the Governor a year later (September 29, 2006), reiterated the loading order and annual report stated in SB1037 as well as expanding on the annual report requirements. The expanded report must include investment funding, cost-effectiveness methodologies, and an independent evaluation that measures and verifies the energy efficiency savings and reductions in energy demand achieved by the energy efficiency and demand reduction programs. AB2021 additionally requires a report every three years that highlights cost-effective electric potential savings from energy efficiency and established annual targets for energy efficiency and demand reduction over 10 years.

The legislative reports require both an on-going assessment of what is occurring within the programs along with a comparison of how much possible savings are left within the POU service territory. This report provides the third party independent evaluation of the City of Lompoc's 2010 electricity conservation programs.

Objectives

The goals of the EM&V effort at the City of Lompoc are to provide unbiased, objective and independent program evaluations by giving:

- Useful recommendations and feedback to improve City of Lompoc programs.
- Assessment of conservation program effectiveness.
- Assessment of the quality of the program data for impact evaluation purposes.
- Increased level of confidence in conservation program results through transparent protocols.

General Utility Background Information

Lompoc is a municipal utility established in 1923. It serves 14,700 customers, of which 90 percent are residential. Residential customers account for 44 percent of the total electric sales while the commercial customers use 21.5 percent; industrial and demand customers 25.5 percent, and municipal facilities 9.0 percent.

Lompoc is a winter peaking utility with a peak demand of about 26 MW.

Although Lompoc serves both residential and commercial sectors, 90 percent of its customers are residential. The majority of the energy efficiency programs focus on rebates to increase appliance efficiency for this large sector

Efficiency Programs Offered

Lompoc initially implemented energy audit programs in 1981. In 1991, the programs were expanded to include energy efficiency education programs. In 2001, energy efficiency rebates and a low-income refrigerator subsidy program were added. Since then, additional programs have been added and existing programs modified to accommodate the community's needs.

Current Residential Customer Programs:

- Refrigerator Rebate: A $144 rebate is paid to electric customers or landlords who rent to City customers to replace working refrigerators or freezers manufactured before 1992 with a new model. The old appliance must be recycled at the City Landfill.
- Refrigerator BuyBack Program: $35 is paid to customers who recycle, at the Landfill, any second working refrigerator.
- Clothes Washer Rebate: A $120 rebate is paid to customers who replace a working (non Energy Star®®) clothes washer with a new Energy Star®® model. The old clothes washer must be recycled at the Landfill.
- Dishwasher Rebate: A $50 rebate is paid to electric customers who replace working dishwashers, which were manufactured before 1994, with an Energy Star®® model. The old dishwasher must be recycled at the Landfill.
- LED Holiday Lighting: A rebate of $4 for up to a 69 light strand and $8 for larger strands is paid to utility customers who purchase LED holiday lighting.
- Electric Dryer and Water Heater Conversion Rebate: For customers with existing electric dryers and/or electric water heat, a $100 rebate is provided to convert to gas.
- Solar PV Rebate: Any electric customer who installs a photovoltaic system that meets all criteria as defined by Lompoc City Electric interconnection agreement for self-generating electric systems and the requirements set forth by the California Energy Commission, will receive a rebate of $3.00 per watt. Non-profit organizations will receive a rebate of $3.50 per watt.
- Energy Audits: Lompoc provides free on-line energy audits.

Current Low Income Customer Programs:

- Income Qualifying Refrigerator Purchase Program: Up to a $600 payment is made for a new refrigerator for income qualifying customers. The old refrigerator must be in working order and

have been manufactured before 1992, and will be recycled at the landfill. The customer is required to repay the City $240 over a one-year time period.

- Rate and Energy Assistance Programs: Lompoc offers a rate discount for low-income customers and a special medical needs rate.

Current Commercial Customer Programs:

- Commercial Lighting Rebate: The City will provide rebates for more energy efficient lighting. A pre and post installation inspection is required.
- Exit Sign Rebate: A rebate is provided to replace existing incandescent or fluorescent-lit exit signs with LED or with electro-luminescence signs.
- Custom Rebate: Any energy efficient retrofit not covered under other program offerings may qualify for a $0.15 per watt saved rebate.
- Energy Audits: Lompoc provides free audits to small businesses.

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FY 2010 *Ex Ante* Gross Energy Savings

Table 1 identifies the City of Lompoc's 2010 *ex ante* gross electricity program savings as identified in the E3 model supplied to Navigant. It should be noted that this version of E3 was not finalized and some of the errors found by Navigant may be only be the result of the draft nature of the E3 input and output.

As can be seen in the table, over 60% of the *ex ante* gross savings comes from the Residential Refrigerator Program followed by the Commercial Lighting Program. The remaining combined programs account for only 1% of the savings.

Table 1. FY 2010 *Ex Ante* Gross Electricity Savings

	Electricity Savings (kWh)			
Program	Residential	Commercial	Total	Percent
Clothes Washers	2,880	0	2,880	1%
Dish Washers	432	0	432	0%
Lighting	20,032	56,222	76,254	32%
Refrigeration	156,382	0	156,382	66%
Totals	**179,726**	**56,222**	**235,948**	

Evaluation Priorities

Both the FY 2008 and FY 2009 electricity EM&V studies focused on the Residential Refrigeration Program. The per unit impacts included for the Lompoc Refrigeration Program reflect the findings from these earlier EM&V efforts. For FY 2010, focus is directed at the next largest program in terms of *ex ante* gross electricity savings. This is the Commercial Lighting Program.

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Impact Evaluation Plan

A useful construct for thinking about the range of efficiency measures offered by the City of Lompoc is the International Performance Measurement and Verification Protocol (IPMVP). Table 2 presents a listing of the IPMVP 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. Our approach to selecting M&V strategies followed these guidelines.

Table 2. Overview of M&V Options

IPMVP M&V Option	Measure Performance Characteristics	Data Requirements
Option A: Engineering calculations based on spot or short-term measurements, and/or historical data. Deemed energy savings fall in this Option.	Constant performance	» Verified installation » Nameplate or stipulated performance parameters » Spot measurements » Run-time hour measurements
Option B: Engineering calculations using metered data.	Constant or variable performance	» Verified installation » Nameplate or stipulated performance parameters » End-use metered data
Option C: Analysis of utility meter (or sub-meter) data using techniques from simple comparison to multi-variate regression analysis.	Variable performance	» Verified installation » Utility metered or end-use metered data » Engineering estimate of savings input to SAE model
Option D: Calibrated energy simulation/modeling; calibrated with hourly or monthly utility billing data and/or end-use metering	Variable performance	» Verified installation » Spot measurements, run-time hour monitoring, and/or end-use metering to prepare inputs to models » Utility billing records, end-use metering, or other indices to calibrate models

The focus of the impact evaluation for FY 2010 is on the Commercial Lighting Program. The program consisted of offering incentives for the following measures:

- Replace T12 with T8 lamps in four foot and eight foot fixtures.
- De-lamp fluorescent fixtures.
- Replace mercury vapor fixtures with high pressure sodium fixtures.
- Provide occupancy sensors

The program utilized both public benefit and ARRA funds. Option "A" was used as the evaluation methodology. All program participants were included in the evaluation.

Gross Impact Evaluation

The methodology employed to measure and verify electricity savings attributed to the Commercial Lighting Program included the following activities:

1. Verify that the correct deemed per unit impact estimates are used.
2. Verify that the numbers of measures claimed were installed and reported correctly in E3.
3. Developed adjusted measure savings values based on these verified values.

All program participants were included in the evaluation. Each of the measures employed deemed energy savings. The deemed energy saving values used to calculate the *ex ante* measure savings were verified as being correct.

Measure Installation Verification

The universe of all Commercial Lighting Program measures, 627 fixtures, was included in the verification process. Since the utility is small and the measures all have deemed impact values, the paper verification method was employed. Navigant requested and received from the City of Lompoc detailed invoices for all participants. These invoices were reviewed and the invoiced measures checked against the number of claimed measures.

Table 3. Commercial Lighting Program Measures Claimed vs. Verified

Measure	Fixtures	Lamps/ Devices	Claimed E3 Lamps/ Devices	Lamp/Device Realization Rate
8 foot 3 lamp	0	0		
8 foot 2 lamp	213	426		
8 foot 1 lamp	101	101		
TOTAL 8 Foot	314	527	454	116%
4 foot 4 lamp	154	616		
4 foot 2 lamp	120	240		
4 foot 1 lamp	9	9		
TOTAL 4 Foot	283	865	665	130%
Delamp 8 Foot	7	7	14	50%
Delamp 4 Foot	2	2	0	New
Occupancy Sensor	16	16	13	123%
HPS 50W	5	5	9	56%

As seen in Table 3, discrepancies were found between the measures found through the review of the invoices and those claimed within E3 for Commercial Lighting Program measures. Many of the discrepancies were caused by mismatching units. For instance, the linear fluorescent unit of measure in E3 is per lamp, but sometimes per fixture values were input.

Review of Other E3 Inputs

In addition to doing a paper verification of the Commercial Lighting Program, the E3 inputs were checked for general reporting accuracy across all measures. An error was found in the reported values for low income refrigerators. The number of low income participants was mistakenly entered three times.

Program Record Observations

In Navigant's initial request for hard copy invoices, it was found that the City of Lompoc had not kept copies of the invoices. Copies of the invoices needed to be requested from the vendors and these were then supplied to Navigant for its review. In the future, copies of invoices should be kept on file. Additionally, the way de-lamping information was identified on the invoices was sometimes difficult to follow. Greater effort needs to be made to insure that the dollar value for the units incented is consistent with the number of units identified.

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Gross Impact Evaluation Results

Table 4 identifies by measure the *ex ante* and, based on verification realization rates, the *ex post* gross energy impacts. The overall verification based realization rate is 82%. The biggest change is for low income refrigerators where an input error was found.

Table 4. Claimed Savings and Verified Gross Savings

Measure	*Ex Ante* Gross Savings (kWh)	Verification Realization Rate	*Ex Post* Gross Savings (kWh)
Clothes Washers	2,880	100%	2,880
Dishwashers	432	100%	432
Energy Star Refrigerators	22,268	100%	22,268
Low Income Refrigerators	83,844	33%	27,948
Refrigerator Recycling	36,974	100%	36,974
Freezer Recycling	13,296	100%	13,296
Residential Energy Audits	27,064	100%	27,064
Holiday LED Lights	20,032	100%	20,032
Four Foot - Linear Fluorescent	24,605	130%	32,005
Eight Foot - Linear Fluorescent	20,430	116%	23,715
De-lamping 8 Foot	4,844	50%	2,422
De-lamping 4 Foot	0	New	470
Occupancy Sensors	3,094	123%	3,808
HID Fixtures	3,249	56%	1,805
Total	**263,012**	**82%**	**215,119**

Net-to-Gross Assessment

Directly estimating net impacts was not part of the scope for this project. Rather, the approach to identifying appropriate net-to-gross values is to rely on the extensive number of net-to-gross assessments conducted primarily for the investor owned utilities (IOUs) in California. These studies relied on larger sample populations and they provide reasonable estimates of net-to-gross ratios (NTGR) for the City of Lompoc. Using these outside studies also allows the City of Lompoc to save valuable budgetary resources.

The Lompoc energy efficiency programs include the list of measures that follow. An *ex ante* NTGR of 0.8 is used for each of these measures.

- Clothes washers
- Dishwashers
- Energy Star® refrigerators
- Low income refrigerators
- Refrigerator recycling
- Freezer recycling
- Residential energy audits
- Holiday LED lights
- Linear fluorescent lighting
- De-lamping
- Occupancy sensors
- HID fixtures

The on-line searchable database for the California Measurement Advisory Council (CALMAC) was used as the source for the studies included in this NTGR literature review. The *ex post* estimates for NTGR are be drawn from these sources when appropriate.

Residential

Recent low income program evaluations have not included assessment of NTGR. This is because, as noted in 2003 KEMA-EXENEGY low income program impact study[1] and accepted by the CPUC, net savings from the LIEE program are assumed to be equal to gross savings.

[1] *Impact Evaluation of the 2001 Statewide Low-Income Energy Efficiency (LIEE) Program*, prepared for the California Investor Owned Utilities, prepared by KEMA-EXENERGY Inc et.al., April 8, 2003

Three recently completed studies included NTGR evaluations for a number of residential measures. Included in the evaluation sample were participants from the California Investor Owned Utilities. Table 5 identifies the NTGR values estimated by measure for each of the three studies. The table also includes a recommended NTGR value for the measures. The recommended values are an average of the findings.

A study conducted for the Northern California Power Agency[2] included evaluating Energy Star® refrigerators. The estimated NTGR from this study for Energy Star® refrigerators was 80%.

Table 5.Range of Residential NTGRs

Measure	*CADMUS Study*	*ITRON Study*	*ADM Study*	*Recommended NTGRs*
Clothes washers	29%-31%	81%	NA	56%
Dishwashers	24%	41%	NA	32%
Refrigerator recycling	51% - 58%	NA	50% - 66%	56%
Freezer recycling	NA	NA	61% - 75%	68%

No studies could be found that included a NTGR assessment for holiday lights or residential home energy audits. Therefore, there is no basis to change the current estimate of 80% NTGR.

Commercial

A good source for commercial sector lighting measure net-to-gross assessment is the 2010 report "Small Commercial Contract Group Direct Impact Evaluation Report".[3] This report presented the evaluation results for the 2006-2008 nonresidential energy efficiency high impact lighting measures (HIMs)and several non-HIM measures, both lighting and non-lighting. These measures were offered by programs implemented by Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), Southern California Gas (SCG), San Diego Gas and Electric (SDG&E) and third party implementers for the 2006-2008 program cycle.

The net-to-gross analyses are based on a self-report methodology that estimated four separate measurements of free ridership from different inquiry routes and then averaged the values to derive the final free ridership estimate at the measure level. The net-to-gross estimates often varied widely by utility within the same measure classification. No reasons were provided for the variance between the

[2] *Measurement & Verification Load Impact Study for NCPA SB5X Miscellaneous Rebate Programs*, prepared for the Northern California Power Agency, prepared by Robert Mowris & Associates, June 25, 2005

[3] *Small Commercial Contract Group Direct Impact Evaluation Report*, CALMAC Study ID: CPU0019:01, prepared for the California Public Utilities Commission Energy Division, prepared by Itron, Inc et. al., February 9, 2010

utilities. Below are the estimates of net-to-gross by measure classification by utility and an overall weighted average across the utilities.

- Linear fluorescent lighting:
  - PG&E - 73%
  - SCE – 79%
  - SDG&E – 87%
  - Weighted (by savings) average – 81%
- High bay lighting:
  - PG&E - 68%
  - SCE – 68%
  - SDG&E – 95%
  - Weighted (by savings) average – 74%
- Occupancy Sensors
  - PG&E - 68%
  - SDG&E – 75%
  - Weighted (by savings) average – 72%

Finding studies that provide recent estimates of NTGR for de-lamping and HID fixtures were scarce. The above value for high bay lighting could be used as a proxy for HID fixtures. De-lamping was lumped into an indoor lighting category in a dated (February 1996) study by Quantum Consulting for PG&E's 1994 commercial lighting technology evaluation. In this evaluation report[4] the NTGR for the indoor lighting measures was estimated to be 67%.

[4] *1994 Commercial Retrofit Program Evaluation of Lighting Technologies*, prepared for Pacific Gas & Electric Company, prepared by Quantum Consulting Inc., February, 1996

Ex Post Gross and Net Impacts

Table 6 identifies by measure the *ex ante* and *ex post* gross and net measure impacts from the City of Lompoc's energy conservation programs. The largest single measure, both *ex ante* and *ex post* is refrigerator recycling. Through verification, the gross program realization rate is 82%. By using the revised NTGRs, the average *ex post* NTGR is 77%.

Table 6. *Ex Ante* and *Ex Post* Gross and Net Program Impacts

Measure	*Ex Ante* Gross Savings (kWh)	Verification Realization Rate	*Ex Post* Gross Savings (kWh)	*Ex Ante* NTGR	*Ex Post* NTGR	*Ex Ante* Net Savings (kWh)	*Ex Post* Net Savings (kWh)
Clothes Washers	2,880	100%	2,880	80%	56%	2,304	1,613
Dishwashers	432	100%	432	80%	32%	346	138
Energy Star Refrigerators	22,268	100%	22,268	80%	80%	17,814	17,814
Low Income Refrigerators	83,844	33%	27,948	80%	100%	67,075	27,948
Refrigerator Recycling	36,974	100%	36,974	80%	56%	29,579	20,705
Freezer Recycling	13,296	100%	13,296	80%	68%	10,637	9,041
Residential Energy Audits	27,064	100%	27,064	80%	80%	21,651	21,651
Holiday LED Lights	20,032	100%	20,032	80%	80%	16,026	16,026
Four Foot - Linear Fluorescent	24,605	130%	32,005	80%	81%	19,684	25,924
Eight Foot - Linear Fluorescent	20,430	116%	23,715	80%	81%	16,344	19,209
De-lamping 8 Foot	4,844	50%	2,422	80%	67%	3,875	1,623
De-lamping 4 Foot	0	New	470	80%	67%	0	315
Occupancy Sensors	3,094	123%	3,808	80%	72%	2,475	2,742
HID Fixtures	3,249	56%	1,805	80%	74%	2,599	1,336
Total	**263,012**	**82%**	**215,119**	**80%**	**77%**	**210,410**	**166,085**

Of particular interest are the low NTGR values for dishwashers. The City of Lompoc may want to drop this measure from its portfolio of measures offered. A possible new measure is LED lamps, which are currently being offered through the City of Palo Alto's programs.