Process Evaluation of Lodi Electric Utility's Efficiency Programs and Impact Evaluation of the Non-Residential Custom Program - Lighting and Appliance Rebate Program: FY 2007/08

Submitted To:

Lodi Electric Utility

Final Report

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TABLE OF CONTENTS

1 EVALUATION OVERVIEW

1.1 Current Program Offerings

Since 1998, Lodi has spent more than $6.5 million on demand-side management rebates and programs designed to increase energy efficiency for the community, resulting in a 14% peak demand reduction and a 10%energy reduction.

Efficiency Program Summaries

Current Residential Customer Programs:

- *Lodi Appliance Rebate Program:* Provides rebates to all customers who purchase an ENERGY STAR ® refrigerator, dishwasher and or front-loading clothes washer.

- *Lodi Energy Efficient Home Improvement Rebate Program:* Provides rebates to customers who install qualifying measures as described next. Rebates are capped at a per customer amount of either $350 per customer, until funds are exhausted, plus an additional $250 allowance for air duct repairs, OR an additional $700 allowance for air duct replacement, if eligible.
    - **HVAC Replacement** - customers that purchase and install new heating, ventilation and air conditioning (HVAC) with a high efficiency seasonal energy efficiency rating (SEER) can receive a rebate: $175 for a 14+ SEER HVAC unit or 13 SEER rooftop unit with variable speed drive or $275 for installation of an ultra-high efficiency of 17+ SEER HVAC unit. (Requires participation in the HVAC System Performance Test.);
    - **Attic Insulation**- a rebate of $0.15 per square foot is available if customer installs attic insulation up to an R-38 (energy efficiency) value;
    - **Radiant Barrier/Thermal Shield -** a maximum rebate of $150 for radiant barrier/thermal shield is available;
    - **Wall Insulation** - a rebate of $0.15 per square foot is available if customer installs wall insulation with an R-8 or greater energy efficiency value;
    - **Air Duct Repairs** - a maximum rebate of $250 is available if customer has leaky or damaged air ducts repaired (Requires participation in the HVAC System Performance Test.);
    - **Air Duct Replacement** - a maximum rebate of $700 (Requires participation in the HVAC System Performance Test.);
    - **Whole House Fan** - install a whole house fan in home and receive a rebate of $100;
    - **Attic Fan** - install an attic fan and receive a rebate of $40;
    - **Shade Screen/Window Tinting** - install shade screens or window tinting and receive a rebate of $0.50 per square foot. *Note: the shade screen or window tinting must block at least 70% of the solar heat gain or sun's rays and the shade screens or window tinting must cover (at a minimum) the west and south facing windows of the home.*

- *HVAC System Performance Test:* Provides a rebate for customers who utilize a select list of HVAC contractors capable of performing a high-end duct system performance test (the test measures air flow, air return, and system balance).

Current School (In-Classroom) Programs:

- *Lodi LivingWise Program:* Provides energy efficiency "kits" and manuals to 425 6th grade students in Lodi schools; the program is designed to teach the students the basics of energy and water conservation.

- *Lodi Solar Schoolhouse Program:* Provides teacher mini-grants and teacher training regarding solar/renewable energy resources; also via this program, sponsors the annual Lodi Solar Olympics (the event, held each May, features solar-powered model race cars, fountains, ovens, and model homes built by area students).

Current Low-Income Residential Programs:

- *Lodi C.A.R.E. Package Program:* Provides grants to very low-income customers in need of assistance paying their electric utility account; the program coordination/customer screening is performed by the Lodi Salvation Army. In order to secure a grant payment, customers must consent to in an in-home energy audit.

Current Commercial/Industrial Customer Programs:

- *Lodi Energy Audit Program:* Lodi offers on-line and on-site residential energy audits as well as on-site small commercial customer energy audits.

- *Commercial (G-1 & G-2) Rebate Program:* Provides rebates for small and medium-sized commercial customers who install designated energy efficiency measures, such as: attic insulation, window tinting/shade screens, programmable thermostats, ceiling fans, appliances, high efficiency lighting retrofits, and maintenance of refrigeration/HVAC equipment.

- *Lodi Commercial/Industrial (G-3 to I-1) Rebate Program:* Provides rebates of up to $12,500 to large commercial and industrial customers; the rebate is for pumps/motors, process equipment improvements, building envelope improvements, HVAC/chiller replacements, and high efficiency lighting retrofits.

1.2 Evaluation Priorities

In 2008, it is estimated that over 90% of Lodi's net annual energy savings will come from non-residential energy efficiency program. Nearly 80% of the energy savings from non-residential projects is expected to be from lighting measures. Because of these high savings estimates, the non-residential energy efficiency program has the highest priority for receiving an independent impact evaluation. The highest priority is with the lighting measures, and this report will discuss the findings from Summit Blue's impact evaluation of Lodi's non-residential lighting program. A later report will focus on Lodi's non-residential refrigeration program, which accounted for about 20% of the estimated 2008 energy savings from the non-residential program offerings.

In addition to impact evaluation, the Summit Blue team also performed a process evaluation. Unlike the impact evaluation, which focused on non-residential lighting, the process evaluation encompassed the entire City of Lodi conservation program efforts.

2 PROCESS EVALUATION

2.1 Background and Objectives

The Summit Blue Team completed a process evaluation of Lodi's efficiency programs, which consisted of the following activities:

a. A review of the database tracking system to streamline program reporting and enhance comparison between and among programs.

b. A review of the measures targeted in Lodi's residential portfolio to determine cost-effectiveness and identify potential alternative measures.

The scope of this process evaluation included:

- Reviewing the databases used to track Lodi's residential energy efficiency programs,
- Completing staff interviews with key program management and conducting "mystery shopping" at a local appliance dealer.
- Assessing the measures currently included in Lodi's energy efficiency portfolio, and
- Identifying alternative measures for Lodi to consider offering to its residential customers.

Since 1998, Lodi has spent more than $6.5 million on demand-side management rebates and programs designed to increase energy efficiency for the community, resulting in a 14% peak demand reduction and a 10% energy reduction.

2.2 Findings

Based on a review of the program records and materials provided by Lodi staff, it is recommended that Lodi conducts a process evaluation all of its energy efficiency programs. Based on this preliminary analysis of its programs, it is most critical for Lodi to review the cost-effectiveness of the measures rebated in this programs.

2.2.1 Tracking Systems Review

A preliminary review of the program database for PY 2007 revealed that Lodi has spent more than $213,000 in rebates for its residential and commercial programs. The rebates range in amount for $25.00 to $14,840. The program records also revealed that total number of rebates paid by program category and also by measure.

Table 1. Summary of Rebate Payments for PY 2007

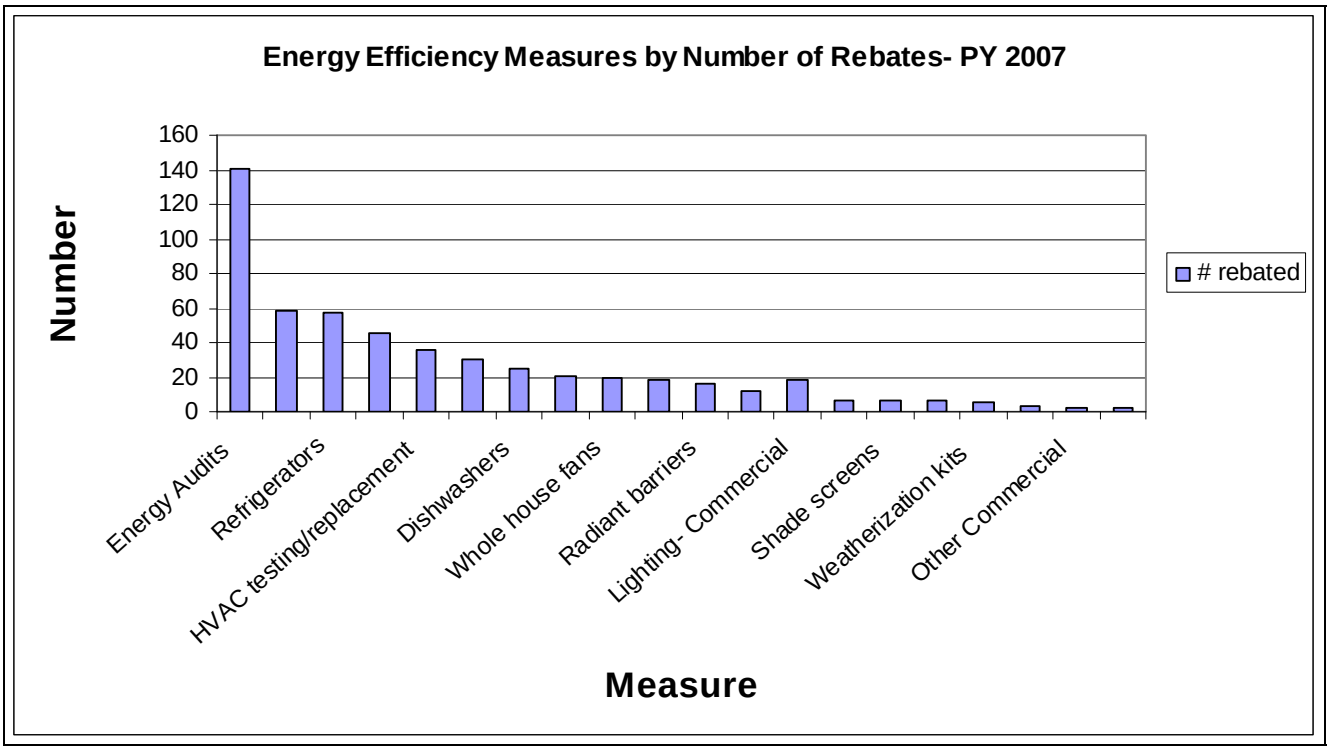
Program Area	# Measures	Total
Lodi Residential Programs	529	$94,336.39
School Lighting Kits	3	$19,899.64
Commercial Lighting	18	$92,646.06
Other Commercial	2	$6,619.38
Total	552	$213,501.47

The residential programs paid out more than 500 rebates but at much lower rebate amounts compared to the Commercial programs (as shown in Table 1). Table 2 illustrates that the commercial lighting program constituted the single largest amount of rebates paid but to only 18 customers. Figure 1 illustrates these results across all measure categories, while Figures 2 and 3 focus on the findings Lodi's two largest residential programs.

Table 2. Program Totals for Lodi's Non-Residential Programs

Program Area	# Measures	Total
Other Commercial	2	$6,619.38
School Lighting Kits	3	$19,899.64
Commercial Lighting	18	$92,646.06
Total	23	$119,165.08

Figure 1. Summary of Lodi's Energy Efficient Rebates by Measure-PY 2007



Summary of Rebates by Program Area

The current database provides a comprehensive listing of all measures. However, it is more meaningful to identify rebates by specific energy efficient program, as shown in Figures 2 and 3.

Figure 2. Rebates by Measure for the EE Home Improvement Program

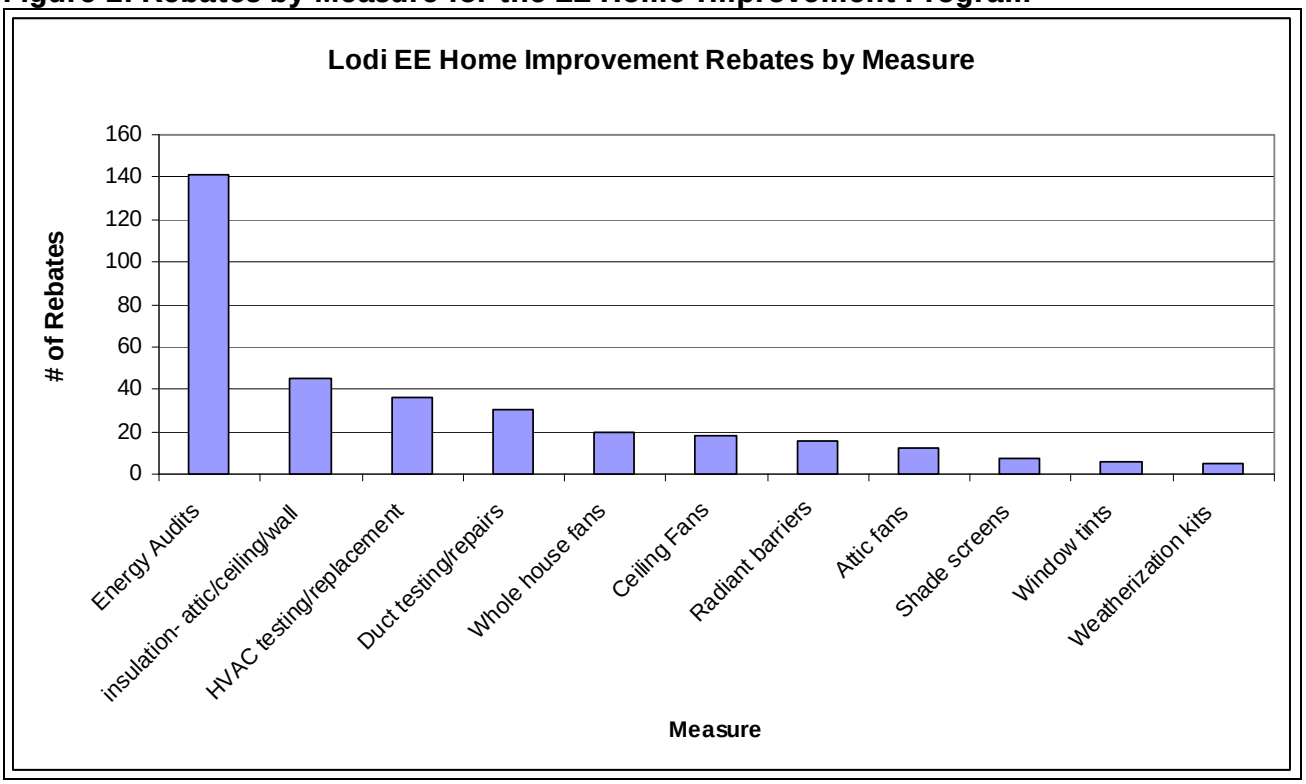
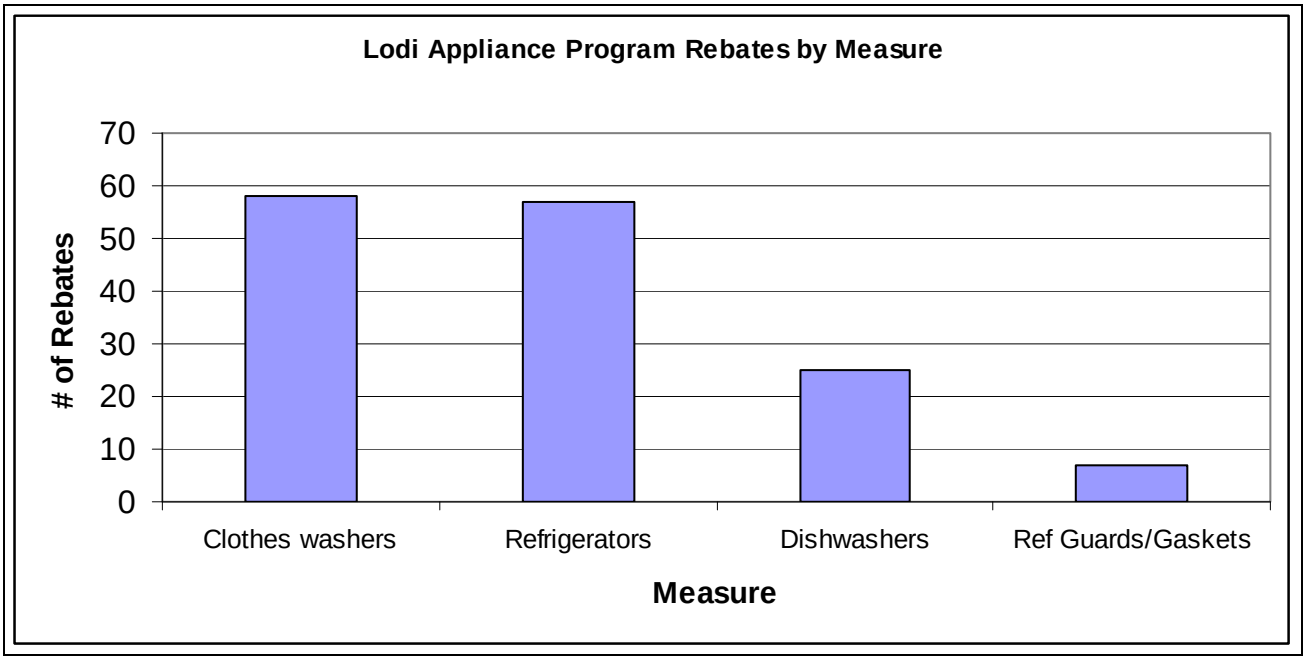


Figure 3. Rebates by Measure for Lodi's Appliance Program



Key Findings and Recommendations from Tracking Systems Review

Given that these programs are often cross-promoted, we reviewed the ways in which the program data are tracked. Currently, all Lodi programs are tracked within the same database and the records date back to November 2003. Under the current program is it difficult to identify rebates paid for each type of measure. Moreover, there seems to be a "disconnect" between the various databases in that the customer information is not currently linked to the actual measures received or rebate amounts. While Lodi has done an excellent job of collecting all relevant information, the program information is difficult to extract. Moreover, the program costs are included in the same format as the actual program rebates.

Key findings regarding the tracking database:

1. All information regarding these programs is catalogued in one central database.
2. The information is comprehensive in that it provides data from the program's inception.
3. The tracking database contains a mix of program costs and rebate amounts but it is not reported in a consistent manner.
4. The energy efficiency measures are listed by text descriptions.
5. All vendors currently working with Lodi are listed in the program database.
6. The Solar PV Program needs to be tracked separately because it is not an energy efficiency program.

Key recommendations to improve the tracking database:

1. Lodi should track its residential and commercial programs in separate databases.

2. The databases should be separated out by Program as a way to facilitate tracking and reporting rather than creating one comprehensive central database.

3. Lodi should track program costs for meetings, lunches, and events separately from the actual program rebates.

4. Lodi should create a numerical legend to track its measure installations by category. This will help Lodi track more quickly and easily installation rates across each measure and across each program.

5. Lodi should consider separating out vendors by category and by program as way to improve overall targeting and outreach. For example, all residential vendors should be listed in the residential database, group by the corresponding measures they install. A similar approach should be used for the commercial vendors.

2.2.2 Program Procedures and Inter-Relationships Review

This process evaluation also included a review of the materials currently used for recruiting customer to all of its equipment and appliance programs. This review identified additional messages that Lodi may want to include in future program updates. This information is supplemented by interviews with program staff, focusing specifically on the ways 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

Key Findings and Recommendations from Program Procedures and Inter-Relationships Review

Figures 4 and 5 illustrate the program flow for Lodi's residential and commercial programs.

Figure 4. Process Flow- Residential Programs

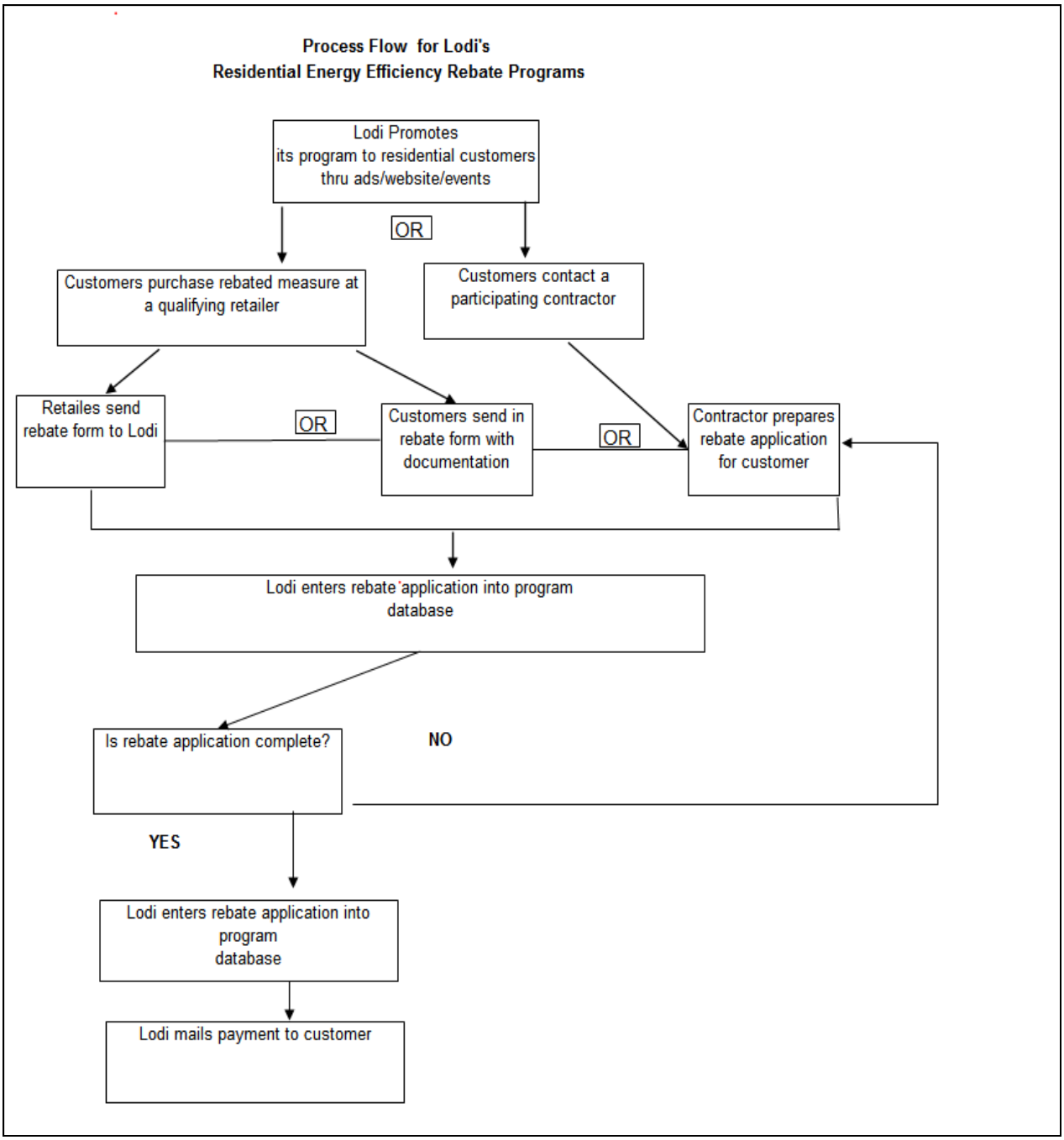
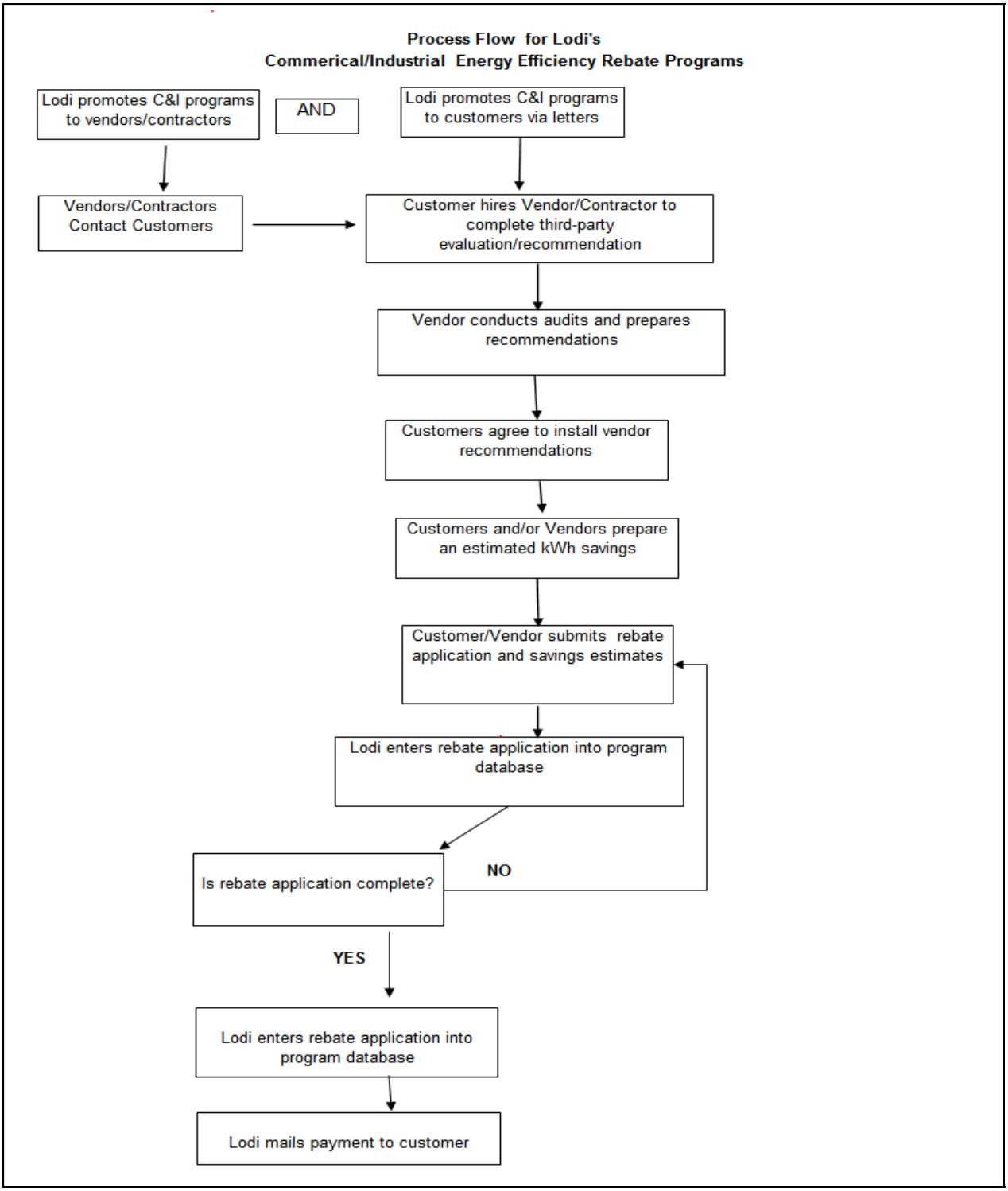


Figure 5. Process Flow- Commercial and Industrial Programs



Staff Interviews

According to the program staff, none of Lodi's current programs are reaching their goals and all are under-subscribed. This suggests that Lodi should consider revising its current approach in program marketing to both commercial and residential customers, and streamlining some of its program offerings to make it easier for both customers and vendors to participate.

Commercial Programs:

The biggest challenge facing the commercial programs was getting the customers' attention because the rebate amounts were relatively low compared to these company's total annual electric costs.

Another major problem was attracting and motivating contractors to encourage customer participation. The commercial programs are all vendor-driven. Although Lodi did notify all electrical contractors via its website and through newspaper ads, it is still having difficulty attracting program participants.

The staff admitted that these programs were based on the customer or vendor asking for the rebates, rather than Lodi staff proactively marketing the program due to limited staff resources.

Residential Programs:

Lodi has had some success with its residential programs in terms of attracting participants, but the program remains undersubscribed. The utility does do some marketing including press advisories, news releases, placing information on the program website, and quarterly newspaper ads. The Lodi EE Appliance Program currently has five active dealers.

As part of this process evaluation, a member of the Summit Blue team visited an active appliance dealer as a "mystery shopper." Overall, the sales staff was well-trained on the benefits of selling high efficiency clothes washer, and was very familiar with all rebates available for ENERGY STAR appliances, including the manufacturer's rebates as well as Lodi's rebate.

Key Recommendations

1. Lodi needs to develop a more focused approach for reaching out to commercial contractors as a way to increase program participation. These activities could include developing a qualified or preferred contractor network, and encouraging vendors to complete applications by providing them with "spiffs" or bonus payments.

2. Lodi needs to incorporate more "non-energy" benefits into its messaging for its residential programs, especially its home improvement program. These non-energy benefits include focusing on increased home comfort, safety, and environmentally-friendly activities.

3. Lodi should streamline its Home Improvement Program into one comprehensive energy efficiency audit and measure installation.

Bundling program measures could appeal to a larger group of contractors who could sell and install multiple energy efficiency measures. This approach would also provide a much clearer message to home owners about the benefits of installing measure combinations, such as duct sealing with insulation, as way to improve the whole house. While Lodi may not be ready to develop a comprehensive offering such as Home Performance with ENERGY STAR Program (www.hpwes.org), it can certainly start to combine the most commonly needed measures into one program offering for a specific rebate amount.

2.3 Recommended Program Changes

This review identified a number of areas for Lodi staff to consider regarding program modifications, especially for its residential programs. Lodi staff should consider making the following program modifications.

1. Ensure that all residential appliances are now meeting the new ENERGY STAR standards that went into effect in 2007. Appendix B provides a summary of those new standards for all current and proposed measures in Lodi's residential program portfolio.
2. Lodi staff should consider eliminating its rebates for dishwashers.

The criteria for making these recommendations are based upon the widespread availability of a range of measures that currently meet or exceed the minimum ENERGY STAR standards.

These program additions include the following:

3. Lodi should consider adding in programmable thermostats as part of its EE Home Improvement Program.

   A rebate of $20 would cover the incremental cost of programmable thermostats in the Lodi area. Moreover, this would help maintain the energy efficiency levels of the other related heating and cooling equipment that are currently receiving rebates. The specifications for these programmable thermostats are in Appendix B.

4. Lodi should consider adding a $25 rebate for ENERGY STAR Digital-to-Analog Converter Boxes.

   Beginning February 17, 2009, the U.S. will shift to digital-only television broadcasts. As of this date, consumers with analog televisions, who do not subscribe to cable or satellite services and rely solely on over-the-air broadcasts for their TV-viewing will need a digital-to-analog converter box, or DTA, in order to continue receiving television broadcasts. The digital-to-analog (DTA) converter box is a device that converts digital television broadcast signals to analog signals. These boxes are currently being sold by a variety of retailers. These boxes are expected to cost between $40 and $70. The ENERGY STAR models consume no more than 8 watts in On Mode and 1 watt in Sleep Mode according to the Environmental Protection Agency (EPA). The product specifications are available on the following website: www.energystar.gov

5. Lodi should consider providing a $25 rebate to encourage the purchase of ENERGY STAR television, DVDs, and related equipment.

   ENERGY STAR qualified TVs use about 30% less energy than standard units. ENERGY STAR models are available on a range of TVs including standard TVs, to HD-ready TVs, and large flat-screen plasma TVs. The product criteria are provided in Appendix B.

6. Lodi should consider developing a rebate program for residential water heaters.

   Even though water heaters are still not under ENERGY STAR guidelines, there are several manufactures that make highly energy efficient electric tank water heaters. These manufacturers also offer special utility-oriented programs and include options to both rent or buy electric water heaters. These manufacturers include American Water Heater Rentals and Marathon Water Heaters.

7. Lodi should consider adding a refrigerator recycling program, leveraging the materials and information available nationally from ENERGY STAR's new national campaign: Recycle My Old Fridge Campaign.

   This campaign encourages every customer who owns an old, inefficient refrigerator to save money, energy, and the environment by recycling old refrigerators and, when a replacement is needed, to buy a new ENERGY STAR qualified refrigerator. More information is available on the following website: http://www.recyclemyoldfridge.com/default1.aspx

   The website also provides the names of two local companies that could participate in this recycling program.

Table 3. Local Lodi Refrigerator Recycling Companies

California Waste Removal Systems Buy-Back Center & Appliance Recycling Company 1333 E. Turner Road Lodi, CA 95240 209-369-8274
North County Recycling & Landfill Drop-Off Center & Appliance Municipal Drop-Off 17900 E. Harney Lane Lodi, CA 95240 209-887-3868

3 IMPACT EVALUATION OF THE NON-RESIDENTIAL CUSTOM PROGRAM - LIGHTING

The primary objectives of an impact analysis are to assess gross and net demand and energy savings and the cost-effectiveness of the installed systems. An impact evaluation verifies measure installations, identifies key energy assumptions, and provides the research necessary to calculate defensible and accurate savings attributable to the program. The methodology and activities used in the impact evaluation are discussed below.

The highest priority for FY 2008 impact evaluation is the lighting portion of the Non-Residential Custom Rebate Program. About 70% of all the energy saved through the Lodi energy efficiency programs in FY 2008 accrue from this portion. The next highest priority is the refrigeration element of the Non-Residential Custom Rebate Program. The evaluation of refrigeration will be done at a later date.

3.1 Impact Evaluation Methodology Overview

The methodologies employed to measure and verify energy savings attributed to the Non-Residential Custom Program included the following activities:

1. Verify measure installation.
   a. Developed a sample for field verification activities.
   b. Conducted field verification activities and observations.
2. Reviewed applications and supporting documentation provided to the City of Lodi Electric Utility.
3. Developed adjusted measure savings values based on field activities and data reviews.
4. Provided conclusions and recommendations for City of Lodi Electric Utility Non-Residential Custom Program.

These activities are discussed in detail in the following sections. Additional detailed information may be found in the appendices.

3.2 Measure Installation Verification

The objectives of the verification activities were to complete site visits and collect key energy program performance metrics including:

1. Establishing the presence of energy efficient measures by comparing the number of installations observed with the number of installations recorded in the rebate application.
2. Providing input on the quality of installations observed – including whether or not they were operating correctly.
3. Where observed equipment did not match program reported installations, determine if retrofits/installations were ever present, and/or the reason that the installation plan changed.
4. Recording key facility performance data, such as daily schedules, seasonal variations in schedules, and control strategies.

3.2.1 Installation Verification Sample

All five projects that included lighting retrofits in FY 2008 were included in the evaluation. The evaluation focused on lighting retrofits primarily involving new T-5 and T-8 fluorescent fixtures and T-8 retrofits, and associated lighting occupancy controls. All five sites reviewed received these measures. Some sites also retrofitted incandescent exit signs to LED based models.

Table 4 details the verification results of the energy efficient installations and savings sampled that occurred under the Non-Residential Custom Program for the City of Lodi Electric Utility. For privacy, the customer names are not given, but rather a site number assigned.

Table 4. Verified Program Installations and Savings

Customer	Retrofit Measures	kW	kWh
Site 1 - Lansas	MH and T-12 to T-5 and T-8 retrofits	13.1	34,094
Site 2 - Lodi Public Library	T-12 to T-8 retrofits with some occupancy sensors	9.1	49,418
Site 3 - Constellation Wine	Pulse start MH to high bay T-8 fixtures, many with occupancy sensors	145.5	700,566
Site 4 - Certainteed	MH and HPS to T-5 high bay with some occupancy sensors and T-12 to T-8 retrofits	56.2	556,924
Site 5 - General Mills	T-12 to T-8 retrofits and occupancy sensors	155.0	1,431,849
Program Total		378.9	2,772,851

The lighting retrofits involved comprehensive retrofits of both commercial office type spaces and warehouse retrofits that replaced high intensity discharge (HID) fixtures with industrial fluorescent fixtures using high output T-5 or T-8 electronics. Many of the HID retrofits also included occupancy sensors that shut off the fixture when an area was vacant. Additionally, some T-12 to T-8 retrofits in office spaces included room or area occupancy sensors. HID retrofits accounted for over 83% of lighting savings. This is both because they provide a larger reduction than T-12 to T-8 retrofits and because they are typically installed in areas with longer operating hours.

In evaluating these projects, particular attention was paid to reviewing the program documents and supplementing it with field verifications. The evaluation of the lighting retrofits involved the IPMVP Option A approach by reviewing engineering calculations and performing site interviews.

In some cases, deemed values were compared to calculated savings values. Only some of the implemented measures had standard deemed values available. These are considered an acceptable alternative to calculated values. Incandescent to compact fluorescent, T-12 to T-8 retrofits, and incandescent exit sign replacement with LED units have standard deemed savings values. In each case, these results were compared to the calculated values. However, no deemed values were available for the HID to fluorescent high bay retrofits or some of the less standard T-12 retrofits, such as replacing one eight-foot lamp with two four-foot units, so calculated values were combined with the available deemed savings for comparison to claimed and calculated savings.

3.2.2 Site Verification Activities

Field activities typically involved two components:

1. Evaluators coordinated with the implementation contractor and primary customer contacts to establish field activity dates and identify site level contacts.
2. While on-site, the evaluation team conducted an area-by-area, measure-by-measure audit, noting retrofit count, type, and operating conditions. Interviews were also conducted at the site representative's convenience.

Field evaluation activities were conducted on August 7-8, 2008. At the time, it was anticipated that all expected installations were completed and finalized. Appendix B provides additional installation details.

3.2.3 Installation Verification Results

Verification work, discussions with participants subsequent to field verification activities, and an analysis of the verified installations indicated that the installations attributed to the Non-Residential Custom Program were installed, but the savings were not necessarily accurately calculated.

Site 1 - Lansas

Lansas included a combination of HID to high bay fluorescent to T-5 replacements and T-12 to T-8 retrofits. It was the only site with no occupancy sensor installations. No exit sign replacements were made at the site. The itemized invoice listed retrofit kits for the T-12 to T-8 retrofits, but did not specify what ballasts were used in the kits, so the descriptions provided on the application were assumed to be correct since they did not specify premium ballasts. Reduced ballast factor units were used in most locations.

The application indicated 4,000 hours of operation in the production areas and 3,000 in the office areas. However, discussions with staff indicated that the offices were used from approximately 7AM to 5PM, five days a week, or 2,600 hours per year. Although the production areas may sometimes operate somewhat longer hours, discussions with facility personnel did not indicate that this was currently the case, so 2,600 hours was used for calculations in these areas as well.

Two additional areas were found with lighting during the verification process. In one case, there was a two lamp T-5 fixture, but as the itemized purchase records did not include such a fixture, it was assumed to have been present prior to the retrofit. A storage room was also located containing four 2-lamp T-8 fixtures. It was unclear whether these units had been installed as part of the retrofit to replace a T-12 system, or if they were installed separately. This remained unclear even with the itemized invoice, since spare units are often ordered so these units were not included in savings calculations.

The wattages used in the application did not match the standard values used in California. This was most noticeable for the T-12 units being removed. Common practice is that Title 24 requirements are baseline and therefore the methodology followed is not to claim savings from standard T-12 lamps and ballasts, only energy efficient units. Consequently, the baseline usage of these units has been calculated using energy efficient T-12 ballasts and reduced wattage T-12 lamps. This, along with the operational hours reductions, resulted in a significant reduction in kWh savings relative to the application. The demand reductions were not affected by the hour reductions, but the T-12 wattage adjustments still had a noticeable effect on the savings. Table 5 summarizes both the claimed and adjusted energy savings for Lansas.

Table 5. Site 1 - Lansas Installation and Savings

	kW Savings	Annual kWh Savings
Claimed Savings	14.9	56,961
Verified Calculated Savings	13.1	34,094
Using Deemed Savings where Applicable	11.2	32,344

Site 2 - Lodi Public Library

Lodi Public Library consisted primarily of T-12 to T-8 retrofits with some exit signs and compact fluorescent screw in units. The scope of work had changed significantly between the time of the application and the actual installation, as the survey submitted with it was from 2005. The site consisted entirely of offices, storage, and patron areas. There were some areas that were not included in the final retrofit.

Most of the retrofit was included on the application, although there were significant reductions in scope. However, thirty-six three-lamp fixtures, which had not been listed on the original plan, appeared to have been retrofitted. The itemized invoice listed some, but not all, of these fixtures, as the claimed numbers of units did not add up to the total provided. However, the total number of ballast and lamps purchased indicates that most likely all of these units were included in the retrofit. However, it appears that some of them may have used tandem-wired two lamp ballasts between units rather than a two-lamp and a one-lamp ballast in each fixture. This does not significantly affect the total wattage of the system.

Eight occupancy sensors were included in the retrofit, controlling 20 two-lamp T-8 fixtures and three four-lamp T-8 fixtures. Standard deemed hour reductions were used to calculate savings for these sensors, most of which were in private offices. The occupancy sensors were operating during the verification site visit. No demand reductions were attributed to the occupancy sensors.

The invoice indicated that approximately 1/3 of the two-lamp ballasts purchased were high output units. Based on the observed conditions and numbers of units, it was estimated that the occupancy sensor areas were not included in these high output units.

Six exit signs were retrofitted from 50 watt incandescent units to LED units. These units operate continuously, 8,760 hours per year. Since no specifications were provided for the LED exit signs, the standard 6 watt units were used for calculations.

As shown in Table 6, this site showed significantly lower savings than were expected based on the rebate application. The reason for this appears to be threefold:

1. As with other sites, the wattages used to calculate energy use for the existing T-12 installation uses numbers for standard ballasts and lamps, which is not standard practice, which uses Title 24 requirements as baseline. This does not mean the savings are not realized at the site, but that they cannot be claimed by the utility.
2. The wattages shown for the planned retrofit indicated the use of premium ballasts for the new T-8 units. However, the purchase order provided to the utility showed that standard T-8 ballasts were used. This results in increased usage relative to the application. Additionally, some of the ballasts used were high output units instead of standard output ones.
3. Finally, the planned installation included 478 fixtures, but in the end, only 386 were actually verified as retrofitted. There was no evidence of removed fixtures and the conference and computer rooms on the sides of the main area were not included in the final project, so the scope appears to have been reduced without notifying the utility.

The deemed savings for this location have a decreased demand value, but an increased energy savings relative to the calculated savings because the operational hours are less than the typical deemed values. Also, the calculated demand savings are increased relative to the deemed values because the compact fluorescent lamps used in the retrofit replaced incandescent lamps that were significantly brighter than those used in the deemed measure.

Table 6. Site 2 - Lodi Public Library Installation and Savings

	kW Savings	Annual kWh Savings
Claimed Savings	31.4	109,912
Verified Calculated Savings	9.8	36,923

Deemed Savings	9.1	49,418

Site 3 - Constellation Wine

Constellation Wine was a warehouse with a small attached office area. Only the warehouse area was involved in the lighting retrofit. The lighting retrofit consisted of replacing 552 metal halide 350 watt pulse start fixtures with high bay T-8 fluorescent fixtures with a number of motion sensors. It was the only site where the verification matched the description on the application exactly. This is not surprising considering it was also the most straightforward installation. However, even in this case the fixture wattages and motion sensor reduction times did not match the standard values typically used by California utilities.

The site is a warehouse, which originally used 468 350-watt pulse start metal halide lights for illumination. These were replaced on a one-for-one basis with high bay fluorescents. Three hundred of the new units included motion sensors.

The wattages provided on the application were slightly off from the more standard values used in California. The 350 watt pulse start metal halide units removed were listed as 400 watts total, in line with standard values. However, the newly installed 6-lamp T-8 high bay fixtures were listed as 218 watts rather than the more standard value of 226 watts.

The three hundred motion sensors listed on the application were all installed and operating as claimed. However, the application claimed a 50% reduction in run hours for these areas, in contrast to the 45% typically claimed for warehouses in the absence of logging for verification. Since no justification was provided for the increased reduction, it has been reduced to 45% for verification purposes. On visiting the warehouse and viewing these areas, it is certainly possible that usage is less than 55%, however without logging the actual usage of the lighting sensors, the standard value should be used. Since occupancy seemed to vary equally throughout the day, demand for these fixtures should also be reduced by 45%.

Table 7 shows the installation details. A purchase order was provided that confirmed the units were new. There are no deemed savings available for a retrofit from pulse start metal halide fixtures to high bay fluorescents, either with or without occupancy sensors.

Table 7. Site 3 - Constellation Wine Installation and Savings

	kW Savings	Annual kWh Savings
Claimed Savings	151.5	729,245
Verified Calculated Savings	145.5	700,566
Using Deemed Savings where Applicable	N/A	N/A

Site 4 - Certainteed

Certainteed contained a combination of HID to high bay fluorescent and T-12 to T-8 retrofits with some motion sensors. The planned installation details provided to the City of Lodi Electric Utility with the application had been changed prior to implementation. It was the only site for which itemized purchase orders were not available for verification. An updated retrofit list was provided during the verification audit, however even this did not exactly match the observed installation. In addition, the proposed retrofit

listed all fixtures as operating 8,700 hours per year. The office areas were only in use 12 hours per day, five days a week, fifty-one weeks a year, for a total of 3,060 hours annually. Office personnel indicated that they were turned off outside of operating hours. Occupancy sensor reductions were not included in the savings calculations. Certainteed was also the only location in which the work was not quite complete. Four fixtures out of the total 335 had not yet been retrofitted, but this did not significantly affect the results.

Only 322 fixtures were listed on the original retrofit plan, as compared to 331 completed and four to be retrofitted as observed during verification. Since lighting counts of large areas often miss a few fixtures, it is likely that the increased numbers are accurate. However, it is also possible that a few sample fixtures had been installed prior to the retrofit. Although an itemized purchase order might help to resolve this discrepancy, it still might not have been possible to determine if additional fixtures, ballasts, and lamps were spares or if they were installed as part of the retrofit.

The occupancy sensors used in the production area can be primarily expected to shut off during off hours rather than peak, since occupancy is high during the day. Therefore, no demand reduction is expected due to these occupancy sensors. Standard deemed reduction values were used to calculate these savings.

Office areas were retrofitted from T-12 to T-8 units by replacing lamps and ballasts in existing fixtures. According to facility personnel, these areas operate 51 weeks per year, 12 hours per day, five days a week, for a total of 3,060 hours per year.

In manufacturing areas, 400 watt metal halide fixtures were replaced with high bay, four-lamp linear fluorescent high output T-5 fixtures. Some of these fixtures included occupancy sensors. Deemed savings are not available for these retrofits and so calculated savings have been used.

Table 8. Site 4 - Certainteed Installation and Savings

	kW Savings	Annual kWh Savings
Claimed Savings	62.5	543,593
Verified Calculated Savings	58.8	554,730
Using Deemed Savings where Applicable	56.2	556,924

Table 8 summarizes both the claimed and adjusted energy savings for Certainteed. As with Lodi Public Library, Certainteed shows a larger energy savings and a smaller demand savings when deemed savings are used than when the savings are simply calculated using observed values. The reduced demand is due to the site's use of low output T-8 ballasts. However, since the office areas of the site, where the T-8 retrofits took place, have shorter operating hours than the deemed estimates use, the energy savings is still greater using those numbers. There is a minimal overall impact because less than four percent of the site's savings are due to T-12 to T-8 retrofits, delamping, and the single wall motion sensor. The remainder of the savings are primarily from HID to T-5 retrofits and fixture motion sensors for which no deemed savings are available.

Site 5 - General Mills

General Mills contained a combination of HID to high bay fluorescent and T-12 to T-8 retrofits. It was by far the largest site of the sample and additional retrofits had taken place beyond the program retrofits, but which were not reported to the City of Lodi Electric Utility. The application to the utility claimed

1,475,137 kWh of electric savings. Although the retrofit largely matched the description in the application, there were a few notable issues. First, as at other sites, some of the wattages used in calculations did not match the standard values typical in California. Additionally, the savings claimed in some cases were based on actual installations of standard ballast and wattage T-12 units, but using Title 24 requirements as standard practice baseline means not following the claiming of savings exceeding that of reduced wattage (34 watt) T-12 lamps and standard electronic ballasts. Although the listed wattages may reflect the actual pre-retrofit situation and the savings may be realized by the site, they cannot be claimed for verification purposes. Finally, due to the limit on rebates provided by the program, savings from additional retrofits were not claimed. The existence of extensive retrofits to lighting not on the application further complicated the verification of the savings as it was often difficult to decisively determine which fixtures were and were not included in the application despite its high level of detail.

The site consisted of about 60 buildings, eight of which were included in the rebated retrofit. Some additional buildings had also received recent lighting retrofits. However, because of the program rebate cap, no program documentation was available for this work. The buildings included in the retrofit varied from a single room with as few as ten high bay units to large complexes with almost a hundred individual line items (including removals and occupancy sensors) and over five hundred fixtures.

Overall, the retrofits fit into several categories:

1. HID to high bay fluorescent retrofits, some with integral occupancy sensors.
2. T-12 to T-8 retrofits with either ballast and lamp replacement in existing fixtures or complete replacement of fixtures, some with area occupancy sensors.
3. Relamping of existing T-8 fixtures.
4. Compact fluorescents substituted for incandescent lamps.
5. Removal of fixtures.
6. Exit sign replacement from incandescent, 50 watt, units to LEDs.

Of these retrofit types, the HID to high bay fluorescents were the most straightforward for verification. It is simple to identify the number of lamps and whether they are T-5s or T-8s. The wattages for these fixtures are standard across different manufacturers, and there is no need to examine the fixture, lamps, or ballasts in detail.

The T-12 to T-8 retrofits are more difficult to assess because they can include many different lamp and ballast combinations. It is very difficult to accurately determine which lamp and ballast are used in each location without opening each fixture for detailed examination. However, this is typically not practical, both because of time constraints and because of access difficulties. Several alternative options are available:

1. Discussions with facility personnel can sometimes reveal the type of lamps and ballasts used.
2. Examination of spares kept at the facility can often clarify what types of units are used on site. However, if many different types are in use this does not always provide adequate information to determine the number of each type of unit.
3. Itemized invoices for the retrofits will typically provide a breakdown of how many of each type of lamp and ballast were purchased, but spares are often included in orders and this does not explain where the units are installed.

4. Retrofit listings will typically list the lamp and ballast description and wattages that can be matched to standard units. However, these lists are not always accurate by the time the final retrofit is implemented and should be compared to invoices and observations for accuracy.

Relamping and compact fluorescents share the difficulty of not necessarily being long term measures. In both cases, it is easy to simply remove the new lamp and replace it with a higher use unit. In practice, this frequently happens, either because personnel do not like the new light quality, or simply because a lamp is replaced with the most convenient spare when it breaks. However, these savings are permitted under California program rules and have been included in the verified values.

Removal of fixtures of course presents a unique verification problem when only a post-installation inspection is performed. It is very difficult to verify that a fixture has been removed, particularly when the verifier did not observe it prior to removal. Although the retrofit description is fairly detailed in terms of locations, it can be difficult to even locate the exact position of the former fixture, much less to determine when it was removed. During the inspection, however, there was no reason to generally believe that such fixtures had not been removed, as they did not appear to be present and it would be highly unusual for a lighting vendor to provide a quote for non-existent fixtures. Therefore, the removal is believed to have taken place as stated for the noted fixtures.

All of the exit signs located within the retrofit areas were LED-based. Since the retrofit plan lists some signs that were already LED and others that were incandescent, Summit Blue has no reason to believe that the count taken prior to the retrofit was not accurate. Additionally, the purchase orders provided to the Program included 32 red LED exit signs with battery backup, which matches the number claimed in the retrofit plan. However, although the provided savings calculations list the exit signs as 2 watts, the manufacturer's data sheet lists them as "less than 4 watts" so the higher value has been used for calculations.

The purchase orders provided for this site did not precisely match retrofit. This may be the result of both the purchase of spare units and the fact that multiple projects took place at this location. Additional units may have been ordered for areas not included in the retrofit and some of the units used in this project may have come from other purchases. Nevertheless, the provided invoices indicate for the most part that the listed retrofits are basically accurate. Premium ballasts are listed on the invoices and a significant number of reduced wattage T-8 lamps were also purchased, so the descriptions on the retrofit plan are considered to be accurate.

Table 9 shows the total estimated savings by retrofit type. It is unclear how many additional projects were performed without rebate applications; however, it is fair to say that despite the savings reductions provided in this verification for Title 24 requirements, the total savings at this site are likely significantly underreported.

Table 9. Site 5 - General Mills Installation and Savings

	kW Savings	Annual kWh Savings
Claimed Savings	152.1	1,475,137
Verified Calculated Savings	155.0	1,431,849
Using Deemed Savings where Applicable	147.4	1,342,075

3.3 Analysis

3.3.1 Overall Site Observations

There were several consistent problems with the applications at all sites:

1. *Over-reporting of T-12 wattages.* This is not a reflection on the actual usage so much as it is a desire to follow common evaluation practice, which uses Title 24 standards as baseline for reporting savings. It is a common problem in much of California, as lighting vendors are not familiar with the Title 24 limitations on T-12 standard ballasts and lamps. It would most likely help if the utility provided a list of standard allowable wattages with the application or made it available for download from the website.
2. *Inconsistencies between the application and the actual installation.* Requiring copies of itemized invoices instead of just bottom-line quotes and purchase orders would help reduce this confusion.
3. *Incorrect reporting of T-8 wattages.* This is, to some extent, related to both the previous two problems. Firstly, vendors are often unaware of the standard wattages used in California, which results in overstating savings from the perspective of using Title 24 standards as baseline, by a few percent. However, a larger problem is related to changes in the scope of work between the time of the initial plan and the actual installation. In several cases, the wattages listed on the application indicated the use of premium ballasts, but the itemized invoices, once obtained, showed the purchase of standard electronic T-8 ballasts, resulting in higher wattages than expected.
4. *Overestimates of operational hours.* In some cases, the operational hours reported by the lighting vendors in their estimates exceeded those indicated by staff at the facility. This was most noticeable when production hours were assumed to apply to office areas.
5. *Under-reporting of savings, apparently due to rebate caps.* Several of the sites failed to include savings due to occupancy sensors in their calculations. This is most likely because the rebate amount was already capped and they did not bother with the additional savings. Additionally, General Mills indicated that they had performed several retrofits without rebates because of the cap. This high rate of underreporting indicates that either:
    a. There is a significant amount of spillover from the program; or
    b. The incentives are higher than necessary and free ridership is a problem.

3.3.2 Program Record Observations

The final program records submitted by the implementation contractor to the City of Lodi Electric Utility were analyzed for accuracy and consistency, and to ensure that the underlying assumptions were reasonable. The key documents analyzed included the following:

- The project applications provided to the program for each site
- The invoices provided to the utility

The primary observations from this review were that the scope of work had changed on many of the projects between the time the application was submitted and the actual project work took place and that the T-12 wattages supplied were not in line with Title 24.

Based on the review of program documents and on-site verification activities, the following conclusions were made.

1. The adjusted final installation rate was determined to be 95% for energy and 92% for demand. This was primarily due to reductions in baseline T-12 wattages, although changes in project scope also contributed to the reduction.

2. The measure savings assumptions were calculated to be representative of the Program installations.

3. The participant facility operating schedules required some changes relative to estimates used on the applications. It would be advisable to explicitly request operating hours as part of the application rather than relying on vendor estimates in the calculations.

4. The savings estimates provided for the retrofit of fluorescent fixtures reflect several revisions to bring them into line with common evaluation practice, including:

    a. The savings attributable to the occupancy controls were adjusted for each project to reflect the standard reductions used in the NRR-DR manual. In the case of Certainteed, the savings had to be added, as they were not initially included.

    b. The base case energy assumptions for Sites 1, 2, 4, and 5 T-12 fixtures were overstated if the common practice of using Title 24 requirements as baseline.

    c. The net changes made to the savings calculations resulted in a net decrease of 5% in kWh savings attributed to lighting retrofits through the program.

5. Itemized purchase orders should be required for applications, along with a list of the final retrofit plan.

6. Standard occupancy sensor reductions and fixture wattages should be used in calculations.

7. Customers should be encouraged to report all savings, despite the rebate cap.

3.4 Impact Evaluation Results

Table 10 provides the savings reported in the final installation review documents submitted for the Program and the verified gross savings. The recommended adjustments are attributable to revised savings estimates for a combination of occupancy sensor reductions, fixture wattages, primarily T-12 baselines, and changes in the planned and installed units.

Table 10. Claimed Savings and Verified Gross Savings

	Claimed		Verified	
Project	kW Savings	Annual kWh Savings	kW Savings	Annual kWh Savings
Site 1 - Lansas	14.9	56,961	13.1	34,094
Site 2 - Lodi Public Library	31.4	109,912	9.1	49,418
Site 3 - Constellation Wine	151.5	729,245	145.5	700,566
Site 4 - Certainteed	62.5	543,593	56.2	556,924
Site 5 - General Mills	152.1	1,475,137	155.0	1,431,849
Total	412.4	2,908,248	378.9	2,772,851

The verified impacts were similar to the original claimed impact estimates. For energy, the verified energy savings were 95% of the claimed and for demand, the verified were 92% of the original claimed energy savings. Calculated savings have been used for Lansas, Constellation Wine, and General Mills. Deemed values were used for Lodi Public Library and Certainteed. At the other sites, only some of the fixtures had deemed savings available and since many of the T-12 to T-8 retrofits actually used low output T-8 ballasts, the deemed values underestimated savings. In addition some sites had longer operating hours than the deemed savings use.

4 IMPACT EVALUATION OF THE RESIDENTIAL APPLIANCE REBATE PROGRAM

The Lodi Appliance Rebate Program provides rebates to all customers who purchase an ENERGY STAR ® refrigerator, dishwasher and or front-loading clothes washer. The rebates are marketed through the local appliance stores and rebates are available for the following amounts:

- Dishwasher - $25
- Refrigerator - $50
- Clothes Washer - $75

The rebate forms must include a copy of the appliance invoice and questions are asked on the form about whether the purchaser has electric or gas water heat (for dishwashers and clothes washers) and for refrigerators, the location of the freezer (top, bottom, or side).

The estimates of energy impact by measure are based on deemed savings. The claimed savings vary by appliance, water heating fuel, and freezer location. These values are:

- Clothes Washer – El WH – 286 kWh and 0.119 kW
- Clothes Washer – Gas WH – 29 kWh and 0.012 kW
- Dishwasher – El WH – 72 kWh and 0.03 kW
- Dishwasher – Gas WH – 32 kWh and 0.13 kW
- Refrigerator – Bottom Freezer – 87 kWh and 0.015 kW
- Refrigerator – Top Freezer – 87 kWh and 0.015 kW
- Refrigerator – Side Freezer – 98 kWh and 0.017 kW

4.1 Impact Evaluation Methodology Overview

The impact evaluation for this program was a low cost review of available data and the application of deemed savings estimates to the observed number of appliance installations. The steps followed included:

1. Obtained a copy of the program tracking database.
2. Reviewed the database and determined the number of rebates by appliance and appliance characteristic.
3. Requested and obtained hard copy of select rebate vouchers to verify that the vouchers existed and that invoices were attached to each voucher.
4. Estimated the number of appliance installations and the associated energy savings for FY 2007/2008 by utilizing the data available in the program tracking database, modifying the number

of applications based on verification efforts, and utilizing the deemed energy savings per measure to develop an overall program impact.

4.2 Measure Installation Verification

For this program, measure verification consisted of visual paper verification that appliance applications and invoices are maintained by the City of Lodi. No on-site visits were performed. Given the relatively low levels of energy savings and the high cost of performing on-site visits, a "paper" verification process was deemed appropriate.

The first step in measure verification was to obtain the program tracking database. All of the applications "vouchers" have been placed by City of Lodi staff within this Access database. However, using the database for evaluation purposes was difficult. The appliance type and appliance characteristics on water heating fuel and freezer location were all included as text within one column of the database. Often, only the voucher number was given and when appliances were identified, the water heating fuel or freezer location was missing. Appliance age was also provided at times, but was also missing for many appliances. This single column had to be manually interpreted into what appliance was being rebated and its characteristics. It is suggested that a code for appliance type and water heating fuel/freezer location be added. Doing so will not only assist future evaluation efforts but make data retrieval for reporting purposes much easier.

Table 11 summarizes the voucher information from the database after performing the manual disaggregation of the data. Almost 60% of the vouchers had no appliance identification and another 11% had no water heat fuel or freezer location identified. Most of the unidentified vouchers represented mass grouping of vouchers from appliance dealers, but regardless of this fact, entering the individual voucher information is needed.

Table 11. Number of Vouchers by Appliance Savings

Appliance	# of Vouchers
Clothes Washer - WH Fuel Identified	31
Clothes Washer - No WH Fuel Identified	10
Dishwasher - WH Fuel Identified	16
Dishwasher - No WH Fuel Identified	3
Refrigerator Freezer Identified	28
Refrigerator No Freezer Location	14
Vouchers Only, No ID of Appliance	145
TOTAL	247

Since the greatest problem was knowing what appliances were receiving rebates for those vouchers with no information, it was decided that the paper verification would be performed on a sample of these 145. Copies of 40 vouchers with supporting invoices were requested for review. Of these 40 requested vouchers, 38 were provided. Of these 38, proper invoices were attached to all. Three of the 38 vouchers included two appliances. Table 12 summarizes the findings from the sampled vouchers.

Table 12. Number of Appliances from the Sampled Vouchers

Appliance	# of Appliances
Clothes Washer - WH Fuel Identified	5
Clothes Washer - No WH Fuel Identified	2
Dishwasher - WH Fuel Identified	21
Dishwasher - No WH Fuel Identified	4
Refrigerator Freezer Identified	8
Refrigerator No Freezer Location	1
TOTAL	41

The value of these 38 vouchers was $1,525. The value of the remaining vouchers with no appliance identification was $5,050. The number of missing vouchers is 5%.

4.3 Impact Evaluation Results

The estimate of savings from the program for FY 2007/2008 is split into two parts. The first is for the vouchers in the database where an appliance is identified. The second is for the vouchers with no appliance ID. In all cases, once the number of appliances are estimated, the deemed energy savings value was applied.

Table 13 identifies the results of this first step in estimating the program impact for the Appliance Rebate Program. When no water heating fuel type or freezer location was identified, the lower of the alternative deemed savings estimates for that appliance were used. The missing voucher adjustment factor reflects that only 38 of the requested 40 vouchers could be found.

Table 13. Step 1 -Partial Estimated Energy Savings from the Appliance Rebate Program

Appliance	# of Appliances	Deemed Savings/unit (kWh)	Deemed Savings/unit (kW)	Missing Voucher Adjustment	Estimated Savings (kWh)	Estimated Savings (kW)
Clothes Washer - Gas WH	31	29	0.012	95%	854	0.35
Clothes Washer - Elec WH	0	286	0.119	95%	0	0.00
Clothes Washer - No WH Fuel ID	10	29	0.012	95%	276	0.11
Dishwasher - Gas WH	16	32	0.013	95%	486	0.20
Dishwasher - Elec WH	0	72	0.03	95%	0	0.00
Dishwasher - No WH Fuel ID	3	32	0.013	95%	91	0.04
Refrigerator - Top Freezer	2	87	0.015	95%	165	0.03
Refrigerator - Bottom Freezer	14	87	0.017	95%	1,157	0.23
Refrigerator - Side Freezer	12	98	0.015	95%	1,117	0.17
Refrigerator No Freezer Location	14	87	0.015	95%	1,157	0.20
TOTAL	102				5,304	1.33

Table 14 identifies the results of the second step in estimating the program impact for the Appliance Rebate Program. As with the first step, when no water heating fuel type or freezer location was identified, the lower of the alternative deemed savings estimates for that appliance were used. The missing voucher adjustment factor reflects that only 38 of the requested 40 vouchers could be found. The cash value adjustment factor reflects that the sum of the value of the vouchers reviewed is $1,525 and the value of the remaining unidentified vouchers is $5,050.

Table 14. Step 2 - Partial Estimated Energy Savings from the Appliance Rebate Program

Appliance	# of Appliances	Deemed Savings/unit (kWh)	Deemed Savings/unit (kW)	Missing Voucher Adjustment	Cash Value Voucher Adjustment	Estimated Savings (kWh)	Estimated Savings (kW)
Clothes Washer - Gas WH	3	29	0.012	95%	3.31	274	0.11
Clothes Washer - Elec WH	2	286	0.119	95%	3.31	1,799	0.75
Clothes Washer - No WH Fuel ID	2	29	0.012	95%	3.31	182	0.08
Dishwasher - Gas WH	21	32	0.013	95%	3.31	2,114	0.86
Dishwasher - Elec WH	0	72	0.03	95%	3.31	0	0.00
Dishwasher - No WH Fuel ID	4	32	0.013	95%	3.31	403	0.16
Refrigerator - Top Freezer	7	87	0.015	95%	3.31	1,916	0.33
Refrigerator - Bottom Freezer	0	87	0.017	95%	3.31	0	0.00
Refrigerator - Side Freezer	1	98	0.015	95%	3.31	308	0.05
Refrigerator No Freezer Location	1	87	0.015	95%	3.31	274	0.05
TOTAL	41					7,270	2.38

Table 15 summarizes the estimated impact for the Appliance Rebate Program in FY 2007/2008. It is estimated that the program achieved 12,574 kWh and 3.71 kW of savings.

Table 15. Appliance Rebate Program Energy Savings for FY 2007/2008

Appliance	Estimated Savings (kWh)	Estimated Savings (kW)
Clothes Washer - Gas WH	1,128	0.47
Clothes Washer - Elec WH	1,799	0.75
Clothes Washer - No WH Fuel ID	458	0.19
Dishwasher - Gas WH	2,600	1.06
Dishwasher - Elec WH	0	0.00
Dishwasher - No WH Fuel ID	494	0.20
Refrigerator - Top Freezer	2,081	0.36
Refrigerator - Bottom Freezer	1,157	0.23
Refrigerator - Side Freezer	1,425	0.22
Refrigerator No Freezer Location	1,431	0.25
TOTAL	12,574	3.71

APPENDIX A: NON-RESIDENTIAL CUSTOM SITE DETAILS

Table A-1. Standard Occupancy Sensor Reductions by Area Type

Space Type	% Savings	Space Type	% Savings	Space Type	% Savings
Assembly	45	Industrial	45	Restroom	45
Break room	25	Kitchen	30	Retail	15
Classroom	30	Library	15	Stair	25
Computer Room	35	Lobby	25	Storage	45
Conference	35	Lodging (Guest Rooms)	45	Technical Area	35
Dinning	35	Open Office	15	Warehouses	45
Gymnasium	35	Private Office	30	Other	15
Hallway	25	Process	45	Parking Garage	15
Hospital Room	45	Public Assembly	35		

Source: 2008 NRR-DR Program Procedures Manual, Table 2-1

Table A-2. Deemed Savings for Selected Measures

Category	Measure	Peak kW Savings	Annual kWh Savings
Compact fluorescent	Screw-in 14-26W	0.038	220
Delamping	Delamp 4' lamp	0.040	235
Exit signs	LED replaces incandescent	0.044	366
Occupancy sensors	Occupancy Sensor: Wall Box	0.176	238
T-8 linear fluorescent	T-12 to T-8 2' lamp	0.008	47
T-8 linear fluorescent	T-12 to T-8 4' lamp	0.006	37

Source: NCPA E3 Calculator

APPENDIX B: ENERGY STAR SPECIFICATIONS

Residential Appliances

ENERGY STAR Qualified Clothes Washers

Clothes Washers Key Product Criteria

Equipment	Criteria
Clothes Washers	Minimum Modified Energy Factor (MEF) of 1.72 and a maximum Water Factor (WF) of 8.0.

The ENERGY STAR criteria for clothes washers changed on January 1, 2007. The new ENERGY STAR criteria require all qualified products to have a Modified Energy Factor (MEF) of 1.72 or greater as well as a Water Factor (WF) of 8.0 or lower. MEF is an equation for Energy Factor that takes into account the amount of dryer energy used to remove the remaining moisture content in washed items.

Criteria/Product Type	Current Criteria Levels (as of January 1, 2007)	July 1, 2009	January 1, 2011
ENERGY STAR top and front loading	MEF[1] >= 1.72 WF[2] <= 8.0	MEF >= 1.8 WF <= 7.5	MEF >= 2.0 WF <= 6.0

[1]MEF = modified energy factor

[2]WF = water factor (gallons per cycle per cubic foot)

ENERGY STAR Qualified Clothes Washer Eligibility

Only front and top loader clothes washers with capacities of greater than 1.6 ft^3 are eligible to earn the ENERGY STAR.

Energy Performance Metrics

Energy Factor (EF) is the previous energy performance metric for clothes washers. It is the quotient of the capacity of the clothes container, C, divided by the sum of the machine electrical energy for the mechanical action of a cycle, M, and the water heating energy required for a cycle, E. The equation is shown here:

$$EF = \frac{C}{M + E}$$

The water heating energy may be from a gas or electric water heater. The units are cubic feet per kWh per cycle, ft3/kWh/cycle. The higher the value, the more efficient the clothes washer is.

Modified Energy Factor, MEF, is the energy performance metric for ENERGY STAR qualified clothes washers and all clothes washers as of January 1, 2004.

This metric has the same units as the energy factor (EF): ft3/kWh/cycle. MEF is the quotient of the capacity of the clothes container, C, divided by the total clothes washer energy consumption per cycle, with such energy consumption expressed as the sum of the machine electrical energy consumption, M, the hot water energy consumption, E, and the energy required for removal of the remaining moisture in the wash load, D. The higher the value, the more efficient the clothes washer is. The equation is shown below:

$$MEF = \frac{C}{M + E + D}$$

Water Factor, WF, is the present water performance metric that allows the comparison of clothes washer water consumption independent of clothes washer capacity. Manufacturers must submit their water consumption factors with their ENERGY STAR qualified clothes washers.

WF is the quotient of the total weighted per-cycle water consumption, Q, divided by the capacity of the clothes washer, C. The lower the value, the more water efficient the clothes washer is. The equation is shown below:

$$WF = \frac{Q}{C}$$

The federal EnergyGuide label on clothes washers shows annual energy consumption and cost. These figures use the energy factor, average cycles per year, and the average cost of energy to make the energy and cost estimates. The Energy Factor, Modified Energy Factor, or Water Factor may not appear on the EnergyGuide label.

Dishwashers Key Product Criteria

Equipment	Criteria
Dishwashers	At least 41% more energy efficient than minimum federal government standards

Product Type	Federal Standard Energy Factor	ENERGY STAR Energy Factor
Standard (>= 8 place settings + six serving pieces)	>= 0.46	>= 0.65
Compact (< 8 place settings + six serving pieces)	>= 0.62	>= 0.88

The current ENERGY STAR criteria for dishwashers became effective January 1, 2007. This criterion is at least 41% above the federal standard and applies only to models manufactured after January 1, 2007.

Energy Performance Metric

Energy Factor (EF) is the dishwasher energy performance metric. EF is expressed in cycles per kWh and is the reciprocal of the sum of the machine electrical energy per cycle, M, plus the water heating energy consumption per cycle, W.

$$EF = \frac{1}{M + W}$$

This equation may vary based on dishwasher features such as water heating boosters or truncated cycles. The greater the EF, the more efficient the dishwasher is. The EF is the energy performance metric of both the federal standard and the ENERGY STAR qualified dishwasher program. The federal EnergyGuide label on dishwashers shows the annual energy consumption and cost. These figures use the energy factor, average cycles per year, and the average cost of energy to make the energy and cost estimates. The EF may not appear on the EnergyGuide label.

Refrigerators & Freezers Key Product Criteria

Equipment	Volume	Criteria
Full Size Refrigerators	7.75 cubic feet or greater	At least 20% more energy efficient than the minimum federal government standard (NAECA).
Full Size Freezers	7.75 cubic feet or greater	At least 10% more energy efficient than the minimum federal government standard (NAECA).
Compact Refrigerators and Freezers	Less than 7.75 cubic feet and 36 inches or less in height	At least 20% more energy efficient than the minimum federal government standard (NAECA).

On April 28, 2008, the ENERGY STAR criteria changed for all full-size refrigerators. All refrigerators greater than 7.75 cubic feet must be at least 20% more efficient than the federal standard. The ENERGY STAR criteria for full-sized freezers and compact refrigerators and freezers did not change at this time.

On January 1, 2004, the ENERGY STAR criteria for refrigerators changed to require all full-size models to be at least 15% above the minimum federal standard to qualify for ENERGY STAR. Please note, the ENERGY STAR criteria for full-sized freezers and compact refrigerators and freezers did not change at this time.

On January 1, 2003, the ENERGY STAR criteria for refrigerators expanded to include all sizes and configurations of refrigerators and freezers.

- All refrigerators and freezers 7.75 cubic feet or greater in volume must be at least 10% above the minimum federal standard to qualify for ENERGY STAR.

- All refrigerators and freezers less than 7.75 cubic feet in volume and 36 inches or less in height had to be at least 20% above the minimum federal standard to qualify for ENERGY STAR.

This expansion allowed the qualification of the previously ineligible products in the following categories:

- Chest freezers
- Upright freezers
- Manual defrost freezers and refrigerators
- Partial automatic defrost refrigerators
- Single door refrigerators
- Compact refrigerators and freezers

Federal Standards (NAECA)

The National Appliance Energy Conservation Act (NAECA) dictates minimum standards for energy consumption in refrigerators and freezers. The standard varies depending on the size and configuration of the refrigerator or freezer.

Refrigerators and freezers are categorized by:

- Configuration (side-by-side, top freezer, bottom freezer, single door refrigerator and freezer, single door refrigerator only, chest freezer, and upright freezer)
- Automatic or manual defrost
- For refrigerators, whether or not they have through-the-door ice service

Adjusted Volume (AV) for refrigerators is calculated as follows: AV = (Fresh Volume) + 1.63 x (Freezer Volume).

For freezers, the adjustment factor is 1.73 so the calculation is: AV = 1.73 x Freezer Volume.

Fresh Volume is the total volume of the main refrigerator compartment.

Freezer Volume is the total volume of the freezer compartment.

Calculate the Federal Standard (NAECA) and the ENERGY STAR criteria for refrigerators and freezers.


You may still find refrigerator and freezer models designated as ENERGY STAR at retail that met the previous ENERGY STAR criteria for an extended period of time. If you have recently purchased one of these models, even though these models do not meet the current ENERGY STAR criteria for refrigerators and freezers, you can be confident that the product is highly efficient.

In addition, some of the ENERGY STAR qualified refrigerators and freezers displayed on the Web site were recently introduced into the market and may not be available for purchase in certain areas.

Central Air Conditioners

New ENERGY STAR Specification to Take Effect January 1, 2009

On January 1, 2009, ENERGY STAR Tier 2 requirements for central air conditioners and air source heat pumps will take effect. The Tier 2 requirements are as follows:

Product Type	SEER	EER	HSPF
Split Systems	>=14.5	>=12	>=8.2
Single Package (including gas/electric package units)	>=14	>=11	>=8

Air-Source Heat Pumps and Central Air Conditioners Key Product Criteria

Equipment	Specification
Air-Source Heat Pumps	>= 8.2 HSPF/ >=14 SEER/ >=11.5 EER* for split systems >= 8.0 HSPF/ >=14 SEER/ >=11 EER* for single package equipment including gas/electric package units
Central Air Conditioners	>=14 SEER/ >=11.5 EER* for split systems >=14 SEER/ >=11 EER* for single package equipment including gas/electric package units

*Energy Efficiency Ratio

Additions to consider

Programmable Thermostats Key Product Criteria

Equipment	Specification
Programmable Thermostats	Shipped with a default energy saving program that is capable of maintaining two separate programs (to address the different comfort needs of weekdays and weekends) and four temperature settings or more for each day.

TVs

TVs, VCRs, & Combination Units Key ENERGY STAR Product Criteria

Equipment	Specification
DCR TVs with POD Slots	**Consume three watts or less when no POD is installed** **Consume 15 watts or less when a POD is installed**
Analog TV Monitors, Televisions, Digital TV Monitors, Component TV Units, VCRs*, TV/VCR Combination Units*, TV/DVD Combination Units*, VCR/DVD Combination Units*, and TV/VCR/DVD Combination Units*	**Consume one watt or less when switched off**

*Units with illuminated or backlit displays or other electronic status indicators may add an additional one watt to the existing one watt specification.