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Final Report

Southern California Edison 2004-2005 IDEEA Constituent Program Evaluations

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IDEEA Constituent Programs: Executive Summary

Southern California Edison (Edison) funded process and impact evaluations of 13 innovative energy-efficiency programs chosen from submissions to the 2004–2005 Innovative Designs for Energy Efficiency Activities (IDEEA) competition. Edison's intent was to identify, fund, and test the best ideas. A key element of the selection criteria was the potential to be integrated into ongoing utility offerings (that is, to be mainstreamed) to fill the gaps in Edison's portfolio. In addition, some programs were continuations of existing initiatives.

The IDEEA Programs

Beyond assessing the feasibility of each program to be mainstreamed into Edison's portfolio, this evaluation included long-term goals regarding new approaches to implementation and marketing. The 13 constituent programs, listed below, focused on all market segments: residential, agricultural, small commercial, large commercial, and industrial markets.

- AC Energy Hog Roundup
- Agricultural Ventilation Efficiency
- AirCare PlusSM Program
- Miniature Cold Cathode Lighting
- Community College District Retrofit
- Convenience Store Energy Efficiency Delivery (CSEED)
- Cool Cash Program
- EnergySolve Demand Response
- Mobile Home Evaporative Cooler
- New Technology for Multifamily HVAC Controls
- Energy Efficiency for Oil Producers
- Refrigerated Warehouse
- 80 Plus

The evaluation methodologies, findings, conclusions, and recommendations specific to these programs can be found in their respective chapters in the compilation of program evaluations.

Overview of Results

As might be expected with programs that involve new technologies and/or new markets, the results were mixed. Ultimately, some technologies in the 2004–2005 IDEEA program were integrated into mainstream program offerings, and one constituent program was integrated in its entirety. Some programs were continued into the 2006–2008 IDEEA cycle, and others ended with no future plans.

Program Impacts

These tables summarize the results of the ex-ante savings, contractor reported savings, and evaluated savings for the 13 programs combined. These data are also provided specific to each program in the section of this summary containing brief program descriptions. More detailed information can be found in the chapter for each individual program. The portfolio as a whole realized 72 percent of the first year kWh ex-ante savings estimates, saving 35,155,435 kWh. The portfolio saved 4,272 KW, or 46 percent of the first year KW estimates. Over the life of the measures installed, the portfolio is expected to save 412,707 MWh.

Table ES1. First Year Ex-Ante Proposed and Reported, and Ex-Post Evaluated Energy Savings and Demand Savings

	Proposal		Reported		Evaluated		First Year Net Realization Rate
	Ex-ante Gross	Ex-ante Net	Ex-ante Gross	Ex-ante Net	Ex-post Gross	Ex-post Net	
kWh	61,383,480	52,286,553	58,510,937	48,882,811	40,765,830	35,155,435	71.9%
KW	12,760	10,915	11,058	9,395	5,424	4,272	45.5%

Table ES2. Program Energy Impact Reporting for 2004–2005 Programs

Year	Calendar Year	Ex-ante Gross Program-Projected Program MWh Savings	Ex-Post Net Evaluation Confirmed Program MWh Savings	Ex-Ante Gross Program-Projected Peak Program MW Savings	Ex-Post Evaluation Projected Peak MW Savings
1	2004	0	0	0	0
2	2005	51,310	34,019	10.23	4.47
3	2006	58,510	35,244	11.05	2.41
4	2007	58,510	35,243	11.05	2.41
5	2008	58,510	35,242	11.05	2.41
6	2009	58,510	29,908	11.05	1.62
7	2010	57,790	29,908	10.63	1.62
8	2011	57,790	29,908	10.63	1.62
9	2012	56,270	29,740	10.63	1.53
10	2013	49,382	29,052	9.25	1.41
11	2014	44,030	28,820	9.25	1.39
12	2015	41,161	18,910	9.20	0.41
13	2016	41,161	17,506	6.19	2.45
14	2017	41,141	17,473	6.18	2.44
15	2018	41,141	17,433	6.18	2.44
16	2019	40,149	17,433	6.11	2.44
17	2020	10,401	6,825	1.27	0.94
18	2021	1,478	26	0.08	0.03
19	2022	0	26	0.00	0.03
20	2023	0	0		
TOTAL	2004-2023	767,244	412,707		

Savings and Realization Rates

As noted in Table ES1, the portfolio realized 72 percent of kWh and 46 percent of KW ex-ante savings estimates. The constituent program evaluations found a number of issues affecting the ex-ante reported savings estimates, which routinely led to overestimation of achievements. For example:

1. The IDEEA program's ex-ante assumptions included savings for measures that do not save energy (such as savings from diagnostic activities).
2. Ex-ante estimates were developed from the experience of implementing a program in another climate zone, resulting in measure savings estimates that were too high. Also, the implementation contractor used a proprietary software model to report savings not calibrated to facility usage data; thus, savings were overestimated.
3. Program savings were claimed for actions that were required by code. In addition, some code compliance measures (such as duct sealing for HVAC) were not done.
4. Savings were claimed for measures that could not be verified because they could not be located, resulting in an overestimation of the reported savings.
5. Projected ex-ante savings for some measures were greater than field observations and reports in the literature, and the required baseline data were unavailable.
6. Behavioral practices (such as manually controlling HVAC equipment) were not taken into account during program implementation, and those measures—automated HVAC controls—could not produce energy and demand savings.
7. A program was built around a technology that worked in its original application, but it did not deliver comparable savings in the program's setting. The projected savings were based on the original application, expecting comparable performance.
8. Implementers estimated a longer measure life than evaluators could confirm. Also, some measures relied on bundled components that had different measure lives. For example, in the Multifamily HVAC Program, the HVAC controls used one component having a measure life of 11 years and two components having a measure life of 8 years, and failure of either component rendered the system inoperable.

Free Riders and Net-to-Gross Ratios

Estimating free riders initially appeared to be a straightforward task, but it turned out to be much more complex in practice. Each program presented its own set of challenges, and a consistent set of questions could not be implemented across the 12 programs that included an impact analysis. (No impact analysis was conducted for the 80 Plus program.)

In these programs, the net-to-gross (NTG) ratio was an adjustment solely based on free riders. For most programs, Southern California Edison program implementers used a default value for NTG of .80. The impact and process evaluations attempted to measure free ridership and to establish the best value, based upon the preponderance of evidence. Evaluations of the constituent programs led to four types of NTG findings.

1. When programs offer a technology that is not available to anyone other than those participating, there are no free riders, and the NTG = 1.
2. Sometimes there is not enough information to accept or reject the null hypothesis that the NTG = .80.
3. When the program includes multiple measures but not all measures are installed, the program level NTG is based on savings-weighted estimates rather than individual estimates. NTG is only applicable to the particular program population.
4. Because many of the programs involved new technologies or new markets, the .80 NTG placeholder is probably too low. A NTG of .80 implies there is a fairly well developed market in which 20 percent would purchase and install the product without program incentives.

The NTG ratio estimation was attempted for each constituent program, and, across the constituent programs, the NTG ranged from 0.8 to 1.0. In some cases, the estimation was not successful, and the default planning assumptions were used. We recommend a default NTG of .90 for the IDEEA and 1.0 for the InDEE Program. Our experience shows the individual programs will be within the .85 to 1.0 range when accurate field measurements can be made.

IDEEA Program Issues and Findings

The underlying objective of the overall process evaluation was to compile lessons learned regarding: (1) the program process, including the selection process; (2) achievement of program objectives; and (3) opportunities for program improvement.

In general, participating customers, trade allies, and implementers were happy with the program offerings and with the technologies installed. They reported that without these programs, they would not have installed the energy-efficiency and demand-reduction measures.

The process and impact evaluations revealed recurring themes that cut across programs. Additionally, we identified administrative and policy issues that pertained to the IDEEA program portfolio as a whole.

Administrative and Policy Issues

- ***Program timing and evaluation effort:*** Because most programs involved either new technologies or new locales (for existing programs), some programs: (1) were slow to get into the field; (2) ran out of money and had to curtail implementation; or (3) reported a majority of installations in the final months of the contract. Thus, reports of program accomplishments lagged, as the last data were received in December 2006. Impact evaluations were affected because sampling and measurement decisions had to wait until installations were complete. Process evaluations were affected because real-time feedback could only be implemented in programs that lagged.

- ***Regulatory guidelines:*** The 2004–2005 IDEEA/InDEE Program was subject to the same regulations of the California Public Utilities Commission (CPUC) as other mainstream energy programs. This may have had an impact on program design and evaluation, as proposed innovative programs lacked the flexibility for experimentation.

- ***Sample size:*** Conventional programs having 100,000 participants can afford a few errors or inappropriate installations and still be cost-effective. However, IDEEA programs tend to have limited implementation scope, and a program with only ten participants cannot afford many errors and still demonstrate its impact and viability with conventional process and impact evaluation guidelines.

- ***Undefined criteria for constituent program success:*** The program RFP and implicit theory lack specificity as to what is success, although program managers agree that integration into Edison's mainstream program portfolio is the ultimate measure. While a constituent program may be not meet its implementation and savings goals, it may still demonstrate the viability of a new technology, or a program may successfully demonstrate an energy efficiency but, in meeting other customer needs during delivery, the program may result in increased energy use.

- ***Structural issues with early program decisions:*** There are some fundamental questions as to how the constituent programs were approved for the 2004–2005 IDEEA. In both the overall process evaluation and the constituent program process evaluation, we question: how certain technologies got through the screening process; how some implementation and savings assumptions were approved; why the definition of customer eligibility was lacking or weak; and why critical evaluation data were not required to be gathered.

- ***Little or no evaluability assessment:*** Evaluability assessment (EA)—determining whether data necessary for evaluation are being collected as part of the program-tracking process, and whether those data will be available when evaluations are actually implemented—was not a formal requirement in some venues. However, although many issues could not be anticipated, other issues could have been addressed early in the program had EA been part of the program planning process. These issues included:

    - Service account identifiers not available;
    - Contact information not being required;
    - Some pre-installation conditions not being tracked; and
    - Determination of potential impacts relative to energy use.

    We recommend early evaluation planning, formal evaluability assessment, and an emphasis on collecting and verifying baseline conditions.

Program Management Approach

Innovative programs need flexibility to react to market forces and implementation issues. However, if these issues are not systematically documented, the evaluation will conclude that the program was not implemented as designed, or that the goals were not met because of program design flaws. Managing innovative programs likely requires more oversight, managerial involvement, and documentation than conventional programs; so policies and procedures for managing these programs should be made explicit.

Changes From the Original Work Plans

A number of program implementation plans were negotiated and changed between the original proposal submitted to Edison and the final signed purchase order (PO). Consequently, the PO was not always the same as the original proposal. Program implementation and management were developed based on the PO, and the evaluation work plans for this evaluation were developed from the final PO and Statement of Work (SOW).

We recommend that future evaluations include the initial stage of the program evolution, from the original proposal to the PO. Changes in the program implementation work plan—whether formal or informal—must be documented to ensure proper treatment of results in the evaluation.

Cross-Program Conclusions and Recommendations

- ***Conclusion 1.*** Record-keeping and data quality issues impacted savings, incentives, and evaluation.

  Recommendation 1. Conduct an evaluability review before awarding the program implementation contract, and hire evaluators prior to implementation.

- ***Conclusion 2.*** New technologies and new approaches to marketing—in addition to conventional approaches to different market segments—need more active program managerial involvement and may need more than one or two years to demonstrate impacts.

  Recommendation 2. Program managers should actively engage with the third-party implementers and conduct formal, quarterly program reviews.

- ***Conclusion 3.*** Training, education, and continued support are needed for long-term savings.

  Recommendation 3. Integrate training into program delivery.

- ***Conclusion 4.*** Billing analysis was less useful than anticipated.

  Recommendation 4. An evaluability assessment, proper data collection, and flexibility to use alternate impact assessment methods when program performance does not support billing analysis can serve as preventive and corrective measures for impact assessment.

- ***Conclusion 5.*** The California Evaluation Protocols may not be appropriate for some pilots and innovative programs.

  Recommendation 5. The CPUC should address pilots and innovative programs with a new protocol or a policy statement.

Summaries of Individual Programs

The results of the process and impact evaluations vary widely among the 13 programs. The following pages contain brief descriptions of each program, including savings (both kWh and KW), and several recommendations based on key results regarding either process or impact.

AC Energy Hog Roundup

A constituent program of the 2004–2005 IDEEA project, the AC Energy Hog Roundup program ran from June 2005 through June 2006 on a Conservation Services Group (CSG) implementation contract for $988,500. Targeting high-use, residential customers in the Coachella Valley, this program contained a tune-up component, a replacement component and incentive, and a CFL component. The program was also designed to help develop the HVAC industry by introducing the diagnostic protocols to HVAC contractors who worked in that area.

Table ES3. AC Energy Hog Roundup Program Savings First Year Ex-Ante Proposed and Reported, and Ex-Post Evaluated Energy Savings and Demand Savings

	Proposal			Reported			Evaluated		
	Ex-ante Gross	Net to Gross	Ex-ante Net	Ex-ante Gross	Net to Gross	Ex-ante Net	Ex-post Gross	Net to Gross	Ex-post Net
kWh	2,167,696	0.8	1,734,157	1,314,105	0.8	1,051,284	473,337	0.91	431,390
kW	1,246	0.8	997	763	0.8	611	196	0.9	176

Based on the findings of the evaluation, the AC Energy Hog Roundup program achieved only limited success in program implementation and savings. Recommendations include:

- Develop screening tools to allow for consistent program implementation.
- If HVAC early replacement programs are to continue in Edison's portfolio, a range of customer financing options should be considered.
- Conduct additional research to refine the DEER database**.**

Agricultural Ventilation Efficiency

To encourage agricultural producers to install energy-efficient ventilation systems on their farms, Edison awarded EnSave a $724,069 contract to implement the Agricultural Ventilation Efficiency program in a manner that would have a lasting impact on the community. Recognizing the potential for energy savings in this sector, EnSave designed this program to educate approximately 2,000 agricultural producers about the benefits of installing high-volume, low-speed (HVLS) fans and to encourage installation via cash incentives.

Table ES4. Agricultural Ventilation Efficiency Program Savings First Year Ex-Ante Proposed and Reported, and Ex-Post Evaluated Energy Savings and Demand Savings

	Proposal			Reported			Evaluated		
	Ex-ante Gross	Net to Gross	Ex-ante Net	Ex-ante Gross	Net to Gross	Ex-ante Net	Ex-post Gross	Net to Gross	Ex-post Net
kWh	3,518,181	0.75	2,638,636	4,679,272	0.75	3,509,454	2,862,201	0.86	2,461,493
kW	457	0.75	343	609	0.75	457	926.2	0.86	796.5

This program started slowly, and while more "traditional-looking" energy-efficient fans were installed than projected, the program did not meet its kWh and kW goals. The fan technology was slow to penetrate the agricultural community; however, where fans were installed, the producers were well satisfied. In many cases, the non-energy benefits outweighed the benefits from energy savings.

Far fewer high volume low speed (HVLS) fans were installed than anticipated, in part because these fans can be 20 feet in diameter and look and operate differently than more traditional fans. The program also incented installation of new fans where none existed before, in addition to replacing the less efficient fans. Recommendations include:

- Record baseline operations and field data.
- Because timing is critical, marketing efforts should include appearances at the well-attended industry trade shows. Many fan vendors and agricultural producers make their purchase decisions early in the year, and they are influenced by offerings at the Expo.
- Because a major market barrier is first cost, continue offering incentives in the successor program.

AirCare Plus[SM]

Edison awarded Portland Energy Conservation Inc. (PECI) a $1,499,813 contract to implement AirCare Plus[SM], a program designed to inspect, diagnose, and make retrofits that save energy, reduce downtime, and increase comfort, and extend equipment service life for small rooftop HVAC units installed in light commercial buildings. AirCare Plus[SM], designed to provide comprehensive services to a hard-to-reach market, integrates the delivery of a package of small hardware retrofits and mechanical adjustments for 3 to17.5 ton HVAC units. The diagnostic work was provided to the customer at no charge and incentives were offered for retrofitting rooftop HVAC systems. PECI's goal was to train 65 technicians throughout Edison's service territory, who would then deliver the HVAC analysis and retrofits on 5,600 rooftop HVAC units as a value-added service.

Table ES5. AirCare Plus Program Savings
First Year Ex-Ante Proposed and Reported,
and Ex-Post Evaluated Energy Savings and Demand Savings

	Proposal			Reported			Evaluated		
	Ex-ante Gross	Net to Gross	Ex-ante Net	Ex-ante Gross	Net to Gross	Ex-ante Net	Ex-post Gross	Net to Gross	Ex-post Net
kWh	7,443,880	0.997	7,427,800	5,351,565	1	5,351,565	1,112,277	1	1,112,277
kW	1,436	0.997	1,432	726	1	726	-207	1	-207

The program did not reach its participation goals or its energy savings goals; nor were the expected number of contractors trained. Evaluation was difficult for various reasons: lack of pre- and post-installation data, incomplete and inconsistent program data, small savings compared to participants' usage, use of proprietary software lacking transparency, and insufficient track record of large scale implementation. In many cases, the service contractor did not inform the customer of the additional diagnostic and tune-up services provided, so there was no participation decision on the part of the building owner. Recommendations include:

- Conduct early evaluation planning, and collect and verify baseline conditions.
- Calibrate and validate software models and make them transparent.
- Ensure that the program's timing and marketing take into account the seasonal nature of the market.

Community College District Retrofit

The Community College District Retrofit program was implemented by Intergy, Inc, and provided a variety of energy-efficiency activities and equipment retrofits to create immediate energy and peak demand savings at a limited number of community colleges. The program was coordinated with existing retrofit projects then occurring on LACCD campuses with Proposition A and Proposition AA bond funds. The program, which called for commissioning activities on LACCD campuses, included such measures as interior and exterior lighting retrofits, HVAC equipment upgrades, air and water distribution efficiency measures, commissioning, PC management software, and vending machine controls.

Table ES6. Community College District Retrofit Program Savings
First Year Ex-Ante Proposed and Reported,
and Ex-Post Evaluated Energy Savings and Demand Savings

	Proposal			Reported			Evaluated		
	Ex-ante Gross	Net to Gross	Ex-ante Net	Ex-ante Gross	Net to Gross	Ex-ante Net	Ex-post Gross	Net to Gross	Ex-post Net
kWh	6,142,318	0.96	5,896,625	6,448,344	0.96	6,190,410	6,330,758	0.83	5,225,318
kW	903	0.96	867	1,098	0.96	1,054	1,053	0.46	489

The program achieved participation targets but fell short of its energy savings goals, realizing 81 percent of the kWh ex-ante savings estimates and 45 percent of demand savings estimates. The evaluation provides some lessons learned that could be helpful for the statewide program going forward. Recommendations include:

- Energy Service Companies (ESCOs) are effective project management and installation mechanisms.

- Community college staff should be trained and educated in energy-efficiency technologies and in continuous commissioning.

- Currently, significant financial barriers hinder installation of energy-efficient technologies. Other technologies will be installed without assistance. Determine which projects will proceed without funding in order to direct incentives to projects that would not otherwise proceed.

Convenience Store Energy Efficiency Delivery

The Convenience Store Energy Efficiency Delivery program was implemented by QuEST. The program provided direct installation of energy-efficiency measures to the underserved, hard-to-reach convenience store market segment targeting three counties in Edison's service territory. The program offered an energy assessment and a comprehensive menu of lighting and refrigeration efficiency measures specific to convenience stores, combined with incentives to reach a short, one-year payback period (100 percent financing, if needed), and direct installation.

Table ES7. Convenience Store Energy Efficiency Delivery Program Savings First Year Ex-Ante Proposed and Reported, and Ex-Post Evaluated Energy Savings and Demand Savings

	Proposal			Reported			Evaluated		
	Ex-ante Gross	Net to Gross	Ex-ante Net	Ex-ante Gross	Net to Gross	Ex-ante Net	Ex-post Gross	Net to Gross	Ex-post Net
kWh	3,175,690	0.96	3,048,662	991,883	0.96	952,208	745,527	1	745,527
kW	182	0.96	175	73	0.96	70	60	1	60

The program fell short of the estimated ex-ante savings estimates. Realization rates were calculated as the ratio of the evaluated net ex-post savings to the reported ex-ante gross savings. For the overall program, the realization rate was 75 percent for energy and 96 percent for demand. The program was undersubscribed and much more difficult to enroll than expected. Findings and recommendations included:

- The program competed with direct-install lighting programs offering 100 percent incentives. Operate future programs in areas where fully funded programs are not offered.

- The one-stop audit/sale/signature approach did not always work well, requiring a second visit from implementers to sell the job. Challenges such as timing, funding, and identifying the decision maker all influenced participation decisions.
- A variety of financing mechanisms to overcome the first cost barrier should be explored.
- More than one marketing and sales approach should be utilized for this market.

Cool Cash Program

Honeywell DMC Services LLC proposed delivering a new pilot program targeting small to medium hotels in Southern California. This was a turnkey, retrofit program that would install Smart System power controllers and motion and infrared occupancy sensors for package terminal air conditioning systems (PTACs) at no cost to the participant, and it offered incentives for the replacement of pre-1993 PTAC units. The program targeted inland desert area around Palm Springs and also climate zones with the highest number of cooling degree days.

ES8. Cool Cash Program Savings
First Year Ex-Ante Proposed and Reported,
and Ex-Post Evaluated Energy Savings and Demand Savings

	Proposal			Reported			Evaluated		
	Ex-ante Gross	Net to Gross	Ex-ante Net	Ex-ante Gross	Net to Gross	Ex-ante Net	Ex-post Gross	Net to Gross	Ex-post Net
kWh	1,416,192	0.8	1,132,954	1,518,312	0.8	1,214,650	168,471	0.86	144,478
kW	838	0.8	670	838	0.8	670	56	0.96	54

The program fell significantly short of the ex-ante savings estimates; it evaluated ex-post net demand savings are 54 KW (compared to the program goal of 670 KW), yielding 8 percent net realization rate. The program evaluated ex-post net energy savings are 144,478 kWh (compared to the program goal of 1,132,954 kWh), yielding 13 percent net energy savings realization rate.

Although the program quickly reached its recruitment and installation goals, it was not implemented as planned. The intended participants were smaller hotels and motels that might lack financial capital to install energy-efficient technologies. However, the program did not have an implementable marketing plan. Limited screening criteria were imposed, and all participants were aware of the technology prior to participation. Recommendations included:

- Document baseline practices prior to installation. Hotel contacts indicated they were already manually controlling PTACs in unoccupied rooms.
- Further development of the technology is needed to overcome customer discomfort during night time hours and to allow different drift temperatures and cycle times for the summer and winter seasons.
- A generous incentive or direct installation could be offered to smaller hotels.

- Hotel staff and management should be trained so they understand how the sensors operate and how to identify failed units.

Energy Efficiency for Oil Producers

Global Energy Partners (Global) implemented a program aimed at increasing the energy efficiency of oil extraction facilities operated by small to medium independent California oil producers. The program offered seven measures, including high-efficiency pumps, controllers, variable-speed drives, and water shut-offs. The design was similar to a program implemented by Global in 2002 and 2003—the Energy Efficiency Services for Energy Consumption and Demand Reduction for Oil Production (2002-2003). The 2004-2005 IDEEA Energy Efficiency for Oil Producers (2004-2005) program built on the experience of the earlier program.

Table ES9. Energy Efficiency for Oil Producers Program Savings First Year Ex-Ante Proposed and Reported, and Ex-Post Evaluated Energy Savings and Demand Savings

	Proposal			Reported			Evaluated		
	Ex-ante Gross	Net to Gross	Ex-ante Net	Ex-ante Gross	Net to Gross	Ex-ante Net	Ex-post Gross	Net to Gross	Ex-post Net
kWh	17,310,000	0.8	13,848,000	18,458,305	0.8	14,766,644	17,024,223	0.8	13,619,378
kW	2,164	0.8	1,731	2,308	0.8	1,846	1,742	0.8	1,394

The program fell somewhat short of the ex-ante estimated savings. Realization rates were calculated as the ratio of the evaluated net ex-post savings to the reported ex-ante gross savings. For the overall program, the realization rate was 74 percent for energy and 60 percent for demand. The program was not implemented as planned. Enrollment relied on previously identified interested contacts. The effect of the innovative marketing strategy on the recruitment component of program marketing was not tested. Recommendations included:

- Where projects are already economically viable, offer less generous incentives, and then direct program funding to marketing, management and/or technical analysis.
- Add program rules to encourage broad participation, and spread the incentives beyond prior participants.
- Review eligible measures and drop standard practice measures.

EnergySolve Demand Response

EnergySolve Demand Response, LLC, implemented the program, installing Westinghouse's RetroLUX-D T-5 energy-efficient fluorescent lighting as a retrofit for existing 4-foot and 8-foot T-12 lamp fixtures and magnetic ballasts. The technology is a two-way, wireless, dimmable, energy-efficient T-5 fluorescent lighting unit that snaps into the fixture without having to access the ballast. (Because it is seldom economically viable to retrofit fixtures using T-8 lamps, implementers planned the retrofit program for small commercial facilities using T-12 lamps.)

Table ES10. EnergySolve Demand Response Program Savings First Year Ex-Ante Proposed and Reported, and Ex-Post Evaluated Energy Savings and Demand Savings

	Proposal			Reported			Evaluated		
	Ex-ante Gross	Net to Gross	Ex-ante Net	Ex-ante Gross	Net to Gross	Ex-ante Net	Ex-post Gross	Net to Gross	Ex-post Net
kWh	2,091,485	0.8	1,673,188	2,135,914	0.8	1,708,731	1,434,260	1	1,434,260
kW	516.25	0.8	413	526.25	0.8	421	309	1	309

Two companies enrolled in the program, funds were fully expended, and some participant sites were rolled into the 2006-2008 program year. However, the ex-ante savings estimates were not met. Two factors that reduced savings were (1) the facilities at one company were operated on a seasonal schedule, and (2) the customers at both companies did not fully utilize the dimming capacity. Realization rates were calculated as the ratio of the evaluated net ex-post savings to the reported ex-ante gross savings. For the overall Program, the KW realization rate was 67.2 percent and kWh realization rate was 84 percent. Recommendations included:

- Continue offering this type of program as a direct-install program.
- Increase the incentive pool, lengthen the program timeframe, and broaden marketing efforts.
- Document baseline operating conditions to gauge accurately a customer's normal behavioral activities, operating schedules, and applicability of the technology.
- Provide training to facilities staff to use the dimming capability and reinforce its use. Also, target companies where hours of operation will not inhibit achievement of energy goals.

Miniature Cold Cathode Lighting

Edison awarded Energy Concepts & Controls a $1 million contract to implement the Miniature Cold Cathode Lighting program. Miniature cold cathode lamps were offered as a replacement for incandescent decorative lamps, particularly in applications where compact fluorescents had not proven to be a viable alternative. The program targeted businesses in Southern California that had significant outdoor signage or indoor lighting requirements.

Table ES11. Miniature Cold Cathode Lighting Program Savings First Year Ex-Ante Proposed and Reported, and Ex-Post Evaluated Energy Savings and Demand Savings

	Proposal			Reported			Evaluated		
	Ex-ante Gross	Net to Gross	Ex-ante Net	Ex-ante Gross	Net to Gross	Ex-ante Net	Ex-post Gross	Net to Gross	Ex-post Net
kWh	6,030,088	0.8	4,824,070	6,294,993	0.8	5,035,994	5,553,865	0.9	4,998,479
kW	1,340	0.8	1,072	774	0.8	619	874	0.9	787

The program fell short of kWh ex-ante savings estimates but surpassed KW estimates. For the overall Program, the realization rate was 79 percent for energy and 102 percent for demand. Acceptance of the technology varied widely. The lighting was not well accepted in indoor applications where color temperature was critical. However, the majority of participants who stayed with the program were happy with the technology. Recommendations included:

- Provide demonstration sites and displays to educate potential customers about the lighting quality and technical requirements.
- Incorporate a quality assurance process to facilitate customer questions and provide immediate assistance when needed.
- Monitor manufacturers development to promote “warm color” temperature lighting when it becomes available.
- Keep detailed records to track the physical location of the lighting installation, the customer account number and the meter number associated with the measures installed.

Mobile Home Evaporative Cooler

The Mobile Home Evaporative Cooler Program sought to improve the efficiency of existing mobile homes with both evaporative cooling and compressor air conditioning through providing evaporative cooler tune-ups. Cal-UCONS and American Synergy Companies delivered the program to the hard-to-reach mobile home sector. The program changed in response to a mid-program evaluation, which showed disappointing energy and demand savings resulting from the evaporative cooler tune-up measure but also showed promising results from the test of fan depowerment. The last third of the program implementation period reflected a shift away from tune-ups entirely, focusing instead on fan depowerment.

ES12. Mobile Home Evaporative Cooler Program Savings
First Year Ex-Ante Proposed and Reported,
and Ex-Post Evaluated Energy Savings and Demand Savings

	Proposal			Reported			Evaluated		
	Ex-ante Gross	Net to Gross	Ex-ante Net	Ex-ante Gross	Net to Gross	Ex-ante Net	Ex-post Gross	Net to Gross	Ex-post Net
kWh	4,821,700	0.89	4,291,131	3,949,781	0.89	3,515305	709,782	0.89	631,706
kW	3,082.5	0.89	2,743	2,779	0.89	2,474	16.3	0.89	14.5

Quantec conducted a limited process evaluation. An impact evaluation had previously been completed by Alternative Energy Systems Consulting (AESC) in association with Stellar Processes. Program contacts unanimously felt that the project was executed well and that customers were well served. However, the program fell far short of ex-ante savings estimates, with a net realization rate of 1.6 percent of kWh savings and .52 percent for KW savings. Energy savings resulting from the evaporative cooler tune-up were hard to discern. The program field tested fan depowerment at 100 sites and subsequently focused on offering this measure. Recommendations included:

- Include evaluation requirements in the program design.
- Plan marketing efforts and training to focus on one-on-one outreach in a personalized, park-by-park, basis.
- Screen and select potential participants who meet specifications of the targeted market.
- Collect and maintain baseline contact information.
- Develop and implement a complete data collection plan to include information for all participants. Plan for data collection at master metered parks.

New Technology for Multifamily HVAC Controls

Edison awarded Resource Management Corporation a contract for $548,800 to implement the New Technology for Multifamily HVAC Controls program. The program featured installation of Energy Eye™, an energy management system designed to control HVAC systems independently through the new, wireless, occupancy-sensing technology. The technology was first introduced into the hotel/motel industry, and using the application in apartment complexes was unique.

ES13. New Technology for Multifamily HVAC Controls Program Savings First Year Ex-Ante Proposed and Reported, and Ex-Post Evaluated Energy Savings and Demand Savings

	Proposal			Reported			Evaluated		
	Ex-ante Gross	Net to Gross	Ex-ante Net	Ex-ante Gross	Net to Gross	Ex-ante Net	Ex-post Gross	Net to Gross	Ex-post Net
kWh	3,360,000	0.8	2,688,000	3,360,000	0.8	2,688,000	183,400	1	183,400
kW	175	0.8	140	175	0.8	140	9.6	1	9.6

The program was implemented as designed, and it expended all direct incentives within the 14 participating multi-family complexes. Still, the program fell short of its ex-ante estimated savings goals. Realization rates were calculated as the ratio of the evaluated net ex-post savings to the reported ex-ante gross savings. For the overall program, the realization rate was 5.5 percent for energy and demand savings. The property managers and tenants did not, on the whole, understand what the system was or how it worked; nor was there a clear maintenance policy or practice in place. A number of technological adjustments were needed, and many systems and/or components were removed. However, the manufacturers went to great lengths to address the system malfunctions and, by the end of the program, had addressed two primary issues: the batteries and the controllers. Recommendations included:

- Reevaluate deployment of the technology in low-income apartment complexes. Test the technology in larger apartment complexes.
- Assess baseline conditions and technology modifications. Screen potential participants to ensure they meet the preferred participant profile.
- Provide tenants and property managers with additional information about the system, including operations and maintenance. Implement or coordinate scheduled battery maintenance, and track battery replacement.
- Further development of the sensor technology are needed to address tenant nighttime discomfort and the need to manually control their HVAC system.
- Consider all system components when determining the system’s measure life. Measure life is likely about half the original estimate.

Refrigerated Warehouse

Edison awarded Onsite Energy an $800,000 contract to implement the Refrigerated Warehouse program, which was designed to reduce energy usage by more than 3 million kWh based upon a simple concept—market financial incentives to a small target audience capable of realizing significant energy savings. Five efficiency measures were offered to the refrigerated warehouse market segment.

ES14. Refrigerated Warehouse Program Savings
First Year Ex-Ante Proposed and Reported,
and Ex-Post Evaluated Energy Savings and Demand Savings

	Proposal			Reported			Evaluated		
	Ex-ante Gross	Net to Gross	Ex-ante Net	Ex-ante Gross	Net to Gross	Ex-ante Net	Ex-post Gross	Net to Gross	Ex-post Net
kWh	3,906,250	0.79	3,083,148	4,008,463	0.79	2,898,566	4,167,729	1	4,167,729
kW	419.9	0.79	331.7	389	0.79	307	389	1	389

The program met its energy savings goals and expended all available incentives to fund the projects. There were only four participants. More lighting measures were installed than originally anticipated and, conversely, fewer mechanical measures were installed than anticipated. Realization rates were calculated as the ratio of the evaluated net ex-post savings to the reported ex-ante gross savings. For the overall program, the kWh realization rate was 104 percent and the KW realization rate was 100 percent. Findings and recommendations included:

- The refrigerated warehouse market is an appropriate niche for efficiency upgrades. Lead time and incentives are critical to promote efficiency upgrades in this market.
- Maintain or increase incentive levels and mainstream the measures.

80 Plus

80 Plus is an upstream, buy-down program that encouraged computer manufacturers to produce more energy-efficient power supplies into desktop computers and desktop-derived servers. The 80 Plus performance specification requires power supplies in computers and servers to operate with 80 percent or greater energy efficiency at 20 percent , 50 percent, and 100 percent of rated load with a true power factor of 0.9 or greater.

This evaluation included only a process evaluation. When the work plan was developed for this evaluation, there were no participating Tier 1 OEMs in California. No 80 Plus systems were sold in the state, and no sales of 80 Plus units were projected for the program period. Thus, no impact evaluation was proposed or conducted. Findings and recommendations included:

- Because market adoption of 80 Plus power supplies has been slower than projected, evaluate the impact of the recent activity in the personal computer industry on continuing program achievements.
- Determine whether increased rebates would increase participation, as the incremental cost of 80 Plus power supplies remains a market barrier for both nonparticipant manufacturers and system integrators.
- Promote industry and public awareness of 80 Plus to build product demand.

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1. IDEEA Constituent Programs: Overall Evaluation Summary

Southern California Edison's Innovative Designs for Energy Efficiency Activities (IDEEA) Program is an annual competitive bidding for innovative energy efficiency program proposals across all market sectors and customer segments. Edison's intent was to identify, fund, and test the best submitted ideas that can be mainstreamed into full scale programs to fill the gaps in their portfolio of proven, reliable programs.

Process and impact evaluations were conducted for constituent programs selected for the 2004-2005 IDEEA Program. The constituent programs focused on all market segments –residential, agricultural, small commercial, large commercial, and industrial markets. The 13 programs in the 2004-2005 IDEEA Program included:

- AC Energy Hog Roundup Program
- Agricultural Ventilation Efficiency Program
- AirCare Plus^{SM} Program
- Miniature Cold Cathode Lighting Program
- Community College District Retrofit Program
- Convenience Store Energy Efficiency Delivery Program (CSEED)
- Cool Cash Program
- EnergySolve Demand Response Program
- Mobile Home Evaporative Cooler Program
- New Technology for Multifamily HVAC Controls Program
- Energy Efficiency for Oil Producers Program
- Refrigerated Warehouse Program
- 80 Plus Program

Southern California Edison experimented with new technologies and new markets on a wide scale. Program theory explicitly included long term goals on learning new implementation and marketing approaches and new technology applications that could be "mainstreamed" – integrated into ongoing utility offerings. Some technologies offered in the 2004-05 IDEEA program have already been "mainstreamed" and one constituent program has been integrated in its entirety. Evidence of new and innovative marketing approaches has been less obvious.

Participating customers, trade allies and implementers were happy with the program offerings and with the technologies installed. Without these programs, the participants reported they would not have installed the energy efficiency and demand reduction measures. The net-to-gross ratios across the constituent programs ranged from 0.8 to 1.0. Net-to-gross ratio estimation was attempted for each constituent program. In some cases the estimation was not successful, and the default planning assumptions were used. Each constituent program evaluation contains a discussion of the net-to gross estimation procedure and final decision as to which estimate to use.

As may be expected with programs that involve new technologies or new markets, there were mixed results. Some constituent programs appear to be successful and some not. Some technologies have proven successful others have high rates of failure. There did not seem to be a consistent understanding of the word “innovation” other than programs or applications that “fill gaps” in Edison’s portfolio of programs, as specified in the original IDEEA Request for Proposals. Some constituent programs involved new market segments, implementation approaches, or technologies. Others were continuations of existing initiatives and appeared to be in the IDEEA Program because there was no other convenient place (at that time) in the Edison program portfolio. In the end, several programs were continued into the 2006-2008 IDEEA cycle, some programs and program components were mainstreamed, and some ended with no future plans.

This chapter provides an overview of the 2004-05 IDEEA Program, beginning with a discussion of the evaluation methodologies utilized in the evaluation and a logic model for the IDEEA program as a whole. This chapter also reports on the cross-program findings, conclusions and recommendations and on final program impacts.

Evaluation methodologies, findings, conclusions and recommendations specific to each of the programs can be found in their respective chapters in this two-volume compilation of constituent program evaluations.

1. Evaluation Methodologies

Process Evaluation Methodologies

The process evaluation included an overall process evaluation of the 2004-05 IDEEA Program, as well as individual process evaluations of the thirteen constituent programs. Although the overall process evaluation pertains to the 2004-05 IDEEA Programs, for the purpose of ongoing feedback to the IDEEA solicitation process, first solicitation for the 2006-08 IDEEA was also included for comparative purposes.

The underlying objective of the overall process evaluation was to compile “lessons learned” from the first rounds of the IDEEA solicitation for the purpose of improving the process for current and future solicitations for these programs. Edison’s interest in this evaluation can be organized into three main areas: (1) the program process, including the solicitation process, (2) achievement of program objectives and (3) opportunities for program improvement.

Besides the overall process evaluation, the study also conducted process evaluations of the individual programs funded under the IDEEA program and included three major efforts.

- Interviews with project management and implementation staff, including implementation contractors.
- Interviews or surveys of program participants and, where possible, non-participants and other market actors.
- Document review, including CPUC filings, constituent program proposals, work plans, contractual statements of work (SOW's), program forms, and tracking databases.

In the constituent program process evaluations, the following are the major cross-cutting aspects for program staff, management, and trade allies that were evaluated.

- *General Process:* What worked? What didn't work? How could the program be improved?
- *Planning vs. implementation:* What were the program goals? Did they change? How was the program implemented? Was it implemented as designed? What were the indicators of success? What were the barriers the program was designed to address? Were they addressed? Were there any unanticipated problems or successes?
- *Program Design:* What was the program logic? How do implementers know if the program has been successful? What would implementers have done differently?

Project Results: Did the program achieve projected results? If not, why not?

For program participants and nonparticipants, following aspects were evaluated

- Satisfaction with services and suggestions for improvement
- Outreach activities, including how the project message was delivered
- Reasons for participation or non-participation
- Prior participation in utility programs and innovative practices
- Spillover effects triggered by program contact or participation
- Free ridership

An evaluation workplan was developed for each of the constituent program prior to conducting the evaluation and a logic model was developed for each program to guide and refine the research. .

All process evaluations included interviews with program managers, implementers, and participating end use customers. Additionally discussions with mid-market and upstream participants, and other actors of interest, including nonparticipants, partial participants, dropouts, and trade allies, were conducted, as dictated by the program design and evaluation workplan.

Impact Evaluation Methodologies

The impact evaluation was designed to address several major research questions.

- Were measures installed as planned and reported? If field-observed equipment did not match program reported installations, why not? Did retrofits persist in their first year, and/or what was the removal date and reason?
- Were the implementation contractor's reported per unit estimates of the gross energy and demand savings installed under the program reasonable? Should any adjustments to these ex ante numbers be made using ex post measurement data?
- What is a reasonable ex post estimate of the net energy and demand savings attributable to the program?

An impact evaluation tailored to each program was designed to verify the gross ex-ante savings estimates provided by the implementation contractor, as well as to estimate the net savings attributable to the Program. The general approach to the impact evaluation included the following steps:

- *Review program records*– a review of program participation data for all installed projects including identifying program specific measures installed, date of installations, a review of pre-installation data collection, and an understanding of the participating customers.
- *Review engineering calculations and secondary literature* – engineering review of savings calculation methods and assumptions used to estimate energy (kWh) and demand savings. This included Program documentation (e.g., Edison Application work papers and implementation contractor tools and assumptions) and reference sources (e.g., DEER database, ASHRAE). This activity identified measure performance variables and variables for supplemental data collection and analysis.
- *Conduct billing data/metered data analysis* – billing/metered data analysis involved analysis of customer bills and/or metered from on-site data logging.
- *Conduct onsite verification* – onsite data collection activities verified measure installations and confirmed selected variables used in the savings calculation process. Measure information was recorded on data collection instruments customized for each program and included:
    - Measure presence and appropriate installation
    - If a measure was missing, determined if they were ever present, and/or the removal date and reason
    - Key energy performance variable of installed measures that typically fall into three categories:
        - Quantity

        - Capacity (e.g., amps, watts, tons)
        - Efficiency
    - Key facility performance data, such as daily schedules, seasonal variations in schedules, occupancy, and control strategies (program specific)
    - A limited set of customer behavior and demographic questions
    - Measure performance, including data logging or spot measurement of select pre-installation and/or post-installation operating conditions

- *Compile participation data and verified methods/assumptions in an analytic database* – this database was used to develop adjustments to savings calculation methods/assumptions based on a review of participation data, engineering review, onsite data collection, and program actors. This activity also entailed adjusting counts of measures installed and key energy performance variables used in the calculations such as baseline assumptions, coincidence with peak, and diversity and interactive effects based on observed data and/or supplementary information**.**

- Recommend adjustments to gross savings estimates for each program as needed based on the above activities – adjustments were recommended by measure type/category, end use, and market segment as appropriate.

- Estimate Net-to-Gross ratios – where possible, ex post net-to-gross ratios were calculated using self-reported participant survey data to develop estimates of free ridership.

- Calculate Program net savings were calculated using the following general approach was used to calculate the ex post program net savings

    Net Savings = Adjusted Gross Program Savings
    - Persistence Loss (where appropriate)
    - Self-reported Free ridership (Participant Surveys)

In accordance with CPUC guidelines, spillover was estimated, where possible, but not included in the calculation of net savings.

2. IDEEA Program Logic Model

The program logic model diagram is shown in Figure 2–-1. The logic model shows the key features of the IDEEA program as understood by the evaluation team, indicating the logical linkages between activities, outputs, and outcomes.

Inputs to the logic model included utility experience and expertise, available technologies, funding for the programs, utility experience and expertise, and experienced implementation contractors. Key external influences to the programs included energy prices, market conditions, national codes and standards, interest rates and other business opportunities

The primary activities involved the solicitation of ideas that focused on different marketing methods or market segments, and/or new technologies to fund and test the innovative programs. Edison provided program management oversight for selected programs.

The activities were expected to result in the following outputs: innovative program ideas were submitted that filled gaps in Edison's portfolio of programs; and, active relationships ere built between third party providers and Edison to maximize program effectiveness.

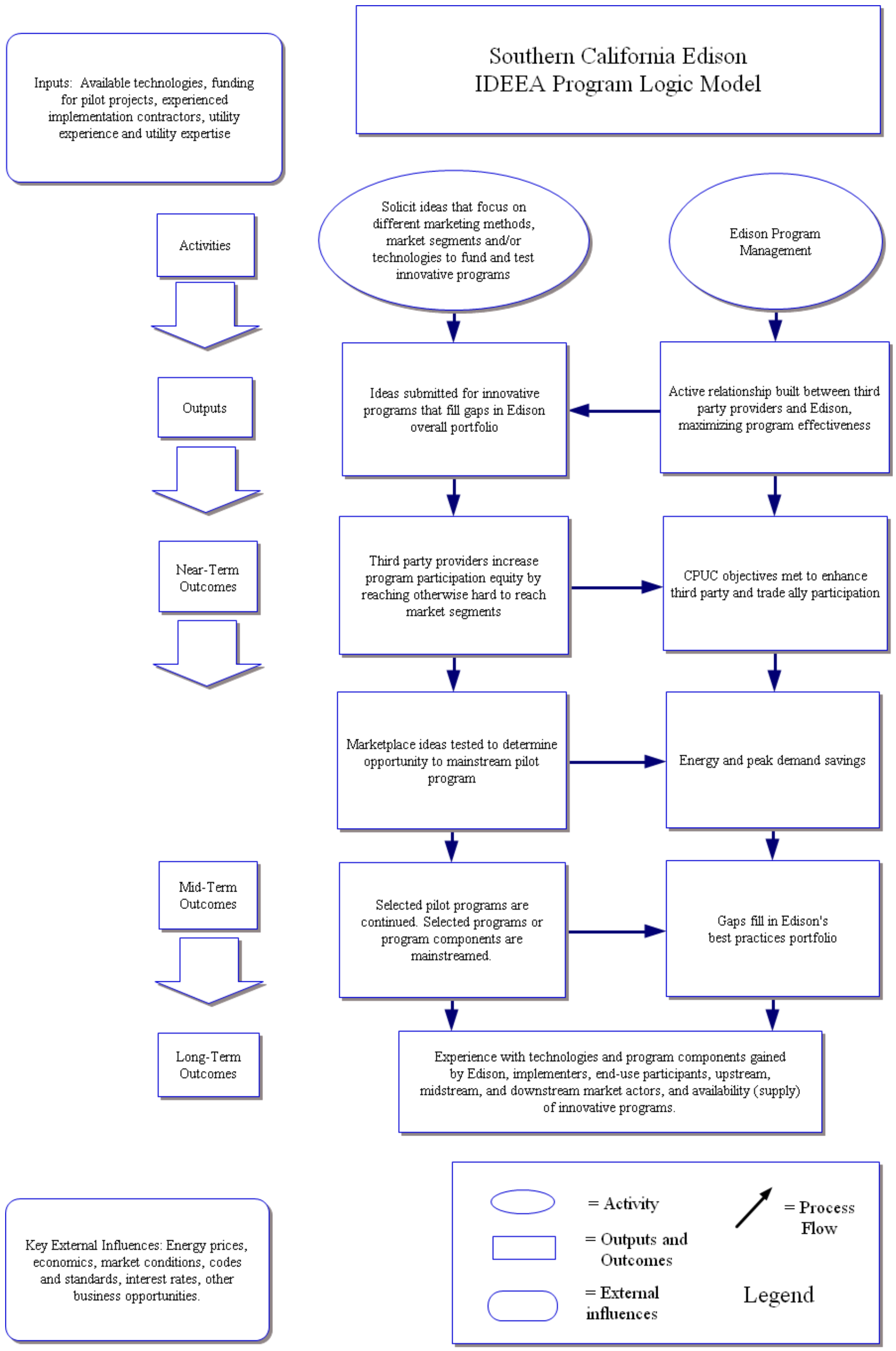
Near term outcomes included immediate kW reduction and kWh savings as the programs were implemented and technologies were installed. Experience with new market approaches and technologies was gained by Edison, program implementers, participant end-users and a number of upstream and downstream market actors. A number of innovative programs were tested in the marketplace to inform future programs and to determine their potential as a mainstream program.

Mid-term outcomes included the selection of programs or program components to include in mainstreamed programs, and to continue into the next round of the IDEEA and InDEE program offerings. In this way, gaps in the Edison best practice portfolio can be filled.

Long-term outcomes include ongoing availability and experience with new technologies and innovative programs.

Logic models for each of the constituent programs can be found in the program specific chapters in this two-volume set of program evaluations.

Figure 1-1. Final Logic Model



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3. IDEEA Program Issues and Findings

There are recurring themes that cut across programs and higher level administrative and policy issues that pertain to the IDEEA program as a whole. The following section reviews the overriding administrative and policy issues that affect bundled programs like IDEEA. Cross-program conclusions and recommendations that emerged from the constituent program evaluations follow. Findings, conclusions, and recommendations specific to individual constituent programs are found in the individual program chapters and are not repeated here.

Administrative and Policy Issues

Program timing and evaluation effort

Because most programs generally involve new technologies or implementation of existing program concepts in new surroundings, it should come as no surprise that some of the constituent programs were:

- Slow to get into the field;
- Ran out of money and had to curtail implementation; or,
- Reported a majority of installations in the final few months of the contract.

Thus, the reporting of program accomplishments lagged, and final statistics were not available until after September 2006 for some programs, with the last data received in December 2006. The 2004-2005 IDEEA program rules were that no new commitments could be made after December 31, 2005, and all installations were to be completed by June 30, 2006 when contracts with implementers ended Impact evaluations were affected because sampling and measurement decisions had to wait until installations were complete. Process evaluation were affected in that “real-time” feedback could only be implemented in programs that lagged. Fortunately, many of the “lessons learned” were also applicable to the 2006-08 IDEEA portfolio, and reinforced the need to integrate evaluability assessment into the program planning process.

Regulatory Guidelines

The 2004-05 IDEEA/InDEE Program was subject to the CPUC regulations as other mainstream energy programs, and this may have an impact on program design and evaluation of programs that are proposed as being innovative, but do not have the flexibility to truly experiment. For example: (1) the IDEEA portfolio is subject to the same benefit cost criteria as any other energy efficiency program, which, in turn, allows for only limited testing of alternatives, (2) the portfolio is evaluated within its one- or two-year time frame, but the time frame may not be sufficient for new, burgeoning program options to be fully explored, and (3) evaluations are specific proceedings, but some constituent programs are continuations of prior programs. The effects of prior years were not addressed in the EM&V Protocol.

Of course, any program, new or existing, conventional or innovative, has implementation issues and savings issues, and normally we would not raise them in an evaluation as potentially fatal flaws. However, one characteristic of the IDEEA constituent programs is their limited implementation scope. With 100,000 participants, a conventional program can afford some dry holes or inappropriate installations and still be cost effective. An IDEEA program with 10 participants, on the other hand, cannot afford many implementation errors and still demonstrate its impact and viability with conventional process and impact evaluation guidelines. It would be extremely useful if a separate Protocol was developed that could be applied to experimental, pilot, or innovative efforts such as the Edison IDEEA Program.[1]

Regulatory guidelines also required an ex ante net-to-gross ratio of 0.80 for program planning. As discussed further below, this assumption is probably unrealistically low for programs where new technologies are implemented, or for programs that are implemented in new market segments.

Undefined criteria for constituent program success

Then, there is the issue of what constitutes “success.” The program RFP and implicit theory lack specificity on this subject, although program managers agree that integration into Edison’s mainstream program portfolio is the ultimate measure of success. However, a constituent program may be unsuccessful in meeting its implementation and savings goals, while, at the same time demonstrating the viability of a new technology. On the other hand, a program may be successful in demonstrating an energy efficiency technology to a new market segment, but in meeting other customer needs during delivery may result in increasing energy use, rather than saving energy. Both of these examples can be found in the 2005 IDEEA Program portfolio: the Demand Response technology worked well, but was implemented at sites that were closed during part of the year, and the program fell short of savings goals; the Agriculture Ventilation program did, indeed, replace some fans with more advanced and efficient ones, but also added fans at the majority of sites, and resulted in a net increase in energy use.

Structural issues with early program decisions

There are some fundamental (and probably un-resolvable) questions about how the constituent programs were reviewed and approved for the 2004-05 IDEEA. In the overall process evaluation and the constituent program process evaluation we question how certain technologies got through the screening process, how some implementation and savings assumptions were approved, how the definition of customer eligibility was lacking or weak and how critical evaluation data were not required to be gathered. For example, in two cases (AC Energy Hog and AirCare Plus), contractors to claimed savings for measures required by code, replaced equipment that was significantly past its useful life, or neglected to implement code-compliance actions (duct repair for retrofit AC replacements). In another case (Multifamily HVAC) battery powered equipment was approved apparently without the practical consideration that the batteries were special models costing $15 to replace – a cost falling not to the program, but to the residential customers, and that without operable batteries, no savings were possible. A similar issue was observed in the Cool Cash program where use of standard batteries might have caused significant loss of measure persistence.

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[1] This issue has since been addressed in the 2006 California Energy Efficiency Evaluation Protocols.

Little or no evaluability assessment

Evaluability Assessment (EA) is a term of art generally applied to the review to determine whether data necessary for evaluation is being collected as part of the program tracking process, and whether those data will be available when evaluations are actually implemented. In some venues, EA is a seamless part of the program planning process (for example, the Energy Trust of Oregon), but in other venues, including Edison, EA was not a formal requirement at the time of the 2004-05 Program.

The proposal selection process was intense, and many issues could not be anticipated. Nevertheless, some issues could have addressed early in the program, had EA been part of the program planning process. These issues included:

- Service account identifiers not available – for example, for the Multifamily HVAC program evaluators had to physically copy down meter numbers in order to get customer energy usage, and only had the resources to do so for the buildings that were already selected for site verification visits.

- Contact information not being required - especially for IDEEA programs, non-participants are individuals or firms that were contacted but did not participate. The general population is not an appropriate comparison group because the program was not available to them. Several programs did not have contact information available, and non-participant information was lost.

- Some pre-installation conditions not tracked – several programs, including AC Energy Hog, AirCare Plus and Cold Cathode did not maintain records of building characteristics, equipment replaced, or altered operating conditions.

- Potential impacts relative to energy use – for the AirCare Plus Program, in particular, savings were projected to be so small, relative to energy use, that no independent evaluation of savings was possible without pre-installation monitoring, which was not part of evaluation plan for the 2004-05 program.

In some cases, the program implementation goals and installations were completed before evaluation started and the evaluation plan was introduced too late to assess evaluability of the program. Essentially, for some of the programs, the points noted above could not be remedied in time to collect the data required for an ideal impact evaluation.

We recommend early evaluation planning, and collecting and verifying baseline conditions. Using any of the available impact evaluation methods requires quality pre- and post-installation data. Any baseline condition that is altered by the program, e.g., temperature settings or economizer settings, must be recorded for all installations. These parameters cannot be verified after measure installation. Early evaluation planning that includes verifying such variables on a sample of installations would be helpful in improving the quality of data, but such verifications do not substitute for accurate recording of baseline data for all installations. Similarly, basic and necessary equipment parameters unaltered after the measure installation (such as nameplate data for maintenance measures) can be verified post-installation; however, if such data are not recorded for a large majority of installations, it would be inaccurate to estimate these parameters from known observations. For major programs with a large number of participants, some missing data can be tolerated. However, for small programs, missing data is a large problem, because each observation is a larger percentage of the total program accomplishments. Certain post-installation treatment data are also not verifiable unless recorded in the program database. For example, the amount of refrigerant added or removed is an evidence of action taken as well as a necessary variable to estimate energy savings using the percentage overcharge and undercharge condition (and requires stamped charge capacity as well for a large majority of installations). Lack of critical baseline and post-installation data such as those described above made it impossible to use standard engineering methods to estimate the impact of this program. Future programs must identify the minimum required data ahead of time and implement a quality data collection plan, and provide access to implementer data collection protocols, where the data are not in the utility database.

Software models used for computing and reporting program savings should also be validated and must be transparent. One way to accomplish this in early evaluation would be to calibrate software with a participant's billing usage. Further refinement in the savings estimates prepared from the software could be had from using site-specific measurements for a sample of installations and adjusting the software model from measured savings.[2] A calibrated software model can be used to estimate the program impacts, provided it is flexible enough to accept site-specific data from non-calibrated participants to estimate the savings impacts.

Program management approach

We have some questions about the program management philosophy for the IDEEA Program. Innovative programs need flexibility to react to market forces and implementation issues. But these issues need to be documented, or the evaluation will conclude that the program was not implemented as designed, or that the goals were not met because of program design flaws. Managing innovative programs probably requires more oversight and managerial involvement, oversight and documentation than conventional programs, and policies and procedures for managing these programs should be made explicit.

Changes from the original work plans

A number of program implementation plans were negotiated and changed between the original proposal submitted to Edison and the final signed Purchase Order (PO). The negotiation process represents the first phase of the program. Changes from the proposal to PO could include, for example, changes in cost, scope, or program refinement. Therefore, the PO may not be the same as the original proposal.

The program implementation was based on the PO. The management process used the PO to manage the operation of the program. The evaluation work plans for this evaluation were developed from the final PO and Statement of Work.

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[2] Relying solely on bench-test results or field tests for a package of measures may not provide an accurate estimate of program savings because of the variability of site-specific conditions, unless field tests are conducted on a very large number of representative installations in all climate zones of Edison's service territory. Or bench/field tests are used to develop a savings model fed by site-specific conditions.

We recommend that future evaluations include the initial stage of the program evolution, that is, from the original proposal to the PO. Changes in the program implementation work plan, whether formal (new Statement of Work or change order) or informal (agreement with program manager) must be documented to ensure proper treatment of results in the evaluation.

Cross-Program Conclusions and Recommendations

Conclusion 1: *Record keeping and data quality issues impacted savings, incentives and evaluation.*

Data collection, data quality, and record keeping impacted not only the evaluability of the programs, but the implementation contractors' ability to receive incentives under the Program.

Data on customer contacts were not well maintained, especially for customers who were contacted but decided not to participate. Unlike utility-wide programs, where all customers have a (theoretical) chance to participate, IDEEA programs target specific customers or customer groups. Nonparticipants for IDEEA programs are only those customers in the targeted groups who could have been aware of the program but did not participate. Some contractors maintained such lists, while others did not, making assessments of program marketing and free ridership very difficult.

Marketing strategies were frequently not fully spelled out, or ignored, or modified so their likely effectiveness for future programs could not be assessed. Some information, including installation conditions, could only have been gathered at the time of participation, and was lost for evaluation purposes.

Some necessary data were not collected or recorded by contractors, including measure location and utility account numbers. No savings could be attributed to measures that could not be located. Account numbers were needed to extract utility data for billing analysis and to confirm location of measures in Edison's territory.

Proper screening of potential participants is essential for success in all programs, but especially in early replacement programs. Program eligibility rules and financing options are needed so that program eligible units are replaced, and do not leave potential savings "on the table."

Over-optimistic, and in some cases unrealistic, ex-ante savings assumptions resulted in very low realization rates for some programs. In several cases, adjusted ex-ante assumptions resulted in high realization rates that were verified through billing analysis or engineering calculations.

Recommendation 1. *Conduct an evaluability review prior to awarding the program implementation contract, and hire evaluators prior to implementation.*

A clearer understanding of evaluation data requirements and measure installation data on the part of the contractors and program managers would serve to alleviate some of the concerns noted above. We recommend early review of ex-ante savings assumptions to anticipate and flag issues related to overly optimistic or unrealistic estimates, as well as other evaluability issues.

An evaluability assessment conducted prior to awarding the program implementation contract will guide the program manager and implementer, to ensure that the program can be evaluated fully. An evaluability assessment reviews the program documents for the details needed to evaluate that program, and provide feedback to the program staff and implementers for any needed corrections to the program savings assumptions, and identifies adjustments required to the implementation process. The assessment should include review of program documentation, including the program draft work plans, program goals, implementation approaches, target market, program theory, data collection plans, savings assumptions, and early measurement and verification methods. A sample Evaluability Assessment template is offered in Volume 2, Appendices.

Conclusion 2. *New technologies and new approaches to marketing, along with conventional approaches to different market segments, need more active program managerial involvement and may need more than one or two years to demonstrate impact.*

Active engagement of the utility program managers with the third party implementers is needed to attain program goals. Innovative programs such as these face a number of challenges to recruit participants. For example, sometimes the process to recruit a customer, conduct an energy audit, develop a proposal, and obtain customer commitment to participate is a long one. The majority of participants required incentives before they could install efficiency measures, stating that first cost was a barrier. Some companies juggled their capital improvement plans so that measures could be installed within their program's timeline.

Some of the programs relied heavily on a time sensitive marketing event to recruit customers while other program marketing and enrollment efforts were sensitive to heating and cooling seasons or seasonal business activity. When the programs started later than expected, the implementers' timing was off and critical events were missed, resulting in lower than expected program participation.

Recommendation 2. *Program managers should actively engage with the third party implementers and conduct formal, quarterly program reviews.*

We recommend that the Edison Program managers conduct quarterly reviews, identifying and providing a level of support and commitment to maximize the value of the early lessons learned to improve make the remaining duration of the programs. These quarterly reviews should also involve input from evaluators examining implementation issues

Quarterly assessment of the effectiveness of program marketing, customer participation, the installation patterns, installation inspections, and preliminary assessment of program savings will help determine whether the program is evolving as designed. Changes should be documented and the associated implications on program accomplishments assessed.

The active engagement of the program manager, implementer and evaluator should ensure that critical market timing needs are met and programs can take advantage of major marketing events.

In addition, programs would benefit from the active involvement of utility account representatives who work with key- and nonkey accounts in program marketing. The account representatives could also assist small business owners who need help to enroll and participate in the programs.

Conclusion 3. *Training, education and continued support are needed for long term savings.*

Program participants in some programs were, in effect, passive recipients of the energy efficiency technologies and gained little or no knowledge about how to manage the equipment for long term energy use. The use of energy service companies (ESCOs) for project management and installation in the Community College District Retrofit Program was very effective, but maintenance staff at participant facilities gained limited knowledge and understanding of energy efficiency and commissioning due to the hands-off nature of the relationship.

Programs such as the Community College, Convenience Stores and Multifamily HVAC Controls, provided insight into this area of great need and opportunity, namely, the need for training and education in energy-efficient technologies and in continuous commissioning. An opportunity for energy savings from the implementation of continuous commissioning exists for these kinds of programs. If the utilities desire to focus not only on the installation of measures, but also on empowering the markets become self reliant, then education and training should be incorporated into the program.

Recommendation 3. *Integrate training into program delivery****.***

Energy efficiency and O&M training should be integrated into programs to increase awareness and understanding of the equipment and operation efficiency improvements. For example, for non-residential operations and maintenance programs, training such as the statewide Building Operator Certification and Training (BOCT) program could be integrated with programs to enhance participant staff ability to operate and maintain the buildings after the efficiency improvements are made.

Conclusion 4. *Billing analysis was less useful than anticipated.*

The billing analysis was less useful than anticipated for a number of reasons. These reasons included: (1) There were very few participants. (2) Installations occurred so late in the program that there was not enough time for post period data to accrue for meaningful analysis. (3) Ex-post savings were too small to measure within the billing data. (4) Billing data could not be matched to the implementers’ database in order to extract measure data, including the measures installed and date of installation. Account numbers were difficult to collect or did not match the address provided or, for some other reason, could not be matched to the implementation contractors’ database. In cases such as these, the engineering analysis was the more reliable method to estimate savings.

Recommendation 4. *An Evaluability Assessment, proper data collection and flexibility to use alternate impact assessment methods when program performance does not support billing analysis can serve as preventive and corrective measures for impact assessment.*

An evaluability assessment can be used to determine whether the billing data will be sufficient, and whether a billing analysis could provide meaning results, before recommending use of this analysis method. Engineering estimates combined with site visits, and metering in some cases, may be adequate for many programs, especially where impacts are likely to be less that 10 percent of actual usage. Where billing analysis is an appropriate tool to estimate impact, managers, implementers, and evaluators need to plan for the analysis and ensure the means to collect data on existing conditions prior to implementation have been built into the program and that the data are recorded accurately. Program staff and evaluators need to ensure that the data can be used to extract utility billing histories and match it to contractors' measure and program data.

Conclusion 5. *The California Evaluation Protocols may not be appropriate for some pilots and innovative programs.*

The EE policy manual made no distinction between evaluating utility-wide programs with 500,000 participants and innovative, pilot or experimental programs with ten participants. The Evaluation Protocols contain Emerging Technology Protocols, which address some of the issues encountered in this evaluation. But small, innovative pilot programs still fall somewhere in between emerging technologies and system-wide programs. Because of this disconnect, conventional measures of program success may not reflect the true promise of either the technology or the program niche.

The IDEEA/InDEE[3] program was designed to test innovative technologies and marketing methods. By their nature, the programs may be small scale and time limited while testing a new concept. With 100,000 participants, a conventional program can afford some dry holes or inappropriate installations and still be cost effective. An IDEEA constituent program with 10 participants, on the other hand, cannot afford many implementation errors and still pass the benefit-cost test.

The IDEEA/InDEE programs were classified as resource programs and the evaluation attempted to use the direct impact method as much as possible. Direct impact analysis has additional benefits to help refine the measure savings estimates going forward.

While an innovative program delivery approach for a mature technology can be evaluated using the CA evaluation protocols, newly commercialized technologies or technologies modified for application to new market segments should not be evaluated using the protocols. As noted before, the impact of some of these technologies cannot be assessed within a year of implementation. Also, some programs have a small number of participants, making it difficult to draw a clear picture from which conclusions can be useful for determining whether to scale up

[3] In 2006-2008 program focusing on new emerging technologies were under the IDEEA, but were separately designated as InDEE programs

those programs. The evaluation protocols for emerging technologies may be appropriate to use in some cases, but not all, because the IDEEA program mostly tested commercially available technologies. And while the IDEEA portfolio is to be evaluated from a cost-effectiveness perspective at the macro level, constituent program impacts and process evaluations present conclusions regarding program viability.

Recommendation 5. *The CPUC should address pilots and innovative programs with a new protocol or a policy statement.*

As stated earlier, the IDEEA program fell somewhere between an emerging technologies program and a full-scale system wide program. We refer to them as pilot programs. Pilot programs should be permitted greater leeway in meeting performance expectations and in achieving expected participation levels. If new ideas are to be tested, there should be greater flexibility in drawing conclusions on their success or failure. By testing these innovative programs on a small scale, and by not requiring protocol defined cost effectiveness tests, energy efficiency portfolio risk can be reduced, while providing a pipeline for potential new full-scale programs.

4. Program Impacts

Ex post gross and net savings estimates as well as project and program realization rates were developed in the impact evaluation using methods discussed under the impact evaluation methodology section above.

Cross-program observations related to net-to-gross ratios are discussed below. Ex-ante savings were overestimated in a number of programs; observations are also discussed below.

Free Riders and Net to Gross Ratios

Estimating free riders initially appeared to be a straightforward task but it turned out to be much more complex in practice. A consistent set of questions could not be implemented across the 12 programs that included an impact analysis (no impact analysis was conducted for the 80+ program). Each program presented its own set of challenges. Briefly, the IDEEA programs generally fell into the following categories, based on who makes the decision, and whether the technologies are conventional or new:

1. The end-user makes the decision to participate in a program that entails using conventional technology: AC Energy Hog, Convenience Store.

2. The end user makes the decision to participate in a program using new technology, or technology never applied to the user market segment: Cold Cathode, Cool Cash.

3. The site personnel are not involved in the decision to participate; that decision is made by a corporate entity influencing many sites and the program involves conventional technologies: Refrigerated Warehouse; Oil Production; Community College Retrofit.

4. The end user is not involved in the decision to participate; that decision is made by a corporate entity influencing many sites or applications and the program involves new technologies: ES Demand Response; Multifamily HVAC.

5. The end user is unaware of the retrofit, which is delivered by a contractor: AirCare Plus.

6. Some combination of the above categories: 80+, Agriculture Ventilation.

Current common practice in estimating participant free ridership and spillover involves survey self reports on a series of questions for each measure or measure group adopted. These include whether the measure was already ordered or installed, the effect of the incentive (if any), prior participation in programs or prior adoption of efficient technologies and financing Spillover is indicated by the self-reports of the influence of the program participation on other current or future energy savings related actions.

In these programs, the NTG was an adjustment solely based on free riders. Southern California Edison program implementers used a placeholder value for NTG of .80. The impact and process evaluations attempted to measure free ridership to accept or reject the null hypothesis that NTG = .80, and to establish the best value, based upon the preponderance of evidence.

Evaluations of the constituent programs led to four types of NTG findings.

5. When programs offer a technology that is not available to anyone other than those participating, there are no free riders and the NTG = 1.

   This includes programs where the general population does not have access to the technology. That is, the technology is not offered in the marketplace or it is very new to the marketplace. For example, in the Multifamily HVAC Program the technology was normally installed in hotels and motels. The manufacturer and implementers modified the product and applications for multifamily apartment buildings. Where measure installation are not be market driven, and not available except through the program the NTG has no relevance, and must be assigned a 1.0.

6. Sometimes there is not enough information to accept or reject the null hypothesis that NTG = .80.

   In some cases, there are no good means to measure free ridership. In other cases, measurement did not provide any better answers than where we started. The Energy Efficiency for Oil Producers Program is one such program. The technologies were being adopted within the industry and some measures offered by the program are likely to be considered outside the program process. Because of ongoing involvement of the participants (prior participation and/or knowledge of the program), all could be considered free riders. Or if cost effectiveness associated with the program incentive alone was the participation trigger, none could be free riders. Therefore, we could not reject the null hypothesis that the NTG ratio is .80, and .80 is used as a placeholder.

7. When the program includes multiple measures, and not all measures are installed, the program level NTG is based on savings weighted estimates rather than individual estimates. NTG is only applicable to the particular program population.

In this case, NTG estimates can be computed for each constituent program measure and participants may not install all offered measures. The NTG are weighted together to compute a melded program level estimate. This NTG is extremely unique to that application, and applies only to the specific ratio of measures installed for that particular market and target audience. This NTG is generally not applicable to future programs.

8. Considering many of the programs involved new technologies or new markets, the .80 NTG placeholder is probably not reasonable. It is probably too low. NTG of .80 implies there is a fairly well developed market where 20% would purchase and install the product without program incentives. This NTG implies a well known technology and strains credibility for new technologies and markets. Programs targeting new market segments or involving innovative technologies should have a net to gross ratio closer to 1.0 than 0.8.

We recommend a default NTG of .90 for the IDEEA and 1.0 for the InDEE Program. Our experience shows that the individual programs will be within the .85 to 1.0 range when accurate field measurements can be made.

Savings and Realization Rates

The constituent program evaluations found a number of issues that affected the ex-ante reported savings estimates and in most cases led to overestimation of ex-ante savings and accomplishments. These include, for example:

1. Program ex-ante assumptions erroneously included savings for measures that do not save energy. The program ex-ante savings for some of the IDEEA programs included savings from diagnostic activities that by themselves do not save energy because no actions were taken as a result. The policy guidance for such activities is clear, i.e., programs are credited only for the actions taken that save energy.
2. The Program implemented a behavioral measure, i.e., adjustment of incorrectly set existing thermostats to match the facility operating schedule. According to the policy guidance the evaluation team received from the CPUC, this measure was retained in the engineering and billing analyses conducted for this program.
3. The Program ex-ante estimates were developed from the experience of implementing a program in another region and another climate zone. As a result, the ex-ante measure savings estimates were too high. The implementation contractor then used a proprietary software model to report savings that were not calibrated to facility usage data; therefore, the Program accomplishments were overestimated.
4. Program savings were claimed for actions that were required by code. And some code compliance measures (duct sealing for HVAC replacement) were not done. If it could be ascertained that compliance would not have been done but for program participation, the program was given credit for the savings. If code measures were not implemented, the program was not penalized.
5. Savings were claimed for measures that could not be verified. This overestimated the reported savings. Where the location of installed measures was not available from contractors, and on site verification could not locate the measures, the claimed savings were not included in the evaluation results.

6. Projected ex-ante savings for all measures were greater than field observations and reports in the literature. Ex-ante deemed savings that are supported by the most recent evaluation studies or the 2005 DEER Database should be assumed. Comprehensive baseline information should also be collected to accurately specify savings.
7. Baseline practices may already be effective at saving energy but these behavioral practices were not taken into account when establishing baseline conditions and ex-ante savings estimates. Therefore, program reported savings were overestimated.
8. A program was built around a technology that worked in its original application, but when installed in the program's setting it did not deliver comparable savings. The projected savings were based on the original application, expecting comparable performance.
9. Implementers estimated a longer measure life than evaluators could confirm. In one particular technology, HVAC controls used in the Multifamily HVAC Program, the three components of the system had different measure lives. One component has a measure life of 11 years (EnergyEye controller) according to the DEER database of measure lives. The second and third components, occupancy sensors with 8 year measure lives, operated together and failure of either component rendered the system inoperable. The technology's measure life is eight years, which is the weakest link in the entire system. For another Program, Convenience Stores, implementers estimated one measure life for bundled measures. However, participants did not always install the full measure bundle, often choosing lighting over mechanical measures. The evaluated savings were reported after unbundling the installed measures. All system components must be considered when determining the system's measure life.

5. Final Program Impacts

Table 1-1 below compiles the first year ex-ante and ex-post energy savings reported for each of the constituent programs. Table 1-2 compiles and reports the demand savings for each IDEEA constituent program. Measure specific realization rates and net-to-gross estimates are included in each program evaluation chapter that follows.

The ex-ante projected savings from the proposal (purchase order) as input by the implementers in their E3 workbooks are listed first in the leftmost three columns. The ex-ante reported savings were recorded by implementers as the final program impacts after measure installation. The evaluated savings report savings derived through the impact evaluation.

The projected, reported, and evaluated NTG ratios are included in the tables. Findings regarding the NTG ratios are discussed in the section above.

An impact evaluation was tailored to each program. Detailed discussions of the methodology and actual activities and analyses can be found in the constituent program evaluations in the following chapters in this two volume set of program evaluations.

The first year net realization rates are also shown in each of the two tables. The overall net realization rate for energy savings was 72% and the demand savings realization rate was 46%. Overestimated ex-ante reported savings and low evaluated energy savings resulted in first year net realization rates that were lower than anticipated. These factors are discussed in the section above.

Table 1-3 reports the compiled lifetime energy savings for all constituent programs, with the exception of 80 Plus which did not have an impact evaluation. The lifetime savings are impacted by factors affecting the ex-ante energy savings, as discussed in the section above.

Table 1-1. First Year Ex-ante Proposed and Reported, Ex-post Evaluated Energy Savings

		Proposal				Reported				Evaluated		
		Ex-ante Gross	Net to Gross	Ex-ante Net		Ex-ante Gross	Net to Gross	Ex-ante Net		Ex-post Gross	Net to Gross	Ex-post Net
AC Energy Hog	kWh	2,167,696	0.8	1,734,157		1,314,105	0.8	1,051,284		473,337	0.91	431,390
Agricultural Ventilation	kWh	3,518,181	0.75	2,638,636		4,679,272	0.75	3,509,454		2,862,201	0.86	2,461,493
Air Care	kWh	7,443,880	0.997	7,427,800		5,351,565	1	5,351,565		1,112,277	1	1,112,277
Cold Cathode	kWh	6,030,088	0.8	4,824,070		6,294,993	0.8	5,035,994		5,553,865	0.9	4,998,479
Community College	kWh	6,142,318	0.96	5,896,625		6,448,344	0.96	6,190,410		6,330,758	0.83	5,225,318
Convenience Store	kWh	3,175,690	0.96	3,048,662		991,883	0.96	952,208		745,527	1	745,527
Cool Cash	kWh	1,416,192	0.8	1,132,954		1,518,312	0.8	1,214,650		168,471	0.86	144,478
Demand Response	kWh	2,091,485	0.8	1,673,188		2,135,913.75	0.8	1,708,731		1,434,260	1	1,434,260
Evaporative Cooler	kWh	4,821,700	0.89	4,291,131		3,949,781	0.89	3,515305		709,782	0.89	631,706
Multifamily HVAC	kWh	3,360,000	0.8	2,688,000		3,360,000	0.8	2,688,000		183,400	1	183,400
Oil Production	kWh	17,310,000	0.8	13,848,000		18,458,305	0.8	14,766,644		17,024,223	0.8	13,619,378
Refrigerated Warehouse	kWh	3,906,250	0.79	3,083,148		4,008,463	0.79	2,898,566		4,167,729	1	4,167,729
Totals		61,383,480		52,286,553		58,510,937		48,882,811		40,765,830		35,155,435
First year net realization rate												71.9%

Table 1-2. First Year Ex-ante Proposed and Reported, Ex-post Evaluated Demand Savings

		Proposal				Reported				Evaluated		
		Ex-ante Gross	Net to Gross	Ex-ante Net		Ex-ante Gross	Net to Gross	Ex-ante Net		Ex-post Gross	Net to Gross	Ex-post Net
AC Energy Hog	kW	1,246	0.8	997		763	0.8	611		196	0.9	176
Agricultural Ventilation	kW	457	0.75	343		609	0.75	457		926.2	0.86	796.5
Air Care	kW	1,436	0.997	1,432		726	1	726		-207	1	-207
Cold Cathode	kW	1,340	0.8	1,072		774	0.8	619		874	0.9	787
Community College	kW	903	0.96	867		1,098	0.96	1,054		1,053	0.46	489
Convenience Store	kW	182	0.96	175		73	0.96	70		60	1	60
Cool Cash	kW	838	0.8	670		838	0.8	670		56	0.96	54
Demand Response	kW	516.25	0.8	413		526.25	0.8	421		309	1	309
Evaporative Cooler	kW	3082.5	0.89	2743.4		2778.76	0.89	2,473.60		16.3	0.89	14.5
Multifamily HVAC	kW	175	0.8	140		175	0.8	140		9.6	1	9.6
Oil Production	kW	2,164	0.8	1,731		2,308	0.8	1,846		1,742	0.8	1,394
Refrigerated Warehouse	kW	419.9	0.79	331.7		389	0.79	307.3		389	1	389
Totals		12,760		10,915		11,058		9,395		5,424		4,272
First year net realization rate												45.5%

Table 1-3. Program Energy Impact Reporting for 2004-2005 Programs

Year	Calendar Year	Ex-ante Gross Program-Projected Program MWh Savings	Ex-Post Net Evaluation Confirmed Program MWh Savings	Ex-Ante Gross Program-Projected Peak Program MW Savings	Ex-Post Evaluation Projected Peak MW Savings	Ex-Ante Gross Program-Projected Program Therm Savings	Ex-Post Net Evaluation Confirmed Program Therm Savings
1	2004	0	0	0	0		
2	2005	51,310	34,019	10.23	4.47		
3	2006	58,510	35,244	11.05	2.41		
4	2007	58,510	35,243	11.05	2.41		
5	2008	58,510	35,242	11.05	2.41		
6	2009	58,510	29,908	11.05	1.62		
7	2010	57,790	29,908	10.63	1.62		
8	2011	57,790	29,908	10.63	1.62		
9	2012	56,270	29,740	10.63	1.53		
10	2013	49,382	29,052	9.25	1.41		
11	2014	44,030	28,820	9.25	1.39		
12	2015	41,161	18,910	9.20	0.41		
13	2016	41,161	17,506	6.19	2.45		
14	2017	41,141	17,473	6.18	2.44		
15	2018	41,141	17,433	6.18	2.44		
16	2019	40,149	17,433	6.11	2.44		
17	2020	10,401	6,825	1.27	0.94		
18	2021	1,478	26	0.08	0.03		
19	2022	0	26	0.00	0.03		
20	2023	0	0				
TOTAL	2004-2023	767,244	412,707				

6. Constituent Program Status

Several of the 2004-2005 IDEEA constituent programs have been mainstreamed, the technology was adopted or the program continued its evolution under the 2006-2008 IDEEA Program umbrella.

The technology offered in the Agricultural Ventilation Program was incorporated into the Agricultural Efficiency Program, where rebates for efficient fans are offered. The energy efficient fans produced significant non-energy benefits and the have large potential.

The cold cathode CFL technology is included in the Express Efficiency program, eligible for rebates. The cold cathode lamps are included in refrigerated cases in the 2006-2008 Grocery Area Energy Network program.

The technologies installed in the Refrigerated Warehouse Program are eligible for rebate through the SPC program. Incentives are not as high under SPC as they were under IDEEA. This program was fully subscribed and there is a large target market for the HVAC and lighting technologies, which may mean that this sector is underserved by SPC.

The Energy Efficiency for Oil Producers Program has been mainstreamed within the Industrial Energy Efficiency Program. The Community College Program is now a statewide initiative and a utility partnership program. The delivery approach used in the Community College Program was extended forward to the 2006-2008 Hospital Facility Energy Efficiency Program.

The concepts and protocol used in the AC Energy Hog Roundup Program were transferred from the residential to the commercial markets. The program transitioned to the Comprehensive Packaged Air Conditioning Systems Program for residential and small commercial customers. The diagnostic philosophy appears in the 2006-2008 IDEEA Comprehensive Home Performance Program. There may be code compliance issues if the ducts are not tested or repaired as needed. Attention to the details of data collection is particularly important in this program.

Two programs continued into the 2006-2008 IDEEA Program cycle. These were 80 Plus (computer power supplies), and EnergySolve Demand Response (dimmable T-5 lighting) which is called the Lighting Energy Efficiency and Demand Response Program.

Going forward, programs and concepts should be reviewed for their impact on other resources. For example, there is some question about how much water evaporative coolers use. The evaporative coolers are more energy efficient than air conditioners. Should programs go forward that focus on evaporative coolers or fan depowerment, for example, some research is needed about how much water the coolers use.

Also going forward, there are other technologies should be eligible for rebates, such as the PTAC controllers used in the 2004-2005 Cool Cash Program for Hotels and Motels. This is an available technology looking for the right market. The technology is appropriate for those (1) who are not already turning off the HVAC, (2) who cannot install the technology without incentives.

Table 1-4. 2004-2005 IDEEA Program Status

Program	Status
AC Energy Hog	Transitioned to Comprehensive Packaged Air Conditioning Systems Program for residential and small commercial customers. Diagnostic approach appears in 2006-2008 IDEEA Comprehensive Home Performance Program.
Agricultural Ventilation	Measure incorporated into mainstream Agricultural Energy Efficiency Program. Continues to have large potential for energy efficient and HVLS fans.
AirCare Plus	Ended.
Cold Cathode	Cold cathode lamps eligible for rebates in Express Efficiency Program; measure included in 2006-2008 IDEEA Grocery Area Network Program.
Community College	Transitioned to statewide Partnership Program.
Convenience Store	Ended. Other lighting programs serve this sector. Continues to have large potential for lighting and HVAC.
Cool Cash	Ended. PTAC controllers could be rebateable technology.
Demand Response	Continued in 2006-2008 IDEEA Lighting Energy Efficiency and Demand Response Program.
Multifamily HVAC	Ended.
Oil Production	Mainstreamed in the Industrial Energy Efficiency Program.
Refrigerated Warehouse	Incentives available through SPC program.
Evaporative Cooler	Ended. Diagnostics may move forward in other residential programs.
80 Plus	Continued in 2006-2008 IDEEA 80 Plus Program.

2. AC Energy Hog Roundup Program

1. Program Description

The AC Energy Hog Roundup program was a constituent program of Southern California Edison's 2004-2005 Innovative Designs for Energy Efficiency Activities (IDEEA) Program, and ran from June 2005 through June 2006. Southern California Edison awarded Conservation Services Group (CSG) a $988,500 contract to implement the Air Conditioner Energy Hog Roundup Program.

The major goal of the AC Energy Hog program was an early replacement program for central air conditioners, and targeted high use customers in the Coachella Valley where high numbers of cooling hours and air conditioning are common. The AC Energy Hog program targeted residential customers with inefficient central air conditioning. The program was also designed to help develop the HVAC industry by introducing the diagnostic protocols to HVAC contractors who worked in that area. The program could have a lasting effect if contractors continued to use the diagnostics to service units beyond the life of the program.

The program included a tune-up component, a replacement component and incentive, and a CFL component. The primary goal of the program was to identify inefficient residential central air conditioners and replace them with efficient air conditioners before their useful life ended. System replacements and tune-ups were expected to produce peak demand reduction and long-term energy savings. The essence of the program was to convince homeowners to replace their air conditioners before the end of their useful life. Early retirement of HVAC systems had not been done in California before this program.

Residential central AC units identified as inefficient 'energy hogs' qualified for replacement air conditioners with state-of-the-art AC technology, having a minimum 13 SEER rating. While air conditioning technology is not particularly new or innovative, the methods used to identify potential participants, the diagnostic approach to tune-up of the AC units, and the emphasis on early replacement were innovative aspects of this residential central air conditioning program.

HVAC contractors assessed the central air conditioning units to determine whether they required a tune-up and/or qualified for replacement. Units that did not require replacement received a tune-up. Assessments and tune-ups were conducted using Proctor Engineering Group's (PEG) proprietary *Check Me!*™ diagnostics which focused on adjusting refrigerant charge and airflow to bring the unit into compliance with manufacturer's specifications and efficient operation. CSG proposed the *Check Me* diagnostics approach because they felt it was shown to result in reliable savings.[4]

[4] Additional information on the CheckMe process is available at <http://www.proctoreng.com/checkme/technical.html>.

The *Check Me!*™ protocols offer an enhanced tune-up and are based on an analysis that checks for problems with refrigerant charge and air flow. Incorrect refrigerant charge and air flow can significantly diminish efficient operation and associated indoor air quality and home comfort. PEG suggests that most air conditioners are incorrectly charged, which reduces the air conditioner's capacity. They also posit that air conditioners with incorrect air flow do not sufficiently cool air or lower humidity. Prior studies on PEG's website have shown that 70% of home air conditioners had inadequate air flow and 82% had incorrect charge.[5]

Central air conditioning units with a rated or operating efficiency of 7.0 EER or less qualified for a $1,000 incentive when replaced with units with an efficiency rating of at least 13 SEER. Contractors were sometimes able to couple the Edison incentive with a manufacturer's rebate to reduce the customer's first cost further. The *Check Me!*™ protocols were used to establish the operating efficiencies.

Central air conditioning with an operating efficiency greater than 7.0 EER did not qualify for replacement AC, but did qualify to have their systems tuned to specifications. If the homeowner was still interested in replacement, contractors referred customers to other Edison rebate and incentive programs.

After the air conditioner assessment and tune-up, all residents were mailed a six-pack of CFL from Energy Federation Inc. The package included two lamps each of 3 different wattages and instructions discussing proper placement. The CFLs were more a 'thank you' for participating in the program, rather than an inducement to participate.

Goals described in the Purchase Order were to conduct 1220 HVAC tune-ups, 244 Energy Hog replacements, and to distribute 7320 CFL. The six-pack CFL given to program participants included two ENERGY STAR screw-in bulbs each of 25-, 20- and 15-watts capacity to replace 100-, 75- and 60-watt incandescent bulbs respectively. Energy savings goals were 1.7 million kWh per year and 997 kW net peak demand reduction.

Program Organization

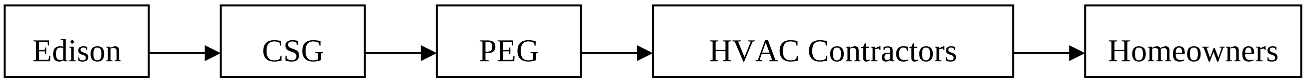
The Program's "chain of command," from Edison to the homeowner, is described below and shown in Figure 1-1.

Edison provided CSG with customer billing data for nearly 22,000 potentially eligible customers. CSG used this data to identify their target market. Once CSG provided Edison with the list of accounts to receive targeted mailings, Edison mailed postcards to over 11,000 customers.

Edison inspected 100% of all AC replacements. Inspections were visual inspections to ensure the equipment was installed. Where it was accessible, the model number was collected and installations were documented with photos. Edison inspectors verified installations by talking with the customer as well. However, Edison inspectors could not visually inspect installations on roofs because they were not allowed on customers' roofs for safety and liability reasons.

[5] <http://www.proctoreng.com/checkme/technical.html>

Figure 1-1. Program "Chain of Command"



Edison provided the homeowners with a $1000 incentive to replace their inefficient air conditioner via the HVAC contractors who reduced the price of replacement AC systems to customers.[6] The $1000 incentive was paid to contractors plus an additional incentive per unit installed. CSG was paid an administrative fee per unit, bringing Edison's cost per replacement to about $1775. Edison also paid contractors $35 for each *Check Me!*™ assessment.[7] Contractors were paid $178 for assessment test and tune-up.

CSG developed and implemented the program. They conducted analyses to target program marketing and focus the efforts of contractors in the Coachella Valley. CSG received calls from customers who responded to the marketing postcard announcing the program. CSG screened callers for eligibility, assigned the customer to HVAC contractors, and tracked the status of contractor follow-up. CSG coordinated with their subcontractor PEG who deployed the program in the field with trained contractors. CSG compiled test results and prepared and submitted reports to Edison. CSG coordinated incentive payments between Edison and the HVAC contractors, via PEG.

Proctor Engineering Group recruited contractors and trained them to use their proprietary *Check Me!*™ diagnostics. Training included both classroom and field training. PEG did not charge for training and provided eight hour sessions with a maximum of four people per session. Some companies spread the training over more than one day to fit the number of contractors and available time. PEG noted that contractors who were already familiar with the protocols needed only refresher courses. PEG requires contractors complete six *Check Me!*™ diagnostics within two weeks to ensure they remember and understand the protocol. Once PEG recruited and trained contractors, PEG was out of the loop until contractors called them from the job site. Contractors reported test data to PEG, which in turn provided contractors with information to adjust the refrigerant charge.

Contractors were not required to purchase equipment or tools from PEG. However, they did need to purchase equipment if not already in their company toolkit, including, for example, a dual input digital thermometer.

Participating HVAC companies reported PEG provided classroom and on-site training. Contractors reported varying amounts of training, from "very little" to "two weeks." One reported that PEG accompanied them on eight *Check Me!*™ diagnostics over the course of one week. Others reported training consisted of two hours, six hours, eight hours, or a two-day class plus on-site mentoring. All but one contractor reported PEG-certified contractors using written

[6] Homeowners acknowledged the incentives reduced the cost of their system.

[7] The test only incentive was $35. Test and tune-up (repair) incentive was $178.

tests and/or on-site observation and mentoring. Only two contractors reported paying for training. One HVAC businessman said they paid the hourly technicians' rate for employees to attend training, the second said they only paid for tools.

PEG reported to CSG, providing test data and documentation required to invoice for the incentives and reporting to Edison. PEG guaranteed payment to contractors by the 10th of the month. To meet that commitment, PEG invoiced and reported to CSG weekly.

HVAC contractors received leads from CSG or they generated their own leads. Contractors used the *Check Me!*™ diagnostics and AC information (rated EER for example) to analyze the system and conduct the tune-up and to determine whether the AC qualified for replacement. Contractors received incentives for each unit assessed as well as a $1000 incentive to replace inefficient AC units. This incentive was passed on to the customer by lowering the cost of the new AC unit.

Quantec, LLC and Strategic Energy Technologies conducted a comprehensive process and impact evaluation of the program. The process evaluation involved interviews with program staff and implementers, discussions with participating and nonparticipating trade allies, and surveys of customers. The impact analysis was a detailed engineering analysis, including reviews and recalculation of engineering algorithms and detailed reviews of program records. A simple billing analysis was also included, and used to corroborate the major findings from the engineering assessment. The billing analysis included homes that had less than 12 month post-installation billing histories because not enough time had elapsed. However, all homes had at least eight months post-installation data, and all homes in the analysis included pre- and post-billing data during the cooling seasons.

The next section describes the program structure and reported achievements. Section 2 presents the process evaluation component of the evaluation. The process evaluation includes a discussion of the program logic, design and implementation, contractor and participant decision making and satisfaction. Section 3 reports the primary impact evaluation results from the engineering assessment of the program. Section 3 also describes the billing analysis that was used as another point of triangulation for the engineering analysis. Finally, Section 4 presents the major conclusions and recommendations.

2. Process Evaluation

Process Evaluation Methodology

The purpose of the process evaluation was to document the Program's origin, original goals and progress, assumptions, and differences between the Program as designed and as implemented. The process evaluation also assesses delivery and implementation issues, barriers to wider implementation, and describes current practices among nonparticipants. Participant satisfaction and issues of free ridership and spillover were also addressed along with lessons learned, and reasons for nonparticipation. A Program logic model guided the research.

Program Logic Model

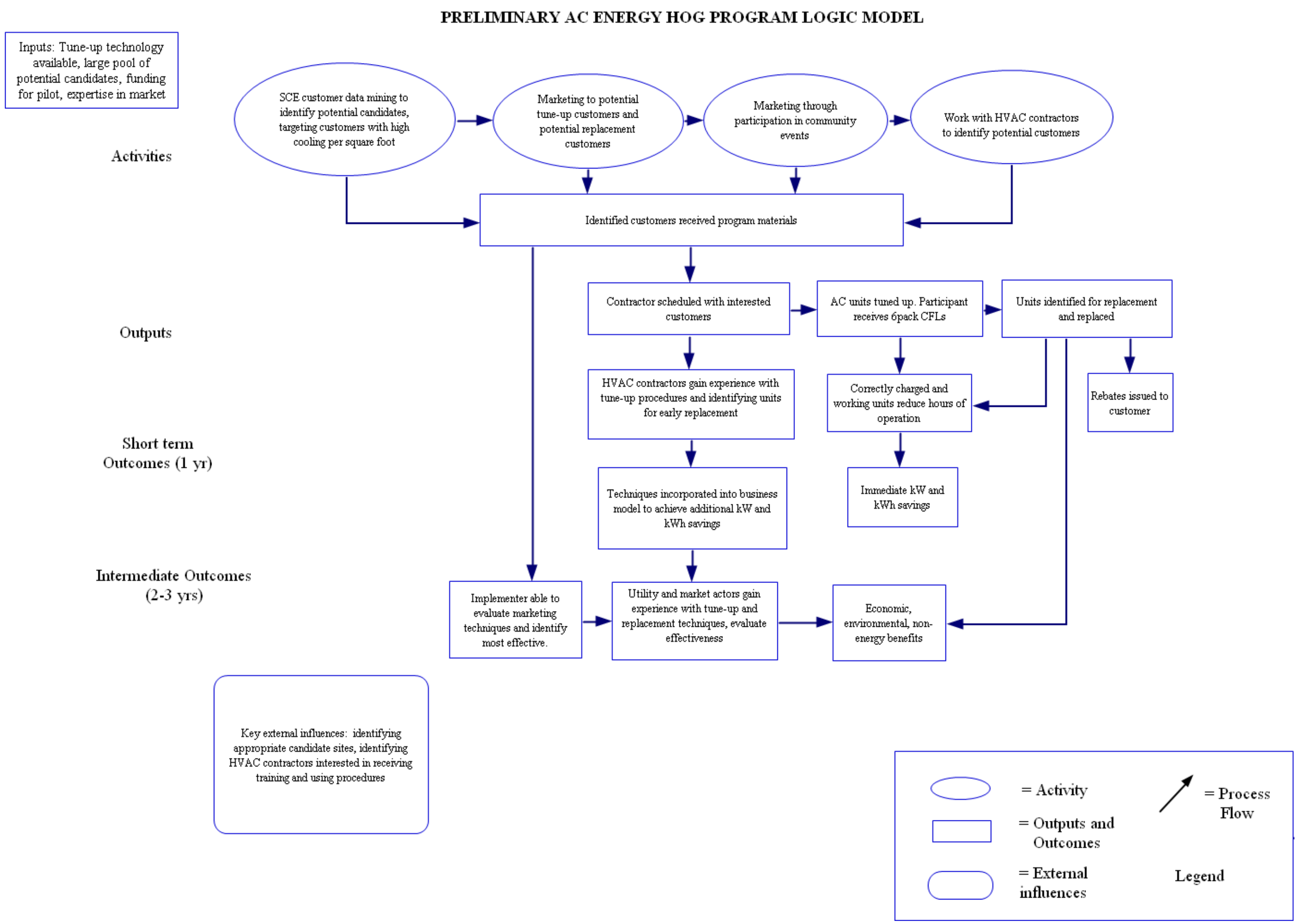
The Program logic model diagram is shown in Figure 2–1. The logic model shows the key features of the program as understood by the evaluation team, indicating the logical linkages between activities, outputs, and outcomes. The primary activities involved recruiting both the HVAC contractors who would deliver the Program and the homeowners who would participate in the Program.

The activities were expected to result in the following outputs: identifying and training HVAC contractors, identifying the participating homeowners, assessing the HVAC for replacement eligibility and providing the tune-up and replacement services.

Short and intermediate term outcomes included immediate kW and kWh savings from the correctly tuned and serviced air conditioners that should operate more efficiently. Experience with a new market approach and technology would be gained by the HVAC contractors, who could incorporate the techniques and protocol into their standard practice. Program implementers and Edison Program Managers would also gain experience with delivery of this type of Program.

The Program was implemented largely as designed. Implementers made changes in the delivery and early focus of the Program, which originally was more of a community-based focus. Primarily because the Program was late getting started, the community-based focus planned for marketing was no longer conducive to Program success. Focus shifted to marketing efforts in the Coachella Valley.

Figure 2-1. Final Logic Model



Process Evaluation Sample Design

The process evaluation included review of program documents and interviews. The evaluation sample plan called for interviews with 4 Edison and CSG staff, the census of participating HVAC contracting businesses, 25 nonparticipating HVAC businesses, 60 participating households, and 60 households that did not participate (Table 2-1).

Table 2–1. Sample Sizes for the AC Energy Hog Process Evaluation

Task	Goal	Achieved
Program/implementer staff	4	3
Participating contractors	14 (census)	13
Nonparticipating contractors	25	25
Program participants	60 (90%±10%)	60
Partial participants (identified but did not participate)	60*	
Nonparticipants		63**
Total	163	164

* Partial participation contact information was not tracked.
** Random sample from original invitation list compiled by Edison

Process evaluation telephone interviews were conducted with the Edison Program Manager, the program implementer from CSG, as well as with the person from PEG in charge of program deployment. In addition, evaluators conducted telephone surveys with 13 of the 17 participating contractors, and 25 nonparticipating contractors. Surveys were conducted with residents from 60 households and 63 nonparticipating households were also interviewed. Documents were reviewed and program databases were used for contact information and program analysis.

Contractor Surveys

A sample of participating and nonparticipating contractors was surveyed to examine the program process, barriers satisfaction and current practice. CSG provided a list of 17 participating HVAC contracting businesses. All owners and/or managers of participating contracting businesses were contacted for the process evaluation. Five were not interviewed; one phone number was wrong and a new number could not be located, one refused, one requested a fax survey but did not return it, one was no longer with the company, and one was not reached after multiple contacts. Table 2–2 shows the final survey call disposition for the participating contractors.

Table 2–2. Participating Contractor Attrition Table

AC Energy Hog Participating Contractor Attrition Table		
	Frequency	Percent
Ineligible/unused sample	1	
Wrong number/non-working number	1	
Eligible sample	16	
Completed surveys	13	81%
Total incompletes	3	
Not available	1	6%
Refused	1	6%
Fax not returned	1	6%

CSG provided a contact list for 91 contractors who were contacted about the program and choosing not to participate. A random sample of twenty-five nonparticipating HVAC contracting business owners or managers was interviewed for the process evaluation. Table 2–3 shows the final survey call dispositions for the nonparticipant HVAC contractor population.

Table 2–3. Nonparticipating HVAC Contractor Attrition Table

AC Energy Hog Nonparticipating Contractor Attrition Table		
	Frequency	Percent
Ineligible/unused sample	14	
Wrong number/non-working number	11	
No contact information	3	
Eligible sample	77	
Completed surveys	25	32%
Total incompletes	52	
Not available	12	16%
Refused	13	17%
Fax not returned	3	4%
Voicemail/call back/no answer	24	31%

Customer Surveys

A sample of participating and nonparticipant households was surveyed to assess program satisfaction, current practice, reasons for participation and energy use behavior.

For participant surveys, a total of 474 households with contact information were included in program files. Table 2–4 shows the final disposition for participants included in the survey sample. There were 338 households with valid phone numbers; 42% refused to participate in the survey and 35% could not be reached because there was no answer or the contact person was not available. The evaluation team conducted the 60 planned interviews.

Table 2–4. Participating Residents Attrition Table

AC Energy Hog Participating Residents Attrition Table		
	Frequency	Percent
Ineligible/unused sample	138	
Wrong number/non-working number	75	
Privacy manager	9	
Business/government	25	
Cell phone	6	
Language barrier	12	
Duplicate contact	11	
Eligible sample	338	
Completed surveys (Targeted 60 completes)	60	18%
Total incompletes	278	
Respondent not available	11	3%
Refused	142	42%
Mid-Interview terminate	16	5%
No Answer, busy, call back, answering machine	109	32%

Table 2–5 compares the number of AC units in the Program with the number represented in the survey sample and the population of participants. There were 474 participants in the AC Energy Hog Program with 672 AC units. Sixty participants with 74 AC units completed a telephone survey.

Table 2–5. Survey Sample and AC Unit Status

Status of unit assessed	Participant Units (N=672)		Units in Survey Sample (N=74)	
	Number of Units	Percent of Total Units	Number of Units	Percent of Survey Sample Units
Assessed and not eligible for replacement	314	47%	17	23%
Eligible and not replaced	175	26%	32	43%
Eligible and replaced	183	27%	25	34%

For the nonparticipant sample, evaluators used the Edison mailing lists of nearly 11,000 potential participants. Of these, about 7,500 had phone numbers in the contact information. A random sample was drawn from this subset of nonparticipant homeowners. Evaluators contacted 498 households to complete 63 surveys in the same zip codes as participants. Attrition for this population is shown in Table 2–6. The survey focused on collecting information to develop a baseline that described standard practice for residential AC maintenance and service.

A sample of partial participant homeowners was included in the original survey plan, that is, residents contacted by an HVAC contractor who refused service through the program. Only one contractor said they kept a list of refusals but they refused to share the list for the evaluation; the remaining contractors said they did not keep a list of refusals.

Table 2–6. Nonparticipating Residents Attrition Table

AC Energy Hog Nonparticipating Residents Attrition Table		
	Frequency	Percent
Ineligible/unused sample	154	
Wrong number/non-working number	104	
Privacy manager	8	
Business/government	30	
Not qualified, no air conditioning	12	
Eligible sample	344	
Completed surveys (Targeted 60 completes)	63	18%
Total incompletes	281	
Respondent not available	37	11%
Refused	50	15%
Mid-Interview terminate	1	<1%
No Answer, busy, call back, answering machine	193	56%

Process Evaluation Results

In this section, the program is described as experienced by individuals who designed and implemented the program, by the sample of businesses that participated in the program, the sample that dropped out, and the sample choosing not to participate.

Program Design

The program was implemented and managed by Conservation Services Group (CSG). CSG hired subcontractor Proctor Engineering Group (PEG) to deliver the program using their *Check Me!*™ diagnostics protocol to test and repair air conditioners. PEG recruited HVAC contractors to deploy the program. Some contractors were already trained to use *Check Me!*™ diagnostics but most were trained by PEG for this program.

Implementers made several changes to the program from that which was proposed. The original program focus was a community based lighting and HVAC program including a community mobilization campaign to motivate residential customers. Implementers resubmitted the program at Edison's request and Edison approved it as a residential HVAC program, without the community-based lighting components.

The program timing and seasonal nature of the air conditioning market was a critical factor affecting this program. For residential HVAC programs, the first and last quarters of the year are critical times to focus on maintenance since the summer months are busy handling "no cooling" repairs. Implementers expected program approval in January 2005 and fully in the field with tune-ups and replacements by late spring or early June when HVAC contractors could focus on maintenance services before the height of the summer season. The program was not approved until April or May2005. The late approval affected program marketing. CSG and Edison were still resolving confidentiality issues in July 2005 so that CSG could obtain customer data, analyze it, and target the marketing efforts.

Largely because the program had a late start identifying and marketing to potential participants, the community-based focus planned for marketing was no longer conducive to program success. CSG shifted the marketing to focus program efforts on the Coachella Valley.

Contractors did not start working with the Program in the field until August. Still at that time, contractors continued to be involved with their heavy summer work load. Summer months in 2005 were abnormally hot and prolonged. HVAC contractors were busy with "no cool" service calls for systems that needed immediate attention for repair or replacement later into the year than usual. Because of this, CSG estimated that the bulk of the marketing, recruitment, tune-ups and replacements would take place between September 2005 and January 2006.

Seasonality issues affected program design and installation targets. Missing the first quarter because of the late start drastically reduced the contractor's field time to start on the new program. Because approval and marketing occurred later than expected, and subsequently contractors' work in the field occurred late, program goals were revised downward. CSG and Edison worked together to deal with issues that came up. The attitude of all parties was "let's figure it out and make it work."

Market Assumptions

HVAC Contractor Recruitment

PEG recruited HVAC contractors using mailing lists and licensing board lists. They marketed to all the contractors in the area, casting a wide net to contractors with a valid C20 license. PEG reports that it was not difficult to interest and train the technicians. Since the *Check Me!*™ software and protocols have been in use since 1999, about 20-30 contractors were actively using the protocols. About 15 technicians were already trained and using the program in the area where the Energy Hog Early Retirement Program was focused. CSG had contacts with Lennox dealers and recruited them early in the program. PEG reports the best way to market the program and recruit contractors was through personal visits and that about one-quarter of the contacted contractors participated.

Edison was not directly involved in recruiting HVAC contractors to deploy the program or in evaluating contractors' technical proficiency. However, Edison did review the list of proposed contractors with their consumer affairs department to determine if there were any issues with the business before PEG trained the contactors. Before the Early Retirement Program, 42% of the participant contractors and 48% of nonparticipant contractors were familiar with the *Check Me!*™ diagnostic protocols but were not using them. Another 33% of the participant contractors and 48% of nonparticipant contractors were not familiar with *Check Me!*™. One-quarter of participant contractors (3) were familiar with the protocol and already using it.

Participant contractors (58%) and nonparticipating contractors (24%) reported they were using other diagnostic tools, but not *Check Me!*™. These diagnostics utilized "internal protocols," "normal gauges," and "simple temperature differences." One participant said they used the "Honeywell Service Assistant Analysis procedure." Asked how the various diagnostics and procedures they used compared to *Check Me!* ™, four contractors reported they "were not as accurate" and one said it was "as comprehensive." Two stated the standard procedures took more time than *Check Me!* and one stated *Check Me!* ™ took more time. Still, 57% of participant contractors said they use the other diagnostic tools.

One nonparticipant contractor and two participant contractors reported that outside of the Early Retirement Program, their customers specifically requested *Check Me*!™ type of diagnostic services.

CSG and PEG felt contractors were interested in participating because it could lead to new sales through early retirement of inefficient systems. In fact, contractors knew the program as the *Early Retirement Pilot.* In addition, the program offered an avenue to keep technicians busy during the Fall and Winter. During the heavy summer schedule dealing with "no cool" calls, contractors are too busy to take on maintenance programs.

CSG and PEG report that several contractors signed up but were not responsive. Some did not see the value in a program with a September rollout when the program was over in December. Implementers noted there are also some contractors who won't work with any utility program. Some have been involved with "notoriously bad" programs where payments were "strung out over six to nine months." These contractors will likely not be convinced to participate in any utility program.

Homeowner Recruitment

The program targeted homeowners with inefficient air conditioning systems. The program had a two-pronged marketing approach: data mining and contractor leads. First, CSG used data mining approaches to identify potential candidates using Edison customer billing records. Edison sent selected customers postcards that described the program and invited customers to participate. Second, contractors were free, and in fact encouraged, to market the program to their customers and generate their own work, taking advantage of the program and incentives.

CSG obtained customer consumption records from Edison. Discussions between CSG and Edison involving the data request and confidentiality issues occurred in July 2005 and hampered the marketing effort. Since Edison could not provide customer specific account information to contractors, they provided CSG with customer data for data mining purposes without names and account numbers. Edison kept a set of records with the customer names and account numbers so that participant data could be matched back to Edison's account data.

Through billing analysis and data mining techniques, CSG identified two groups of customers they later targeted. One group included those who consumed at least 200% of the average cooling load for homes constructed before 1992. The second group included those consuming between 150%-200% of average cooling for homes constructed before 1992.[8] CSG did not go below the 150% threshold or market to smaller homes with lower energy use, but contractors generating their own leads did. CSG obtained housing size data from Edison for about half the population. They obtained additional housing size and age data from real estate websites. Housing size and energy consumption were used to develop an energy intensity rating

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[8] CSG Final Report, page 1-2.

(kWh/square foot). The potential participants were likely to have at least one and perhaps multiple central air conditioners. These profiles focused program marketing.

Edison sent letters on behalf of both Edison and CSG directly to the selected customers. Before the first mailing, Edison removed time-shares and others who would not qualify. Four large mailings were completed. Edison sent the first mailing of about 6,000, in three batches, to customers identified with over 200% average cooling load. Edison sent a second mailing of about 5,000, in three batches, as a follow-up to the first group, excluding referrals. It is possible that the customer received mailings from both batches. The third and follow-up fourth, mailings of about 5,000 were sent to customers consuming 150%-200% of the average cooling loads. Edison sent 22,523 pieces of mail, on Edison letterhead, to about 11,000 customers.

Postcards provided a phone number for interested customers to call CSG directly. CSG talked with the potential customer, described the program, and screened out customers with new equipment. If customers did not have an existing relationship with a contractor, CSG assigned referrals to contractors on a rotating basis. The numbers of referrals made to specific contractors were weighted toward the number of trained technicians. Customers with existing relationships with contractors were referred to those contractors. CSG followed up with contractors to ensure the referred customer had received service. Assessments at 900 homes were projected and anticipated to result from the mailings. In total, 474 homes had AC assessed, 52% of the assessment goal.

PEG and contractors felt the marketing letters to customers, using Edison letterhead, were important marketing tools. Letters explained that the assessment was free and that there was a $1000 incentive for replacement. Contractors felt the letters showed that Edison was willing to validate the program.

In addition to this data-mining approach used to identify potential participants, contractors generated leads from their own clientele and marketing efforts. CSG expected contractors would generate about 70%-75% of all program leads. or, at a minimum, at least half the leads, because they had existing established relationships with their clients. Implementers assumed that contractors would know which HVAC systems would likely qualify for replacement and that the contractors could benefit from promoting the program to these customers. However, by the end of the program contractors had generated about 27%.[9] Some contractors did not market the program to their customers, but waited for referrals from CSG and Edison. CSG reported that one contractor in particular aggressively and successfully promoted the program to his customers. That particular contractor could send newsletters to 12,000 customers, and depending on whether program activity coincided with newsletters, the contractor stated he could potentially market the program to those customers in the future.

[9] CSG Final Report, pg 5.

Marketing and Participation Decisions

HVAC Contractor Decision-making

PEG reports that most contractors using *Check Me!*™ are offering incentivized services, typically through a utility program for new air conditioners or heat pumps. If the diagnostics are offered without incentives, they are usually offered to distinguish service offerings, based on a business model of increasing customer comfort.

Table 2-7 reports benefits HVAC contractors remember being told about the Program. Most participating contractors (11 of 13) heard about the program from PEG. One heard about it from a customer, one from Honeywell, and two from CSG. Most heard about it through multiple methods, including mail and phone. Three also received a fax, one attended a trade show and one attended an Edison training event.

Only half (13 of 25) the nonparticipating contractors remembered where they heard about the Early Retirement Program. Half of these contractors (7 of 13) heard about the program from Edison. Three remember hearing about it from PEG and one from CSG. Nonparticipating contractors also heard about the program through mail, phone, fax, and by attending a presentation.

Participating contractors remembered that program benefits included usefulness as a marketing tool, developing customer relations, and that Edison would pay for inspections and incentives for replacements. While some nonparticipant contractors also remembered these benefits, 68% (17) did not remember being contacted and/or could not remember any program benefits (Table 2–7).

Table 2–7. Benefits Remembered by HVAC Contractors

	Participant Contractor N=13		Nonparticipant Contractor N=25	
	Count	Percent	Count	Percent
Useful for marketing; helps get new business	13	100%	3	12%
Develop good customer relations	8	62%	1	4%
Southern California Edison will pay for inspections and incentives for replacements	7	54%	3	12%
Tune-ups and replacements of inefficient AC units will save energy	4	31%	1	4%
This was an experiment	1	8%		
Learned new skills	1	8%		
Don’t remember contact			10	40%
Don’t remember benefits			7	28%

Source: Survey of participant contractors (n=13), nonparticipant contractors (n=25), multiple answers allowed

Virtually all of the participating contractors stated the program was a good way to increase sales, develop customer relations, or that the program was a good marketing tool. Two noted they already used the *Check Me!*™ protocol. In short, all participant contractors felt the program was good for business (Table 2–8).

Table 2–8. Key Factors in Participant HVAC Contractor Decision Making

	Participant Contractor N=13	
	Count	Percent
A good way to increase product sales/competitive advantage	11	85%
To use program as marketing tool	7	54%
Will help contractors get more business and enhance their value to customers	7	54%
Develop good customer relations	4	31%
Already using *Check Me!*™ in maintenance practice	2	15%
Try to participate in Edison programs	1	8%
Free to customer	1	8%
Increase industry knowledge	1	8%

Source: Survey of participant contractors (n=13), multiple responses allowed

About half the nonparticipating contractors could not say why they decided not to participate in the Early Retirement Program (Table 2–9). Those who did stated that they already had a good business or that they were not large enough to take on the program requirements. One noted they were very interested but that Edison did not follow-up with information.

Table 2–9. Key Factors in Nonparticipant Decision Making

	Nonparticipant Contractor N=25	
	Count	Percent
Had a good business already	4	16%
Company too small; too busy; not enough man power	4	16%
Too much hassle	2	8%
Very interested but Edison did not get back with information	1	4%
Didn't see an advantage	1	4%
Already offered service	1	4%
Had not made decision yet	1	4%
Couldn't say	11	44%

Source: Survey of nonparticipant contractors (n=25)

As shown in Table 2–10, over three-quarters of participating contractors (10 respondents, 77%) stated that Edison's sponsorship was "somewhat" or "very important" to their decision to participate. The primary reason respondents reported that Edison's sponsorship was important was that Edison lent legitimacy and credibility to the program, helping them to "get in the door." Two stated they would have participated without Edison's sponsorship.

Table 2–10. Importance of Edison Sponsorship

	Frequency	Percent
Not at all important	2	15%
Somewhat unimportant	0	
Not important and not unimportant	1	8%
Somewhat important	4	31%
Very important	6	46%

Source: Survey of participant contractors (n=13)

In addition to discussing baseline maintenance practices, contractors were asked who typically buys maintenance contracts. Most could not provide any distinguishing demographics or profile. Participant contractors said program participant households were the same general population as their regular customers. These contractors felt that, for the most part, participants were looking for something free or they were knowledgeable about energy and available programs.

Nonparticipating contractors stated they thought their customers purchased maintenance contracts for peace of mind, since customers lived in the desert where air conditioning is a necessity. Nine of the nonparticipant contractors noted they provided services to both residential and small commercial customers.

HVAC Contractor Firmagraphics

Participant and nonparticipant HVAC contractors were asked a number of questions about their firms to establish profiles of these groups.

With the exception of one nonparticipant firm with 90-100 employees, the nonparticipant firms employ half the staff that participant firms do. On average, 78% of the employees of the nonparticipant firms are also AC technicians. Seven of the 90 AC technicians (10%) in the nonparticipant firms are using the *Check Me!*™ or similar diagnostic tools.

As seen in Table 2–11, on average, nearly half (47%) of all employees at participant firms are AC technicians. At these firms, 52%, 48 of 93 AC technicians, are trained and using the *Check Me!*™ diagnostics. Seventy-three percent of participant firms (8 of 11 respondents; 2 did not respond) continue to offer the Program's diagnostic services in addition to regular maintenance services.

Table 2–11. Firmagraphics

	Participant Contractors N=13			Nonparticipant Contractors N=25		
	Avg	Min	Max	Avg	Min	Max*
Employees	17	5	42	5	0	19
Employees who are AC technicians	8	2	30	3	0	10
Percent of employees who are AC technicians	47%	15%	100%	78%	21%	100%
Percent of technicians who are using *Check Me!*	52%	0%	100%	10%	0%	100%

Source: Survey of participant contractors (n=13), nonparticipant contractors (n=25)
*Excluding one firm with 90-100 employees, where 20 are AC technicians

The firms that currently offer *Check Me!*™ or similar diagnostics were asked what percent of their customers buy *Check Me!*™ services and what percent buy standard service. Four nonparticipant firms reported offering diagnostics with 10%, 25% and 50% of their customers purchasing the service. Eight participant firms reported offering diagnostics services. Four said the service is free, and four said that 3%, 60%, 75%, and 100% pay a fee for the service.

HVAC contractors were also asked about business revenue generated through preventive maintenance services and on-call, emergency and repair related services. Note that the percentages do not add to 100% because firms also offer other services. Table 2–12 shows that the participant and nonparticipant HVAC businesses have nearly the same split between providing preventive maintenance services (29% - 34%) and on-call services (57%). The range between businesses varies widely, from 0% to 90% for preventive maintenance services, and from 0% to 100% for on-call ‘emergency’ services.

Table 2–12. Business Revenue Generation

Percent of Overall Business Revenue Generated through:	Participant Contractors N=13			Nonparticipant Contractors N=25		
	Avg	Min	Max	Avg	Min	Max*
AC preventive maintenance services	34%	0%	85%	29%	0%	90%
AC on-call services, troubleshooting or repair	57%	0%	90%	57%	10%	100%

Source: Survey of participant contractors (n=13), nonparticipant contractors (n=25)

One contractor referenced the turnover in technicians in the HVAC business. They are not currently offering the services because they lost all their technicians trained to conduct the diagnostics. Two participating contracting firms also referenced the high turnover among HVAC technicians. Virtually all the staff had turned-over at the two firms, including the business manager, since participation in the program. They noted that high turnover is common in the HVAC business.

Homeowner Decision-making

Participant homeowners were asked how they heard about the program and why they chose to participate. Table 2–13 shows that over half the respondents, 57%, heard about the program through the mail. Over 67% could not remember who contacted them, whether it was Edison, a program implementer, or an installation contractor. Of those who did remember, 10 said the contractor and eight said Edison contacted them.

Table 2–13. How Residential Customers Heard about the Program

	Frequency	Percent
Mail	34	57%
In person	9	15%
Newspaper/advertisement/TV/bill insert/internet	5	8%
Phone call	2	3%
Attended a presentation	1	2%
Don't know	9	15%

Source: Survey of participants (n=60)

Homeowners remember being told about the program benefits, as shown in Table 2–14, and offered their reasons for participation, shown in Table 2–16. Over forty percent of respondents stated the benefits of the program were that the tune-ups and replacements would save money. About 10% fewer respondents (33%) said they participated to save money (Table 2–15). Twenty percent remembered that saving energy was a program benefit; however, 30% said they participated to use less electricity and to reduce environmental problems. Seventeen percent remembered incentives were a benefit of the program, and 15% said they participated because the incentives helped to finance the AC.

Table 2–14. Benefits Remembered by Homeowners

	Frequency	Percent
Tune-ups and replacements of inefficient AC units will save money	26	43%
Tune-ups and replacements of inefficient AC units will save energy	12	20%
Incentive/discount/financing help available	10	17%
Necessary for AC service	8	13%
It was never explained to me	3	5%
Needed new AC; to add an AC	3	5%
This was an experiment	1	2%
Spend a lot of money at once	1	2%
Inspection/cleaning	1	2%

Source: Survey of participants (n=60), multiple answers allowed

Table 2–15. Reasons Homeowners Participated

	Frequency	Percent
To save money	20	33%
To use less electricity/less environmental problems	18	30%
Worried AC unit might break down	18	30%
Incentives available / free or little cost	9	15%
Ensure operating properly, check efficiency	2	3%
Wouldn't hurt to participate	1	2%
Wanted newer AC, selling house	1	2%
Old unit	1	2%

Source: Survey of participants (n=60), multiple answers allowed

Almost three-quarters (72%) stated that Edison's sponsorship was "somewhat" or "very important" to their decision to participate (Table 2–16). Reasons respondents reported that Edison's sponsorship was important included: rebates (16), Edison is our supplier (8), Edison's name and affiliates are associated with quality, honesty, credibility, or, Edison lent legitimacy to the program (8), Edison is committed to saving energy (6), and, they would have installed the AC regardless of the sponsorship (5).

Table 2–16. Importance of Edison Sponsorship for Residential Customers

	Frequency	Percent
Not at all important	4	7%
Somewhat unimportant	4	7%
Not important and not unimportant	9	15%
Somewhat important	10	17%
Very important	33	55%

Source: Survey of participants (n=60)

Residents were asked how important the 6-pack of CFLs was to their decision to participate in the program. Most, 72% said the CFLs did not make any difference one way or another or the CFLs were "somewhat" or "very insignificant" in their participation decision. Only 28% said the CFL 6-pack was "somewhat" or "very significant." Sixty-five percent (39 respondents) said they had between one and 20 CFL installed in their home before the program. Thirty-five percent (21) did not have any CFL before the Program. Over 75% (46) installed CFL from the 6-pack. Of these, nearly half (22, 48%) installed all six CFLs.

The program implementer reports and databases show about half the customers who qualified for replacement AC units actually replaced them (183 of 355, or 52%, replaced their eligible AC).

The reasons that 12 participant survey respondents cited for not replacing an eligible AC were:

- May possibly replace within next 1-2 years (4 respondents)
- Didn't think it was needed (3 respondents)
- Couldn't afford it (3 respondents)
- Unsure about the rebate (2 respondents)

Two who said they might replace the AC in the next couple of years offered additional comments. One said they were "remodeling and weren't ready to change," and the second would need to "replace the heater and the whole bit" at the same time.

Homeowner Demographics

Participant and nonparticipant residential homeowners were asked a number of demographic questions to establish profiles of these groups.

As shown in Table 2–17, participant respondents report summer 2006 AC use was 5% higher than summer 2005 AC use (75% in 2006 vs. 70% in 2005). In addition, 12% more respondents used their AC 100% of the 2006 cooling season. Eight participants own a swamp cooler and two reported using it 20% of the 2006 cooling season. Four reported using the swamp cooler between 20% and 50% of the 2005 cooling season, for an average usage of 29% over the cooling season.

Table 2–17. Homeowner AC Use

	Participants	Nonparticipants
Number (percent) using AC 100% summer 2005	18 (30%) (n=55)	
Overall average AC use summer 2005	70%	
Number with swamp cooler	8 (13%) (n=60)	5 (8%)
Average swamp cooler use 2005	29% (n=4)	
Number (percent) using AC 100% summer 2006	25 (42%) (n=58)	23 (43%) (n=53)
Overall average AC use summer 2006	75%	83%
Average swamp cooler use 2006	20% (n=2)	100% (n=1)

Source: Survey of participant households (n=60), nonparticipant households (n=63)

Nonparticipant respondents reported using their AC 83% of the 2006 cooling season, on average. Nearly the same number and percentage of nonparticipants (23, 43%) and participants (25, 42%) reported using the AC 100% of the 2006 summer cooling season. Five reported they had a swamp cooler at their home, with four stating they did not use it at all in 2006 and one reporting they used it 100% of the cooling season.

Table 2–18 shows other homeowner demographics for participant and nonparticipant survey respondents. On average, participants lived in smaller homes, slightly older homes, with more people and slightly fewer AC than did nonparticipants. Three nonparticipant and one participant were excluded where home size was recorded as over 20,000 square feet.

Table 2–18. Homeowner Demographics

	Participant Households N=60			Nonparticipant Households N=63		
	Avg	Min	Max	Avg	Min	Max*
AC	1.4	1	3	1.8	1	5
House square footage	2043	1000	3700	2511	1400	5000
House age	27.2	6	56	25.4	3	86
Number in household	2.2	1	14	1.9	1	7

Source: Survey of participant households (n=60), nonparticipant households (n=63)

Program Delivery and Implementation

Program Presentation

Participating contractors received customer contact information from CSG and PEG. Nine contractors confirmed they received leads, two said they did not, and one stated they received some contact information, but mostly, the customers called them directly. In addition to receiving referrals, contractors identified potential participants by generating their own leads from their existing customer base. CSG's final report to Edison stated that 73% of customers were CSG referrals and 27% were contractor referrals.[10]

Contractors were asked how they presented the program to their customers. When leads came from CGS or PEG, contractors said the customers already knew about the program and the incentive and they did not need to do any marketing. Where the contractor generated their own leads, or were marketing to customers who already had a maintenance agreement, respondents reported they presented the program by emphasizing any number of the following:[11]

- There was a $1000 discount/rebate through the program.
- Sometimes additional manufacturer rebates could be coupled with Edison's incentive.
- The PUC paid for the program; the tune-up was a free service.
- The tune-up was a more extensive check of the system and superior to standard practice.
- The service helped to prevent the break/fix cycle, extended the unit's life, and saved energy.[12]
- The program offered new equipment.

[10] CSG, Final Report, page 5.

[11] Summarized from contractor interview responses.

[12] Evaluators recognize the referenced "break/fix cycle" may not be well documented, nevertheless, contractors presented the program to prospective customers in this way.

- The third party verification of the diagnostics lent credibility to the program.
- Edison wanted to be sure the units were running properly so the customer could save energy and money over the long term with a better serviced unit.

One contractor noted that because the service provided a more extensive check of the system, they got many new customers. One contractor reported that the fact the incentive came from the utility and there were qualification guidelines added 'tangible' credibility to the program. He reported that when customers are offered an incentive by the HVAC company, the customers are not always convinced that the incentive is real; perhaps the contractor was 'just saying' they are reducing the price. Contractors reported the $1000 utility incentive in this program was large enough to make a difference in the ability to sell the job. In general, costs flowed from the implementation contractor to customers. While contractors appear to have reduced customer costs by passing on incentives, however the price reduction to customers cannot be determined. The program did not maintain data on customer costs.

Air Conditioner Replacement Criteria

Program requirements for AC replacement included three primary criteria. These included:

1. The unit must be operating so that it could be tested.
2. An operating unit with *rated* EER of 7 or less automatically qualified for replacement.
3. After correcting refrigerant charge, a unit with an *operating* EER of 7 or less qualified for replacement.

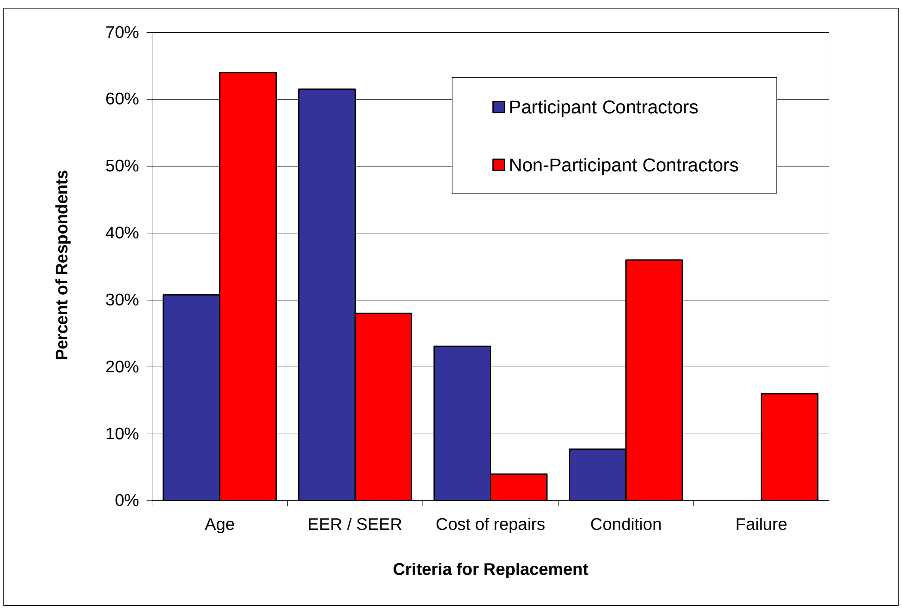
AC units that were not operational at the time the tests were conducted were not eligible for replacement with the incentive. However, contractors noted that if the homeowner paid to repair the system to operational condition (for example, repair a sensor) then the system could be tested to determine if it met operating EER requirements for replacement. Contractors evaluated the cost of repair vs. replacement without incentives before recommending a course of action to the homeowners. Some homeowners opted to replace a non-operational system without repair and testing, that is, replace the unit without this program's incentives.

Units which had an operating EER of 7 or less could only qualify if this test result occurred after the refrigerant charge had been adjusted. The contractor's database confirms that AC units coded "ineligible" where it appeared to qualify by EER of 7 or less, were all coded as either undercharged or overcharged. This meant the charge was not adjusted and contractors determined the unit was ineligible. In some cases, for example, where the unit qualified by EER but was not adjusted and tested, the homeowner refused to adjust the Freon and retest since it could cost them money. Contractors reported in survey data, and PEG confirmed, that sometimes there was a fee for adjustment. More than one contractor noted a fee was charged if more than one pound of Freon was needed to adjust the refrigerant charge. Charging fees for these services is the contractor's discretion; however, it did lead to some units remaining unadjusted, untested, and ineligible, thereby leaving savings on the table. Standard fees, covered by the program, would address these situations where Freon adjustments are needed prior to the retest establishing eligibility.

In open-ended survey responses, participant contractors reported that the criteria used to determine whether a unit qualified for replacement was the operating EER (62%), age (31%), cost of repairs (23%), and condition (8%). Nonparticipant contractors reported age (64%), condition (36%), efficiency (28%), broken or failed (16%), and cost of repairs (4%). (Figure 2–2)

Participant responses reflect the programs' criteria for early retirement replacement and nonparticipant responses reflect replacement on failure. Participant report of "operating EER" (program requirement for replacement) and nonparticipant report of "efficiency" as replacement criteria may not be directly comparable since the nonparticipant contractors do not typically test the unit's operating efficiency. However, both criteria address unit efficiency. Age was important to both groups, but more important to nonparticipants. Nonparticipant contractors' 'broken or failed' criteria for replacement reflects their standard practice for replacement on failure. This criteria is not reflected by participants, who focused on early retirement and not failure.

Figure 2–2. Criteria for Replacement



Source: Survey of participant contractors (n=13), nonparticipant contractors (n=25)

Comparison of Customer and Contractor Responses: Baseline Services and Duct Repair

Maintenance Services

Participant and nonparticipant households were asked if they received maintenance services, how often, and the cost of services. As seen in 3-20, thirty-six nonparticipant households (57%) maintained regular service contracts. Excluding the 5 nonparticipants who paid for a replacement AC, 21 nonparticipants reported average service costs were $215, where costs ranged from $35 to $900.

Thirty-four (57%) of participant households stated they had some kind of service on their AC prior to the Program, including one person who serviced the unit themselves. Sixteen participant households (27%) stated their last service call was regular maintenance and 16 stated it was a special service call, one did not know the nature of the contractor's work. Of the 33 participants who hired contractors to provide service work on their systems, 12 (36%) did not know what it cost. The other 21 respondents reported costs ranged from $40 to $200 with an average cost of $73.

Participant and nonparticipant households reported how often they obtained maintenance services. Table 2–19 shows the frequency of maintenance services reported by homeowners. Over half, 58% of the 43 participants whose last service call was maintenance, and 25% of the 63 nonparticipants, said they obtain service at least once a year. Over half (57%) of the nonparticipants and 23% of participants said they obtain service at least every six months. Of 57 nonparticipants who had service in the last three years, 82% had service in 2006 and 9% in 2005.

Table 2–19. Frequency of Maintenance Service

	Participants		Nonparticipants	
	Count	Percent	Count	Percent
At least once every six months	10	23%	36	57%
At least once every year	25	58%	16	25%
At least once every two years	3	7%	3	5%
Once in the last five years	1	2%	1	2%
Once longer than five years	1	2%		
Never, or when it breaks	3	7%	6	10%
Uncertain			1	2%
Total	43		63	

Source: Survey of participants (n=43), nonparticipants (n=63)

Participant and nonparticipant households and HVAC contractors were asked about their AC maintenance and service practices to establish a baseline for 'typical' maintenance practices. Participant contractors were asked about routine services typically provided outside of the Early Retirement Program. This was an open ended question and answer options were not read (Table 2–21).

Over one-quarter of both participant (30%) and nonparticipant (26%) households do not know what maintenance services are being provided. More nonparticipant than participant households were able to name maintenance services they received from contractors. Five nonparticipant households had new AC units installed. Two participants had new AC installed prior to participation.

About half the participant and nonparticipant households said their contractor provided a basic inspection while over 90% of the contractors stated they provided a basic inspection. All participant and 80% of nonparticipant contractors install new AC systems. The contractor groups named virtually the same services, and with few exceptions, responses between the two groups were within 9% of each other. Services that weren't within 9% included checking and cleaning filters (11%), check or test pressures (12%), and check motors (20%). In these cases, the participants named the items less often than nonparticipants. One participant contractor said they did not do maintenance work, only repair and new installations. Two participants said they use the *Check Me!*™ protocol with manual gauges and don't call in results to PEG. One stated they typically do Honeywell warranty work.

More than 50 percent of participants and nonparticipants use a basic tune-up service. Nearly two-thirds of participating and nonparticipating contractors stated they clean coils and adjust refrigeration charge. About half of them state they adjust airflow.[13] These services have the largest impact on saving energy from a tune-up. It is likely that contractors might be using less accurate equipment to measure charge and airflow but they are aware of the concept of an enhanced tune up. This suggests that tune-up services provided in the marketplace have the potential to save energy. Therefore, enhanced tune-up programs should be measured against a baseline maintenance practice to be developed from a more expanded study. Program savings from providing an enhanced tune-up service might be less than estimated for customers who already have a tune-up contract.

Table 2–20. Baseline Maintenance Practices

	Contractors				Residents			
	Participant N=13		Nonparticipants N=25		Participant N=60		Nonparticipants N=57	
Install new AC	13	100%	20	80%	2	3%	5	9%
Basic inspection	12	92%	24	96%	28	47%	30	53%
Check & clean or change filters	9	69%	20	80%	9	15%	18	32%
Check and clean condenser coil	9	69%	18	72%	2	3%	7	12%
Adjust refrigerant charge	8	62%	17	68%	3	5%	6	11%
Measure air flow and refrigerant charge	7	54%	12	48%	1	2%	6	11%
Adjust air flow	7	54%	12	48%	2	3%	6	11%
Visual inspection of other parts & controls, e.g., belts, wiring, electronics, thermostats, etc.	6	46%	10	40%	2	3%	8	14%
Duct inspection & repair	3	23%	4	16%	1	2%	5	9%
Check amps	2	15%	6	24%				
Check & adjust fan speed	2	15%	3	12%	2	3%	1	2%
Lubricate	2	15%	2	8%	1	2%		
Check motors	1	8%	7	28%				
Check/test pressure	1	8%	5	20%				
Repairs in general					5	8%	3	5%
Don't know					18	30%	15	26%

Source: Survey of participant contractors (n=13), nonparticipant contractors (n=25), participant households (n=60), nonparticipant households (n=57), multiple answers allowed

[13] Again, note this was an open ended questions and contractors were allowed to describe their services in their own words. Some categories might have similar meaning.

Participating HVAC contractors reported common maintenance issues addressed by the Early Retirement Program included balancing airflow, measuring temperature drops, and refrigerant charge adjustments. However, again, they noted that outside of the program, manual gauges were normally used and the tests were not as accurate as the diagnostic tests using *Check Me*!™ tools and procedures.

Contractors were asked if they recorded site measurements and estimated energy and demand savings when the *Check Me!*™ protocol was not used. Sixty-nine percent of participating contractors and 78% of nonparticipating contractors said they did not.

Those who did record measurements and provide savings estimates were asked what tool they used. The five nonparticipants said:

- there "was no need for diagnostics"
- "not any specific tool"
- savings were estimated "in [my] head"

The four participant contractors said they used:

- "standard gauges and meters"
- "the same as *Check Me!*™ program"

Duct Inspection and Repair

Participant and nonparticipant households were asked specifically if duct inspection was part of routine maintenance service received prior to the program. About one-quarter of each group did not know if the ducts were inspected. Almost half of the participants and 36% of nonparticipants said the ducts were not inspected. Participants were also asked if the ducts were inspected as part of the program. Again, 15, 25%, said the ducts were inspected and 47% said the ducts were not inspected (3–21).

Three of the 15 participants and one of the 24 nonparticipant homeowners whose ducts were inspected said they were sealed or repaired prior to the program,. One of the three participants paid $300 for repair and sealing, the other two did not pay anything. The nonparticipant reported paying $2000 to repair and seal the ducts. One person reported ducts required sealing during the program and did not pay anything for the work.

Table 2–21. Homeowners' Duct Inspection

	Participant Households		Nonparticipant Households	
	Count	Percent	Count	Percent
No, contractors did not inspect the ducts	29	48%	20	36%
Yes, contractors did inspect the ducts	15	25%	24	43%
Don't know if ducts were inspected	16	27%	12	21%
Total	60		56	

Source: Survey of participant households (n=60), nonparticipant households (n=56)

Contractors were also asked specifically if duct inspection was part of routine maintenance work.[14] Responses from homeowners and HVAC contractors indicate duct inspection was not routine service, but that the ducts were addressed when requested or if obviously in need. Roughly the same percentage of participant and nonparticipant contractors inspect the ducts as part of routine maintenance work (Table 2–22, 31%-36%). Participant and nonparticipant contractors who reported "it depends," explained that they inspect the ducts if the "customer requests and pays a separate fee," they'll conduct a "duct blaster test if the airflow seems too low," they do a visual inspection, and "only if it's a problem." One participant contractor stated, their "climate zone requires it now" under Title 24.

Table 2–22. Contractors' Duct Inspection

	Participant Contractors		Nonparticipant Contractors	
	Count	Percent	Count	Percent
No, duct inspection is not routine service	3	23%	5	20%
Yes, duct inspection is routine service	4	31%	9	36%
It depends	6	46%	10	40%
Uncertain			1	4%
Total	13		25	

Source: Survey of participant contractors (n=13), nonparticipant contractors (n=25)

If repairs or sealing are required, nonparticipant contractors replace the ducts or repair using "duct tape," "duct sealing product," or "whatever is approved." Participants stated they prepared

[14] There is a distinction between a duct inspection and a duct leakage test. Inspection refers to a qualitative visual inspection, which is likely to reveal only the major leakage problems (like disconnected ductwork). Title 24 requires a duct pressurization (duct blaster) test during unit replacement, which provides quantitative leakage and repair effectiveness information. Responses indicate visual duct inspections are not typically included in standard practice. Contractors conduct duct testing less frequently. Correct duct testing and sealing are areas where contractor education may be warranted. At program commencement, Title 24, requiring duct testing, was not in effect. Duct repairs were outside the scope of the program, as was duct blaster testing. For this reason, we recommend development of a quality installation protocol for new air conditioners.

a quote and fixed it if the customer agreed to pay for the extra service. One participant contractor stated he conducted a *Duct Blaster*™ test and sealed until he got less than 6% leakage.

Market Barriers

Edison, CSG and PEG all noted that the late start of the program affected the ability to meet program goals. Because of the late start, CSG could not introduce the program to contractors before the cooling season started, as originally planned. Contractors are busy with service calls through the cooling months, from May through September. This made rolling out the program in September, with only a few short months left to implement it, a barrier to recruiting and enrolling contractors. The timing of program rollout is important when the ability to capture energy savings relies heavily on a seasonally driven delivery channel.

The key to reaching the Early Retirement Program goals rested with the contractor's ability to convince home owners that a functional air conditioner, apparently without problems, should be replaced before the end of its useful life. Convincing someone to replace their AC unit largely became a discussion of first cost, as reported by those who chose not to replace an eligible unit (they did not have the money or they did not think it was needed). Free assessments and the $1000 replacement incentives were designed to address that barrier.

PEG provided marketing materials for contractors. However, one contractor reported that his company could have used additional help, particularly with specific language, to sell the customer both the assessment and replacement. Marketing the program so that customers understand the benefits of early replacement is the underpinning of program success.

Nonparticipant HVAC contractors were asked what they thought the major reasons that businesses like theirs did not offer preventive maintenance services such as the *Check Me!*™ diagnostic protocols. Contractors sited red tape, time, and the fact that "they don't advertise enough." As noted in their surveys and Firmagraphics (Table 3–10) the nonparticipant businesses were smaller, which made it more difficult for the business to participate simply in terms of the sheer number of technicians with available time.

Participant HVAC contractors also reported that while the diagnostics were more accurate than their standard approaches, it was more time-consuming to conduct. The incentives for conducting assessments were designed to address that barrier and the contractors noted they would use the diagnostics protocol with incentives. However, 60% of the contractors noted that the incentive did not cover 100% of their incremental costs. Incentives will continue to be necessary to overcome the cost of spending additional time diagnosing the system, until the diagnostics become standard practice.

Participants' Experience with the Program and the Technology

HVAC Contractor Experiences

Contractors reported that it was important to conduct the tests and sell the job to the homeowner in the same visit. They stated that jobs usually did not close where the technician had to call back to their base company and have someone else contact the homeowner in order to sell the job. That is, some HVAC businesses had a two-stage process to sell the job. Field personnel collected data and subsequently someone else from the company talked with the homeowner to sell the job. One contractor stated they changed their procedures so that the same person tested the system and sold the job to the homeowner in the same visit.

One contractor (doing the most business under this program) reported that customers who were interested in replacing the system with the $1000 incentive, but who did not qualify, were not always interested in replacement under Edison's Home Energy Efficiency Program where the incentive was $300-$600. Because of this "disappointment factor," the contractor who generated most of his own leads changed his approach so that he only discussed the program and incentives with homeowners after he tested the system and determined it was eligible for replacement.

Contractors referred homeowners to other Edison programs when they were interested in replacing their AC but did not meet the EER cutoff of 7 or less.[15] One contractor interviewed noted that they did whatever they could to help the customer with rebates or incentives from Edison, the manufacturer, or their own shop ("You can't leave without a sale"). Contractors reported that they kept no records or records were not available that tracked which customers were referred to other Edison programs. There are no means to determine who followed up with the Edison Home Energy Efficiency Program.

Contractors reported that the program's diagnostic service model fit well with their current business model. Most said it was a "great" fit. One contractor reported he made slight changes in their company's service process and marketing and created a new department. The only issue raised was that technicians had to buy some diagnostic equipment that is not part of the typical toolkit.

Contractors were asked if they had initial concerns about folding the *Check Me!*™ protocol and program requirements into their regular business practice. Most (10) said they had no concerns. Issues raised included the added time to complete service, paperwork, and liability. Nonparticipating contractors' concerns were related to time, trouble, and hassle.

Contractors reported that the only real level of effort needed to integrate the program's service model into their business objectives was the necessary contractor training "and the rest was easy."

Participating contractors all reported that the services offered through the program helped them to generate more business. When asked if the incentives provided by Edison to conduct the enhanced tune-up covered their incremental costs of providing the diagnostic services, 40% (five of 13) said incentives covered 100% of their costs, and 30% (three) said half the incremental costs were covered. The remaining five respondents said that 2%, 5%, 25%, 30% and 40% of their incremental costs of providing program services were covered by incentives. One noted that their costs were not covered by incentives unless they sold new equipment.

[15] Three contractors who assessed 53% of all AC under this Program were asked specifically if they referred customers to other Edison programs, the circumstances for referral, and whether they kept track of these customers.

Four contractors said that the customer contributed to the cost of the tune-up. Two said that the customer had to pay if more than one pound of Freon was added. One charged $35, and one said the customer contributed 20% to the cost of the tune-up. Variation in contractor charges might affect customers' decision to participate.

Duct repair, as noted elsewhere, was an additional cost to the customer. Not all customers were willing to pay the repair cost and therefore some airflow repairs were not made. These repairs would have allowed a follow-up test to determine whether the repair resulted in an acceptable operating EER and corrected airflow, or whether the unit qualified for replacement.[16]

All contractors who replaced air conditioners reported that the customer contributed to the cost of the new AC installations. Amounts varied, ranging from $2,000 to $6,000 per AC. For some homeowners who had two systems replaced, costs could be $8,000 to $10,000.

One of the benefits of the *Check Me!*™ diagnostics protocol and other protocols that pay attention to energy savings is that the contractors can provide an estimate of energy savings that can result from a tune-up. This is not a report usually provided in typical maintenance services. Three contractors noted that the third party report and certificate offered through the program (*Check Me*!™ report/certificate) were advantageous in that they added credibility to their recommendations and encouraged customers to make changes.

Participant and nonparticipant households were asked if the contractors providing maintenance services before the program gave them an estimate of energy savings (Table 2–23). Seventeen percent of participants (10) and 5% of nonparticipants (3) said they were provided an estimate of savings. The majority said that either they did not receive one or they did not know.

Table 2–23. Reports of Savings Estimates

	Participant Households		Nonparticipant Households	
	Count	Percent	Count	Percent
No, contractors did not provide an estimate	29	48%	37	66%
Yes, contractors provided an estimate	10	17%	3	5%
Don't know if energy savings estimate provided	21	35%	16	29%
Total	60		56	

Source: Survey of participant households (n=60), nonparticipant households (n=56)

HVAC Contractor Satisfaction and Suggestions

Twelve of the 13 contractors delivering the program said they were "very satisfied" with the Early Retirement Program overall.

[16] The contractor made air flow adjustments that were possible in easily accessible areas by adjusting the equipment and diffusers. Duct sealing, duct repairs, and duct testing were not included in the program, and contractors did not provide these services unless customers paid for these activities outside the program. Essentially, it appears any airflow adjustments that would have required accessing ducting were avoided.

One contractor said he was “very dissatisfied.” He explained that PEG sent him referrals for customers who had maintenance contracts with someone else. When he found issues with the systems, he did not get the work to repair or replace the system, which put his business in the red and caused them to stop participating. (The database shows this contractor did not replace any units and completed few tune-ups.) The contractor felt that Edison needed to do more advertising so that customers did not feel the program was a sales gimmick. They also needed help with language and approach when selling to maintenance contract customers so that he did not get blamed for all the issues found and asked to fix them for free. In addition, they needed help with language to use with property managers and owners so that their tenants do not blame the owners for issues found and subsequently hold them liable. This contractor also noted that the $35 incentive was not enough to conduct the *Check Me!* diagnostics when no other adjustments are needed, that is, when no other services can be sold.

Suggestions for program improvements included:

- Increase Edison’s marketing so people understand there is no “catch” to the free tune-up and incentives. Contractors noted that customers do not “know” PEG and contractors.
- Start earlier in the year and offer the program every year, particularly September through November when work slows down after the cooling season.
- Move the minimum replacement qualification criteria to 8 EER.
- Incent higher SEER.
- Keep the program paperless, that is, obtaining approval for AC replacement onsite, via telephone, is preferable to sending in paperwork to obtain AC replacement approval.
- Require diagnostics on new systems. Compile diagnostics, including duct pressure diagnostics, when installing a new system so that there is a starting point and the customer knows what the numbers should be.
- The manufacturer should not authorize or implement warranty work until Check Me!™ diagnostics are completed.
- Speed up the process to get numbers/results from PEG while on the jobsite to eliminate the need to call twice.
- Require that PEG enforce requirements. The contractor making this suggestion stated that some technicians disqualified a unit for replacement so homeowners called another participating contractor who qualified the system for replacement in order to approve the $1000 rebate.
- PEG/CSG should keep track of tests and customers so the original company contacting the customer gets the new business and the program is implemented consistently.
- Provide marketing materials and training to contractors so they know how to sell the diagnostics and are not held responsible to repair identified faulty items at their cost.

Homeowner Experiences

Program participants were asked if the contractors talked with them about their AC systems. Most, 51 or 85% said the contractor did talk with them about their AC. However, 18% said they did not remember what they talked about, others were provided information about the system itself or test results (20%), some were informed their unit was still efficient and they did not need a new unit (24%), and some were told they needed a new AC or the new AC was more efficient than the existing (25%). Six percent reported the contractors reviewed maintenance and operation items.

Only two respondents reported that contractors had difficulties collecting information about their AC unit. One said contractors "had to keep calling someone." The second said that the "unit needed to be fixed and it took more people to change it out."

Participants were asked if they knew what was done to their AC after the contractor's inspection. Thirty percent of respondents were uncertain (Table 2–25).

Table 2–25. Homeowner's Knowledge of Work Completed

	Participant Homeowners	
	Count of Responses	Percent of Respondents (n=60)
Repair	3	5%
Tune Up	17	28%
Replaced AC	13	22%
Suggested replacement	19	32%
Uncertain	18	30%
Other	4	7%
Total	74	

Source: Survey of participant households (n=60)

Homeowners Satisfaction and Suggestions

Customers were asked if they were satisfied with the received program services. Thirty-eight of 60 participating homeowners were "very satisfied" with the Early Replacement Program overall. Participants variously stated the contractors were honest, polite and communicative, did what they said they were going to do, gave them important information, and were considerate of their schedules. (Figure 2-3)

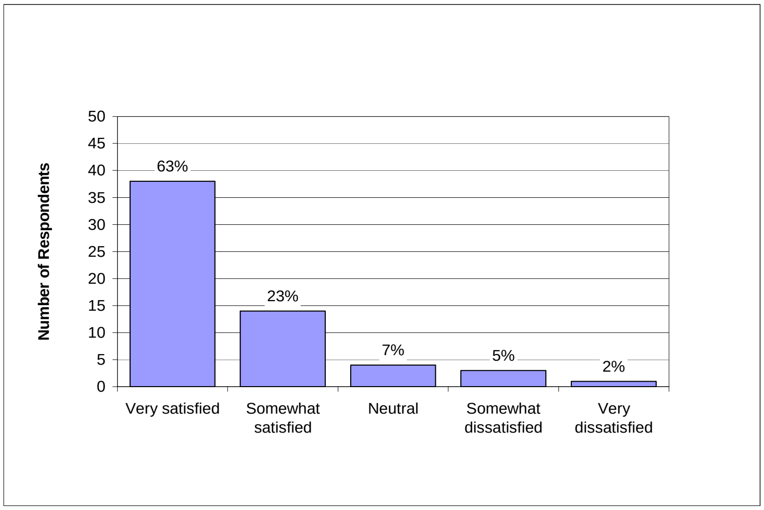
Fourteen, 23%, were "somewhat satisfied." Some were disappointed they did not qualify for the rebates, one noted they were not given any options once the AC qualified for replacement and the replacement unit was noisy, two said contractors didn't check the ducts and they would like to have known the condition. One person said, "I really didn't understand after everything had been done whether I qualified for a new AC or not."

Eight, or 13%, were neutral to "very dissatisfied." One noted contractors did not clean the filters. Other complaints included:

- "I felt like he wanted to sell me a new air conditioning unit"
- "I don't think he stood behind what he said he would do"

- "I expected more of a discussion of the cost and that the inspection would be more thorough and explained"

Figure 2–3. Participant Homeowner Satisfaction



Source: Survey of participant households (n=60)

Homeowners' suggestions to improve the program included:

- Increase the rebate or otherwise lower the overall costs to the customer.
- Design a low-income AC program.
- Give the rebate to anyone who wants to upgrade.
- Allow customers to choose their own contractor instead of choosing from a list.
- Improve communications:
  - Provide better information in promotional materials about what the program will provide.
  - Provide better directions if AC qualifies for replacement.
  - Provide timely explanations for why the unit does not qualify.
  - Provide information about the AC unit including capacity and compressor size.

Free Riders

AC Replacement

There were 474 participants in the AC Energy Hog Program with 672 AC units. Sixty participants with 74 AC units completed the telephone survey. Contractors replaced residential air conditioners manufactured between 1967 and 2001 through this program.

It appears that 29% of all participant households replaced at least one eligible air conditioner. Twenty-one (35%) of survey respondents reported they replaced an AC in their home. Contractor databases reported 23 (38%) of the survey respondents installed an AC. Between the self-report and the database, 16 agreed that an AC was replaced. Of these 16, 10 said they would have replaced the AC in the absence of the program. Four would have replaced the AC "this year." These four respondents are classified as 100% free riders (Table 2–25).

Respondents who would have replaced the system "this year" confirmed that they had financing available or funds set aside for AC replacement. One of the four free riders reported he was actively searching for a contractor, and of three contractors interviewed, the contractor selected was the only one who mentioned the $1000 incentive through the Early Retirement Program. Another homeowner was actively looking to replace his systems because Freon was leaking. The replaced units of the four free riders were 10, 15, 16 and 20 years old. The 10-year-old unit was determined through self-report; age of this particular unit was not recorded in the database. Only one unit was older than the estimated EUL of 18 years.

Table 2–25. Free riders

<table>
<tr><th>Survey Respondents
21 AC Replacements Reported</th><th>Contractor Database
23 AC Replacements Reported</th></tr>
<tr><td colspan="2">16 households with both survey self report
and contractor database reported AC replacements</td></tr>
<tr><td colspan="2">10 reported they were planning to replace the AC</td></tr>
<tr><td colspan="2">4 reported they would have replaced the AC "this year"
and had financing available</td></tr>
<tr><td colspan="2">2 reported they would have replaced the AC in "1-2 years"</td></tr>
<tr><td colspan="2">2 reported they would have replaced the AC in "3-5 years"</td></tr>
<tr><td colspan="2">2 reported they didn't know when they would replace the AC</td></tr>
</table>

Respondents who would have replaced their AC more than one year out were not considered free riders. These customers stated they would replace their AC in "1-2 years," "3-5 years," or "don't know" (two responses each).

CFL Installation

In this program, CFLs were mailed to the customer as a 'thank-you' after the AC assessment and replacement (where one occurred). There is no free ridership associated with the CFL component of the program since the CFLs were given away; there was no purchase decision involved, and more importantly, there was no adoption decision – customers were never asked whether they wanted the CFLs.

Tune-Ups

Participant households were asked if the maintenance services received prior to participation were different from those received through the Early Retirement Program. Only 10% said services were different, 43% said the services were not different and 47% said they did not know if the services were different. The six who said services were different reported that:

- "nobody ever tested it to see the temperature rate"
- they "had not gotten a report before"

- "they got more extensive"
- "the guarantee was a lot longer than the old one"
- "he wrote down a lot of figures and called someone"

Of the 43 participant households whose last service was for regular maintenance, 81% reported they had regular service every six months (10 respondents) or annually (25 respondents). Since most respondents appear to have regular maintenance service and they did not distinguish between this service call and an enhanced tune-up, there were no free riders taking advantage of the enhanced tune-up utilizing the *Check Me!*™ diagnostic protocols.[17]

Potential Spillover

Homeowners

Participant households were asked if they had installed any other energy efficient measures since the air conditioner service was completed. Forty (70%) had not made any additional efficiency purchases or installations. Eighteen (30%) said they had installed 11 different measures in addition to the CFL. Measures reported included a refrigerator (7), washer/dryer (4), microwave, water heater, stove/cook top, windows/ doors (2 each), insulated curtains, attic insulation, solar panels, window sealing, pump (1 each).

During the same timeframe Edison fielded the Energy Hog program, Edison also offered the Home Energy Efficiency Program that offered rebates for purchasing efficient appliances. Rebate programs Edison offered during that time included a refrigerator rebate program, refrigerator and freezer recycling program, electric water heater program, pool pump and motor replacement program. Incentives were offered for AC replacement. Of the 18 respondents installing efficiency measures, six later reported participating in other Edison efficiency programs, however only two participant's responses indicated the efficiency measures could be related to a rebate program. One other person mentioned waiting for a rebate.

There were very few instances where customers requested to participate in both the Energy Hog program and the Home Energy Efficiency Program. One customer participated in both programs, receiving one incentive for each of two AC units. This was because only one unit qualified for incentive under the Early Retirement Program. The unit that did not qualify for Early Retirement did qualify under the Home Energy Efficiency Program. There was no double dipping between programs.

Overall, as seen in Table 3–27, 25% (15) of participant households and 21% (13) nonparticipant households reported they had participated in other Edison programs. The majority of both participant (70%) and nonparticipant (68%) households had not participated in other Edison Programs.

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[17] Additional information on the *CheckMe!* process is available at <http://www.proctoreng.com>.

Edison did not specifically track simultaneous participation in this program and other efficiency programs. Edison should have the capability to identify participation across programs. This would provide additional information for the impact evaluation, to determine whether savings were resulting from the program measure only or from additional measures installed and incentivized through other programs. Tracking participation across programs also provides information needed to specify eligibility and baseline for future program participation.

Over half of both participating and nonparticipating contractors had participated in other (usually earlier) customer direct AC rebate programs (Table 2–26). Some contractors, like homeowners, had participated in more than one program. Contractors named CFL direct install, thermostat replacement, and duct testing and sealing programs.

Table 2–26. Participation in other Edison Programs

	Contractors				Residents			
	Participant N=13		Nonparticipants N=25		Participant N=60		Nonparticipants N=63	
No, have not participated in other Edison Programs	3	23%	7	28%	42	70%	43	68%
Yes, participated in other Edison Programs	9	69%	14	56%	15	25%	13	21%
Don't know	1	8%	4	16%	3	5%	7	11%

Source: Survey of participant contractors (n=13), nonparticipant contractors (n=25), participant households (n=60), nonparticipant households (n=63)

HVAC Contractors

HVAC contractors were asked if they would use the Early Retirement Program practices in the future, either at their own expense or with incentives. All responding participating contractors said they would use the practices with incentives, with one adding, "If the techs are willing to buy the equipment." Of the nonparticipating contractors, 16% said they would use the program practices at their own expense, 28% said they would not use them at their own expense or with incentives, 28% said they would use them with incentives, and 28% were uncertain (Table 2–27).

Table 2–27. Future Use of Program Practices

	Participant Contractors N=13	Nonparticipant Contractors N=25
Would not use Program practices at own expense or with incentives		28%
Would use Program practices at own expense		16%
Would use Program practices with incentives	100%	28%
Uncertain		28%

Source: Survey of participant contractors (n=13), nonparticipant contractors (n=25)

HVAC contractors were asked if they had added any other energy-efficiency services to their business practices since hearing about the program. The majority of nonparticipating contractors

(80%) and only 33% of participating contractors had not added any efficiency services. Nonparticipating contractors said they were offering higher-efficiency equipment, but not services aimed at increasing efficiencies. Participating contractors adding energy-efficiency services (eight respondents, 62%) said they added duct testing and airside diagnostic testing to determine equipment and performance problems. Two also offered the highest-efficiency equipment stocked, and suggested windows and insulation.

Contractors who added efficiency equipment and services were asked how influential the Early Retirement Program was in the decision to add energy-efficient equipment or services. Of the participating contractors, 75% said the program was “very influential” and 25% said the program was “somewhat influential.” Nonparticipant contractors (80%) said the program was “not at all influential” and only one (20%) said hearing about the program was “somewhat influential” in their decision to offer efficient equipment.

Lessons Learned by Program Staff, Future Plans

Program Control

Conservation Services Group (CSG), a third party contractor, administered the program. CSG, and ultimately Edison, relied on Proctor Engineering Group (PEG) to implement the program and deploy it in the field with independent HVAC contractors that PEG recruited, trained and certified. The program relied on these contractors to explain the program and diagnostic protocol to customers.

Edison’s biggest concern with this program was potential lack of control and quality control. Edison was concerned about quality control on two levels. The first concerned quality control or oversight that CSG had over PEG and their HVAC contractors. This is because the contractors present the program to residential customers. Edison was not involved in training or certifying HVAC contractors.

The second concerned information customers received. Edison noted customers received information from several channels, which increased the potential for lost or inaccurate information. Edison does not know if the contractors provided all the information to the customers that they could or should. Without a clear understanding about how the program is presented to customers or how customers are encountering the program, an uncertainty about this level of quality control remains. Edison’s manager suggested a reduction in the number of “middlemen” could improve control.

Both CSG and PEG felt the program worked well, including the ‘chain of command’ from Edison, to CSG, to PEG, to HVAC contractors, and finally, to customers. They did not feel there were quality control issues or too many intermediaries between Edison and the homeowners. PEG sent a customer satisfaction postcard to every customer receiving *Check Me!*™ diagnostics and felt responses from this program’s participants were no different than other programs. Any postcards that returned with less than satisfactory ratings received follow-up calls to address customer issues.

Payments to Contractors

PEG ensured timely payment to the HVAC contractors, so that payment was seamless, from Edison to CSG to PEG, and finally, to HVAC contractors. Timely contractor payment was an important issue for PEG; they guaranteed payment by the 10^{th} of the month. The primary reason for consistent and timely payment is to address the contractors' experiences with other utility programs where payments can be delayed many months.

PEG billed CSG weekly in order to keep the payments flowing to contractors. PEG's end-of-month reports, required for payment by CSG, were prepared by extracting data to fit CSG and Edison's requirements.

Late Start

Edison authorized the program months later than expected, leading to a late start. Compounding this late authorization was to the length of time needed for Edison to approve marketing methods. Edison's concerns about confidentiality and potentially releasing customer account data to the HVAC contractors inhibited CSG's data mining efforts employed to target the program to customers with high usage. Working through this issue resulted in the majority of marketing efforts occurring in July and August. Summer temperatures also extended the "no cooling" calls for service work and delayed HVAC contractors' ability to give the program attention. Contractors were not able to focus on the program until September. Originally, all fieldwork was scheduled for completion by the end of December. This short program period deterred some HVAC contractors from fully engaging in the program.

Revising program goals downward was a mutual decision made by Edison and CSG. There was no change order to the contract, and while new goals were agreed upon, CSG was tasked to "do as many as possible" by Dec. 31, 2005. When it appeared the proposed targets could not be met, Edison could have withdrawn funding, and assigned it to another IDEEA program,. In this case, however, Edison retained funding in hopes that the program attracted the numbers of customers originally proposed. The program expended about half the original proposed budget.

Marketing

PEG and CSG felt that the letters sent to targeted customers on Edison letterhead were a very important component of the program's marketing. Each of the four mailings included 5,000 to 6,000 pieces. In future programs, however, CSG suggests smaller batches of targeted mailing to handle the volume of calls received on the toll free line.

CSG also reported that developing good screening questions and clearly explaining the program to potential participants is important, since each of the referrals represents a potential customer for the contractor, and each contact costs the contractor time and money. Customers must understand what the program offers, what the eligibility requirements are, and the customer's potential financial responsibilities before a contractor visits the home.

Communication

CSG also reported that there were communication challenges with the HVAC contractors deploying the program. CSG worked not only with one contractor from a participating HVAC firm, but with several, including the owners, sales and service staff. Coordinating communication could be challenging. Near the end of the program, they found it necessary to communicate directly with each party rather than relying on one contact person within a company to disseminate information to all the parties who required the information.

All of the customer data tracking between CSG and HVAC contractors was manual. While each kept their own customer database that tracked referrals and job status, the databases were not interconnected or interactive. This led to multiple people doing data entry and multiple spellings for the same name, which made it difficult to extract data later. Ideally, going forward, CSG would like to develop a secure website for contractors to receive leads. Contractors could track the status of those leads and change the status at each stage of the job. Administrators and implementers could use the website to track the leads, run aging reports, and follow up where needed.

In addition, using one interactive database would alleviate the problems associated with data quality and multiple records for the same customer with different spellings. The interactive database could also include the customer account number needed by Edison and evaluators, keeping the account number masked from general view, but available for evaluation and analytic purposes.

CFL Delivery

Edison suggests improvements for the CFL delivery component of the program As implemented, the CFLs were delivered by mail and it was not known whether customers installed the CFLs. (Survey self reports indicate over 75% of respondents installed CFLs from the 6-pack and of these, nearly half installed all 6 CFLs.) Edison suggests that the CFLs be direct-install or dropped from future versions of this program. If a direct install program, a contractor walks through the home with the homeowner, identifying and replacing CFLs. At the same time, the contractor could assess the home to suggest other services that Edison provides.

The CFLs were a post-participation “thank you” gift and not intended to be the driving factor in the participant’s decision to participate. Survey self-reports indicate that for 72% the CFLs did not make any difference to participation one way or another, or that the CFLs were “somewhat” or “very insignificant” in their participation decision.

Contractor Participation

CSG reports there are some HVAC contractors who understood the benefits of the program early and took advantage of the incentives offered by Edison, marketing the program on their own. Other HVAC contractors waited for referrals to come to them, claiming the program was a pilot and was not going to run long enough to be worth their while. Going forward, early intervention is needed to generate HVAC contractors’ interest in taking the marketing lead. Without changing the delivery model, CSG suggests newsletter inserts and promotional packages may be helpful in generating HVAC contractors’ interest in the program. It would also help if the program operated for a longer period. CSG reports contractors stated they would market the program to customers much differently if they knew it was a full time program.

PEG notes that for the first time, incentives were available to retire inefficient air conditioners through this program. The energy-efficiency standards, the SEER, are now high enough so that the differential between the inefficient units and the high quality units made the program cost effective. The incentive addresses the incremental cost and is helpful to both the HVAC contractor and purchaser.

The implementers were asked about the characteristics of HVAC businesses that make them best suited to deploy an HVAC maintenance program like this. The respondent offered that a program works better with established larger businesses interested in progressive ways to handle business. Successful HVAC contractors are also able to maintain computer systems and databases and input usable data. The easiest businesses to work with were those with technical expertise in the field, sales expertise, and office/administrative capabilities that could stay on top of scheduling and referrals.

Program Improvement—Amp, Power, and Airflow Measurements

Several questions surfaced during the impact evaluation regarding the amp and power measurements taken on site. Field technicians recorded amp measurements without decimal digits, that is, they were rounded up to whole numbers. Rounding off the amperage unnecessarily introduces a measurement error in a number used to estimate the operating EER. PEG states that the decimal amp measurement is not needed for their protocols and that, the decimal won't make a difference. Evaluators contend it is important to record full digits with decimals and without rounding.

HVAC contractors were asked how difficult it would be to record the amps as actual measured numbers with decimals, rather than recording amps as a whole number. All contractors reported that it would not be hard; it was not an issue, and that "the measurements are taken and meters record it that way." Contractors were also asked if there was any technical reason that amp measurements were not recorded after the new AC was installed. All contractors stated that they took these measurements or there was no issue. Collecting and recording these data with required detail does not appear to be an issue and should be required going forward.

HVAC contractors were asked if there would be any technical difficulties recording power measurements and airflow measurements in future programs, noting that these measurements were not taken in this program. Nine of 12 contractors stated that they took these measurements or there was no issue. Only one contractor stated there was no technical reason not to take these measurements, but it was not standard practice when installing a new system. One stated they do not have time to do the work themselves and they hire another contractor to take the measurements. One contractor stated taking airflow measurements was invasive to the customer since they had to punch a hole in the duct.[18] One stated they do not often check the airflow and

[18] Evaluators note that punching a hole in the ducts may not be needed to measure air flow. TrueFlow grids don't require a hole.

just fix it when there are issues, and when they have time. Going forward, collecting these data should be required for evaluation.

Program Improvement—Data Quality

One of the program challenges involved data. Each entity, Edison, CSG, PEG and the evaluation team required data, had different data needs, and had different data requirements. Each entity reported that there were data quality issues with data collected through the program for reporting and analysis including issues with accuracy, consistency, missing data and data format. There were also issues with formulas that did not function correctly in the E-3 Workbook that needed correction.

Early in the program, there were issues with data needed to market the program and questions about which data to provide to contractors. CSG needed customer data from Edison to target the program to the most likely population of potential participants. Edison could not provide customer names and account numbers for confidentiality reasons. CSG reported that the lack of customer account information made it difficult to obtain information from customers and from the PEG contractors. CSG needed Edison customer account information to submit participant data to Edison.

Edison required participant data in a specific format, including the customer name and account numbers. However, even though Edison extracted customer account data for CSG, CSG could not provide the account data to PEG and the HVAC contractors. PEG collected participant test data from customers for their tracking and assessment purposes and reported to CSG. When Edison received participant data files, they added customer account numbers to many records with missing data. This process needs to be streamlined to increase accuracy and reduce redundancy.

The program evaluators required data from several sources, including the marketing data that Edison provided to CSG, data provided by CSG to Edison in the “flat files” and Workbook, and data collected and recorded by PEG. To develop databases with data elements for each participant extracted from different files, databases needed a unique identifier common to all files in order to match participant data across the databases. The same unique identifiers were not contained across files. Names and addresses were often spelled differently from one file to the next, including files supplied by the same contractor, making these data elements ineffective identifiers. For example, one participant with multiple AC units appeared five times on two spreadsheets with four different name/address spellings. It was not clear whether this participant had two or five ACs. Two different contractors entered AC test data but there were inconsistencies in the data the contractors recorded, apparently for the same units, including model numbers, age of the unit, and the number of units.

The account number was not present in all the files. The account number is needed to request customer consumption data from Edison for the billing analysis as well as to match the billing data to measure and test data files. In short, omissions and inconsistencies between files resulted in time consuming and difficult efforts to extract needed data as well as inaccuracies in reporting data about the number and types of units assessed and installed.

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3. Impact Evaluation

Impact Evaluation Methodology

The program ex-ante savings were based on assumed equipment operating hours, and a demand saving differential after installing new equipment (air conditioners and CFLs) or improving equipment efficiency after maintenance. Key issues in estimating the program ex-post net savings were possible adjustments to the program ex-ante assumptions and ascertaining measure persistence for the CFLs from participant surveys.

Approach – Selection of Primary Analysis Methodology

Evaluators estimated the program ex-post gross savings by replacing the ex-ante assumptions with program data, reviewing the DEER database to validate ex-ante engineering assumptions, and conducting billing analysis. The program was substantially implemented when the impact evaluation began; therefore, pre-installation metering was not feasible. The measures did not lend themselves to accurate metering after installations were completed. Instead, evaluators reviewed the program data and the contractor’s test results. The adoption rate and persistence for CFLs and free ridership were estimated from the survey of a sample of participating customers.

Engineering Assessment – Verification & Evaluation

The program impacts were estimated separately for its three constituent measures, i.e., CFLs, air conditioner tune-up and air conditioner replacement. The program net ex-ante net savings goals and reported accomplishments were estimated using a 0.8 NTG ratio.

Billing Analysis

The program ex-ante savings for the AC replacement measure were large enough to be reflected on the participants’ electric bills. A billing analysis was conducted after the participants’ electric bills for the 2006 cooling season, through August, were available. The impact evaluation methodology was consistent with the approved evaluation plan.

Results from the billing analysis support results from the engineering analysis. Because the effect of the CFLs have some small impact on savings estimates that cannot be separated from the effect of the air conditioner tune-ups and replacements in the billing data, the engineering analysis is used as the primary means to estimate CFL energy savings.

Data Availability, Data Quality

Program data files had some incomplete and inaccurate data. These inconsistencies and inaccuracies were troublesome for both the engineering and billing analyses portions of the impact evaluation. The primary files used for analysis were the “flat files” that implementers provided to Edison, and the PEG “CheckMeSum” spreadsheets which recorded data for the tests on existing units and the tests on new units on two separate worksheets. There were discrepancies between spreadsheets in the same file and it was difficult to match records between worksheets and even within the same worksheet without tedious manual scrutiny and manipulation. There was no file provided by the contractors which was aggregated to the household level and included information about all units at the household in one record. Matching records between the Edison billing records, the implementer's flat files and the HVAC contractors' CheckMe test files was extremely challenging.

In addition to making adjustments for the missing data, evaluators reviewed the diagnostic test results recorded in the contractor's databases. The implementation contractor estimated the operating EER of air conditioners but evaluators did not use those values in estimating the program savings. The available data and field measurements were deemed as unlikely to provide accurate estimates, which are difficult to develop from uncontrolled field conditions anyway.[19, 20] For example, the program test data includes only the amperage measurement provided as a rounded number, not as measured reading.[21] This approximation could increase the measurement error ranging from 5–15 percent. Because HVAC contractors did not take power measurements before and after making charge adjustments, relying on the amperage reading alone would ignore possible variations in the voltage and power factor. Further examination of the test data revealed a small number of outliers with unusual characteristics such as too low amperage reading or too high refrigeration charge capacity that could distort the savings estimates based on the contractor estimated EER.

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[19] Airflow measurements were not taken by contractors. Evaporator power draw or amperage draw was not recorded. Additional information on the *CheckMe* charge adjustment process is available at http://www.proctoreng.com>.

[20] The reasons for rejection of operating EER were more than just the rounded amperage measurements used by PEG. PEG did not measure the power draw; only amperage on the condenser side. They did not measure airflow or the power draw or amperage on the evaporator side. PEG used default airflow of 400 cfm per ton, which according to them, is the industry standard. The power consumption on the evaporator side was then estimated using this default airflow. The data on amperage measurement were questionable for a significant portion the population. For example, we noticed condenser amperage as low as 2 to 3 amps per ton. We did not always notice amperage measurements to be consistent with the air conditioner capacity. Because this key component of the operating EER estimate did not inspire confidence in data quality and accuracy and airflow measurements were not made (another assumption), we rejected the derived operating EER based on their data. The contractor makes adjustments for ARI conditions using a proprietary algorithm that we did not assess because the data used were rejected. The operating EER was estimated only for the tuned-up air conditioners. The application of operating EER concept was not uniform across all measures.

[21] PEG asked contractors to provide rounded measurements; this is not a database rounding issue. For reasons explained in the footnote above, we feel that using DEER-adjusted data in conjunction with billing analysis would provide reasonable estimates of the program impacts. For field-measured operating EER to be reliable, it should be computed using the standards used by manufacturers to estimate the rated capacity and efficiency. This means that the entering indoor dry bulb and wet bulb temperatures must be controlled to 0.1 deg F and leaving air flow must be measured with similar precision. The outdoor temperature must be controlled, according to manufacturers' practice. Then adjustments should be made for rated conditions of 80DB/67WB entering indoor and 95 DB outdoor ambient. These adjustments, ideally, should be specific for a manufacturer and model. The computation of net BTUS and watts without basic field measurements are unlikely to provide a reasonable estimate of operating EER. The program data had only one measurement that appeared to present unreliable data. We used billing analysis and DEER-adjusted engineering estimates, and the results suggest that our approach was reasonable in rejecting the operating EER-based estimates.

Characteristics of AC Units in Program Database

PEG databases recorded AC system data including age, manufacturer and model, and test data for each test conducted. The database was used to extract age and operating EER data to profile the systems included in the program. Units were separated into several groups by replacement eligibility and actual replacement. Table 3–1 shows various groupings, which are not mutually exclusive groups.

The median age of all units assessed in the Early Retirement Program was 18 years. All units that were eligible for replacement had a median age of 21 years while those actually replaced had a median age of nearly 23 years. Units not eligible for replacement had a median age of 14 years.

Table 3–1. Age of AC Units

	N	N Missing	Mean	Median	Minimum	Maximum	Std Dev
All units with age information	632	40	17.88	18	1	39	7.589
Eligible for replacement	334	23	21.14	21	2	39	6.735
Replaced	171	11	22.77	23	4	39	6.632
Eligible but not replaced	163	12	19.44	19	2	34	6.434
All not replaced	461	29	16.07	17	1	39	7.112
Not eligible for replacement	278	12	14.05	14	1	39	6.76
Unable to repair - ineligible	20	5	16.65	18.5	6	26	6.907

Source: Status data from contractor databases

Evaluators conducted tests to determine whether the age distributions between these groups were statistically significant. Results are shown in Table 3–2. Using pairwise t-tests to compare the means of the three groups with each other shows each pair is significantly different with a chance for error at less than 0.01%. The F-test fails to show any difference in the variance of any of the pairings. A chi-squared test (binning ages by groups of five years) shows significant differences between each group with significance of less than 0.01%.

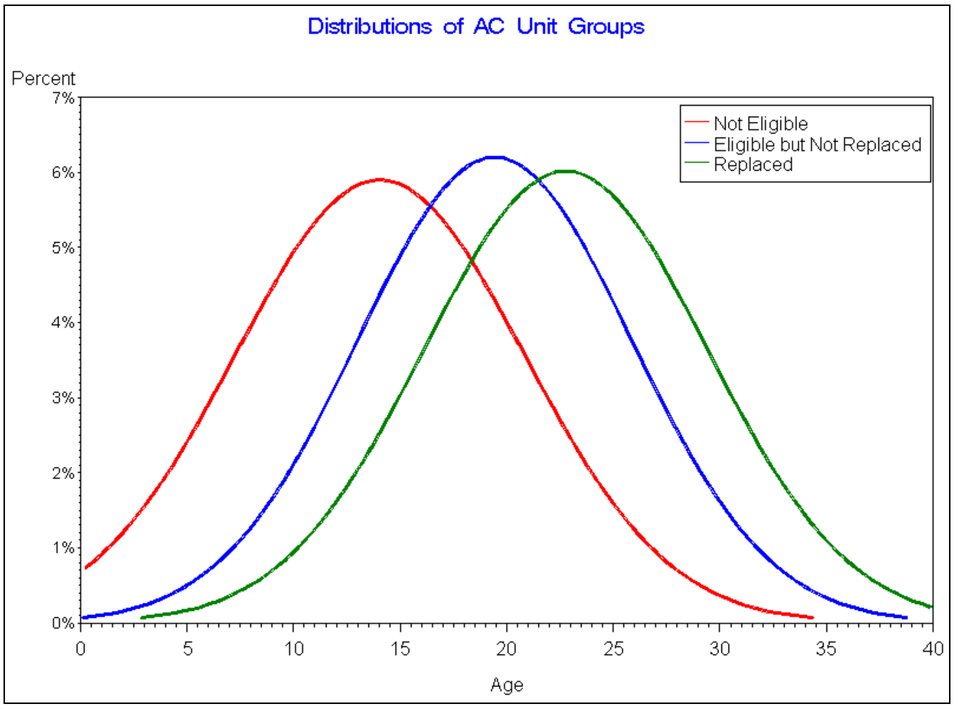
Table 3–2. Statistical Comparison of AC Groups

	T-Test for Means (Pooled)		F-Test for Variances		Chi-Squared Test for Distributions	
	t	p	F	p	Chi-Squared	p
Not Eligible for Replacement vs. Eligible but Not Replaced	8.23	<.0001	1.10	0.4898	70.4	<.0001
Replaced vs. Eligible but Not Replaced	4.65	<.0001	1.06	0.8983	36.6	<.0001
Replaced vs. Not Eligible for Replacement	13.37	<.0001	1.04	0.6963	141.6	<.0001
Replaced vs. Not Replaced	10.71	<.0001	1.15	0.254	112.6	<.0001

Source: Status and age data from contractor databases

The age distribution of three primary, mutually exclusive, groups is shown in Figure 3–1. In this graph, participant’s air conditioning units were grouped into three possible categories. The units were not eligible for replacement if the operating EER was greater than 7.0 or the refrigerant charge could not be adjusted to test the unit. The unit was eligible for replacement with a rated or operating EER of 7.0 or less, and, eligible units were either replaced or not replaced. Figure 3–1 cuts the distribution at zero since there are no units less than zero years old. In all, 32 units were 5 years old or younger so it would be inaccurate to abruptly stop a normal approximation completely at age zero. The normal approximation of the 'not eligible' group had a positive value at zero since there were several AC units with very young ages, including two units with an age of 2 years and four units with an age of 1 year.

Figure 3–1. Age Distribution of AC Groups



Source: Status and age data from contractor databases

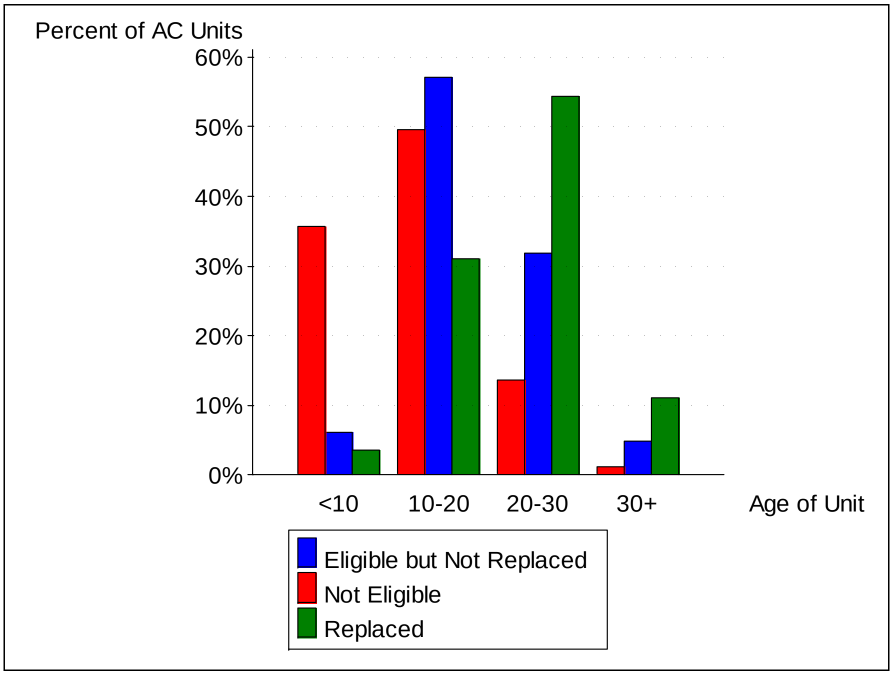
Table 3–3 and Figure 3–2 show the age distributions of the three eligibility groups side by side in 10 year increments. Over 50% of units eligible and not replaced were between 10 and 20 years old, while about 30% of replaced units fell in this age bracket. Conversely, 50% of replaced units were between 20 and 30 years old, while about 30% of units eligible and not replaced fell in this age bracket. About 35% of ineligible units were less than 10 years old and about 50% were between 10 and 20 years old.

Table 3–3. Distributions by Age Group and Eligibility

Age	Eligible - Not Replaced	Not Eligible	Replaced
<10	10	99	6
10-20	93	138	53
20-30	52	38	93
30+	8	3	19

Source: Status and age data from contractor databases

Figure 3–2. Age Distribution Bar Graph



Source: Status and age data from contractor databases

The operating and rated EER of the various replacement groups was also examined, as shown in Table 3–4 as well as in Table 3–5 and Figure 3–3. The operating EER was lower than the rated EER in each group shown in Table 3–4, and shows there was degradation from rated to operating EER in the units eligible for replacement.[22] The category for "unable to repair-not eligible" includes units that were still operational, but that homeowners refused to repair. This occurred in a few cases where the contractor found the operating unit needed refrigerant or airflow repairs, required before the unit could be retested for eligibility. Customers refused to make repairs when, for example, they would need to pay an additional fee.

[22] The contractor makes adjustments for ARI conditions using a proprietary algorithm that we did not assess because the data used were rejected. HVAC contractors recorded rated (nameplate) and operating EER. HVAC contractors recorded operating EER after tune-up adjustments were made. If tune-ups were possible but the homeowner refused them, the operating EER recorded represents a pre-tuned up system.

Table 3–4. Replacement Status, Rated and Operating EER

Replacement Status	EER	N	Mean	Std Dev	Minimum	Maximum
Unable to repair - not eligible*	Rated EER	25	9.1	1.2	7.2	11.3
	Operating EER	25	5.7	0.9	3.3	7.0
Not eligible for replacement	Rated EER	290	9.5	1.08	7.1	13.0
	Operating EER	283	8.3	0.9	7.0	12.1
Eligible, but not replaced	Rated EER	175	8.8	1.09	6.1	11.7
	Operating EER	175	5.9	0.8	3.3	7.0
Replaced	Rated EER	182	8.4	1.2	6.0	10.9
	Operating EER	180	5.7	0.9	2.9	7.3

Source: Status and age data from contractor databases
*Operating unit required repair before final eligibility test; customer refused repairs and unit recorded as ineligible.

We examined the economic useful life (EUL) of the air conditioners by examining the relationships between age, rated EER and operating EER of the air conditioners. Table 3–5 shows the relationship of Rated EER to age of the assessed units. Clearly, the oldest units have the lower EER, where units at 6 EER are over 30 years old, and 7 EER are 19 years old and older. The minimum age for units of 8 EER is 15.

Table 3–5. Rated EER by Age

Rated EER	N Obs	N	Mean Age	Min Age	Max Age	Std Dev
EER Less than or equal to 6.0	2	2	33.50	31	36	3.54
EER Less than or equal to 7.0	33	33	29.36	19	37	3.70
EER Less than or equal to 8.0	155	155	24.90	15	39	5.34
EER Less than or equal to 9.0	357	357	20.64	2	39	6.55
EER Greater than 9.0	315	275	14.30	1	33	7.35

Figure 3–3. Rated EER of Participating Units

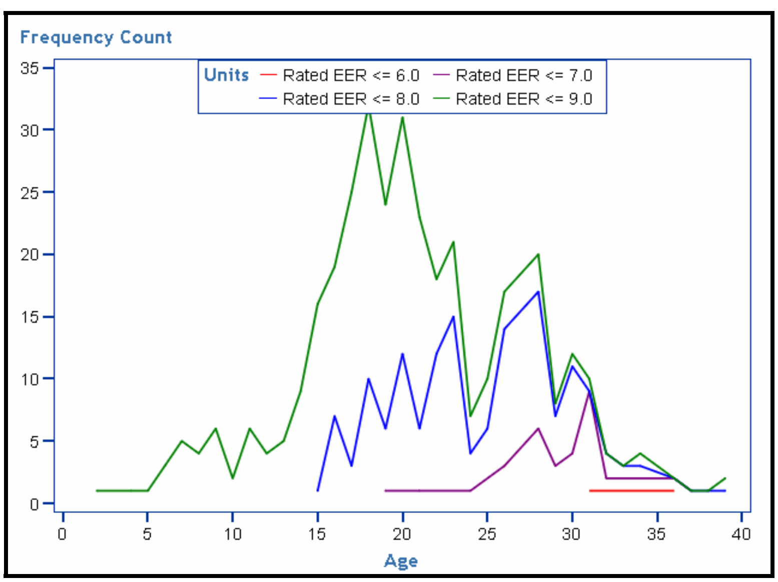
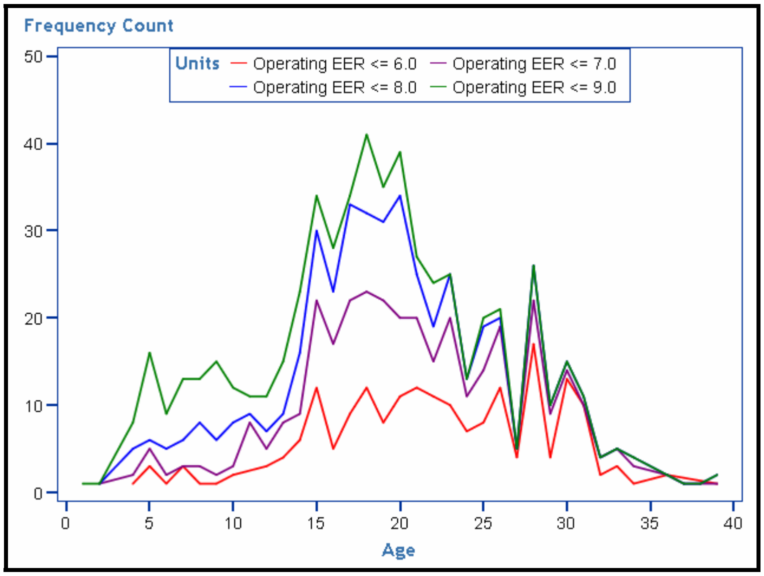


Figure 3–4. Operating EER of Participating Units



The operating EER distributions are quite different from the rated EER distributions. Figure 3–4 shows that the EER distribution spans across all ages of air conditioners. Within each distribution, the largest number of units is between 15 and 27 years old. These distributions by operating EER are quite similar. The younger units with poor operating EER are likely installed with incorrect charge and/or airflow adjustments.

Table 3–6 shows the mean age for each group of units, where units are grouped by operating EER. The mean age drops as the operating EER increases, however the minimum and maximum ages remain quite similar.

Table 3–6. Operating EER by Age

Operating EER	N Obs	N	Mean Age	Min Age	Max Age	Std Dev
EER Less than or equal to 6.0	210	199	21.95	4	39	6.87
EER Less than or equal to 7.0	381	353	20.87	2	39	6.81
EER Less than or equal to 8.0	512	476	19.94	2	39	6.92
EER Less than or equal to 9.0	615	575	18.67	1	39	7.29
EER Greater than 9.0	57	57	9.93	1	25	5.74

The mean age of all units older than 23 years (average age of replaced units) was 28.23 years and the median age was 28 years (Table 3–7). Table 3–8 shows the difference in mean and median ages between the “cutoff age” (for example 23 years) and all units older than that. For example, units replaced in the program had a median age of 23 years. The median age of all older units was 28 years. The difference in median age was 5 years. Likewise, the median age of units older than 18 years was 23 years. The difference in median age between units 18 years old and all units older than 18 years was 5 years. The difference in median age between units 15 years old and all units older than 15 years was 6 years (Tables 3–7 and 3–8).

Table 3–7. Age Groups, Rated and Operating EER

	Variable	N	Mean	Median	Std Dev	Minimum	Maximum
All Units	Age	632	17.88	18.00	7.59	1	39
	Rated EER	672	9.03	8.88	1.21	6	13
	Operating EER	663	6.84	6.74	1.56	2.91	12.12
Older than 15	Age	402	22.41	21.00	5.02	16	39
	Rated EER	402	8.46	8.22	1.08	6	12
	Operating EER	398	6.34	6.32	1.34	2.91	12
Older than 18	Age	292	24.38	23.00	4.50	19	39
	Rated EER	292	8.33	8.10	1.12	6	12
	Operating EER	288	6.13	6.12	1.30	2.91	12
Older than 23	Age	141	28.23	28.00	3.31	24	39
	Rated EER	141	8.13	8.00	1.29	6	12
	Operating EER	139	5.79	5.64	1.26	2.91	12

Table 3–8 also reports the mean operating EER of each of the age groups. For all groups, the mean operating EER is less than 7, which was the minimum EER for replacement within the program.

Table 3–8. Age Differences

	Number of Units with Age Data	Difference in Mean Age of Older Units and Cutoff Age	Difference in Median Age of Older Units and Cutoff Age	Number of Units with Operating EER Data	Mean Operating EER	Difference between Code (EER 11) and Mean Operating EER
Age 0	632	17.88	18.00	663	6.84	4.16
15 years	402	7.41	6.00	398	6.34	4.66
18 years	292	6.38	5.00	298	6.13	4.87
23 years	141	5.23	5.00	139	5.79	5.21

Impact Evaluation Results

The program impacts were estimated separately for its three constituent measures, i.e., air conditioner tune-up and air conditioner replacement, and CFLs. Table 3–9 presents the first year ex-ante gross and net energy savings goals and reported program accomplishments.

Table 3–10 shows the first year ex-ante gross and net demand savings goals and reported program accomplishments. The program net ex-ante net savings goals and reported accomplishments were estimated using a 0.8 NTG ratio. The program reported achieving approximately 60 percent of their original goals kWh goals, and 80 per cent of their KW goals.

Table 3–9. Comparison of Ex-Ante Energy Savings Goals and Reported Accomplishments

	Ex-Ante Program Gross Annual kWh Goals	Ex-Ante Program Net Annual kWh Goals	Reported Ex-Ante Gross Annual kWh Savings Accomplishments	Reported Ex-Ante Net Annual Program kWh Accomplishments
AC Tune-Up	782,020	625,616	430,752	344,602
AC Replacement	961,116	768,893	720,837	576,670
CFLs	424,560	339,648	162,516	130,013
Total	2,167,696	1,734,157	1,314,105	1,051,284

Table 3–10. Comparison of Ex-Ante Demand Savings Goals and Reported Accomplishments

	Ex-Ante Program Gross Annual KW Goals	Ex-Ante Program Net Annual KW Goals	Reported Ex-Ante Gross Annual KW Savings Accomplishments	Reported Ex-Ante Net Annual Program KW Accomplishments
AC Tune-up	464	371	255	204
AC Replacement	570	456	427	342
CFLs	212	170	81	65
Total	1,246	997	763	611

The program impacts are determined by two factors: (1) program performance in terms of accomplishing program participation goals, and (2) estimated ex-post savings impacts for the installed measures compared to the ex-ante measure savings assumptions. The program gross and net realization rates have been calculated as the combined effect of these two factors. The program goals, overall and for its constituent measures, ex-post gross and net energy savings, and respective realization rates are shown in Table 3–11. The program evaluated ex-post gross energy savings are 473,337 kWh compared to the program gross savings goal of 2,167,696 kWh. The program evaluated ex-post net energy savings are 431,390 kWh compared to the program goal of 1,734,157 kWh, yielding 25 percent net energy savings realization rate.

Table 3–11. Comparison of Programs Goals and Ex-Post Gross and Net Energy Savings

	Ex-Ante Program Gross Annual kWh Goals	Ex-Ante Annual Net Energy Savings Goals	Evaluated Gross Ex-Post Program kWh Savings	Gross Energy Realization Rate	Evaluated Net Ex-Post Program kWh Savings	Net Energy Realization Rate
AC Tune-Up	782,020	625,616	172,635	22%	172,635	28%
AC Replacement	961,116	768,893	235,368	24%	193,421*	25%
CFLs	424,560	339,648	65,334**	15%	65,334	19%
Total	2,167,696	1,734,157	473,337	22%	431,390	25%

*The net-to-gross ratio for replacement does not apply to above code savings, which were found in the program. After adjusting evaluated savings by the free rider ratio to 167,787 kWh, savings were adjusted upward by 25,634 kWh to account for the incremental difference between at code and above code savings.[23]
** CFL annual savings were adjusted by the first-year installation rate of 52%, resulting from our survey of participants, as discussed below. Lifetime savings have been increased as the rate of adoption increases after the first year.

The program goals, ex-post gross and net demand savings, and respective realization rates are shown in Table 3–12. The program evaluated ex-post gross demand savings are 196 KW compared to the program goal for demand savings of 1246 KW, yielding 16 percent gross demand savings realization rate. The program evaluated ex-post net demand savings are 176 KW compared to the program net demand savings of 997 KW, yielding an 18 percent net realization rate.

Table 3–12. Comparison of Programs Goals and Ex-Post Gross and Net Demand Savings

	Ex-Ante Program Gross Annual KW Goals	Ex-Ante Annual Net Demand Savings Goals	Evaluated Gross Ex-Post Program KW Savings	Ex-Post Gross Demand Realization Rate	Evaluated Net Ex-Post Program KW Savings	Net Demand Realization Rate
AC Tune-Up	464	371	49	11%	49	13%
AC Replacement	570	456	141	25%	118*	26%
CFLs	212	170	6**	4%	6	5%
Total	1,246	997	196	16%	176	18%

* The net-to-gross ratio for replacement does not apply to above code savings, which were found in the program After adjusting evaluated savings by the free rider ratio to 92 KW, savings were adjusted upward by 26 KW to account for the incremental difference between at code and above code savings.[24]
** CFL annual savings were adjusted by the first-year installation rate of 52%, resulting from our survey of participants, as discussed below. Lifetime savings have been increased as the rate of adoption increases after the first year.

As mentioned earlier, the program reported achieving only 60% of kWh and 80 percent of kW goals. Realization rates compared to ex-ante evaluated results are shown in the Table 3–13 and Table 3–14 below. The program evaluated ex-post gross energy savings are 473,337 kWh

[23] Equation to compute first year kWh net savings for AC replacement: ((235,368-25,634)*(1-.20))+25,634

[24] Equation to compute first year KW net savings for AC replacement: ((141-26)*(1-.20))+26

compared to the program reported ex-ante gross savings goal of 1,314,105kWh, yielding a realization rate of 36 percent. The program evaluated ex-post net energy savings are 431,390kWh compared to the reported ex-ante net of 1,051,284 kWh, yielding 41 percent net energy savings realization rate. The program evaluated ex-post gross demand savings are 196 KW compared to the reported ex-ante gross for demand savings of 763 KW, yielding a 26 percent reported gross demand savings realization rate. The program evaluated ex-post net demand savings are 176 KW compared to the reported ex-ante net demand savings of 611 KW, yielding a 29 percent net realization rate.

The program was credited with above-code savings that would not have occurred in the absence of the program. However, the above code savings did not apply to the free riders, so the adjustment was made *after* the free rider ratio was applied. This does not quite conform to the CPUC reporting guidelines, but the net savings number is an accurate representation of savings. After adjusting evaluated savings by the free rider ratio to 167,787 kWh, savings were adjusted upward by 25,634, kWh to account for the incremental difference between at code and above code savings.[25] After adjusting evaluated savings by the free rider ratio to 92 KW, savings were adjusted upward by 26 KW to account for the incremental difference between at code and above code savings.[26]

Table 3–13. Comparison of Reported Program Accomplishments and Ex-Post Gross and Net Energy Savings

	Ex-Ante Program Gross l kWh Reported	Ex-Ante Net Energy Savings Reported	Evaluated Ex-Post Gross Program kWh Savings	Gross Energy Realization Rate	Evaluated Ex-Post Net Program kWh Savings	Net Energy Realization Rate
AC Tune-Up	430,752	344,602	172,635	40%	172,635	50%
AC Replacement	720,837	576,670	235,368	33%	193,421	34%
CFLs	162,516	130,013	65,334*	40%	65,334	50%
Total	1,314,105	1,051,284	473,337	36%	431,390	41%

*CFL annual savings were adjusted by the first-year installation rate of 52%, resulting from our survey of participants, as discussed below. Lifetime savings have been increased as the rate of adoption increases after the first year.

[25] Equation to compute first year kWh net savings for AC replacement: ((235,368-25,634)*(1-.20))+25,634

[26] Equation to compute first year KW net savings for AC replacement: ((141-26)*(1-.20))+26

Table 3–14. Comparison of Reported Programs Accomplishments and Ex-Post Gross and Net Demand Savings

	Ex-Ante Program Gross KW Reported	Ex-Ante Net KW Savings Reported	Evaluated Ex-Post Gross Program KW Savings	Gross Energy Realization Rate	Evaluated Ex-Post Net Program KW Savings	Net Demand Realization Rate
AC Tune-Up	255	204	49	19%	49	24%
AC Replacement	427	342	141	33%	118	35%
CFLs	81	65	6*	7%	6	9%
Total	763	611	196	26%	176	29%

* CFL annual savings were adjusted by the first-year installation rate of 52%, resulting from our survey of participants, as discussed below. Lifetime savings have been increased as the rate of adoption increases after the first year.

Final Program savings, NTG ratios and realization rates are shown in Table 3–15 and. Table 3–16. The individual components of the program have different net-to-gross ratios. The AC Tune-up component was deemed to have a NTG of 1.0, because the enhanced tune-up involving *CheckMe* is not generally available, and customers did not have knowledge of the difference between a "normal" or enhanced tune-up, nor did they know what kind of tune-up they received as part of their maintenance contracts. For the AC Replacement component, a free rider estimate of 25% was found. Customers were categorized as free riders if they were planning on replacing their AC within the year *and* knew the details of how they were going to pay for the replacement.

However, only four respondents were categorized free riders, out of the 16 in our survey with confirmed replacements (the remaining 44 respondents had a tune-up only). Because the absolute number of free riders was so low, we could not reject ex-ante NTG, and use it in the tables below. No net to gross ratio was calculated for the CFL component, because it was a giveaway, or a "gift", and no customer purchase decision was involved. Note also that the tune-up was a give-away if the customer chose not to replace the AC.

The ex-post gross savings were adjusted to net out free riders. For the program as a whole, the NTG was calculated by dividing the total ex-post net savings by the total ex-post gross savings. The NTG was .91 for kWh and .90 for KW.

Realization rates were calculated as the ratio of the evaluated net ex-post savings to the reported ex-ante gross savings. For the overall program, the realization rate was 33 percent for energy and 23% for demand savings.

Table 3–15. Program Energy Savings

	Ex-Ante Reported Gross kWh Savings	Ex-Post Gross Program kWh Savings	NTG Ratio	Evaluated Ex-post Net kWh Savings	Realization Rate
AC Tune-Up	430,752	172,635	1.00	172,635	40%
AC Replacement	720,837	235,368	0.80	193,421	27%
CFLs	162,516	65,334	na	65,334	40%
Total	1,314,105	473,337	.91	431,390	33%

Table 3–16. Program Demand Savings

	Ex-Ante Reported Gross KW Savings	Ex-Post Gross Program KW Savings	NTG Ratio	Evaluated Ex-post Net KW Savings	Realization Rate
AC Tune-Up	255	49	1.00	49	19%
AC Replacement	427	141	0.80	118	28%
CFLs	81	6**	na	6	7%
Total	763	196	.9	176	23%

Compact Fluorescent Lamps

Compact Fluorescent Lamps were a give-away in this program. The six-pack CFL mailed to all program participants included two ENERGY STAR screw-in bulbs each of 25-, 20- and 15-watts capacity to replace 100-, 75- and 60-watt incandescent bulbs respectively. 2,802 CFLs were given to 463 program participants. There is no free rider adjustment to the savings. Other adjustments are described below and shown in Table 3–17.

The program ex-ante savings were estimated assuming an average wattage reduction of 58 watts per CFL and 2.74 operating hours per day, yielding 58 kWh per year as average energy savings. Ex-ante peak coincident demand reduction (29 watts) was assumed as half of the average watts saved per CFL.

The program impacts were estimated from the DEER savings data shown in Table 3–17.

Table 3–17. DEER Savings Estimates for CFLs

Baseline Incandescent Lamp Wattage	CFL Wattage	Annual Energy Savings (kWh per CFL)	Peak Coincident Demand Savings (watts per CFL)
100	25	57.652	5.468
75	20	42.278	4.010
60	15	34.591	3.281
		44.840 average	4.250 average

Ex-Post Net Program Savings from CFLs

The program ex-post gross energy and peak coincident demand savings per CFL (44.84 kWh and 4.25 watts) were significantly less than respective ex-ante savings estimates (58 kWh and 29 watts). The ex-ante assumptions of 2.74 operating hours and 0.5 diversity factor were higher than those used in the DEER estimates, i.e., 2.1 operating hours per CFL and a modeled coincidence factor of about 7.5 percent.[27]

The program ex-post gross savings for CFLs were not adjusted for free ridership since this was a giveaway program. The ex-post net first year savings were computed by adjusting gross savings by the installation rate reported in the surveys, that is, respondents reported 52% of the CFL were installed.

Table 3–18 compares the program ex-ante and ex-post gross and net energy savings and the gross and net realization rates for CFLs. The gross and net realization rates for energy savings, measured against program goals, is 15% and 19%, respectively. Measured against reported achievements, gross and net realization rates are 40% and 50%. These are lower than respective ex-ante estimates for two reasons: (1) ex-ante and ex-post operating parameters were different, and (2) the program did not meet its goals.

Table 3–18. Ex-Ante and Ex-Post Energy Savings and Realization Rates for CFLs

	Ex-Ante Gross kWh Savings Goals	Ex-Ante Net kWh Savings Goals	Evaluated Gross Ex-Post kWh Savings	Evaluated Net Ex-Post kWh Savings	Gross Realization Rate	Net Realization Rate
Goals	424,560	339,648	65,334	65,334	15%	19%
Reported	162,516	130,013	65,334	65,334	40%	50%

[27] The results from a recent light logger study conducted by KEMA, Inc. (report published in 2005), which are not yet incorporated into the DEER estimates, show a statewide average of 2.23 operating hours for CFLs, 2.1 hours for SCE and 2 hours for San Bernardino County. The report also confirms about 7.5 percent peak demand coincidence factor for CFLs. The differences in operating hours shown in the KEMA report were stated as statistically insignificant among the IOU service territories and statewide averages but its use in estimating future savings is still subject to a review; therefore, current DEER savings estimates were used to estimate the program ex-post gross impacts.

Table 3–19 compares ex-ante and ex-post peak coincident demand savings and the gross and net realization rates for CFLs.

Table 3–19. Ex-Ante and Ex-Post Demand Savings and Realization Rates for CFLs

	Ex-Ante Gross KW Savings Goals	Ex-Ante Net Annual KW Savings Goals	Evaluated Ex-Post Gross KW Savings	Evaluated Ex-Post Net KW Savings	Gross realization rate	Net Realization Rate
Goals	212	170	6	6	3%	4%
Reported	81	65	6	6	7%	9%

The program evaluated ex-post gross and net peak coincident demand savings from CFLs are 12KW and 6 KW and the respective realization rates are 3 percent and 4 percent of program goals, and 7% and 9% of reported achievements.

Lifecycle Net Savings from CFLs

The ex-ante EUL for CFLs was assumed as eight years; however, the DEER database uses 9.4 years as EUL for screw-in CFLs. The DEER recommended EUL was appropriate to use since the CFLs provided to customers met the ENERGY STAR specifications and had rated life of 10,000 hours. In estimating the program ex-post net lifecycle savings over 9.4 years, final savings adjustments were made for an estimated percentage of CFLs customers who will install their currently uninstalled but in-stock CFLs over the next three years. A maximum CFL installation and persistence factor of 79 percent was adopted from a light logger study conducted by KEMA, Inc. in 2005 in which the installation and persistence rate of CFLs rebated in 2001 was verified in 2004.[28] The maximum net annual savings were estimated by reducing the ex-post gross annual savings by the maximum installation and retention fractions.

The first year CFL savings in this program were increased using an annual adoption rate. This adoption rate is the difference between the maximum adoption rate of 79 percent and the first year installation rate of 52%. That is, first year savings increased by 27%, with the increase spread over the next three years. Thereafter, the ex-post net savings recur until the end of EUL, based on the year of installation. Year 10 includes incremental savings of the additional CFL installed in years 2 through 4, year 11 includes savings from installations in years 3 through 4 and Year 12 includes incremental savings from installations in year 5. Year 13 captures the 0.4 year life of the lamps installed in year 4. Table 3–20 shows the program ex-post net lifecycle energy savings from CFLs. Total lifecycle savings attributable to the CFL giveaway in this program are 1,013,685 kWh.

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[28] The 79% adoption rate is the best available data on persistence loss, although in the referenced program the bulbs were purchased. There may or may not be a difference in adoption rate of lamps that were purchased vs. lamps that are free.

Table 3–20. Program Ex-Post Lifecycle Net Energy and Demand Savings for CFLs

Ex-Post EUL	Ex-Post Lifecycle Net Energy Savings
9.4	1,013,685

Air Conditioner Tune Up

The program offered to tune-up air conditioners that did not qualify for a replacement. The tune-up was an enhanced service in which refrigeration charge and air flow would be adjusted. The program ex-ante savings were estimated from the 2001 DEER update data in which the measure peak coincident demand saving of 0.38 kW per air conditioner was estimated. The non-coincident demand reduction of 0.543 kW was calculated using an estimated diversity factor of 0.7, which yielded 641 kWh per air conditioner in energy savings using 1,180 run hours per year.

The program ex-post gross savings were estimated from the 2004-2005 DEER update study that provides savings estimates depending on the vintage of the building and percentage of refrigeration charge added or removed. The program scope excluded performing repairs of duct work; therefore, the DEER savings estimates for duct repair were not used. Table 3–21 shows the DEER savings estimates for the refrigeration charge adjustment measure. The weighted average savings are calculated using the proportion of air conditioners in each age group of the tested population of 672 air conditioners, and have been used to estimate savings for air conditioners for which the manufacturing date was not available from the data set.[29]

Table 3–21. DEER Savings Estimates for Refrigeration Charge Adjustments

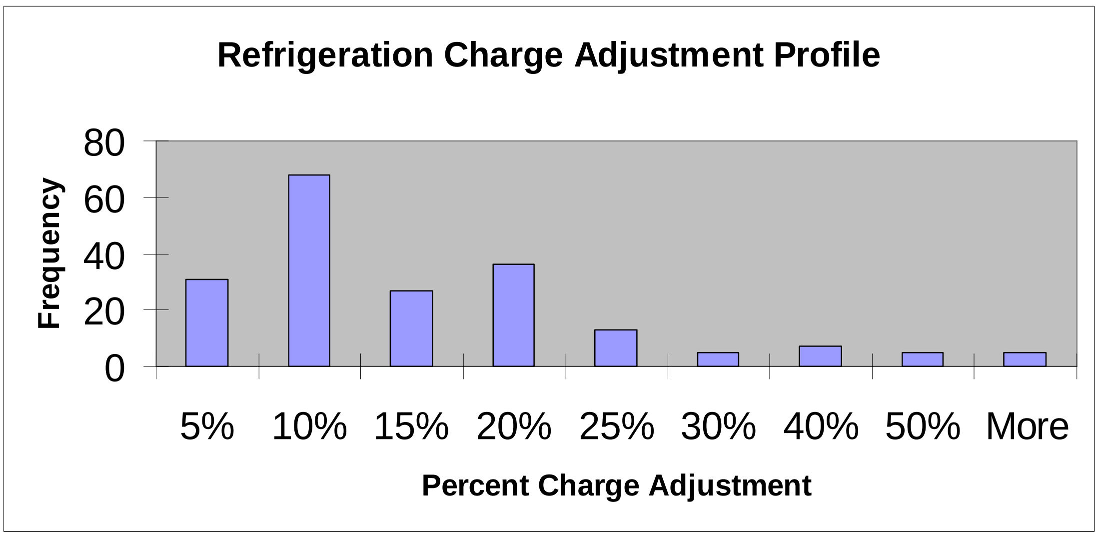
	± 20 Percent or Less Charge Adjustment			± More than 20 Percent Charge Adjustment		
Unit Vintage	Units in Category	kWh per Ton	Peak Watts per Ton	Units in Category	kWh per Ton	Peak Watts per Ton
Built Before 78	6	211.009	99.938	1	458.438	205.727
1978-1992	81	202.615	37.25	21	440.515	119.812
1993-2001	32	177.634	77.6	8	385.721	162.904
2002-2005	3	171.613	75.709	2	372.562	161.189
Weighted Average		195.713	51.862		423.130	135.856

The refrigeration charge was adjusted in 197 out of 672 air conditioners tested, i.e., either a refrigeration charge removal or addition was required in 29 percent of the tested air conditioners. The program has been credited with savings only from air conditioners where refrigeration charge was adjusted.

[29] Manufacturing date of an air conditioner available from the name plate data is assumed to be the building age for the purpose of assigning appropriate DEER savings.

The average age of tuned up air conditioners was 18 years and average cooling capacity was 3.75 tons. The program data provided stamped charge capacity for 160 out of 197 air conditioners where the refrigerant charge was adjusted. For the remaining 37 air conditioners, which included 12 units where refrigeration charge was removed and 25 units where refrigeration charge was added, an average charge adjustment value was used for the appropriate charge adjustment category. Thus, a 7.12 percentage charge removal was used for air conditioners where refrigeration charge was removed but the stamped charge capacity was not available, and a 17.54 percentage charge addition was used for air conditioners where refrigeration charge was added but the stamped charge capacity was not available. The program average refrigeration charge adjustment was 14.26 percent. Figure 3–5 profiles the distribution of refrigeration charge adjustments made in the program.

Figure 3–5. Profile of Refrigeration Charge Adjustment



Tables 3–22 and 3–23 show the program ex-ante and ex-post gross energy and coincident peak demand savings for the tune-up service. The program evaluated ex-post gross energy and peak coincident demand savings are 172,635 kWh and 49 KW, and respective gross realization rates measured against reported achievements are 40 percent and 19 percent. The program realized 22% of energy savings goals and 11% of demand savings goals. Although the average ex-post gross energy saving per tune-up (876 kWh) is more than the ex-ante assumption of 641 kWh, the overall realization rate is lower. The program is credited with savings from the number of units treated whereas the ex-ante estimates assumed that savings would apply to all tested air conditioners, regardless of the need for a charge adjustment.[30] The program did not meet its goals, which was another reason for low gross realization rate. The program ex-ante assumption on the average capacity of a serviced air conditioner was 3.5 tons, which was slightly less than the average capacity of 3.75 tons found in the program database. The program evaluated ex-post

[30] The ex-post average gross savings per tune-up are more than the ex-ante estimate because very old air conditioners were tuned up for which the DEER savings estimates are significantly higher than those for newer air conditioners. Additionally, 34 air conditioners required a charge adjustment of more than 20 percent which also increases available savings.

gross energy saving was 234 kWh per ton, which was significantly higher than the ex-ante savings assumption of 183 kWh per ton.

The program savings estimates could have included an additional adjustment, i.e., air conditioners that required less than five percent charge adjustment would not be credited with program savings. The DEER savings estimates for refrigeration charge adjustment measure were prepared for two broad ranges (above and below 20 percent adjustment). Data were insufficient and not definitive to apply the same savings estimates at the low end of charge adjustment.[31,32] The program data showed 31 out of 197 air conditioners required a charge adjustment of less than five percent (12 with charge addition and 19 with charge removal). A small amount of charge adjustment will not realize the same amount of savings as a 15 percent charge adjustment provides. It is more likely though that a low charge adjustment might not reduce a noticeable amount of energy usage. At this time, data are not available that show a linear relationship between the magnitude of charge adjustment and the resulting savings from which savings can be extrapolated for each percent change in refrigeration charge. Eliminating tune-up projects with small charge adjustments would provide more conservative estimates of program impacts. However, an offsetting factor was that 22 air conditioners required a charge adjustment of more than 25 percent that could provide more savings than those indicated in the DEER database. For these reasons, no adjustments were made to the program savings calculated using the DEER estimates.

The program evaluated ex-post gross demand savings calculated using the data from the DEER database do not (at this time) differentiate the direction of change in demand savings for charge addition and charge removal. While a refrigeration charge adjustment results in an improved EER and saves energy, the peak demand can increase by repairing undercharged units because longer run hours draw less power before repair but shorter run hours and more power draw after repairs.[33] Demand decreases by repairing overcharged air conditioners because fewer run hours draw more power before repairs and longer run hours and less power draw after repairs. This is a limitation of the DEER estimates for the refrigeration charge adjustment measure. The program savings impacts were not adjusted for this reason because data are not currently available to make such adjustments. The realized demand savings are likely to be less than those shown in the program ex-post gross and net impacts.

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[31] Personal communication with Jeff Hirsch of James J. Hirsch and Associates on October 20, 2006.

[32] We are not aware of other sources of data that would provide a basis for correcting or replacing DEER estimates for repairing undercharged or overcharged units for low charge adjustments. We believe that the last DEER update had examined all data available then and included data that were appropriate to use. If additional data have been collected since then, it should be submitted to the DEER update team for integration into the DEER update study currently under way, led by Itron.

[33] We believe that a repaired undercharged air conditioner is more likely to run longer than 15 minutes, thereby, registering peak demand. In our opinion, it is highly unlikely that a repaired unit will cycle for less than 15 minutes and not register peak demand. We have recommended a study to assess the peak demand impact of repairing incorrectly charged air conditioners.

The Program Ex-Post Net savings for Tune-Ups

The NTG of 1 for the tune-up measure was used since the measure was offered as a complimentary service to identify inefficient air conditioners for replacement. Table 3–22 compares program energy savings goals with ex-ante and ex-post gross and net annual energy savings and presents the gross and net energy savings realization rates for the tune-up measure. Table 3–23 compares the program demand savings goals with ex-ante and ex-post gross and net annual demand savings and presents the gross and net demand savings realization rates for the tune-up measure.

The program evaluated ex-post net energy and peak coincident demand savings from tune-ups are 172,365 kWh and 49 KW and the respective realization rates are 50 percent and 24 percent of reported achievements. The respective realization rates of program goals are 28% and 13% for kWh and KW respectively.

Table 3–22. Ex-Ante and Ex-Post Energy Savings and Realization Rates from Tune-ups

	Ex-Ante Gross Annual kWh Savings Goals	Ex-Ante Net Annual kWh Savings Goals	Evaluated Gross Ex-Post First Year kWh Savings	Evaluated Net Ex-Post First Year kWh Savings	Gross Realization Rate	Net Realization Rate
Goals	782,020	625,616	172,635	172,635	22%	28%
Reported	430,752	344,602	172,635	172,635	40%	50%

Table 3–23. Ex-Ante and Ex-Post Demand Savings and Realization Rates from Tune-ups

	Ex-Ante Gross Annual KW Savings Goals	Ex-Ante Net Annual KW Savings Goals	Evaluated Gross Ex-Post First Year KW Savings	Evaluated Net Ex-Post First Year KW Savings	Gross Realization Rate	Net Realization Rate
Goals	464	371	49	49	11%	13%
Reported	255	204	49	49	19%	24%

Some program contractors had a relationship with customers to provide an annual tune-up service. While these customers could not be free riders for an enhanced tune-up service, the program savings should only be the incremental difference between savings from a standard tune-up and the program tune-up service because the program contractors performed the basic and enhanced tune-up at the same time for contracted customers of annual tune-up. The program savings were not reduced for this reason because data are not currently available on the scope of a basic tune-up service and resulting savings. Additional research is required to establish savings from a basic tune-up service.

Lifecycle Ex-post Net Savings

The program ex-ante assumption of EUL for the refrigeration charge measure (eight years) was less than the DEER EUL estimate (ten years). Two issues were considered in estimating the program ex-post net lifecycle savings. First, the average age of tuned up air conditioners was 18 years; second, the EUL of an air conditioner is estimated at 18 years.[34] If full lifecycle savings were credited to the program over a ten-year measure life, it would imply that most air conditioners that were already past their EUL would not have been replaced over that time. While a significant proportion of air conditioners last longer than its estimated EUL, it would be unrealistic to assume that a large proportion of air conditioners would not be replaced sooner than ten years after the tune up. The CPUC evaluation protocol or the policy manual does not provide policy guidance to assess the program impact where equipment past its EUL is serviced or replaced. The ex-ante assumption of 8 years was therefore not changed. Life cycle savings are shown in Table 3–24 below.

Table 3–24. Program Ex-Post Net Lifecycle Savings from Tune-Ups

Ex-Post RUL	Ex-Post Lifecycle Net Energy Savings All Units
8	1,381,079

Air Conditioner Replacement

The primary emphasis of this program was to identify inefficient air conditioners and induce an early retirement of these air conditioners and replacement with new more efficient air conditioners with a minimum 13 SEER. The program provided incentives for the replacement of air conditioners with estimated operating EER of 7 or less. The program ex-ante savings were estimated assuming an average operating EER of 6.03 and an average cooling capacity of 3.6 tons for the replaced units. The power drawn by an old and new air conditioner was calculated as 7.164 and 3.826 KW, i.e., average demand savings of 3.338 KW per air conditioner. The ex-ante energy savings per air conditioner were estimated as 3,939 kWh, assuming 1,180 full load cooling hours. The ex-ante peak coincident demand saving per air conditioner was calculated as 2.336 kW, applying a 0.7 diversity factor to average demand saving of 3.338 kW.

The program ex-post gross energy and demand savings were estimated from the DEER savings data appropriate for the age of the replaced air conditioners. The DEER base case energy usage and peak coincident demand were adjusted for the nameplate EER rating of the replaced air conditioner. The retrofit energy and demand savings were calculated as the difference between the adjusted DEER baseline and the new baseline, also adjusted for the nameplate SEER of the new air conditioner.

The DEER database baseline assumes that an air conditioner is in good state of repair. Energy savings from replacing such air conditioners are calculated as the difference between the repaired state baseline and the EER of a new air conditioner. The implementation contractor demonstrated the condition of replaced air conditioners by repairing 22 of 183 replaced air conditioners. These air conditioners were already included in the tune-up database; therefore, savings that would result from improving their performance from the deteriorated state to a repaired state are already

[34] Measure Life Update dated July 14, 2005 by SERA Inc.

accounted as part of tune-up measure savings. The implementation contractor did not demonstrate that repairs were necessary for the remaining 163 replaced air conditioners, which were assumed to be operating in good condition. Thus, the baseline usage for all 183 replaced air conditioners was assumed to be corresponding to the repaired state condition of the DEER database, and savings were calculated using the DEER estimates after making adjustments only for the nameplate EER.

The program progress reports showed savings in addition to those estimated based on the difference in the baseline and new equipment usage. The rationale for these additional savings, equivalent to the tune-up of a new air conditioner, was that a certain percentage of new installations are imperfectly installed in the market place so the program should be credited for installing air conditioners correctly.[35] These deemed ex-ante savings were later removed from the program accomplishments and final data files. The evaluation team believes that IOU programs are expected to provide code compliant correctly installed measures; therefore, additional savings should not apply to account for imperfect market practices. The intent and effort in this program was to identify energy hogs and retire them early by installing new air conditioners, not identify improperly installed new air conditioners and retro-commission them.

The implementation contractor measured the refrigeration charge of new air conditioners using the *CheckMe™* tests; however, power or amperage measurements were not made as done for the existing systems. As a result, the contractor's savings basis for the baseline and new equipment was different. Further, duct repairs (if required) do not appear to have been performed. A codes and standards consideration in this program related to repairing ducts while replacing air conditioners. The program staff indicated that duct repair was excluded from the contract with the implementation contractor. According to the provisions of updated Title 24 that became effective in October, 2005 when the program implementation had just started, duct repair would have been mandatory, if it was not excluded from the Edison contract signed before the new Title 24 became effective. The implementation contractor stated that they had assumed that their subcontractors comply with the mandatory codes and standards. The program data indicate that contractors appeared to offer customers to repair ducts for an extra price. The program staff indicated that Edison requires contractors to follow the codes and standards but it is not acting as "code police." The program data showed only a few notes from subcontractors indicating customers' refusal to sign up for the optional duct repair, and no evidence was found in the program data on duct repairs performed.[36]

While the utility may not act as "code police," the evaluation team believes that additional savings from repairing damaged ducts would be lost as customers are unlikely to get ducts repaired after an air conditioner has been replaced. Without checking and repairing damaged ducts, a new air conditioner cannot be optimized for proper airflow and it is likely to operate at less than its rated efficiency specifications. One way to ensure that contractors follow the applicable code is to tie their performance evaluation to key indicators that should include the

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[35] The CheckMe test was performed on new units but airflow or power measurements were not taken. Duct tests were not performed and duct repairs were optional.

[36] We did not check with the local building department to determine whether any permits were pulled for duct repairs on the 900+ participating units.

number of installations for which a contractor provides the repair permit number issued by local authorities.

The program data for new air conditioners provided the model numbers for condenser, furnace and evaporator coils for most but not all project records. A representative review of the model numbers found matching pairs of condenser and evaporator coils, where data were available. The implementation contractor did not measure the amperage/power after installing new air conditioners or measure airflow. These issues emphasize the need to develop standard quality installation protocols for new air conditioners. These protocols should include post-installation refrigeration charge and power measurement and airflow adjustment. A starting point for the development of quality installation procedure could be the new HVAC installation guidelines prepared by the Consortium for Energy Efficiency (CEE).

The program ex-ante savings were based on the program implementer's estimated operating EER The program field data showed an average contractor estimated EER of 5.75 for the replaced air conditioners. These estimates were not used in estimating program savings because of concerns about the amperage measurement data and lack of airflow measurements. Further, the contractor estimated operating EER using a proprietary method that has not been validated with publicly available field measurements.[37] The engineering and billing analysis methods showed similar average kWh saving impact per air conditioner replacement, which is significantly less than that which would result from using the contractor estimated operating EER as the baseline. This confirmed that the contractor estimated operating EER was less than the actual operating EER or the EER of newly installed AC was also less than its rated efficiency because some elements of quality installation process were not followed, or, the combination of the two reasons.

The program used the contractor estimated operating EER of 7 to screen and qualify air conditioners for replacement. If field estimated operating EER is likely to be used in the future as the sole qualifying criterion, a method should be developed to estimate and validate the operating EER.

The program ex-post gross energy and peak coincident demand savings are 235,368 kWh and 141 KW, both realizing about 33 percent of gross reported achievements. The program realized 24% of kWh and 25% of KW gross savings goals respectively (Table 3–25 and 3–26).

Table 3–25. Ex-Ante and Ex-Post Energy Savings for AC Replacement

	Ex-Ante Gross Annual kWh Savings Goals	Ex-Ante Net Annual kWh Savings Goals	Evaluated Gross Ex-Post First Year kWh Savings	Evaluated Net Ex-Post First Year kWh Savings	Gross Realization Rate	Net Realization Rate
Goals	961,116	768,893	235,368	193,421*	24%	25%
Reported	720,837	576,670	235,368	193,421*	33%	34%

[37] The implementation contractor offered to explain the proprietary algorithm used to estimate the operating EER under a confidentiality agreement. This option was not exercised because of concerns over measurement methods and data issues would still remain unresolved.

* After adjusting evaluated savings by the free rider ratio to 167,787 kWh, savings were adjusted upward by 25,634, kWh to account for the incremental difference between at code and above code savings. The discussion follows.

Table 3–26. Ex-Ante and Ex-Post Demand Savings for AC Replacement

	Ex-Ante Gross Annual KW Savings Goals	Ex-Ante Net Annual KW Savings Goals	Evaluated Gross Ex-Post First Year KW Savings	Evaluated Net Ex-Post First Year KW Savings	Gross Realization Rate	Net Realization Rate
Goals	570	456	141	118*	25%	26%
Reported	427	342	141	118*	33%	35%

* After adjusting evaluated savings by the free rider ratio to 92 KW, savings were adjusted upward by 26 KW to account for the incremental difference between at code and above code savings. The discussion follows, below.

The low gross realization rates are for the following three reasons.

1. The program did not meet its participation goals.

2. The program ex-ante savings estimate assumed an average operating EER of the replaced air conditioners as 6.03 and the program average operating EER was 5.75.

   As explained before, the baseline operating EER could be significantly higher than the program estimated operating EER. The average age of replaced air conditioners was 22 years (range 4 to 39 years) but their performance was not demonstrated as sufficiently degraded; otherwise, the program impacts would have been higher than the evaluation estimates. Conventional wisdom is that older air conditioners are less efficient; therefore, they should be retired early with more efficient air conditioners. The program savings impacts do not support this theory.

   Table 3–27 shows the age profile of replaced air conditioners and Figure 3–6 profiles the rated EERs of replaced air conditioners. Our analysis shows poor correlation between the operating EER and unit age (R2=0.277[38]). An accurate operating EER was not calculable within this program. Neither age or operating EER alone appear to be reliable nor conclusive criterion to use as a basis for air conditioner replacement. Additional research is needed to select the most appropriate criteria to use to select air conditioners for early replacement. The age distribution of the air conditioners shows the economic useful life is about 30% longer than assumed. In addition, the actual operating EER appears to higher than reported. The billing analysis showed tune-ups achieved nearly two-thirds of the savings of replacements, where replacement savings averaged 355 kWh/ton and tune-up savings averaged 234 kWh/ton.

   We suggest a policy review of the early retirement concept and recommend continued monitoring of the savings from tune-ups. As an alternative to early retirement of air conditioners, future program designs should evaluate the relative cost-effectiveness of

[38] Adjusted R square derived from regression model with 623 observations.

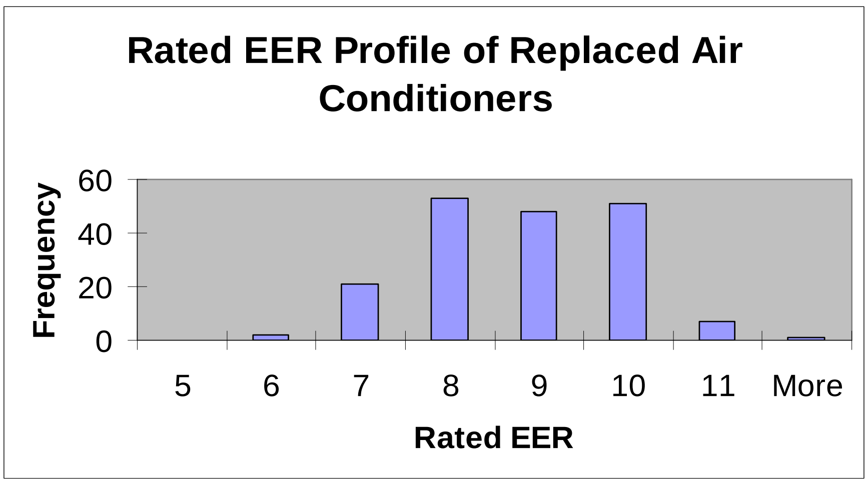
replacing the compressor or fan coil instead of the whole air conditioning unit, and offering a more refined tune-up service that include coil cleaning. .

3. Because the rated EER of replaced air conditioners was significantly higher than the ex-ante assumption on the operating EER, the demand savings were less than expected. The average ex-post gross peak coincident demand saving per air conditioner is 0.8 KW compared to the ex-ante assumption of 2.336 KW. The average ex-post gross energy saving is 1,286 kWh compared to the ex-ante assumption of 3,939 kWh per replaced air conditioner.

Table 3–27. Age Profile of Replaced Air Conditioners

	Manufactured Before 1978	1978–1992	1993–2001	2002–2005
Number of ACs	33	135	13	2

Figure 3–6. Profile of Rated EER of Replaced Air Conditioners



The program was implemented in 2005 when the new efficiency standard for air conditioners and updated Title 24 standards became effective. There was an exemption, however, in the implementation of new efficiency standard (SEER 13) that permitted the installation of air conditioners already manufactured before January 23, 2006. Although the air conditioners replaced in the program met or exceeded the new efficiency standard, new air conditioners were not required to have SEER 13 during the program implementation period. Therefore, full savings calculated as the difference between the baseline usage of replaced air conditioners and new baseline based on the SEER of installed air conditioners, were credited to the program. If the new efficiency standard was mandatory during the implementation period, the program savings for units replaced on failure would have been estimated as the incremental difference between the minimum required SEER and the SEER of the installed air conditioners, i.e., above code savings only. Since this program focused on early replacement, the full EER difference, not just the above code difference, applied.

In this program the tune-up and air conditioner replacement services were combined which raises a program delivery process issue that also influences the impact assessment, i.e., whether to repair qualified air conditioners regardless of a customer's decision to agree for a replacement. The decision to repair or not repair air conditioners that might be replaced later is affected by the time taken by a customer to decide on program participation. If a qualified customer decides to replace an air conditioner immediately upon learning about eligibility, it may be not necessary to repair that air conditioner. For all qualified and non-qualified air conditioners that were repaired, the program has been credited with appropriate savings. A total of 22 units were repaired and ultimately replaced; thus, burdening the program with the expense of initial repairs that possibly could have been avoided. Future programs should review and redesign the marketing and delivery process to avoid the expense of repairing air conditioners that might be replaced in the program.

This program found fewer air conditioners (29 percent) that required repairs compared to recent market assessments, which have reported that 40 to 70 percent of air conditioners are commonly found with an improper refrigerant charge. It is common in energy efficiency programs to find that only a certain percentage of contacted customers would qualify and ultimately participate in the program. The program design and the program costs should build this assumption into the program marketing cost but program savings should be based only on the number of retrofits or tune-ups performed, as done for this program. For these reasons, the program was not credited with savings from all tested air conditioners that were not repaired.

Ex-Post Net Program Savings

The program free ridership, estimated from the survey of participating customers, was 25% percent for air conditioner replacement. The program ex-post gross savings were adjusted for air conditioner replacement free ridership by 20%. Since the survey sample was small, we cannot reject the null hypothesis that .80 is the correct NTG adjustment.

It is assumed that free riders would have replaced air conditioners with minimum code requirement.[39] The program installed 104 air conditioners that exceeded the code requirement. The NTG is applied only to the savings estimated as the difference between the baseline and at code replacement for all air conditioners. For air conditioners that exceeded the code minimum SEER rating, free ridership adjustment was not made to the incremental savings (25,634 kWh) between at code and above code specifications.

The program ex-post net energy and peak coincident demand savings are 193,421 kWh and 118 KW, where 34% percent of reported net kWh achievements and 35% of reported net KW achievements were realized.

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[39] The four free riders confirmed they were replacing their AC without the program, but did not indicate they were planning to replace the AC with above-code units.

Lifecycle Ex-post Net Savings

The economic useful life (EUL) of an air conditioner is 18 years; however, the average age of replaced air conditioners was approximately 22 years. While equipment often lasts beyond its EUL, the replaced air conditioners were past their EUL and had no theoretical remaining life.[40] In a strict sense, replacing such air conditioners does not constitute early retirement for a program that expected to retire air conditioners that had an average remaining life of eight years. Since the existing air conditioners could have failed at anytime and would have to be replaced with code-compliant air conditioners, estimating measure savings was challenging. The California Evaluation Protocols and the current Energy Policy Manual do not provide policy guidance for estimating savings in this situation. The 2001 CPUC Energy Efficiency Policy Manual (page 20) specified limiting the EUL to 20 years, even when a measure was expected to last longer. This policy direction has since been removed from the current version of the Policy Manual. A more fundamental question for policymakers is to address whether to encourage replacement of equipment already past its EUL and recommend a method of estimating lifecycle energy and demand savings. A review of data from HVAC dealers and distributors on the age of replaced air conditioners might indicate the average replacement age and would establish an upper bound on the measure life for the purpose of crediting savings from early retirement and/or HVAC tune-up programs.

For this evaluation, it is assumed that old air conditioners would have been replaced anyway with code compliant air conditioners after seven years.[41] The program lifecycle savings were credited for the first seven years with no additional savings accruing thereafter for the code-compliant air conditioners installed in the program. For the installed air conditioners that exceeded the code requirement, lifecycle savings from year eight through eighteen (measure EUL) were credited as the difference between at code and above code specification. Lifetime savings for AC replacement are shown in Table 3–28.

The program installed 79 air conditioners that exactly met the code requirement and 104 air conditioners that exceeded the code requirement which raises the question of possible double counting of savings between this program and the Codes and Standards program. If future IOU programs continue to encourage installation of code compliant equipment, method(s) should be developed to eliminate double counting of savings between the programs. This may also require coordination and data exchange among programs.

Table 3–28. Lifecycle Ex-Post Net Energy Savings for AC Replacement

Ex-Post RUL	Ex-Post Lifecycle Net Energy Savings
7	1,635,920

[40] The EUL of any equipment is estimated as the unit of time when 50 percent of equipment is expected to fail.

[41] Athens Research, John Peterson, conducted survival analysis to estimate RUL for central air conditioners. Informal memo sent to Shahana Samiullah, Edison, and Ben Bronfman, Quantec, 1/20/07.

Billing Analysis

In addition to the engineering analysis, a billing analysis was conducted using the participant's consumption data. The engineering analysis computed savings for each unit individually, based on its age and test data. The billing analysis computes savings at the household level. Because some homes had more than one air conditioning unit, and combinations of tune-up or replacement, households were placed into groups according to the service received and number of AC units. The effects of the CFL could not removed through the billing analysis. Therefore, the engineering analysis was used to calculate savings for the program. The billing analysis does support and confirm the engineering analysis results.[42] Methodology and results are presented below.

To conduct the billing analysis, Quantec first requested monthly energy consumption data from Edison for all 474 Energy Hog program participant households dating back to June 2003 was obtained. However, based on the site and participant information available, Edison was unable to confidently match all 474 participants. Matching the Edison billing data with measure installation data created by Conservation Services Group (CSG) was further complicated by the fact that more than a quarter of the listed participants did not have a valid account number. As a result, a phased matching approach was utilized. After matching those participants with valid account numbers, the majority of the remaining participants were successfully matched using the participant's name and address. After removing additional sites flagged by Edison as questionable matches based on the site and participant data available, both billing and measure data was available on 451 of the 474 (95.1%) for the billing analysis.

To further ensure quality results, several additional filters were applied to the raw billing data before conducting the analysis. First, after matching each participant's pre- and post-installation periods (i.e., limiting the analysis to only the same months of the year in the pre- and post-periods), all participants without a minimum of six matched pre- or post-installation monthly meter reading were dropped from the analysis. While an entire year of data is preferred in order to understand the full range of annual use, sufficient time had not passed since the average installation to impose such a stringent filter. Data through August 2006 was available and used in the analysis, so that the bulk of the cooling season was captured.

Second, while program installed lighting and air conditioning measures were obviously intended to reduce overall energy consumption it is also possible that other household changes between the pre- and post-period, such as household size, substantial remodeling, and the addition or removal of energy-intensive appliances, could impact energy consumption.[43] To help prevent such changes from disguising the true impact of the program, a ratio of change between the pre-

[42] DEER savings assume proper installation of a new air conditioner to ensure rated efficiency. We did not penalize the program impact by reducing DEER estimates although we know that the program did not follow QI install procedure. We have noted that estimated savings are not conservative for this reason. The results of billing analysis and engineering analysis are close so we do not see an issue with the use of DEER cooling hour estimates.

[43] The issues were not specifically probed in the interview.

and post-periods was calculated for each participant by dividing the observed average daily post-installation energy consumption by the average daily pre-installation energy consumption.

The resulting ratio indicated the magnitude of the difference in consumption between periods. For example, a ratio of 1.10 indicates a household consumed 10% more energy in the post-period than in the pre-period, while a ratio of 0.90 would indicate the opposite. While the ratio looked only at raw change (no weather-normalization), it provided a reasonable metric for identifying and subsequently removing participants exhibiting “extreme” changes in their consumption unlikely to be related to the program. For the purposes of this analysis, “extreme” change was defined as those participants in the top and bottom 5% of the ratio’s distribution. Although observed differences in daily consumption were as high as 5.05 and as low as 0.16, the values at the 5% and 95% threshold were 0.71 and 1.33, respectively.

Third, all participant billing data that could not be confidently matched to program contractor data was removed from the analysis. Without contractor data to supplement the billing records, it was not possible to know how many units were located at the participating site or the capacity of the treated (either replaced or tuned) units.

Fourth, to improve clarity and accuracy, the analysis was limited to only participants who had all units located on their property either tuned-up or replaced. Since it is difficult to identify and differentiate the impact of a single tune-up or replacement at locations with multiple treated and untreated units, limiting the analysis improves the validity of the results. In addition, since the majority of participants only have one unit on site, the filters improve accuracy with minimal impact on data attrition.

The data attrition associated with inabilities to match program records including measure data and test data with SCE billing data, as well as the four filters discussed above, is presented in Table 3–29.

Table 3–29. Energy Hog Billing Analysis Data Attrition

Metric	Number of Unique Participants Removed	Percentage of Total Unique Participants Removed	Number of Unique Participants	Percentage of Total Unique Participants
Total Program Participants	- - -	- - -	474	100.0%
Unable to Accurately Match Billing and Measure Data	23	4.9%	451	95.1%
Less than Six Matching Months in Pre- and Post-Period	34	7.2%	417	88.0%
Extreme Pre-Post Consumption Changes	41	8.6%	376	79.3%
Unable to Accurately Match Contractor Data	75	15.8%	301	63.5%
Not all Units on Premise Treated	31	6.5%	270	57.0%
Final Sample	*204*	*43.0%*	*270*	*57.0%*

In addition to collecting and assessing participant billing data, weather data for the participating region was also gathered. The weather data utilized in this analysis was also provided by SCE. While Energy Hog participants lived in 10 unique different ZIP codes, according to SCE records, all of the participating ZIP codes can be normalized using a single weather station (SCE Weather Station #181).

Since the combination of measures, as well as the number of each measure, installed at participating sites varied dramatically, the participants were distributed into groups based on the measure received and analyzed separately. Since all participants received CFLs, the participants were differentiated based on the air conditioning measure(s) received.

It is important to note that while program implementers considered all assessed air conditioning units as tune-ups, for the purposes of this analysis only those units that either had refrigerant added, removed, or received an airflow adjustment were identified as being "tuned-up." Four participant groups with sufficient sample size to provide statistically significant results were found. In all, 245 of the 270 participants identified above were placed into groups and incorporated in the analysis. The groups were identified as follows:

- Group 1: No Replacement or Tune-up (n=134)
- Group 2: Single AC Unit Tuned-up (n=44)
- Group 3: Single AC Unit Replaced (n=46)
- Group 4: Two AC Units Replaced (n=21)
- Not Analyzed: Other Measure Combinations (n=25)

It is also important to note that although program implementers tuned-up some existing units that were eventually replaced, for the purposes of this analysis a tuned-up unit that was subsequently replaced was not considered as a tune-up when creating the groups. For example, if a participant had a single unit that was assessed, tuned and then replaced, they would be designated to Group 3.

Once separated into groups, four separate fixed effects regression models were conducted using a pre-post indicator, daily HDD, and daily CDD as independent variables to determine the impact of the program upon daily energy consumption accounting for the impact of weather changes between periods. The regression model utilized is outlined below:

$$ADC = \alpha + \beta_1 PrePost + \beta_2 AVGCDD + \beta_3 AVGHDD + \varepsilon$$

where

- ADC is the average daily consumption during the pre (post) Program period;
- $PrePost$ is a dummy variable distinguishing between pre and post installation periods. Its coefficient captures the impact of participation;
- $AVGCDD$ is average daily cooling degree days in the pre (post) period based on location; and
- $AVGHDD$ is average daily heating degree days in the pre (post) period based on location; and
- ε is the error term.

The results of the regression models, as well as the average annual pre-installation energy consumption and percent of pre-installation consumption saved, are provided in Table 3-30. The results determined by the billing analysis and presented in the table are consistent with the findings of the engineering approach. Due to data attrition (see Table 3-29) and insufficient sample sizes for other measure combination, the final analyzed sample included 88 (Groups 3 and 4) of the total 183 units (48%) replaced by the program.

Table 3-30. Energy Hog Billing Analysis – Savings by Group

Tier	n*	Average Annual Pre-Installation Consumption (kWh)	Average Annual Savings (kWh)	Percent of Pre-Installation Consumption Saved
Group 1 (No Replacement or Tune-up)	134	18,068	503	2.8%
Group 2 (Single AC Unit Tuned-up)	44	14,206	867	6.1%
Group 3 (Single AC Unit Replaced)	46	14,300	1,491	10.4%
Group 4 (Two AC Units Replaced)	21	19,671	3,197	16.3%

*Does not sum to 270 because 25 participants exhibited different combinations and counts of tune-ups and replacements. However, none of the other combination groups were large enough to conduct analysis with adequate statistical significance.

**All regression results were significant at the 95% level.

Standard errors for the four above models were as follows: Group 1- 221, Group 2- 294, Group 3- 353, Group 4- 713.

The results presented in the previous table are offered with respect to unit capacity in Table 3-31. The table provides the average tonnage of units present at the participating home (note the analysis was limited to only those participants that had all their units treated), as well as the average annual energy saving per observed ton. Not surprisingly, Group 4 participants had the greatest tonnage (6.7 tons on average) since all participants had two units. In addition, the findings that Groups 2 and 3 exhibited lower average tonnage (4.1 and 3.7 tons, respectively) is consistent with the lower average annual pre-participation energy consumption presented in Table 3-31.

Table 3–31. Energy Hog Billing Analysis – Savings by Group

Tier	n*	Average Total Tonnage	Average Annual Savings (kWh)/Ton
Group 1 (No Replacement or Tune-up)	134	5.2	97
Group 2 (Single AC Unit Tuned-up)	44	4.1	211
Group 3 (Single AC Unit Replaced)	46	3.7	398
Group 4 (Two AC Units Replaced)	21	6.7	479

To determine the overall savings attributable to the program, the per-unit savings determined by the billing analysis (Table 3–32) were applied to the population of installed program measures. Note that the per-unit savings for replacements is the weighted average of the savings determined for Group 3 (one unit replaced) and half of savings determined for Group 4 (two units replaced). In addition, the billing analysis was unable to ascertain per-unit savings for program CFLs since changes in consumption due to the installation of CFLS was overshadowed by the impact of the tuned or replaced air conditioner. This problem was further compounded by the fact that only 52% of the bulbs were installed (see Volume 2, Appendices) in participating homes.[44] As a result of the small number of bulbs, accurately identifying the savings attributable to the CFLs at the household level within the air conditioning savings and other variations in energy consumption was not possible. However, per-unit CFL savings were calculated using the adjoining engineering analysis. It is also critical to note that since the CFL savings could not be assessed independent of the per-unit tune-up and replacement savings presented in Table 3–33, overall savings may also capture any savings attributable to CFLs installed at the home. As a result, the savings presented in the table may slightly overstate the actual savings generated by the tune-up and replacement measures.

Table 3–32. Energy Hog Billing Analysis – Per-Unit Savings

Measure*	Annual Energy Savings (kWh/Per-Unit)
Air Conditioning Tune-up	867
Air Conditioning Replacement**	1,525

*Savings attributable to CFLs could not be accurately determined via billing analysis. Per-unit CFLs determined using adjoining engineering analysis.

**Weighted average of Group 3 and 4 regression results

The per-unit savings presented in the Table 3–33 were then applied to the population of measures installed by the program. As noted previously, only those units receiving an air-flow adjustment or having refrigerant added or removed were designed as tune-ups. As presented in Table 3–33, the program generated an annual savings of 449,090 kWh. Note this value does not explicitly include any savings generated by CFLs at households that did not either have their participant unit(s) tuned-up or replaced.

Table 3–33. Energy Hog Billing Analysis – Savings by Group

Measure	Annual kWh Savings (Per-Unit)	Total Installations	Total Annual Measure Savings (kWh)
Air Conditioning Tune-up	867	196	170,019
Air Conditioning Replacement*	1,525	183	279,071
Overall**			449,090

*Weighted average of Groups 3 and 4

**Savings attributable to CFLs could not be accurately determined via billing analysis. Per-unit and overall Program savings from CFLs was determined using adjoining engineering analysis.

Attempts were also made to determine the percentage of estimated savings realized in each group using both site level and measure level statistically adjusted engineering models (SAE). However, SAE models are only as accurate as the estimated savings used as inputs. Since the program implementer's files show constant estimated savings associated with each air

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[44] 60 survey respondents reported installing 186 of possible 360 CFLs, 52%.

conditioning unit tune-up (641 kWh) and unit replacement (3,939 kW) for all participants (despite differences in the age, size and efficiency of the replaced unit), the SAE results were unreliable and the SAE methodology deemed inappropriate. The sample regression tracked closely with the revised engineering estimates and no additional SAE were conducted.

Table 3–34 below compares the per unit ex-post gross energy savings from the billing analysis with the ex-post savings from the engineering analysis. Results appear to triangulate nicely, although the billing analysis was unable to estimate the CFL savings. This comparison gives us some comfort that the overall program assessment and savings are reasonable and robust.

Table 3–34 Comparison of Engineering and Billing Analysis Savings Estimates

Measure	Billing Analysis Ex-post kWh Savings (Per-Unit)	Engineering Analysis Ex-post kWh Savings (Per-Unit)
Air Conditioning Tune-up	867	876
Air Conditioning Replacement*	1,525	1,286

Final Program Impacts

The Program reported participation of 474 households with 672 air conditioning units. There were 314 air conditioners assessed but not eligible for the program, 175 air conditioners eligible that were not replaced, and 183 air conditioners that were replaced. (Table 3-35)

Table 3–35. Participant AC Status

Status of Unit Assessed	Participant Units (N=672)	
	Number of Units	Percent of Total Units
Assessed and not eligible for replacement	314	47%
Eligible and not replaced	175	26%
Replaced	183	27%
Total	672	100%

Altogether, 2,802 CFLs were given to 464 program participants. Survey results show that 52% of bulbs provided to respondents were installed. This includes 37% who installed all six bulbs and 23% who installed none.

Table 3–36 shows the number of air conditioning units tuned-up, replaced, and the number of CFLs distributed. The program goals for the number of units was not met. Fifty-five percent of the target number of air conditioners were tuned-up. Thirty-eight percent of the targeted number of CFL were distributed. Seventy-five percent of the targeted number of air conditioning units were replaced.

Table 3–36. Program Achievements: Number of Units

	Program Goal: Units	Program Achievement: Units	Percent Program Achievement
AC Assessments	1220	672	55.1%
AC Tune-up	1220	197	16.1%
AC Replacement	244	183	75.0%
CFLs	7320	2802	38.3%

Table 3–37 shows the ex-ante savings estimates from the original program goals, and from the final program report. Ex-post evaluated savings are shown in the following portion of the table. While the realization rate for the program was low, the overall net to gross ratio was higher than the original program assumptions.

Table 3–37. Savings Summary

	Proposal				Reported			Evaluated		
	Ex-ante Gross	Net to Gross	Ex-ante Net		Ex-ante Gross	Net to Gross	Ex-ante Net	Ex-post Gross	Net to Gross	Ex-post Net
kWh	2,167,696	.80	1,734,157		1,314,105	.80	1,051,284	473,337	.91	431,390
kW	1,246	.80	997		763	.80	611	196	.90	176

Lifecycle Savings

Table 3–38 below is the CPUC required table showing lifecycle savings for the AC Energy Hog Roundup constituent IDEEA program. Savings are assumed utilizing the measure life for each component as described earlier, accounting for the proportion of measures installed in 2005 and 2006. CFL replacement has a 52% in the first year, and a 79% retention in the out years

Table 3–38. Lifecycle Savings

Program ID*:	IDEEA AC Energy Hog							
Program Name:								
	Year	Calendar Year	Ex-ante Gross Program-Projected Program MWh Savings (1)	Ex-Post Net Evaluation Confirmed Program MWh Savings (2)	Ex-Ante Gross Program-Projected Peak Program MW Savings (1**)	Ex-Post Evaluation Projected Peak MW Savings (2**)	Ex-Ante Gross Program-Projected Program Therm Savings (1)	Ex-Post Net Evaluation Confirmed Program Therm Savings (2)
	1	2004						
	2	2005	2,167,696	431,390.09	1245.864	173.23		
	3	2006	2,167,696	442,697.92	1245.864	174.30		
	4	2007	2,167,696	454,005.76	1245.864	175.37		
	5	2008	2,167,696	465,313.59	1245.864	176.44		
	6	2009	2,167,696	465,314	1245.864	176.44		
	7	2010	1,206,580	465,314	675.88	176.44		
	8	2011	1,206,580	465,314	675.88	176.44		
	9	2012	1,206,580	297,527	675.88	84.56		
	10	2013		124,892		35.41		
	11	2014		76,645		31		
	12	2015		72,121.77		29		
	13	2016		76,644.90		28		
	14	2017		65,337.07		27		
	15	2018		25,634		26		
	16	2019		25,634		26		
	17	2020		25,634		26		
	18	2021		25,634		26		
	19	2022		25,634		26		
	20	2023						
	TOTAL	2004-2023	14,458,220	4,030,685				

Definition of Peak MW as used in this evaluation: Summer peak

4. Conclusions and Recommendations

Based on the findings of the evaluation the AC Energy Hog Roundup program achieved only limited success in program implementation and savings. Two significant themes relate to the implementation and customer screening process and the technical calculation of the operating EER—the primary screen for unit eligibility. Program expectation may be further confused by the application of an a priori net-to-gross ratio inappropriate for innovative, pilot or experimental programs. All of these issues have implications for "mainstreaming" of early replacement programs and should be carefully considered by utility planners and regulators.

Conclusion 1**:** Proper screening of potential participants is essential for success in all programs, but especially in early replacement programs. Although the survey sample was small, 25% of respondents who had their AC units replaced were planning to replace the unit "this year" and knew exactly how they were going to pay for the replacement. An additional 12% of the survey sample would replace the units in "1-2 years." This becomes even more important when several contractors or subcontractors implement the program. It is probably not possible to screen out all free riders and consumers considering action, but some program design changes should be considered.

Recommendation 1**:** Develop screening tools to allow for consistent program implementation across all contractors, including:

- Sales training for contractors and subcontractors including the range of program options and the definition of "early replacement"
- A script that the contractor could use when discussing the program
- A checklist of steps to follow when talking to customers
- A uniform set of materials with mandatory information to be provided to customers on the evaluation of their AC systems and available program options

Conclusion 2**:** Notwithstanding the reservations of the program qualifying criteria, over half of the units eligible for replacement under the program criteria were not replaced, leaving potential savings "on the table." The most frequent reason for non-replacement was customer financial constraints. Others noted that they did not think they really needed a new air conditioner or that the contractor was trying to sell them something. Better communication about the program, energy savings, payback and the premise for early retirement could alleviate some of the homeowner's concerns.

Recommendation 2**:** If early replacement programs are to continue in SCE's portfolio, a range of customer financing options should be considered, including:

- Increased standard incentive
- Increased incentive for qualifying low-income customers
- Low interest loan options, including interest buy-down

Conclusion 3**:** Program databases developed independently by implementers introduced error in recording customer data. The data systems tracking customers' activities were inefficient; implementers could not easily tell whether contractors followed up with interested customers or in what stage of the process they were. Communication issues between implementers and contractors, largely in terms of tracking the participation status of interested customers, also need to be improved and streamlined. Energy savings analysis could use records of the more accurate and detailed test data collected on-site. Amp measurements with decimals could be recorded in the database as well as power measurements, since these are measurements taken on site. Finally, even though the marketing materials from Edison stated the customer must have their account number available for the contractor, there were many missing or erroneous account numbers in the databases.

Recommendation 3**:** Develop and monitor a web-based customer tracking system that integrates field and utility (billing) information, with the appropriate security checks and balances.

Conclusion 4**:** An *a priori* net-to-gross ratio of 0.8 is not appropriate for this program and may be inappropriate for any IDEEA-type program. The *a priori* net-to-gross ratio was applied even though one component of the program—the compact fluorescents—was a giveaway "gift," and thus did not involve any customer purchase decision. Further, the *Check Me!*™ portion of the program was generally not available outside the program, so no customer could have been a free rider for this measure. The tune-up was also marketed as a "free" measure, again, circumventing any customer purchase decision.

Recommendation 4**:** During the program planning process the program components and goals should be better related to realistic net-to-gross ratios. In particular,

- Programs targeting new market segments or involving innovative technologies should have a net to gross ratio closer to 1.0 than 0.8.
- Program components should be screened to determine whether net-to-gross ratios are appropriate. In particular, giveaway components should never have the ratios applied.

Conclusion 5**:** The methodology used to measure operating EER may not be a reliable approach to screening central AC for early replacement. The overall distribution of operating EER from program records did not produce believable results. The correlation between age and operating EER was 0.27. The mean operating EER for all units was 6.8, and for units eligible to be replaced, it was 5.8. Both evaluated engineering and billing analyses found annual savings of about 1300 kWh per unit. Replacements appear to have achieved less than 50 percent of the savings to be expected from replacing a 6.0 EER unit with an 11.0 EER (as required by code).

***Recommendation 5*:** Most if not all early retirement programs targeting the commercial sector require that units replaced have at least five years of useful life remaining in order to be eligible for incentives. When the motors, compressors or 'packaged units' are retired prior to end of useful life, the incentive pays for multiple years of savings with annual savings calculated based on remaining years of useful life.[45]

- All approaches used to estimate EUL and RUL have some flaw. There is evidence that remaining useful life could be 5-7 years but it does not appear conclusive. We recommended an RUL study to be conducted so that appropriate program policies for early retirement programs can be developed.

- Since age does not seem to be a reliable indicator of deteriorated performance, the entire question of early replacement of central AC units that are beyond their EUL is open to debate. We recommend considering these units be repaired, replacing perhaps the compressor or fan coil only.[46] We also recommend further study on this issue related to replacement efficiencies and cost.

- For equipment with at least five years of remaining EUL, early retirement may be considered if it is more cost effective compared to an enhanced tune-up and repairs. If operating EER is to be the criterion, the method needs to be refined. If the replacement decision is age-based, the baseline should be the rated EER of existing equipment, and savings would correspond to the difference between new EER and the rated EER.

Conclusion 6: The DEER savings estimates for refrigeration charge adjustment measure were prepared for two broad ranges (above and below 20 percent adjustment), but data were insufficient and not definitive to apply the same savings estimates at the low end of charge adjustment.[47] A small amount of charge adjustment (less than five percent) will not realize the same amount of savings that a 15 percent charge adjustment provides. It is more likely though that a low charge adjustment might not reduce a noticeable amount of energy usage. At this time, data are not available that show a linear relationship between the magnitude of charge adjustment and the resulting savings from which savings can be extrapolated for each percent change in refrigeration charge. For low charge adjustments, the DEER savings data might be overstating savings. The program evaluated ex-post gross demand savings calculated using the data from the DEER database do not (at this time) differentiate the direction of change in demand savings for charge addition and charge removal. The peak demand can increase by repairing undercharged units. This is a limitation of the DEER estimates for the refrigeration charge adjustment measure.

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[45] For example, SCE Large Business Early Retirement Program, the Standard Performance Contract

[46] Repair is suggested as an alternative to replacing the entire AC unit, which is more expensive than replacing key components. Unit efficiency degradation could be due to compressor or fan coil failure, or refrigerant leaks and condenser/evaporator coil degradation. Compressor replacement is a costly procedure that could introduce leaks and contamination into the system. Efficiencies gained with compressor replacement may not approach new unit efficiency. Similarly, the efficiency improvements from fan coil replacement without outdoor unit replacement are limited.

[47] Personal communication with Jeff Hirsch of James J. Hirsch and Associates on October 20, 2006.

Recommendation 6: Conduct Additional Research to Refine the DEER Database**.** Additional research is needed to ascertain that low charge adjustment saves energy, as well as development of a more detailed range of performance parameters for future use. Future DEER updates should review and adjust demand savings estimates so that demand savings are not overstated by repairing undercharged air conditioners.

Conclusion 7: The program did not repair air conditioning ducts while replacing air conditioners, as required by updated Title 24. The program staff indicated that duct repair was excluded from the contract with the implementation contractor; however, Edison requires contractors to follow the codes and standards without acting as "code police." While the utility may not act as "code police," the evaluation team believes that additional savings from repairing damaged ducts would be lost as customers are unlikely to get ducts repaired after an air conditioner has been replaced. Without checking and repairing damaged ducts, a new air conditioner cannot be optimized for proper air flow and it is likely to operate at less than its rated efficiency specifications.

Recommendation 7: Establish performance indicators to factor in contractors' code compliance efforts. One way to ensure that contractors follow the applicable code is to tie their performance evaluation to key indicators that should include the number of installations for which a contractor provides the repair permit number issued by local authorities.

Conclusion 8: Approximately 44 percent of air conditioners installed in the program exactly met the code requirement, which could be possibly double counting savings between this program and the Codes and Standards program. At this time, methods and processes do not exist to ensure that savings from program implementation are credited only once without double counting.

Recommendation 8: If future IOU programs continue to encourage installation of code-compliant equipment, method(s) should be developed to assure double counting of savings between programs does not occur. This may also require coordination and data exchange among programs.

Conclusion 9: The program did not always follow a few elements of the quality installation procedure for new air conditioner installation, e.g., duct repair, air flow measurement, and matching evaporator and condenser coils.[48] Without quality installation process, a new air conditioner is unlikely to perform at its rated efficiency specifications, thereby saving less energy than is technically feasible. Using the DEER database to estimate program savings that assume a quality installation may overstate savings if quality installation procedures were not followed during program implementation.

Recommendation 9: Develop quality installation protocols and specify its use in AC replacement programs If air conditioner installation programs are to continue in the future, a joint effort should be undertaken by appropriate participants to develop a quality installation

[48] CheckMe test was performed on new units but airflow or power measurements were not taken. Duct tests were not performed and duct repairs were optional.

process guideline. A starting point for the development of quality installation procedures could be the HVAC installation guidelines prepared by the Consortium for Energy Efficiency (CEE). Once a quality installation process is standardized, its use should be mandated in energy-efficiency programs.

Conclusion 10: In this program the tune-up and air conditioner replacement services were combined, which raises a program delivery process issue that also influences the impact assessment, i.e., whether to repair qualified air conditioners regardless of a customer's decision to agree for a replacement. The decision to repair or not repair air conditioners that might be replaced later is affected by the time taken by a customer to decide on program participation. If a qualified customer decides to replace an air conditioner immediately upon learning about eligibility, it may be not necessary to repair that air conditioner. A total of 22 units were repaired and ultimately replaced, thus burdening the program with the expense of initial repairs that possibly could have been avoided.[49]

Recommendation 10: Review the program delivery process to eliminate repairs on equipment to be replaced. Future programs should review and redesign the marketing and delivery process to avoid the expense of repairing air conditioners that might be eventually replaced in the program.

Conclusion 11: This program found fewer air conditioners (29 percent) that required repairs compared to recent market assessments,[50] which have reported that 40 to 70 percent of air conditioners are commonly found with an improper refrigerant charge.[51] It is common in energy-efficiency programs to find that only a certain percentage of contacted customers would qualify and ultimately participate in the program. This program was not credited with savings from all tested air conditioners that were not repaired or did not require a repair. The experience of this program suggests that three air conditioners will have to be tested to find one air conditioner that will require repairs or replacement. The program marketing cost is significantly affected by the ex-ante assumption made on the number of qualifying air conditioners that may be found during program implementation. Another ex-ante assumption made for this program was that all screened air conditioners would require repairs; therefore, ex-ante savings were overstated.

Recommendation 11: Establish program goals and marketing budget from market data.

The program design should build a realistic assumption into the program marketing cost about the ratio of screened to repairable air conditioners. The program ex-ante savings should be based only on the number of retrofits or tune-ups expected, not the number of air conditioners screened for this program. The percentage of air conditioners that will require a repair or replacement

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[49] The test only incentive was $35. Test and tune-up (repair) incentive $178.

[50] The program was implemented in the Palm Spring Desert area where home owners might be maintaining air conditioners better than is done elsewhere to ensure comfort in this hot climate region. About 30 percent of participating and nonparticipating contractors reported offering an annual maintenance contract. The evaluation did not research how this compares to other parts of CA.

[51] The definition of an improperly charged unit is determined by the *CheckME* process which uses subcooling/superheat temperatures to assess the charge condition. Additional information on the CheckMe diagnostic process is available on<http://www.proctoreng.com>.

would vary depending on the program design and service territory. The program implementation manager should periodically review these parameters as part of performance assessment and make the needed adjustment in the program delivery processes so that ratio of repairable to screened air conditioners is maximized for a given marketing budget. Evaluators also note the definition of improper charge may vary across different programs. A standard definition will be needed for any cross-program comparisons. In addition, if contractors are paid more to adjust charge, there an incentive for contractors to declare a unit “improperly charged.” Further analysis on the impacts of small charge adjustments and a reasonable threshold for initiating repairs are important program design issues.

3. Agricultural Ventilation Efficiency Program

1. Program Description

EnSave Energy Performance, Inc. (EnSave) proposed an Agricultural Ventilation Efficiency Program to encourage agricultural producers in Southern California Edison's service territory to install energy-efficient ventilation systems on their farms. Southern California Edison awarded EnSave a $724,069 contract to implement the project under the 2004-2005 Innovative Designs for Energy Efficiency Activities (IDEEA) program. Recognizing there is potential for energy savings in this sector, the Program was developed to serve agricultural producers not often targeted for energy-efficiency programs.

The Agricultural Ventilation Efficiency Program was initiated to introduce energy efficiency into a market that is a large contributor to California's economy. Agricultural producers in Edison's territory contribute $9.8 billion of California's $25 billion agricultural market.[52] This market can have large operating costs, but energy-efficiency programs typically do not service this sector. The Program was designed to educate producers of a variety of agricultural products: dairy, swine, poultry, crops, grapes, nursery and greenhouse products, for example. At the same time, EnSave planned to educate the larger agricultural community about energy efficiency, and market the Program by reaching out to ventilation fan manufacturers, dealers, extension agencies such as the University of California Extension Service, California Dept. of Agriculture, the Farm Bureau, National Farmers Association, Western Growers, and other networks used by the agricultural community. The intent was to provide information and encourage installation of the fans in a manner that would have a lasting impact on the community.

In Program documents, EnSave stated their goal was to educate approximately 2,000 agricultural producers from all sectors of agriculture about the benefits of installing energy-efficient ventilation systems. EnSave planned to educate this hard-to-reach and underserved sector about the benefits of energy-efficient agricultural fans, introduce High-Volume Low-Speed (HVLS) fans into the agricultural sector, and encourage installations through cash incentives. Participants could retrofit fans one-for-one, or they could replace several smaller fans with a smaller number of larger-diameter fans. The Program not only targeted existing fans for replacement, but also targeted new construction for installation of energy-efficient fans. Producers who installed the efficient fans in new construction, rather than standard fans of inferior efficiency, qualified for rebates. The Program was not limited by type of agricultural production and targeted the hard-to-reach agricultural customers within the Edison service territory; any agricultural producer could install the fans and qualify for incentives.

Program implementers and managers felt that in addition to serving an otherwise overlooked market segment, the innovative aspects of the Program were:

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[52] EnSave IDEEA proposal

- incentivizing high-efficiency agricultural fans, ranging in size from 12” to 54”, to encourage installation;
- introducing a newer technology, High-Volume Low-Speed (HVLS) fans, into the agricultural sector and encouraging installation through incentives;
- educating the extended agricultural community by working with fan manufacturers and dealers, agricultural producers, extension agencies, the farm bureau, and other networks.

Edison had no program to assist agricultural customers who wanted to add energy-efficient fans to their new or existing structures. This Program filled that need. Program documents stated that the ultimate goal of the Program was to successfully demonstrate the benefits of the technology to agricultural producers so that they would continue to install efficient fans beyond the end of the Program.

This program offered tiered cash rebates to agricultural producers for replacing their existing, inefficient fans with energy-efficient and HVLS fans. These fans were designed to produce about the same airflow at lower wattage. Incentives were designed to cover about one-quarter of the installed cost of the fans. HVLS fans qualified for a $1,000 incentive. Other fans meeting efficiency standards qualified for incentive ranging from $125 for a 12”-14” fan to $250 for a 52”-54” fan. Table B–1 (in Volume 2, Appendices, Agricultural Ventilation Chapter), derived from EnSave documents, shows the incentives offered and efficiency requirements for various fan sizes.

EnSave promoted the installation of energy-efficient agricultural ventilation fans, as well as the relatively new technology, the HVLS fans. The HVLS fans require less horsepower than conventional fans but move the same amount or more air, thereby reducing electricity use without sacrificing performance. The Program installation goals included 170 HVLS fan installations. Additional information about the HVLS fans is found in Volume 2, Appendices.

EnSave estimated that producers who installed fans through the Program would collectively save approximately 417 kW (coincident peak demand reduction) and over 3.2 million kWh annually. EnSave also proposed that a corollary benefit to the agricultural sector’s participating producers would be first-year collective cost savings of about $430,000.[53]

The evaluation of this Program included both a process and an impact evaluation. Although this was a 2004-2005 program, the evaluation conforms to the 2006 Protocols at the Basic level (Option A, simple engineering). The purpose of the process evaluation was to document project progress, assumptions, and barriers to wider implementation, to assess customer satisfaction, and to document barriers to participation. The impact evaluation included review of Program records, site visits and inspections.

The Program impacts were influenced by Program performance in terms of accomplishing Program participation goals, and, estimated ex-post savings impacts for the installed measures

[53] EnSave’s proposal was based on Edison’s 2003 agricultural electricity rate of $0.1354/kWh, as reported by the California Energy Commission, <www.energy.ca.gov/electricity/current_electricity_rates.html>

compared to the ex-ante measure savings assumptions. The Program gross and net realization rates were calculated as the combined effect of the two factors.

The evaluation included both a process and an impact evaluation. The process evaluation included interviews with the Edison Program manager, with Program implementation staff, with owners of agricultural operations that participated in the Program, as well as participating ventilation fan vendors and installers. Nonparticipant vendors and agricultural producers were also interviewed. The impact evaluation included site visits and an engineering analysis.

This report is organized into five sections. The next section (Section 2) presents the process evaluation, including the Program logic model, results of interviews with Program staff and participants, and free rider estimates. Section 3 describes the impact evaluation and the engineering and site visit results, and calculates realization rates, ex-post gross and net savings, and lifecycle savings. The final section (Section 4) presents the major conclusions and recommendations.

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2. Process Evaluation

Process Evaluation Methodology

The purpose of the process evaluation was to document project progress, assumptions, and barriers to wider implementation, to assess customer satisfaction, and to document barriers to participation and describe current practices among nonparticipants. A Program logic model guided the research.

Twenty-eight agricultural producers participated in the Program, including one poultry (duck), twenty-two dairy, and five greenhouse operations. The researchable issues addressed in the process evaluation included the Program's origin and original goals, and differences between the Program as designed and as implemented. Delivery and implementation issues such as experience with fans, participant satisfaction, and issues of free ridership and spillover were also addressed. Lessons learned, and reasons for nonparticipation in the Program were addressed.

Program Logic Model

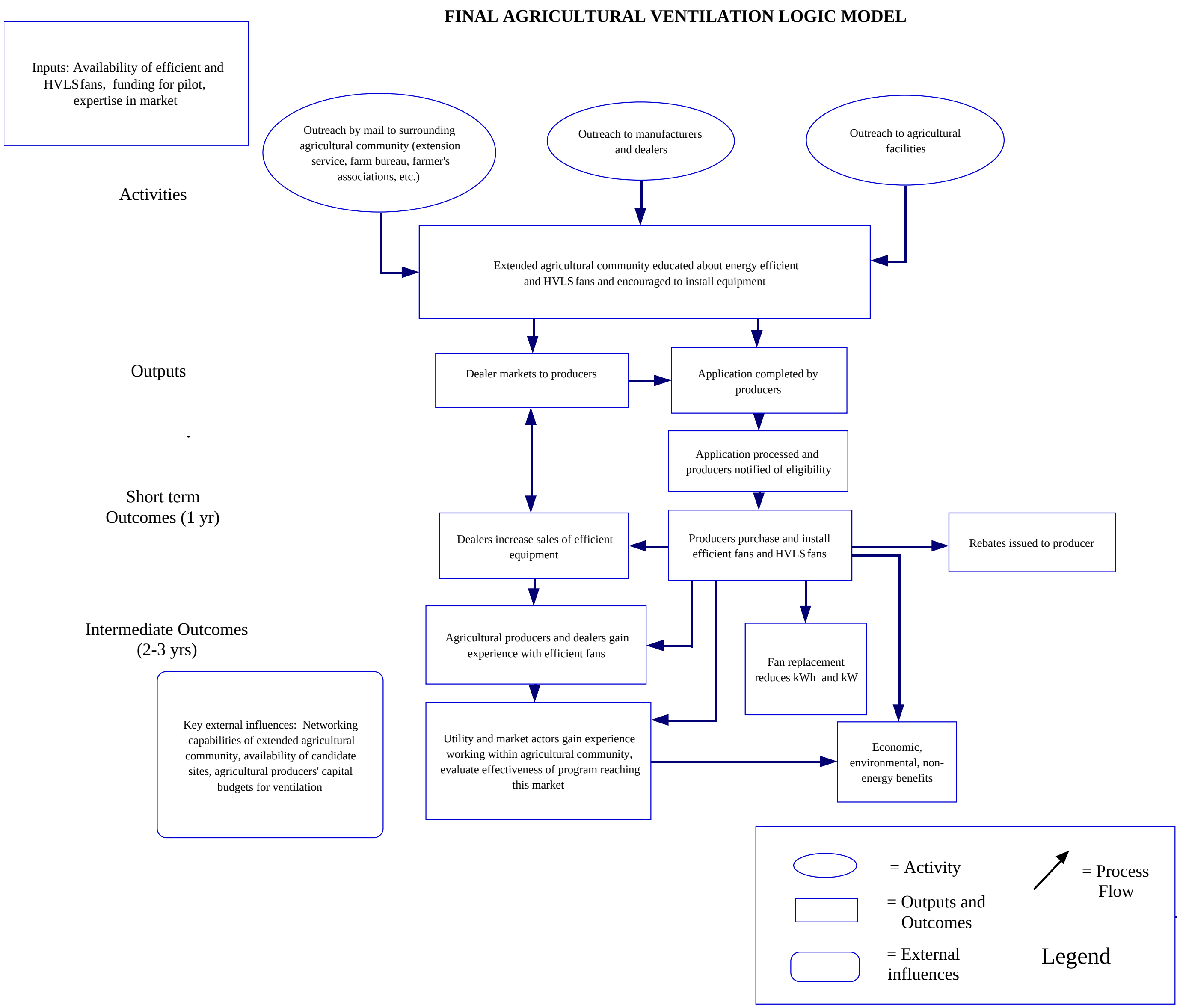
The Program logic model diagram is shown in Figure 2–1. The logic model shows the key features of the Program as understood by the evaluation team, indicating the logical linkages between activities, outputs, and outcomes. The primary activities involved outreach tailored to several different market actors to introduce the Program and technology to the extended agricultural community. Development of showcase farms to demonstrate the HVLS fans and educate the extended agricultural community was originally planned but not completed. The activity was not included in the final logic model.

The activities were expected to result in the following outputs: (1) the extended agricultural community would learn about the energy-efficient fans and Edison's rebate program, (2) energy-efficient fans would be marketed to agricultural producers, (3) agricultural producers would complete the web-based Program application, and (4) producers would receive the notice of eligibility and proceed to install fans.

The outputs expected were the installation of energy-efficient and HVLS fans, rebates issued to the producers, and increased sales of efficient fans by vendors and dealers. Short and intermediate term outcomes included immediate kW and kWh savings, and increased experience among producers and the extended agricultural community with the HVLS technology and other energy-efficient fans that replaced "standard" equipment. In addition, a variety of market actors would gain experience working with the agricultural community. Economic, environmental and other non-energy benefits were also expected to be realized. An outcome expected for all IDEEA projects was that Edison staff would gain experience with a new market approach and technology.

In terms of major activities, the Program was largely implemented as designed. There were two primary departures. The HVLS showcase farms were not developed or implemented (only one farm installed the fans midway through the project and it was not set up as a showcase farm). The website application was not available until late in the Program.

Figure 2–1. Final Logic Model



Process Evaluation Sample Design

The process evaluation of the Agricultural Ventilation Efficiency Program was informed by interviews with Program implementers, Program managers, Program participants, partial participants, and nonparticipants. Partial participants are defined as agricultural producers who expressed an initial interest in the Program and dropped out without following through with installation of the fans. Nonparticipants were contacted about the Program but did not follow-up or express an interest in participating. Interviews were conducted with ventilation fan vendors and agricultural producers.

As shown in the first column of Table 2–1 below, the original evaluation sample plan included interviews with four Edison and EnSave staff, six agricultural participants where site visits were conducted as part of the impact evaluation, and 66 nonparticipant agricultural producers. The sample plan did not originally include surveys with trade allies, that is, the participating and nonparticipating agricultural fan vendors.

As implemented (shown in the second column of Table 2–1), the process evaluation included interviews and surveys with the Edison Program manager and three people from EnSave who were most involved with implementation; seven of the 28 participating agricultural producers were interviewed with an extended survey, and 16 producers were surveyed with a 'short' form.[54] Twenty-three nonparticipating agricultural producers with ventilation requirements were interviewed. Two of the six producers who expressed initial interest in the Program and who later dropped out were also interviewed (partial participants). Trade allies were interviewed, including six of the eight participating ventilation fan dealers and seven nonparticipating fan dealers.

Table 2–1. Survey Sample Goal and Achievement

Task	Goal	Achieved
Staff/implementer interviews	4	4
Participant agricultural producer interviews	6	7 extended 16 short form
Partial Participant agricultural producer (drop-out) interviews		2
Nonparticipant agricultural interviews	66	23
Participant trade ally interviews (ventilation fan dealers)		6
Nonparticipant trade ally interviews (ventilation fan dealers)		7
Total interviews	76	65

The process work plan called for interviews with all participating producers where the impact evaluation team conducted site visits. A random sample of six representative sites was chosen for

[54] The original process evaluation plan called for interview of the census of the six expected participants where site visits were conducted for the impact evaluation.

the site visits. Interviews with four of the six were conducted on-site by the impact evaluation team. Three additional extended interviews were conducted by phone.

EnSave identified six producers who had committed to participate in the Program but who later dropped out. Two were interviewed to determine why they dropped out. The remaining four were not available after repeated attempts to contact them.

Surveys were also conducted with agricultural producers who were potential participants, in order to determine why they did not participate (Table 2–2). Southern California Edison provided a list of 2,892 potential participants. This was also the list EnSave used in their initial mass mailing. There were 491 that had good phone numbers, and 23 completed the nonparticipant survey. Many were not qualified as survey respondents because they had no ventilation or fan requirements (orchards, for example). Another large group remained unavailable; both early morning and evening calls were made in attempts to reach members of this farming community.

Table 2–2. Nonparticipant Producer Sample Disposition

	Frequency	Percent
Sample provided by Edison	2,892	
Potential participants with phone numbers	571	
Ineligible/unused sample	361	
Not qualified-no ventilation	165	
Not qualified-don't remember contact	36	
Wrong number/non-working number/computer/fax/duplicates	80	
Language barrier	16	
Busy/no answer/answer machine	64	
Eligible sample	210	
Completed surveys	23	11%
Refused	4	2%
Unable to reach after 5 attempts	180	86%
Terminated call during survey (time constraint)	3	1%

EnSave provided lists of participating and nonparticipating agricultural fan vendors to be contacted for Program evaluation purposes. All eight participating vendors were called and six surveys were completed. Two remained unavailable after repeated attempts to reach them.

A random sample of the 85 nonparticipating agricultural fan vendors EnSave had previously contacted about participating in the Program was also interviewed (Table 2–3). Seven nonparticipating fan vendors completed the survey. In this sample, over half were ineligible because the phone number was not working or they were not agricultural vendors. Another large group was never available after repeated attempts.

Table 2–3. Nonparticipating Fan Vendor Sample Disposition

	Frequency	Percent
Sample provided by EnSave	85	
Ineligible/unused Sample	49	
Ineligible-not agricultural vendors	34	
Wrong number/non-working number	15	
Eligible sample	36	
Completed surveys	7	19%
Not available	25	69%
Refused	2	6%
Unable to reach after 5 attempts	2	6%

Research questions were developed as part of the work plan and then used to develop interview guides. The questions explored the decision-making process used by participating agricultural producers, and also explored the participants' experiences with the technology since the installation. Program drop-outs were interviewed to learn why they did not participate. Agricultural fan vendors were interviewed to learn more about their experience selling the fans and the market for energy-efficient and HVLS fans. All were asked if they had participated in other Edison programs.

The interviews took place from August through December, 2006. Before interviewing participants, interviewers confirmed that the respondent was involved in the decision to participate. All respondents were involved in the decision-making process for the project, or were aware enough of the project details to provide meaningful information.

Process Evaluation Results

In this section, the Program is described as experienced by individuals who designed and implemented the Program, by the sample of producers that participated in the Program, by the sample of producers who chose not to participate, and by the sample of agricultural fan vendors.

Program Design

The Program's targeted customers are defined as hard-to-reach customers because of their geographic location outside of the major metropolitan areas of the San Francisco Bay Area, San Diego, the Los Angeles basin, and Sacramento. These rural customers typically do not receive as much energy efficiency marketing specific to their business operation as other customer groups, nor do they normally have the time to learn about energy efficiency improvements on their own. The Program aims to remedy this gap by marketing specifically to agricultural customers.[55]

[55] EnSave Energy Performance, Inc., *Agricultural Ventilation Efficiency Program Proposal*, page 11.

Edison and EnSave both noted that the eligibility requirements changed early in the Program to increase efficiency requirements necessary to qualify for incentives. The incentive levels were also changed from a fixed incentive per fan when implementers determined that they would expend the incentives without reaching the savings goals. The prescriptive incentives were changed to calculated incentives based on ex antes estimates of kWh saved. Incentives were about eleven cents/kWh saved. Edison and EnSave felt the incentives were better structured on a kWh/saved basis to reflect the Program savings achievement.

The original Program documents stated that energy-efficient fans would be installed in place of existing inefficient fans on a one-for one basis, or in the case of HVLS they can replace several small fans with a smaller number of large diameter HVLS fans. In both cases, the result is a lowering of energy usage.[56] The documents did not address installing new fans where none existed. However, as noted in Table 1–3 and Table 1–4, new fans were installed both in newly constructed buildings and in existing buildings. While the Program did not originally propose to install new fans where none existed before, its natural evolution to include new load was not questioned by Edison or EnSave. The Edison Program Manager and the EnSave implementers explained that there was no explicit change in the Program to allow installation of new fans. Rather, the intention was to encourage the installation of more efficient fans than would have been installed without the Program.[57] Edison managers saw the Program as fitting the mold of "SPC" or Standard Performance Contracts. The Edison SPC program offers financial incentives to offset the capital cost of installing high-efficiency equipment or systems. None of the Agricultural Ventilation Efficiency Program marketing materials reviewed for the process evaluation mentioned that the Program's aim was to replace inefficient existing fans with energy-efficient fans. Rather, the solicitations promoted the Program stating that cash incentives were available to install new, energy-efficient fans. While the Program was not implemented as it was originally designed, and it did build load, Program staff did not feel this was a departure from its original intent, nor was it an issue.

Market Assumptions

EnSave proposed a marketing plan including extensive outreach to the extended agricultural community as noted above. The marketing was designed to provide producers with consistent and on-going information from many different channels. The theory was that if producers heard about the HVLS and high-efficiency fans from many sources within their professional and social networks, they would be more apt to install the fans in the future.

EnSave initially developed a list of 315 potential fan dealers and 27 manufacturers through their own contacts, extension agencies, broker lists and internet sites. Introductory packets were sent out in March 2005 and two newsletters were also sent later in the Program. EnSave worked with manufacturers and equipment dealers to educate them about the efficient fans and to learn more

[56] Ibid. Page 6.

[57] Base case fan efficiencies were determined from parameters provided in the Implementer's E3 calculator documentation and assumptions on fan motor efficiency. Field collected nameplate data were also used.

about the dealer network. One component of the early marketing was an “opt out” card which recipients sent back to EnSave if the recipient did not want to be contacted.

EnSave actively marketed the Program to about 95 fan vendors and manufacturers. Following the initial information mailing to recruit dealers, EnSave also conducted a phone campaign spanning March 2005 through October 2005. In May 2005, a workshop was conducted for dealers and producers with Walt Boyd, the inventor of the HVLS fan. In all, eight agricultural fan vendors chose to participate and marketed the Program and fans to their customers.

EnSave provided a list of NAICS codes to Edison, which was used by Edison to extract a list of potential participants from their database. EnSave’s strategy was to cross-reference producers in Edison’s territory with lists from other brokers. The initial list included about 3700 agricultural producers. While targeted customers were within the agricultural community, it was not known whether their producers used ventilation fans. EnSave estimates the introductory mailing was sent to about 3,200 producers in Edison’s territory. Additional mailings were made to these producers in each month from June through September 2005, and a “time is running out” postcard was sent to producers in December 2005. Direct outreach was made to Program applicants who supplied their phone numbers. EnSave also identified potential participants by asking dealers if they had customers who might be interested in installing the HVLS fans.

Once the initial information packet was mailed to manufacturers, equipment dealers and the larger agricultural community, EnSave kept in touch through newsletters sent in August 2005 and April 2006. Program modification postcards were sent in June 2005 to inform manufacturers, equipment dealers and the larger agricultural community of the change in the incentive levels from a fixed incentive per fan to an incentive based on kWh saved.

EnSave also sent press releases to 93 agricultural organizations and 37 agricultural publications. The March 24, 2005 issue of Sunkist NewsLink and the Aug. 24, 2005 issue of the Western United Dairymen newsletter published information about the Program. EnSave’s proposal detailed a marketing approach that included direct mail campaigns and quarterly newsletters.[58]

Four “showcase farms” were also proposed in the original IDEEA program documents. These farms were to be spread throughout the Edison service territory and showcase the HVLS fans. The showcases would offer working facilities so other producers could observe how the HVLS operated and what they looked like first hand. This goal was not met since only two HVLS fans were installed at one site in July 2005. No showcase farms were developed.

The Program was planned for a January 2005 start, so that it could take advantage of marketing at the Tulare County WorldAg Expo, the largest farm show in the nation. However, because the Program started late, in March and April of 2005, EnSave could not attend the February Ag Expo. Disseminating information about the Program to the various market actors at this farm show was a key element of the marketing plan. EnSave reports that manufacturers and dealers

[58] See sample in Volume 2, Appendices.

feel this particular Ag Expo is "one of the best venues in which to promote a program."[59] They also noted that ventilation sales are often placed at this show.

One of the marketing challenges faced by EnSave was the reluctance of some equipment vendors to share their client lists. These client lists were one source of information used to develop the marketing contacts. In particular, EnSave reports that the unwillingness of an equipment dealer for swine producers led to fewer contacts within that sector than could have otherwise been realized.

Marketing and Participation Decisions

Various market actors were surveyed, including participating and nonparticipating producers and vendors. The nonparticipants were initially contacted about the Program and chose not to participate. Two producers interviewed initially planned to participate and dropped out.

When survey respondents were asked how they first heard about the Program (Table 2–4), the majority of respondents identified mail, phone, and to a lesser degree, direct contact as the means. Direct contact included trade shows and contact from EnSave representatives. Both dropouts heard about the Program from equipment dealers. All seven of the participating producers heard about the Program through "word of mouth" and none said they heard about it from EnSave. Clearly, learning about the Program through "face-to-face" contact was more successful in recruiting participants than relying on mail marketing alone.

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[59] EnSave final program report dated 7/31/06, page 8.

Table 2–4. How Respondents Heard about the Program

	Producers			Vendors			
	Participants (n=7)	Drop-outs (n=2)	Non-participants (n=23)	Participants (n=6)	Non-participants (n=7)	Total (n=45)	Percent of Respondents
Mail		2	19	4	5	30	67%
Phone		2	1	5	4	12	27%
Word of mouth	4					4	9%
Edison presentation				1		1	2%
Trade show				2		2	4%
Installer	2					2	4%
Dealer supplier	1	2				1	2%
Manufacturer workshop	1					1	2%
EnSave				6	5	11	24%
Don't know			3			3	7%

Source: Survey of producers: participants (n=7), drop-outs (n=2), nonparticipants (n=23); vendors: participants (n=6), nonparticipants (n=7). Multiple responses allowed.

As shown in Table 2–5, the Program benefits most frequently recalled by vendors and producers were the potential for saving energy and money, rebates, and an increase in energy efficiency. One fan supplier said a benefit was that there would be ventilation where there was none before. One nonparticipant producer said the Program would not benefit him with his small volume of fans. More than half the nonparticipants did not remember benefits; the marketing message did not strike a cord with these producers.

Table 2–5. Benefits Respondents Recalled

	Producers			Vendors			
	Participants (n=7)	Drop-outs (n=2)	Non-participants (n=23)	Participants (n=6)	Non-participants (n=7)	Total (n=45)	Percent of Respondents
Energy and money savings	3	2	5	6	7	23	51%
Rebates/Edison helps pay for fans	3		1	3	1	8	18%
Turn-key system	1					1	2%
Don't know			14			14	31%
Nobody talked to us			2			2	4%
Other			1	1		2	4%

Source: Survey of producers: participants (n=7), drop-outs (n=2), nonparticipants (n=23); vendors: participants (n=6), nonparticipants (n=7). Multiple responses allowed.

Participants and nonparticipants were asked how important Edison's sponsorship was to their decision-making (Table 2–6). The majority of participants said that sponsorship was very important. Several participants commented that Edison's sponsorship was important because the Program gave them legitimacy, it reassured producers, and the incentives helped to sell the fans.

Nonparticipant producers and vendors stated Edison's sponsorship was "not at all important" in their decision making. The reason they gave was that the Program itself did not fit their needs, that they had no fans, and sponsorship was irrelevant. At the same time, one nonparticipating fan vendor said, *"Everybody appreciates a program with backing from someone reputable."* Another said, *"We are interested in saving money and sharing savings with our customers; we trusted the program regardless."*

Table 2–6. Importance of Edison Sponsorship to Decision-making

	Participant Producers (n=7)	Dropouts (n=2)	Nonparticipant Producers (n=23)	Participant Vendors (n=6)	Nonparticipant Vendors (n=7)
Not at all important			13		5
Somewhat unimportant	1				
Not important and not unimportant			3		
Somewhat important	2	1	4	1	
Very important	4	1	3	5	
Uncertain					2

Source: Survey of producers: participants (n=7), drop-outs (n=2), nonparticipants (n=23); vendors: participants (n=6), nonparticipants (n=7).

Participating producers included 22 dairy farms, five greenhouse operations, and one duck farm. Table 2–7 lists the respondents' reasons for participation. Nearly all participant producers stated that they participated because rebates were available from Edison, which made the fans more affordable. Producers retrofitting existing fans with new fans stated that the Program allowed them to improve the air volume, re-position fans for better ventilation, and move from "talking about it" to "doing it." All seven who responded to the longer interview stated that they paid for the fan installation costs, and that the rebate covered the fans themselves. Without the rebate, producers said they could not have installed the fans.

Program participants also indicated that one of the primary reasons they chose to participate in the Program was the energy saving potential of the efficient fans.

Non-energy benefits were also important reasons for participation. Greenhouse producers said that the fans circulate the air more uniformly, reducing the overall heating needs and reducing the growth of fungus and mildew. In turn, this reduces the need for fungicides. Greenhouse producers also stated that the ventilation improved plant growth and production. Dairy farmers stated that ventilation was installed for animal well-being and "happy cows."[60] The "happy cows" mean more births, better milk production, and reductions in deaths from heat exposure.

Table 2–7. Reasons for Participation

	Producer Participants (n=24)	Fan Vendor Participants (n=6)
Saw need in agriculture community		1
Good way to increase sales		2
Payback was reasonable		1
Replace with efficient and/or new fans; better ventilation	7	
Energy and money savings	9	6 ("there is a market for fans that save energy and money")
Rebates / Edison helps pays for fans	21	
Animal well-being	9	
Greenhouse productivity increase, reduced fungicide	4	

Source: Survey of: participant producers (n=24) and participant vendors (n=6)

Five of the six participant dealers (vendors) stated that they worked primarily with dairy farms. One also worked with poultry farms and greenhouses. One supplier focused solely on greenhouses. Fan suppliers said they participated because the Program could increase their sales, stating that there is a market for fans that save energy and money. Suppliers stated that there was no specialized or technical training necessary to begin selling and installing the new fans.

Almost all of the participating fan vendors (five of six) were aware of the high-efficiency and HVLS fans prior to contact by EnSave. Three of the participants claimed to specialize in offering

[60] As noted earlier, fan installations varied by participant. One-for-one replacement with more efficient fans, relocating fans for better ventilation, and installing more fans were all activities undertaken by various participants.

high-efficiency and/or HVLS fans, and had been doing so from four to ten years. Three of the six participant fan suppliers said they had previously installed the high-efficiency or HVLS fans. These fans were of the same efficiency and their customers requested them.

Two participant fan suppliers (serving one dairy farm and one greenhouse) said they normally would not have installed any ventilation. Without the Program, two suppliers would have installed their standard 36” Schaffer fans. One supplier said he would have installed some of the HVLS fans without the rebate.

Reasons for nonparticipation were gathered from producers that dropped out of the Program, producers that were contacted but chose not to participate, and nonparticipating vendors.

Neither of the two producer drop-outs were aware of the energy-efficient fans before being contacted about the Program. Neither producer had plans to install them in the future. The two drop-outs interviewed offered two different reasons for leaving the Program. One just did not make enough time to complete the forms to receive the incentive for the four qualifying fans installed. The second did not have funding for the fans in its capital budgets. EnSave’s final report states there were five dropouts or partial participants. One did not participate because of the high cost of the fans and the other four didn’t send in paperwork, even after repeated contacts with the producers. In a sense, these were not dropouts, because they did install fans. However, they were not able to take advantage of the Program incentives because they did not send in paperwork.

Nearly 52% (12 of 23) of nonparticipant producers indicated that they were aware of energy-efficiency fans and HVLS before being contacted about the Program. However, only three out of 23 indicated that they had already installed any of these fans. Similarly, three respondents indicated that they may install energy-efficient fans within the next year.

Nonparticipant agricultural producers were asked why they chose not to participate in the Program. Half (12) of the nonparticipant producers stated they did not need fans right now. Three respondents indicated a lack of interest or time, and two said they did not believe they qualified for the Program. Three said their business did not use or require fans.

Fan suppliers were asked why they chose not to participate in the Program. Only three of the nonparticipant fan suppliers interviewed served the target market of agricultural producers. One respondent worked with both dairies and beef-processing plants. One worked solely with dairies and one solely with poultry producers. Two of the nonparticipant fan suppliers worked with cold storage businesses. One supplier worked with hospitals and one supplier worked with schools.

Only one nonparticipant fan vendor working within the agricultural sector knew about the energy-efficient fans prior to contact by Ensave. This vendor stated he had been offering the high-efficiency and HVLS fans for eight years, primarily in the PG&E territory, and did not participate because he did not have any customers in the Program’s service area. Another supplier said [its] *“clients still couldn't afford the fans with the incentives.”* Two of the nonparticipants said they didn’t sell or install enough fans to make the Program worth their time. *“We have not been installing fans lately. We are a small business and work only within a small community of dairies.”*

Program Delivery and Implementation

Producers and vendors/installers worked directly together to determine which fans to install and where to install the fans. A total of 2,154 fans were installed and received incentives through the Program.

Table 2-8 shows that the goals for the number of fan installations changed from the revised Scope of Work dated December 2004 and the goals shown in the final Workbook at the end of the program. The total number of planned installations decreased by 107 units. Regardless, the Program exceeded both the original and revised goal for the total number of energy efficient fans. With regard to the HVLS fans, the program failed to meet its goal. Only two of the projected 170 HVLS fans were installed (1% of projected). The planned showcase farms were also slated to demonstrate the HVLS fans. Only one farm installed the HVLS fans and it was not developed as a showcase farm.

Overall, the distribution of installations by size was vastly different than projected. It appears that producers primarily install 12”-14” fans, 20”-26” and 50”-56” fans. By far the most popular in this program were the largest of the three.

Table 2-8. Program Achievements: Number of Units

	Scope of Work Program Goal: Units	Final Worksheet Program Goal: Units	Program Achievement: Units	Percent Program Achievement
12-14" fan	55	39	158	405%
16-18" fan	54	126	0	0%
20" - 26" fan	218	94	686	730%
27" - 30" fan	164	160	0	0%
36" fan	657	600	18	3%
48" fan	165	165	26	16%
50"-56"	109	125	1264	1011%
8' - 24' HVLS fans	164	170	2	1%
Totals - Unit Goals	1,586	1,479	2,154	146%

Source: Surveys of 23 participants and data extracted from EnSave documents

The 2,154 fans installed with Program incentives included 1,652 new fans and 349 retrofit fans. In addition, 153 fans were installed in facilities where both new and retrofit fans were installed, but the specific number of new and retrofit fans could not be recalled by producers (Table 2–9).

Table 2–9. Number of Fans Installed

	New Fans		Retrofit Fans		Both Retrofit & New (counts not known)		
	Count	Percent of total	Count	Percent of total	Count	Percent of total	Total
Number of fans	1,652	77%	349	16%	153	7%	2,154

Source: Surveys of 23 participants and data extracted from EnSave documents

Twenty-three of the 28 participants were reached for interviews and asked about the existence of fans prior to participating in the Program. One of the 23 respondents replaced existing fans in their facilities while 15 had no existing fans in their facilities at the time they participated in the Program. Seven producers replaced existing fans and installed new fans. Of the five who could not be reached, records show that one installed only retrofit fans, one installed both new and retrofit, and three installed only new fans (Table 2–10).

Table 2–10. Number of Sites and Fans Installed

	Only New Fans Installed		Only Retrofit Fans Installed		Both Retrofit & New Fans at One Site		
	Count	Percent of total	Count	Percent of total	Count	Percent of total	Total
Number of sites	17	61%	2	7%	9	32%	28
Number of fans	1521	71%	27	1%	606	28%	2154

Source: Surveys of 23 participants and data extracted from EnSave documents

Twenty producers were able to confirm whether the new fans were installed in new buildings or in existing buildings. Twenty-eight percent (28%) of the new fans were installed in new construction and 72% were installed in existing buildings where there was no ventilation before.

Only one producer commented that he would have liked additional fans to choose from. The installer made the choice and apparently it met only the minimum efficiency required to qualify for the rebate. This producer would have installed a more efficient fan, given the choice.

Seven participants completed an in-depth interview and were asked how they operated the original fans, and about changes in operations following installation of the new fans. The two respondents with existing fans (both dairy farms) indicated that the operation of stall fans, from mid-May through mid-October, was staged to operate at 75 degrees and 85 degrees Fahrenheit. Fans in the milking barns were either turned on at 60 degrees or 70 degrees. Operation of all fans ceased during the winter season (mid-October through mid-May). These two respondents indicated that there were no changes in temperature set points or general fan operations after installation of the new fans.

Five participants who installed new fan systems completed the in-depth interview. One used manual controls, stating they will convert to automatic controls "very soon." All other systems were thermostatically controlled. Three of the five respondents operated fans 24 hours/day.

Only one participating fan vendor said they anticipated operational issues. This vendor claimed, "*some of the fans get rusted, go bad, and need to be replaced . . . as many of them are installed near wash bins where there is a significant amount of evaporative moisture."* None of the producers reported performance or operational issues. Neither the Edison Program Manager nor EnSave implementers had been contacted about this or any other operational problem. No fans were "going bad" during the Program.

Producers were also asked whether the new fans were installed in new construction or existing buildings. Two could not specify the number of new fans installed in their existing building and one could not specify the number installed in a newly-constructed building. The remaining 20 producers however, installed 1306 of the new fans, or 79% of the 1652 fans identified as new fans (Table 2-11). Of these 1306 new fans, 28% were installed in new construction and 72% were installed in existing buildings where there was no ventilation before.

Table 2-11 shows the number of each size of fans installed, as well as whether the fans were new fans or retrofit installations. Most fans were 48” to 51” fans, and 62% (800 of the 1290) were new fans installed where none had existed before.

Table 2-11. Size and Number of Fans Installed

	New Fans	Retrofit Fans	Unspecified New or Retrofit Fans	Total
12”-15” fans	158			158
20”-36”	692	12		704
48”-51”	800	337	153	1290
20’ HVLS	2			2
Total	1652	349	153	2154

Source: Surveys of 23 participants and data extracted from EnSave documents

Market Barriers

Program implementers reported it was difficult for producers to make the leap to HVLS fans and change out the inefficient fans for the better technology. Only two 20-foot HVLS fans were actually installed. Producers were hesitant to install the HVLS fans because they look different from standard fans, and producers were unfamiliar with this fan’s performance. The high-efficiency fans installed through the Program looked more similar to standard fans so they presented less of a challenge to gaining acceptance. The proposed showcase farms were designed to address this market barrier, but unfortunately, no showcase farms were implemented.

Producers were asked about market barriers that would prohibit the widespread installation of energy-efficient/HVLS fans. Several producers referenced first cost of the fans and lack of funding as barriers, and stated that they could not have installed the fans without the rebate. Five of the six participating fan vendors agreed that the main market barrier to the widespread use and adoption of the high-efficiency and HVLS fans was the initial capital investment necessary to purchase the equipment. Dairy producers reported that their ability to fund the fans or other improvements at their facilities is highly dependent on the price of milk. One of the vendors commented that dairymen have been experiencing particularly difficult times as, *“Milk has dropped from $18/100 weight to $10/100 weight, and dairymen have no capital to invest in fans now.”*

One producer who installed fans under both this Program and its successor stated that current incentives are much lower, impacting the number of fans that can be installed. Producers suggested that rebates be continued and additional funding be made available.

When asked about the reason for considering but not installing energy-efficient and HVLS fans prior to Program participation, participants listed initial cost, satisfaction with passive windows, use of 36” fans, and lack of attention. Producers offered that the timing of the potential investment would have depended on the price of milk. Since incentives do not cover the cost of installation, the capital investment can be quite high. EnSave newsletters to the agriculture community provide examples showing a one-and-a-half-year payback after incentives.

One fan vendor offered that insufficient marketing and customer awareness was also a market barrier. More than one producer commented that they had heard about the Program from a vendor or supplier and not from Edison. One stated that "*not many knew about the Program*." Two producers said they would like to have heard about the Program from Edison. These responses suggest that additional marketing is needed to reach the target market.

EnSave reports extensive marketing using direct mail, newsletters, and market actors to spread the word throughout the agricultural community. At the same time, EnSave also notes that continued outreach including one-on-one phone contact with dealers and producers is critical. Attending the Ag Expo farm show is also critical to reach this market at the time producers are making purchase decisions. Unfortunately, the Program was started by Edison later than EnSave had anticipated, so that marketing the fans and Program at this event was not possible.

Both Edison and EnSave are learning which agricultural markets are best suited to the fans and technology. Edison could direct additional outreach to market actors. The outreach should include information about energy efficiency and information about available programs that the vendors could market to their customers.

Nonparticipating fan vendors said the barriers to widespread installation included cost, education and marketing, time, and the belief that the fans don't save energy or money. One nonparticipant vendor commented that the Program should be offered in other service territories he services. Another commented, *"I seem to always find out about these programs too late and the money is already gone . . . better promotion of program to likely participants [would help]."*

EnSave noted that the list of 315 potential fan vendors and installers boiled down to 87 who could have participated. Of the 87, only eight vendors participated. Much of EnSave's challenge with the vendors was convincing them to add new fans to their inventory. EnSave kept in constant communication with vendors to track sales and progress. In general, this took much phone work and hand-holding. Additional vendors would increase the marketing base and ultimately the number of installations.

Market barriers can be summarized as:

- Lack of product awareness
- Small number of vendors marketing the fans
- First cost

Participants' Experience with the Program and Technology

When asked about their satisfaction with the Program overall, and with the efficiency improvements resulting from Program participation specifically, 87% (20 of 23) participating producers indicated that they were "very satisfied" with both the Program and the fans. One participant didn't answer, one stated he was "satisfied," and one stated he was "not satisfied."

Virtually all the producers referenced non-energy benefits and were happy with the fans. Greenhouse operators commented on better air circulation leading to healthier plants, less mildew, less fungus and fungicide use, and more uniform temperatures. One producer reported that the greenhouses are heated with natural gas boilers, and since the air is more uniformly distributed and circulated (de-stratified) there is less need for heating and gas. Dairy farmers discussed increased comfort and happy cows, increased milk production and births, as well as reductions in mortality.

Producers installing new load noted that the increase in energy costs with the new fans was offset by the increase in production. One producer commented that the Program has to be packaged and "turnkey" to install HVLS fans.

In response to a question about what made their facilities good candidates for the installation of high-efficiency and HVLS fans, participating producers suggested these items:

- Inefficiency of existing fans
- Lack of fans in existing buildings
- New construction designed to include fans
- Being an industry leader
- Having a facility and/or corporate support for a culture of continuous improvement

Producers commented that the installers were well trained and knowledgeable. Others noted that the Program went smoothly. Comments included *"Edison and the rep were on the same page." "Edison and the installer worked it out; it was easy."*

Suggestions that producers made to improve the Program included continued promotion and a focus on new installations rather than retrofits. Other producers suggested Edison develop programs with a primary focus on pumps, and a program to work with citrus wind machines.

Fan vendors were asked for suggestions to improve or expand the Program to other agricultural producers. Two participating fan vendors identified the need for better marketing. One suggested investing in TV and/or radio advertising as a way of bolstering customer awareness. One respondent commented that the Program should also offer services and incentives for refrigeration upgrades to address a growing need.

Participating fan vendors, overall, were satisfied with their experience with the Program. On a three point scale, including "not satisfied" "satisfied" and "very satisfied," three offered that they were "very satisfied" and three offered that they were "satisfied."

Free Riders

The 23 participant producers who were interviewed were asked questions to assess free ridership and to quantify the NTG ratio. Respondents were asked if they had considered installing fans before the Program, whether they would have installed fans without the incentive, when they would have installed them, and whether they would have been of the same efficiency level.

Table 2–12 summarizes the results of the respondents' answers. Of the 23 respondents, 14 said they would have installed fans without the Program. Eleven of the 14 said the fans would have been the same efficiency as those installed through the Program. One of the eleven stated that the fans were already ordered when the installer told him about the Program. He called Edison to receive the rebate; this person was a free rider. Four of the eleven stated that they would install new fans within the same year, that the fans were in the budget, but that the fans were not yet ordered. These four can be considered 50% free riders. One additional producer said that the fans were not budgeted or ordered but that he would install them in the next one to two years. This producer can be considered a 25% free rider.

All told, of 23 respondents, there were 3.25 free riders, or, 14% of the participants. The NTG ratio for the Program is .86.

Table 2–12. Free Riders

	Producers		
	Participants (n=23)	Dropouts (n=2)	Nonparticipants (n=23)
Considered installing fans before Program, without incentives	14	0	3
Already ordered or installed	1	0	3
Budgeted, not ordered, will install within same year	4	0	3
Not budgeted or ordered, will install in 1-2 years	1	0	0

Source: Survey of producers: participants (n=23), drop-outs (n=2), nonparticipants (n=23)

Potential Spillover

To get a sense of whether there was any spillover from the Program, participants and dropouts were asked questions about future plans to install the energy-efficient fans in other applications or locations, either at their own expense or with incentives. Respondents were also asked if they had participated in other Edison programs.

Two of the 23 participant producers interviewed installed additional fans after participation in the Program. One installed eight fans under this Program and installed another 24 fans eighteen months later. The producer reported that the incentives levels were less than they were for the original eight fans. A second producer reported that he was so satisfied with the Program that he installed additional fans on his own, but did not specify the number.

Feedback from nonparticipating producers suggested that three out of 23 respondents (13%) added energy-efficient equipment at their facilities after hearing about the Program. The equipment included swamp coolers, a vacuum pump, and a variable-speed motor for a booster pump. When asked how influential hearing about the Program was in their decision to add efficient equipment, one stated "very influential," one said "somewhat influential," and the last said "not at all influential."

Fan vendors were asked if they had added additional energy-efficient equipment to their product line since hearing about or participating in the Program. Of the six participating vendors interviewed, only one had added other energy-efficient equipment to their product line since participating in the Edison program. Participating in the Program was “not very influential” to their decision to add other equipment. None of the nonparticipating vendors added energy-efficient equipment to their product line since learning about the Program. Therefore, the Program is not steering vendors toward offering energy-efficient products and services.

Potential spillover from other Edison programs to the Agricultural Ventilation Efficiency Program was explored by asking respondents whether they had ever participated in other Edison energy-efficiency programs. Two of the six participant vendors said they had participated in previous programs, including lighting discounts and VFDs, and four said they had not participated in previous Edison programs. Comparatively, three of seven nonparticipant vendors indicated they had not participated in prior Edison energy-efficiency programs. Two indicated that they had participated in prior programs, including a 2004 lighting program and a vacuum pump rebate program.

When asked about previous or concurrent participation in other Edison-sponsored programs, seven of 23 participating producers (30%) indicated that they had previously participated in at least one other program focusing on either variable-speed vacuum pumps, milk pumps, water pumps, motors, energy-efficient blowers, lighting, or plastic covers for roofs. One mentioned a remote shutoff program, and one participated in an interruptible power program.

Nine of the 23 nonparticipating producers (39%) stated that they had participated in other Edison energy-efficiency programs. Most frequently, respondents had participated in pump-focused programs. Other programs focused on combustion, refrigeration, and insulation.

Overall, only one-third of the participating and nonparticipating producers had participated in any other Edison program. Likewise, 38% of the participating and nonparticipating vendors had participated in previous Edison programs. There is additional potential in this sector; Edison could target this sector to market its programs, particularly fans, pumps, and motors.

Lessons Learned by Program Staff, Future Plans

Program managers and implementers learned a number of important lessons that will inform future Program efforts.

Overall, Edison Program managers felt EnSave was very responsive and flexible, and were willing and able to accommodate changes. In addition, Edison managers felt EnSave had a good grasp of the industry.

Edison felt the Program fell short of their proposed goals largely for three reasons:

1. The lateness of the Program impacted the Program in two ways: it caused the implementers to miss an important trade show and there was less time to enroll participants.

2. Overcommitted administration and staff changes caused implementers to lose focus for several months.
3. Some producers were too busy to submit paperwork in order to receive incentive payments; those savings could not be counted, and incentives could not be paid.

Issues with the Program administration were limited to the implementer's internal tasking and invoicing. For example, the planned web interface for applicants took too much time to complete, and as a result, it was virtually too late to benefit the Program. The online application form collects important tracking information, including name, company, address and phone, HVLS horsepower and CFM, the specific date range during which fans are in use, the presence of thermostat controls on fans and their setpoints, the presence of fan timers and hours per day of use, the total square footage of buildings, the Edison account number, and the dealer's and installer's names and phone numbers. All of this information would be very useful in tracking and evaluating the Program.

EnSave had some difficulty using the E3 calculator to track their installations, but eventually the spreadsheet helped with reporting. Edison's concern in the first year of the Program was to validate invoices so that they correctly reflected installations. Affidavits signed by the customer and distributor were submitted to Edison and inspected. Getting all the right paperwork and documentation required for incentives with the first submission was a bit rough at times.

Site inspections were conducted though there were some problems coordinating timely inspections. Edison inspected all installations that received more than $14,000 in incentives and randomly inspected 10% of all installations under that amount. Edison recommends 100% inspection, including 20% physical inspection and inspection of paperwork for all other installations.

At the onset of the Program, expenditure of the incentives outstripped the pace of the applications. EnSave and Edison modified incentive levels and they feel that the level of incentives was right, given time constraints and obstacles encountered. They received no feedback from producers about whether the amount was too high or too low.

The incentive checks were mailed to the end user, that is, the producer, although some paperwork was filled out by the end user and some by the dealers. The process needed some smoothing and streamlining. Indeed, some producers did not receive the incentives after installing fans because they did not submit paperwork to Edison. Incentives directed toward the dealer or distributor may help motivate them to work with the buyer to fill out the paperwork.

Since the HVLS technology is not commonplace, offering incentives with a limited focus on the HVLS technology could prove successful in introducing it to a wider audience. There are additional applications where HVLS fans are appropriate that could be explored. Establishing the showcase farms with the HVLS technology as originally planned could also be a helpful marketing tool.

Marketing barriers surfaced early on in the Program. The first was a delay in the start of the Program. This timing issue meant that the implementers could not attend a highly influential annual farm trade show, the "WorldAg Expo," to market the Program and the fans. About

100,000 attendees from 60 countries typically visit the Expo in Tulare, CA in February every year.[61] Building in up-front contact is extremely important when introducing and marketing this technology. Marketing to a broad audience should include appearance at the well attended trade shows, such as the "WorldAg Expo." Many fan vendors and agricultural producers make their purchase decisions early in the year, and are influenced by what they see at the Expo.

EnSave feels that the late start had a serious impact on the Program participation. To compensate, EnSave increased other facets of their marketing efforts, such as sending newsletters to a variety of market actors. Implementers learned that outreach to dealers and producers, including phone contact, is critical to the diffusion of this technology.

EnSave also found Edison's tracking spreadsheet and workbook reporting excessively time-consuming and burdensome. It took much unplanned administrative time to complete the spreadsheet. EnSave commented that the reporting requirements were unclear, the workbook did not follow with their activities, and they were unable to track their installations using the workbook. Implementers developed their own tracking spreadsheet.

EnSave found it challenging to convince fan vendors to take on new fan products. As a result, a small number of agricultural fan vendors promoted the Program. Vendors tried to match customers to qualifying fans. EnSave was in constant communication with the vendors, and found it took a great deal of phone work and "hand holding" to help them through the Program. In the end, however, vendors were supportive of the Program and interested in seeing it continue.

The amount of time it took to attain committed participants varied widely from one participant to another, taking from days to months, depending on the producer's level of interest and enthusiasm. The level of effort needed to acquire commitment should not be underestimated.

Marketing the new HVLS technology was an ongoing challenge to the Program implementers. Only one farm installed two HVLS fans. As a result, the four farms showcasing some of the anticipated 170 HVLS fans did not materialize. EnSave did introduce the technology to the greater agricultural community through their marketing campaigns. Producers have not grasped this technology, being more comfortable with fans that look familiar. It is evident that additional communication, marketing, and education are needed to promote this technology.

Through their work within this program, EnSave developed the *Energy Efficient Ventilation Fan Ranking Guide*, which they distributed to 120 manufacturers, equipment dealers and producers in late June 2006. To develop their guidebook, EnSave used fan specifications and test data from the Bioenvironmental and Structural Systems Laboratory (BESS labs), at the Dept. of Agricultural Engineering, University of Illinois, in Urbana-Champaign. The ranking guide listed fans that met the efficiency guidelines and provided a simple payback worksheet. EnSave noted that manufacturers contacted them to find out how they could get their fans rated as energy efficient and listed in the guide. Manufacturers were referred to BESS labs, which conducted all the testing. This interest by manufacturers in providing energy-efficient fans to the marketplace

[61] http://www.worldagexpo.com/general_info

is a positive secondary benefit of the Program. It shows that manufacturers, producers, and equipment dealers recognize that energy efficiency is a factor considered in purchase decisions.

Another positive outcome of this Program is the continued interest in the Program. EnSave reports that they continued to receive calls from interested producers after the close of the Program. Interested producers are directed to the new Agriculture Energy Efficiency Program, a follow-after to this program. EnSave estimated there are about 7,500 fan installations among Edison's agricultural customers which could possibly qualify for Edison's 2006-2008 Agricultural Energy Efficiency Program.[62]

[62] Email correspondence with EnSave, 8/1/06.

3. Impact Evaluation

Impact Evaluation Methodology

The general approach to measuring and verifying energy savings included the following activities:

1. Measure-installation verifications, including:
    a. Developing a sample for field verification activities
    b. Conducting field verification activities and observations, which included the installation of data logging equipment
    c. Reviewing data on verification activities completed by Edison
    d. Developing adjusted measure installation factors based on field activities and data reviews
2. Engineering analysis to develop ex-post realization rates, including:
    a. Completing a review and evaluating Program data
    b. Analyzing data provided through field activities and in-depth participant interviews
    c. Completing analysis of data provided through onsite data-logging activities
    d. Determining operating schedules and temperature setback settings of retrofit fans installed at participant sites
    e. Developing project realization rates
3. Calculation of adjusted gross and net Program ex-post savings

Each of these activities is discussed in detail in the following sections.

Measure Installation Verification

The objectives of the onsite verification activities were to complete visits to numerous sites and collect key energy Program-performance metrics including:

1. Establishing the presence of energy-efficient fans by comparing the number of installations observed for a sample of sites with the number of installations recorded by the Program implementation contractor
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, determining if retrofits or installations were ever present, and/or what the removal date and reason was
4. Recording key facility performance data, such as daily schedules, seasonal variations in schedules, and control strategies (thermostat settings).
5. Installing data logging equipment to verify self-reported run hour estimates and measure power consumption of the newly installed fans

The impact evaluation field plan and field activity sample details are provided in Volume 2, Appendices.

The sample of sites selected for verification activities was derived by taking into account each market sector's percentage of total measures installed and total recorded Program ex-ante energy savings. After determining the sample size, the individual dairy, poultry, and greenhouse sites to be visited were selected at random. Because the dairy industry was relatively variable with respect to site-specific fan installations, the sample of sites to visit within this market sector was stratified in order to ensure that a representative sample of fan control systems would be verified. The Agricultural Ventilation Efficiency Program was targeted at three main market segments: Dairy, Poultry and Greenhouse. Among the three participating markets, dairy producers represented the largest installed base and also had the greatest uncertainty in estimating fan operating hours because fan operation varied depending on outdoor temperature.[63] Operating hours at poultry and greenhouse facilities were generally considered to be more predictable and could be verified through a review of historic facility operating data because these facilities are fully occupied at all times and are not likely to be as sensitive to heat as dairy operations.[64] Finally, installations at poultry producers were not verified because these installations account for less than 5% of total installations. Table 3–1 provides details on the number of sites and fans installed by market sector.

Table 3–1. Program Recorded Fan Installations

Market Sector	Sites Installed	Fans Installed
Dairy	24	1316
Poultry	1	98
Greenhouse	5	740
Total	30	2154

Verification efforts correlate most closely with IPMVP Option A, including partial measurement of isolated retrofits, coupled with engineering analysis, to determine the energy use or demand of the energy-efficient installations.

Field activities typically involved three components:

1. Site visits were coordinated with the implementation contractor and primary customer contact to establish field activity dates, identify site-level contacts, and address bio-security issues.
2. While at the site, evaluation staff conducted an area-by-area, fan-by-fan audit, noting fan count, type, voltage, and operating conditions.

[63] It was also assumed that changes in dairy farm occupancy were relatively predictable because of required milking schedules.

[64] Based on information provided through participant affidavits, fans installed in the poultry market were also thermostatically controlled, although they ran for a longer duration throughout the year. Interviews with greenhouse sector participants revealed that the fans are also thermostatically controlled but were in the initial stages of implementing them. Run hours in this sector were also close to year round.

3. Where data logging equipment was installed, a detailed description was provided with respect to logger location and the spot measurement data collected. A pick-up date was also provided to each site, and the evaluation team called each site in advance of returning to retrieve loggers.

Field verification activities took place between July 10th and July 14th, 2006, with a total of seven sites visited, or roughly 25% of all sites that participated in the Agricultural Ventilation Efficiency Program. Table 3–2 correlates expected verification activities to achieved verification activities. Overall, the two greenhouse sites verified represented 26.9% of greenhouse market sector recorded kWh (Net) savings, and 26.3% of greenhouse market sector recorded kW (Net) savings. Subsequently, the five dairy sites verified represented 42.5% of dairy market sector recorded kWh (Net) savings, and 39.5% of dairy market sector recorded kW (Net) savings.

Table 3–2. Expected and Achieved Verifications

Market Sector	Planned Verifications	Achieved Verifications	Planned Sites also Receiving Power Logging	Sites Receiving Power Logging
Dairy	6	5	3	4
Greenhouse	2	2	1	2
Total	8	7	4	6

The discrepancy that existed between the number of verifications stated in the research plan and those achieved was due, in part, to scheduling difficulties with the Program participants. In addition to attempts to schedule visits, attempts to contact participants while in the field were often complicated because many dairy producers did not carry cell phones with them when working. It should be noted that although only seven out of the expected eight verifications occurred, the sample is statistically representative of the Program because 38% of ex-ante Program savings were represented by the final sample.

Installation Verification Results

As stated previously, the primary objective of the verification was to establish the presence of Program measures and installations recorded in the final flat file provided by the Program implementation contractor. Subsequently, an installation adjustment factor was derived based on the verification data collected during the site visits. This factor accounts for differences between the installations recorded in the EnSave Program reporting records and verified installations.

Table 3–3 provides the Program reported fan installations and evaluation verified installations at the seven sites in the evaluation sample. In general, the field verification sample compares well with the Program records, with verified fan installations totaling 105% of fans installed in Program records. Verification activities at two sites indicated installation rates much higher than Program records. The occurrence of additional fans being installed by participants is consistent with the Program records and narrative. For example, EnSave reported that “two existing applicants have decided to increase the number of fans to be installed. EnSave and Edison have agreed to allow the additional fans, since the producers applications are still open.” Producers interviewed by the evaluation team indicated that the fans were likely installed under “the Program,” but could not confirm this. It was also noted in the process evaluation section of this report that participants occasionally installed fans but failed to submit paperwork for various reasons, and this may account for the additional installation observed in the verification field activities.

Table 3–3. Installation Rates Determined from Evaluation Field Activities

Site #	Market Sector	Program Reported Fan Installation Count	Verified Fan Installation Count	Installation Rate
Site 1	Greenhouse	130	120	92%
Site 2	Greenhouse	60	60	100%
Site 3	Dairy	18	36	200%
Site 4	Dairy	234	251	107%
Site 5	Dairy	110	108	98%
Site 6	Dairy	220	216	98%
Site 7	Dairy	26	50	192%
Total		798	841	105%

Discussions with participants subsequent to field verification activities, and an analysis of the verified installations provided several observations:

- Many participants from the dairy market sector expressed that the non-energy benefits from the fans (increased comfort of the livestock, enhanced productivity, etc.) were more valuable than the potential energy savings generated by the Program. To that end, many participants strived to maintain energy consumption levels greater than or equal to consumption levels previously established with older fans.
- Many participants from the greenhouse market sector explained that the non-energy benefits provided by the fans (increased air flow throughout the facilities, reduced heating requirements, diminished cases of mold) were just as, if not more, important than the reduced energy consumption afforded by the Program. Hence, many were willing to increase their load consumption by installing fans that they did not previously utilize.
- Because the variation in the number of recorded fans and fans observed in the field was small, the installation rate attributed to the Agricultural Ventilation Efficiency Program was calculated to be 100%, or 2,154 fans.

A second objective of the verification activities was to provide information on the quality of installations completed through the Program. In general, all facilities verified by the evaluation team appeared to be installed well and operating correctly. Figure 3–1 provides an example of a typical dairy farm feeding operation with a program measure fan installed.

Figure 3–1. Typical Dairy Farm Freestall

The retrofit fans provide roughly 20% to 50% more air flow than the base fans of similar horsepower, allowing either fewer fans to be installed or a like number of fans to be installed with greater airflow. As noted in the participant discussion findings above, many of the participants were willing to increase their overall energy consumption in favor of non-energy benefits. As a result, verification findings revealed a retrofit to base fan ratio greater than or equal to one at verified sites.

Figure 3–2 shows the difference between a base and Program measure fan installed at one of the participant dairy freestalls.

Figure 3–2. Base and Program Measure Fans Installed at a Dairy Retrofit

Base Fan | Program Measure Fan

The energy-efficient fans installed through the Agricultural Ventilation Efficiency Program at various greenhouse sites were somewhat less robust due to the fact that they were installed indoors, but still provided increased air flows throughout the facilities. Figure 3–3 depicts the difference between a base and Program fan installed at a participating greenhouse.

Figure 3–3. Base and Program Measure Fans Installed at a Greenhouse Retrofit

Base Fan

Program Measure Fan

Several observations are worthy of note:

- In reviewing the performance of the systems installed, it was observed that many greenhouse facilities operated the fans under a 24-hour schedule. However, the methodology employed to determine when the fans were to be activated was difficult to quantify and record due to the fact that many sites utilized climate management systems to adjust fan operation to account for a variety of factors including humidity, temperature, and ambient wind impacts.
- The dairy sector utilized a more rudimentary approach in determining when to operate the fans. All dairy participants used thermostats to control fan operations, and all thermostats measured outdoor temperatures. Once a specified threshold temperature (specified by the participant) was met, the energy-efficient fans would be activated. Of importance to note is that participant thermostat set points remained consistent before and after the fan retrofits. A weighted analysis of means revealed that the average threshold temperature utilized by Program participants was 75 degrees Fahrenheit.

Edison's internal verification protocol on the Program required verification of site installations where the Program incentive amount was $14,000 or more, and 10% verification of all other sites. Only fan models and quantities were verified. Table 3–4 provides a summary of the five sites verified by Edison showing that Program reported installation quantities matched with verification counts at all sites. There was no overlap in the Edison field sample and evaluation team field sample because the evaluation contractor focused on dairy installations for reasons cited earlier in this report, while Edison's activity focused more on the greenhouse market. We were not able to coordinate our field activities with the 2 dairy sites verified by Edison.

Table 3–4. Summary of Edison verification activity

Site #	Market Sector	Date Inspected	Quantity	Quantity Match with Program Records?
Site 8	Dairy	4/20/2006	33	Yes
Site 9	Greenhouse	5/17/2006	130	Yes
Site 10	Greenhouse	6/8/2006	156	Yes
Site 11	Dairy	6/20/2006	225	Yes
Site 12	Greenhouse	7/7/2006	334	Yes

The Edison verification data supports the 100% Program installation rate that the evaluation team recommends.

Engineering Analysis

An engineering analysis was conducted to develop adjusted realization rates for the Program. This included a detailed review of Program records and documents and data logging activities as described in the following sections.

Review and Evaluation of Program Data

The final Program records submitted by the implementation contractor to Edison were analyzed for accuracy and consistency, and to ensure that the underlying assumptions were reasonable. The key documents analyzed included:

- The final Program 'flat file' submitted on August 1, 2006.[65] This file documented installation activities at each participant site, including the type and number of fans installed, underlying energy savings assumptions, and the dates of the various installations. The format of the Ag Vent Program file was different from the standard flat file format used by other IDEEA programs. *This file provided Program net energy savings values.*
- The final Program 'workbook' dated July 15, 2006.[66] This document provided a reporting format for the CPUC and represented a summary of the information contained in the Program flat file. It did not contain site-specific data. *This file provided Program net energy savings value as well*.
- The implementation contractor's savings worksheet[67] designed for the Program. *This file provided Program energy savings assumptions.*

[65] Edison VENT IDEEA Final Installation Report 08.01.06.xls

[66] Edison VENT July 2006 Report Workbook 07.15.06.xls

[67] Agricultural Ventilation Fan Efficiency Program, Documentation of Savings and Incentive Calculations and Baselines.doc

- The whitepaper titled "Agricultural Ventilation Fan Efficiency Program Documentation of Savings and Incentive Calculations and Baselines." This file documents the approach to calculating savings from fan installations used in the Southern California Edison Agricultural Ventilation Fan Savings Calculator.
- Cut sheets for fans installed through the Program.

Several observations resulted from this review.

1. Program records indicated that approximately 276 energy-efficient fans installed through the Program were retrofits. Verification activities confirmed that these estimates were, for the most part, accurate. In addition, on-site observations correlated directly with the type of fan installations recorded for each participant site (e.g., 48", 50", 51", etc.).

2. The implementation contractor's savings and efficiency estimates were reviewed for accuracy and consistency. The calculation worksheet allocated kW ratings for a variety of existing and retrofit fans by analyzing fan tests conducted by BESS[68] Lab, and accounting for fan nameplate information. The evaluation team concluded that EnSave was accurate in attributing kW consumption values to both existing fans and fans installed through the Program. However, a separate analysis of fan operating hours was conducted, and the data extrapolated, to derive kWh consumption of Program fans.

3. There was a discrepancy between the physical installation record sheets and the final flat file provided by EnSave. The flat file indicated that 130 twenty-inch energy-efficient fans were installed at one location. However, the installation records (and verification activities) detailed 120 fans being installed at this particular site.

4. The gross demand and energy savings values reported in the final Program workbook differed *significantly* from the values recorded in the final Program flat file. The workbook reported that net demand and energy savings values are 457.2 kW and 3,509,454 kWh respectively, versus 694.3 kW and 2,162,545 kWh in the flat file. It was concluded that incorrect per-unit demand and energy savings estimates were used in the workbook. For example, the per-unit energy savings stated in the workbook appear to be based on an average annual operating hours estimate of approximately 7,673 hours. This is higher than the weighted average of 7,200 annual hours for the greenhouse market, and significantly higher than the weighted average of 2,083 annual hours for the dairy market. It is recommended that the implementation contractor review their workbook assumptions and revise the per-unit gross savings estimates accordingly. Using the Program default NTG of 0.75, Table 3–5 provides the workbook net savings estimates, and the net savings calculated from the Program flat file. The adjusted Program net savings are presented later in this report.

[68] Bioenvironmental and Structural Systems Laboratory

Table 3–5. Comparison of Reported Net Savings and Calculated Net Savings

Net Effects	Workbook Reported	Flat File Reported
Net Coincident Peak kW	457.2	694.3
Net Annual kWh	3,509,454	2,162,545

Site Data Logging Activities

In order to confirm Program assumed annual fan operating hours, the evaluation team installed power loggers on a sample of energy-efficient fans distributed among the sample of sites visited. The data loggers recorded amperage on the circuits used to supply the single speed retrofit fans, and spot measurements of voltage and power factor were used to calculate resulting demand and energy consumption values. Logging occurred within the Edison peak-summer period defined as 6/2/2006 through 10/6/2006. Loggers were in place for approximately three weeks. The sample of sites and circuits used to verify fan run hours was selected based on the following factors:

- The dairy market sector utilized setback thermostats to operate the installed fans. In addition, a majority of the participant sites were within close proximity of one another. Hence, it was concluded that logging operating hours on fan circuits at four sites that were separated by a sufficient distance would yield a representative sample of the market.
- The greenhouse market sector accounted for a variety of variables in determining when to operate the installed fans. As such, it was more difficult to extrapolate operating schedules for the entire market segment. It was concluded that by logging fan circuits at two sites that represented approximately 25% of the total number of fans installed in the greenhouse market sector, a representative sample of the greenhouse segment would be obtained.

The results of the evaluation team's data logging activities are provided below.

Verification of Fan Operating Hours

Data loggers were installed at four participant dairy sites and two participant greenhouse sites to further confirm self-reported operating schedules. These loggers recorded the amperage draw of the fans throughout the day, and when the fans were turned on or off. At the dairy sites, the loggers were only placed in freestalls that were subject to the influences of the setback thermostats. The greenhouse data loggers were placed on random fans controlled by their respective greenhouse operating systems.

It was discovered, after collecting the loggers, that only two loggers (one greenhouse fan and one dairy fan) provided pertinent information due to the fact that the current transducers failed to record meaningful amperage readings on fans. This is likely attributable to the fact that the fan operating amperage was below the low error threshold allowable for the transducers used. As such, the logger data was inconclusive. However, because the majority of the dairy participants were located within a small geographic area, these sites operated under nearly identical weather patterns throughout central California and the data collected from the thermostat set points and historic weather data provided information that allowed for an accurate estimate of fan operating hours installed at dairy sites. The data from the operative logger installed at the single fan at one greenhouse site did provide useful information and was included in the analysis. In general, data gathered through thermostat and weather analysis, onsite interviews, and a review of application data provided sufficient information to accurately assess fan run times in both the dairy and greenhouse markets.

Analysis of Thermostat Setback Capabilities

In order to accurately quantify the percentage of fans operating at any given time in the dairy market segment, it was necessary to identify and confirm average thermostat setback settings utilized by each participant site. Onsite verifications conducted at six participant sites confirmed that Program records correlated with established operating protocols.

A weighted comparison of means was utilized to derive the average freestall thermostat setback setting employed by the dairy market sector participants. This was calculated to be 75 degrees Fahrenheit. Moreover, an analysis of averaged temperature data[69] provided the necessary information required to calculate average hourly operating schedules of the fans installed through the Agricultural Ventilation Efficiency Program.[70]

Figure 3–4 provides a graphical representation of the average hourly temperatures for the demographic region of Fresno, which was deemed representative of the Program's fan installation area. The red curve corresponds to the average thermostat setback setting employed at the participant dairy sites. Once the threshold temperature had been met, the new fan installations would operate to cool the livestock.

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[69] Energy10 WeatherMaker v1.0.4

[70] This was a temperature analysis aggregating hours for which the temperature was greater than 75 degrees.

Figure 3–4. Average Hourly Temperature and Thermostat Setback Settings of Fresno, CA

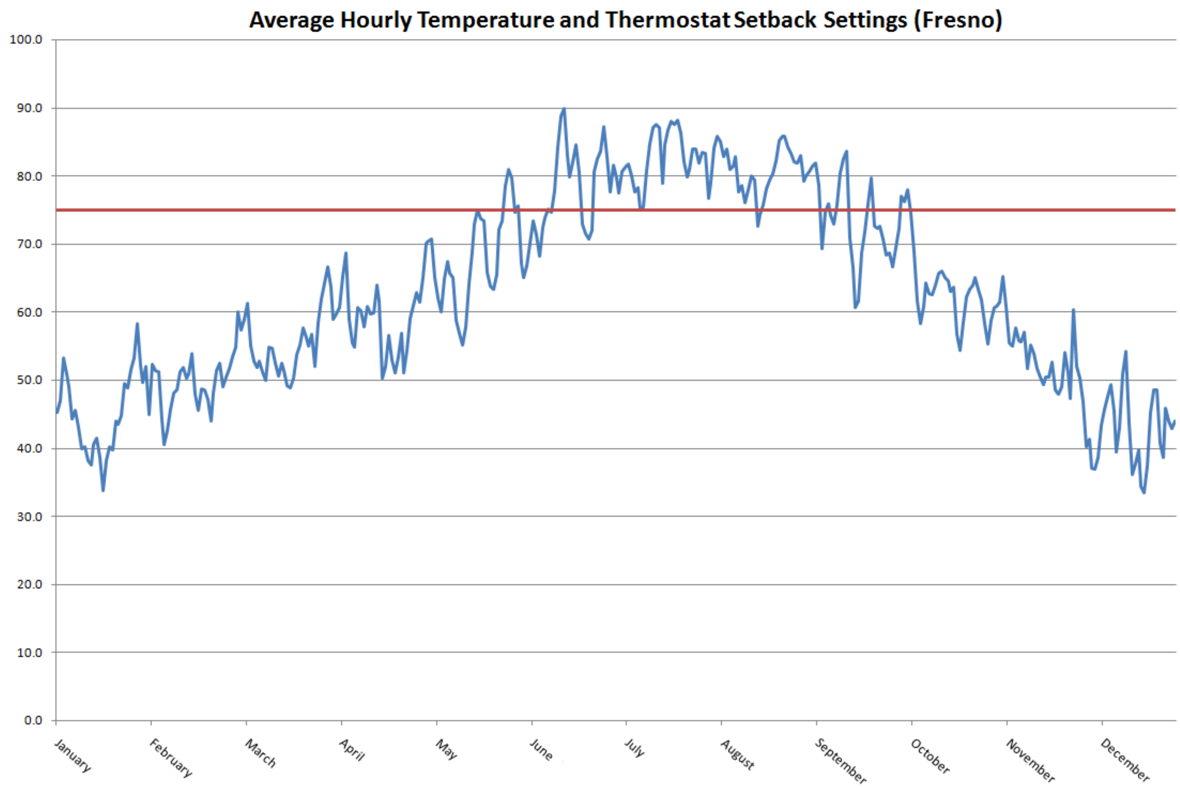

Figure 3–4 indicates that the fans are mainly operative between May and October. Interview data confirmed this with a majority of respondents stating that they did not operate the fans from mid-October to mid-May. A detailed analysis of the hourly temperature data for this demographic region revealed that fans installed in the dairy sector were expected to run an average of 2,040 hours per year. This was done by aggregating the total number of hours throughout the year that the temperature was equal to, or greater than, the average thermostat setback setting. Overall, this value compared favorably with the 2,083 weighted average annual operating hours reported in the Program flat file.

Impact Evaluation Results

Engineering Estimates of Ex-post Gross Program Savings

The Program savings estimates are based on a Microsoft© Excel-based tool created and used by EnSave specifically for the IDEAA project. The tool, the Edison Agricultural Ventilation Fan Efficiency Program Savings Calculator (the Savings Calculator), provided energy savings, demand savings, and incentive calculations for the respective program. The tool was derived from fan test information published by the Bioenvironmental and Structural Systems (BESS) Laboratory at the University of Illinois at Urbana-Champaign. Although the tool was not provided to the evaluation team, the documentation related to the tool was reviewed by the evaluation team to identify how the energy savings were derived. The following sections discuss the review of the tool and several observations about the use of the tool in the dairy and greenhouse markets.

Engineering Review of Fans Installed at Dairy Sites

The EnSave calculator provided adequate discussion on the various inputs required to calculate savings and incentives, however it did not provide sufficient data on how Program savings were estimated for each site, such as the base case and Program-installed fan efficiencies.[71] These data were also not available from EnSave. In order to validate the savings estimated by the Savings Calculator, the evaluation team estimated demand savings for various fans using parameters provided by the calculator documentation and assumptions on fan motor efficiency. One key component of the Savings Calculator was the fan kW figures calculated based upon fan tests conducted by BESS Lab. These tests provided fan efficiency ratings based on CFM/watt values. Table 3–6 provides the efficiency ratings for base fans and the minimum efficiency for Program-qualified fans between 50” and 51”. These fans accounted for 97% of fan units installed through the Program at dairy sites, and 95% of energy savings for this market. The fan CFM ratio shows that 1.42 base fans are needed to provide the same air flow as a single Program fan at minimum Program efficiency. It is important to note that Program savings estimates are based on the assumption that a specific CFM rate was necessary for each site, and that 1.42 base fans would have been installed for each efficient fan installed through the Program to meet this CFM target.

Table 3–6. Base and Measure Fan Efficiencies (CFM/Watt) for the Predominant Fan Installed at Dairies

Fan Size	Base Fan (CFM/Watt)	Measure Fan Minimum (CFM/Watt)	Fan CFM Ratio
50" & 51"	15.6	22.5	1.42

The evaluation team calculated the motor power requirements for the one-horsepower motors used in 50” and 51” fans using fan motor efficiency estimates based on EPAct and NEMA Premium® Efficiency data provided by Motor Master +. As shown in Table 3–7, a one-horsepower base fan at 76.8% efficiency requires 0.971 kW. The fan CFM ratio of 1.42 indicates that 1.42 base fans would be required to provide the same airflow as one Program measure fan, yielding a net base demand of 1.379 kW in required base fan demand. Based on an assumed measure fan motor efficiency of 85.7%, one measure fan would require 0.870 kW. The resulting difference in demand is 0.509 kW.[72] This same analysis was conducted using only fan CFM ratios (identical motor efficiencies), yielding a savings of 0.408 kW per fan. These calculated

[71] EnSave established a “base case” fan for situations where no fans previously existed. Savings were computed as the difference between the Program-installed fan and the base case fan. Base case fan efficiencies were determined from parameters provided by the E3 calculator documentation and assumptions on fan motor efficiency. Field collected nameplate data were also used, where appropriate.

[72] Estimated average gross kW savings / fan of 0.509 kW = 0.971 kW / base fan x 1.42 fan CFM ratio - 0.870 kW / measure fan.

demand savings compare favorably to the Program-recorded average gross kW savings of 0.389 kW per 50” fan and .427 kW per 51” fan. This analysis assumes that fewer high efficiency fans were installed compared to the number of lower efficiency fans needed to achieve the same airflow.

Table 3–7. Calculated and Program Recorded Average Gross Demand Savings—Dairies

Fan Size	Hp	Assumed Base Fan Motor Efficiency	Assumed Base Fan kW	Base Fan Required kW Adjusted for CFM Ratio of 1.42	Estimated Measure Fan Motor Efficiency	Estimated Measure Fan kW	Estimated Average Gross kW Savings / Fan Adjusted for Motor Efficiencies	Estimated Average Gross kW Savings / Fan Not Adjusted for Motor Efficiencies	Program-Recorded Weighted Average Gross kW Savings / Fan
50" & 51"	1	0.768	0.971	1.379	0.857	0.870	0.509	0.408	0.407

Based on this analysis, the evaluation team accepts the savings estimates provided by the Savings Calculator (program recorded gross savings) for the 50” and 51” fans. A similar analysis was conducted on the other fan types installed through the Program and their respective kW savings estimates were deemed accurate.

This analysis provided the gross ex-ante and ex-post savings estimated for fans installed in the dairy market. Table 3–8 also provides the verified run hours based on the ex-ante estimates and field verification activity. The ex-ante analysis provides reported fan installations, average kW savings per fan, and the demand and energy savings values provided in the final Program flat file records. The ex-post analysis provides the final recommended unit installations, adjusted kW savings per fan, and the recommended demand and energy savings for the dairy market.

Table 3–8. Dairy Ex-ante and Ex-post Gross Savings Estimate

Fan Size	Verified Annual Operating Hours	Ex-ante Analysis				Ex-post Analysis			
		Recorded Unit Installs	Ave Net kW / Unit	Recorded Net kW Savings	Recorded Net kWh Savings	Verified Unit Installs	Adjusted Gross kW / Unit	Adjusted Gross Program kW	Adjusted Gross Program kWh
20"	2,040	6	0.283	1.7	2,834	6	0.378	2.3	4,624
36"	2,040	18	0.300	5.4	9,621	18	0.400	7.2	14,688
48"	2,040	26	0.324	8.4	15198	26	0.432	11.2	22,930
50"	2,040	676	0.389	263.2	529249	676	0.519	350.9	715,931
51"	2,040	588	0.427	251.0	548065	588	0.569	334.7	682,829
20'	2,040	2	8.750	17.5	29,964	2	11.667	23.3	47,600
Total		1,316		547.2	1,134,931	1,316		729.7	1,488,602

Engineering Review of Fans Installed at Greenhouse Sites

In order to accurately attribute energy savings to the greenhouse fans, the evaluation team emulated the approach and methodology used to evaluate the dairy market. Table 3–9 details the ratio of base fans to energy-efficient fans that would be required to provide an equivalent CFM for the fan sizes installed in greenhouses.

Table 3–9. Greenhouse Base and Measure Fan Efficiencies

Fan Size	Fan CFM Ratio (CFM/Watt)
12"	1.51
20"	1.41

Table 3–10 shows the analysis of energy savings calculated from the fan CFM ratio table. The base fan kW consumption parameters were adjusted according to the CFM ratio and further compared to the model average gross kW savings per fan. The calculated demand savings compare favorably to the unit demand savings recorded by the Program.

Table 3–10. Calculated and Program Recorded Average Gross Demand Savings—Greenhouses

Fan Size	Hp	Assumed Base Fan Motor Efficiency	Assumed Base Fan kW	CFM Adjusted Base Fan Equivalent kW	Measure Fan Motor Efficiency Modeled	Measure Fan kW from Model	Estimated Average Gross kW Savings / Fan Adjusted for Motor Efficiencies	Estimated Average Gross kW Savings / Fan Not Adjusted for Motor Efficiencies	Program-Recorded Average Gross kW Savings / Fan
12"	1/3	0.768	0.323	0.488	0.857	0.290	0.198	0.124	0.134
20"	1/3	0.768	0.323	0.456	0.857	0.290	0.166	0.199	0.188

Table 3–11 highlights the run hour assumptions, ex-ante, and ex-post savings values attributable to the fans that were installed in the greenhouse market. Due to the fact that the greenhouse market participants employed a complicated, hard-to-simulate, fan operation system, the implied operating hours were obtained from participant interviews and Program application sheets.

Table 3–11. Greenhouse Installation Ex-ante and Ex-post Gross Savings Estimate

Fan Size	Verified Annual Op Hours	Ex-ante Analysis				Ex-post Analysis			
		Recorded Unit Installs	Ave kW saved / Unit	Recorded Net kW Savings	Recorded Net kWh Savings	Verified Unit Installs	Adjusted Gross kW / Unit	Adjusted Gross Program kW	Adjusted Gross Program kWh
12"	7,253	60	0.134	8	58,173	60	0.179	10.72	77,752
20"	7,211	680	0.188	127.5	919,410	680	0.251	170.45	1,229,139
Total		740		135.5	977,583	740		181.17	1,306,891

Including the 1,306,891 gross kWh savings for the greenhouse market, 1,488,602 kWh for the dairy market, and 66,708 kWh savings attributable to the poultry market, the Program gross ex-post energy savings are estimated at 2,862,201 kWh annually.

Final Program Impacts

The Program impacts were estimated collectively for all measures installed through the Agricultural Ventilation Efficiency Program. Table 3–12 presents the first year ex-ante gross and net energy savings goals and reported Program accomplishments.

Table 3–13 shows the first year ex-ante gross and net demand savings goals and reported Program accomplishments. Implementers reported the Program net ex-ante net savings goals and reported accomplishments were estimated using a 0.75 NTG ratio.

However, it should be noted that there was a discrepancy between the overarching savings reported by the final flat file and the final workbook. The final flat file specifies net annual Program savings to be 694 kW and 2,162,545 kWh, whereas the final workbook specifies net annual Program savings to be 457 kW and 3,509,454 kWh.

Table 3–12. Comparison of Ex-ante Energy Savings Goals and Reported Accomplishments

	Ex-ante Program Gross Annual kWh Goals	Ex-ante Program Net Annual kWh Goals	Reported Ex-ante Gross Annual kWh Savings	Reported Ex-ante Net Annual Program kWh Accomplishments
AgVent	3,518,181	2,638,636	4,679,272	3,509,454

Table 3–13. Comparison of Ex-ante Demand Savings Goals and Reported Accomplishments

	Ex-ante Program Gross Annual kW Goals	Ex-ante Program Net Annual kW Goals	Reported Ex-ante Gross Annual kW Savings	Reported Ex-ante Net Annual Program kW Accomplishments
AgVent	457	343	609	457

The Program impacts are determined by two factors:

1. Program performance in terms of accomplishing Program participation goals.
2. Estimated ex-post savings impacts for the installed measures compared to the ex-ante measure savings assumptions.

The Program gross and net realization rates have been calculated as the combined effect of these two factors. The Program goals, overall and for its constituent measures, ex-post gross and net energy savings, and respective realization rates are shown in Table 3–14. The Program evaluated ex-post gross energy savings are 2,862,201 kWh compared to the Program gross savings goal of 3,518,181 kWh. The Program evaluated ex-post net energy savings, using NTG ratio of .86, are 2,461,493 kWh compared to the Program ex-ante goal of 2,638,636, yielding a 93 percent net energy savings realization rate.

Table 3–14. Comparison of Programs Goals and Ex-post Gross and Net Energy Savings

	Ex-ante Program Gross Annual kWh Goals	Ex-ante Annual Net Energy Savings Goals	Evaluated Gross Ex-post Program kWh Savings	Gross Energy Realization Rate	Evaluated Net Ex-post Program kWh Savings	Net Energy Realization Rate
AgVent	3,518,181	2,638,636	2,862,201	81%	2,461,493	93%

The Program goals, ex-post gross and net demand savings, and respective realization rates are shown in Table 3–15. The Program evaluated ex-post gross demand savings are 926.2, as compared to the Program ex-ante goal for demand savings of 457 kW.

Table 3–15. Comparison of Programs Goals and Ex-post Gross and Net Demand Savings

	Ex-ante Program Gross Annual kW Goals	Ex-ante Annual Net Demand Savings Goals	Evaluated Gross Ex-post Program kW Savings	Gross Demand Realization Rate	Evaluated Net Ex-post Program kW Savings	Net Demand Realization Rate
AgVent	457	343	926.2	202%	796.5	232%

Gross and net realization rates calculated with implementer-reported ex-ante results and evaluated ex-post results are shown in Table 3–16 and Table 3–17 below. The Program evaluated ex-post gross energy savings are 2,862,201 kWh compared to the Program reported ex-ante gross savings of 4,679,272 kWh, yielding a Program realization rate of 61% percent. The Program evaluated ex-post net energy savings are 2,461,493 kWh compared to the reported ex-ante net of 3,509,454 kWh, yielding a 70 percent net energy savings realization rate.

Table 3–16. Comparison of Implementer-Reported Program Accomplishments and Evaluated Ex-post Gross and Net Energy Savings

	Ex-ante Program Gross kWh Reported	Ex-ante Net Energy Savings Reported	Evaluated Gross Ex-post Program kWh Savings	Gross Energy Realization Rate	Evaluated Net Ex-post Program kWh Savings	Net Energy Realization Rate
AgVent	4,679,272	3,509,454	2,862,201	61%	2,461,493	70%

Table 3-17 shows the Program evaluated ex-post gross demand savings are 926.2 kW and the implementer-reported ex-ante gross demand savings of 609 kW, for a 152% realization rate. The Program evaluated ex-post net demand savings are 796.5 kW and the implementer-reported ex-ante gross demand savings of 457 kW, for a 174% realization rate.

Table 3–17. Comparison of Implementer-Reported Programs Accomplishments and Evaluated Ex-post Gross and Net Demand Savings

	Ex-ante Program Gross kW Reported	Ex-ante Net kW Savings Reported	Evaluated Gross Ex-post Program kW Savings	Gross Demand Realization Rate	Evaluated Net Ex-post Program kW Savings	Net Demand Realization Rate
AgVent	609	457	926.2	152%	796.5	174%

Final Program savings, NTG ratios and realization rates are shown in Table 3–18 and Table 3–19. The individual components of the Program were assumed to have a net to gross ratio of .86 for evaluation purposes as compared to the implementer’s final workbook assumption of .75.

Realization rates were calculated as the ratio of the evaluated net ex-post savings to the reported ex-ante gross savings.

Table 3–18. Program Energy Savings

	Ex-ante Reported Gross kWh Savings	Evaluated Ex-post Gross Program kWh Savings	NTG Ratio	Evaluated Ex-post Net kWh Savings	Realization Rate (Evaluated net ex-post /reported ex-ante gross)
AgVent	4,679,272	2,862,201	.86	2,461,493	53%

Table 3–19. Program Demand Savings

	Ex-ante Reported Gross kW Savings	Evaluated Ex-post Gross Program kW Summer Savings	NTG Ratio	Evaluated Ex-post Net kW Savings	Realization Rate (Evaluated net ex-post /reported ex-ante gross)
AgVent	609	926.2	.86	796.5	131%

Lifecycle Savings

Table 3–20 shows that the economic useful lifetime of the fans is 15 years, which would produce net lifecycle savings of 36,922,395 kWh. Table 3–21 summarizes proposal, reported and evaluated Program savings. The evaluated kW savings refer to summer savings as shown in Table 3–21.

Table 3–20. Program Ex-post Lifecycle Net Energy Savings

Ex-post EUL	Ex-post Lifecycle Net Energy Savings
15	36,922,395

Table 3–21. Savings Summary

		Proposal				Reported			Evaluated		
	Ex-ante Gross	Net to Gross	Ex-ante Net		Ex-ante Gross	Net to Gross	Ex-ante Net		Ex-post Gross	Net to Gross	Ex-post Net
kWh	3,518,181	.75	2,638,636		4,679,272	.75	3,509,454		2,862,201	.86	2,461,493
kW	457	.75	343		609	.75	457		926.2	.86	796.5

The distribution of lifetime savings in CPUC format is shown in Table 3-22, below.

Table 3–22. Program Lifetime Savings

Year	Calendar Year	Ex-ante Gross Program-Projected Program MWh Savings (1)	Ex-post Net Evaluation Confirmed Program MWh Savings (2)	Ex-ante Gross Program-Projected Peak Program MW Savings (1**)	Ex-post Evaluation Projected Peak MW Savings (2**)	Ex-ante Gross Program-Projected Program Therm Savings (1)	Ex-post Net Evaluation Confirmed Program Therm Savings (2)
1	2004						
2	2005	4,679	2,461	0.609	.797		
3	2006	4,679	2,461	0.609	.797		
4	2007	4,679	2,461	0.609	.797		
5	2008	4,679	2,461	0.609	.797		
6	2009	4,679	2,461	0.609	.797		
7	2010	4,679	2,461	0.609	.797		
8	2011	4,679	2,461	0.609	.797		
9	2012	4,679	2,461	0.609	.797		
10	2013	4,679	2,461	0.609	.797		
11	2014	4,679	2,461	0.609	.797		
12	2015	4,679	2,461	0.609	.797		
13	2016	4,679	2,461	0.609	.797		
14	2017	4,679	2,461	0.609	.797		
15	2018	4,679	2,461	0.609	.797		
16	2019	4,679	2,461	0.609	.797		
17	2020						
18	2021						
19	2022						
20	2023						
TOTAL	2004-2023	70,189	36,922				

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4. Conclusions and Recommendations

The Program was slow to get off the ground and missed an important marketing event, the AgExpo in Tulare, CA. Only two of the anticipated 170 HVLS fans were installed. While more energy-efficient fans were installed than projected, the Program did not meet its kWh and kW goals. The fan technology was slow to penetrate the agricultural community. Where fans were installed, however, the producers were happy with the technology. In many cases, the non-energy benefits outweighed the benefits from energy savings.

Conclusion 1. *The Program was not implemented as planned and changes in program design were not documented.*

According to the Technical Proposal, the Program was designed to replace inefficient fans with efficient fans. The Program evolved organically to include installation of efficient fans in new construction. The Program evolved even further to include installation of new fans in existing buildings. Neither EnSave nor Edison was aware the Program documents limited discussion to replacement of existing fans. Both felt the intent of the Program was intact and that the Program followed with the philosophy that more efficient fans were installed in retrofit or replace-on-burnout applications than would have been without the Program. The addition of new load was not an issue. In reality, new load—that would not have existed absent the Program—was added whenever fans were installed where none had existed before. This occurred in both new and existing buildings. In new construction cases where high efficiency fans where installed in lieu of standard efficiency fans, it is likely that energy savings were realized based on the assumption that a greater number of standard efficiency fans would have been installed to achieve the same air flow as the high efficiency units. In retrofit applications, it is likely that participants could install larger numbers of inefficient fans to achieve the same airflow as smaller numbers of efficient fans. As such, we consider the energy savings attributable to high efficiency fans *in achieving the desired air flow* to be a valid program savings. In applications involving a one-for-one replacement of existing fans, there were substantial non-energy benefits, but only marginal energy savings. .

Recommendation 1. *Clearly define the extent of the Program, follow the implementation plan, and document any changes in program design.*

The proposal should clearly define the extent of the Program and specifically acknowledge that new load will be added. Going forward, the Program should define eligible participants as anyone in the market for ventilation fans, including both retrofits for old fans and new fans. Clear metrics should be established to track activity within the various sub-markets, such as retrofit and new construction. These metrics should be reported with a frequency that allows for adjustments in program activity if program goals are at risk. For example, an early recognition that the new construction market was dominating program activity may have refocused outreach efforts on the retrofit market.

Conclusion 2. *Baseline operations and field installations need to be clearly identified.*

The number of new and retrofit fans and whether they were installed in new construction or existing buildings was not clearly documented. The existing conditions, including the presence or absence of fans, their efficiency levels and operating hours, were also not completely documented. The location of fans installed through the Program was not documented at all, which made field verification very difficult, particularly when, as was the case with some dairy farms, there were multiple barns with structures spread out over 10,000 acres. Some producers did not have records or recall how many new fans were installed and how many were retrofit. There was some discrepancy between counts in the implementer's records and at the site. Another baseline correction that could be made is with the implementer's workbook assumptions, including, for example, operating hours.

Recommendation 2. *Record baseline operations and field data.*

It is recommended that baseline conditions be clearly documented and that the implementation contractor review their workbook assumptions e.g., number and horse power of fans removed or retrofitted. Installers should clearly document the location of all fans installed, and the operating hours and conditions. In general, this requires transparent documentation of model data, quantity, capacity, efficiency, and operating data (annual run hours, etc.) on both base and measure equipment. For example, data provided by the Program did not document the model data or key efficiency metric, cfm/watt, on many fans. Because of this, the evaluation contractor could not verify the accuracy of some of the assumptions in the ex-ante savings calculations.

Conclusion 3. *Timing is critical in program marketing.*

Because the Program started late, EnSave did not attend a major marketing event held each February. As such, the Program and fans did not get the exposure they might have otherwise received. Marketing to a broad audience should include appearance at the well-attended industry trade shows, such as the WorldAg Expo. Many fan vendors and agricultural producers make their purchase decisions early in the year, and are influenced by what they see at the Expo.

Recommendation 3. *Ensure future programs targeting the agricultural sector are ready to 'hit the streets' in time to take advantage of major marketing events like the agricultural trade shows.*

Conclusion 4. *The major market barrier is first cost.*

Nearly all participants reported that they would not have been able to install the fans without the rebate. Dairy producers' ability to participate is highly dependent on the price of milk. Other agricultural producers are also dependent on the market prices for their products.

Recommendation 4. *Continue the incentive level into the successor program.*

To ensure continued ability to install energy-efficient fans, continue the Program's incentive levels into the successor programs. Several producers noted that they had a number of buildings, and would install additional fans particularly if the incentive was available.

Conclusion 5. *The number of HVLS fans planned for installation was minimal.*

Producers did not make the leap to HVLS fans. Only two 20-foot HVLS fans were actually installed, and this producer had already made the decision to install HVLS fans. Producers were hesitant to install the HVLS fans because they look different from standard fans and they were unfamiliar with this fan's performance. The proposed showcase farms were designed to address this market barrier, but unfortunately, no showcase farms were implemented.

Recommendation 5. *Increase marketing and education about the HVLS fans.*

Marketing and education efforts around the HVLS fans should be increased. Offering incentives with a limited focus on the HVLS technology could prove successful in introducing it to a wider audience. Establishing the showcase farms with the HVLS technology as originally planned could also be a helpful marketing tool.

Conclusion 6. *Savings and incentives were lost on busy producers.*

Some producers did not submit paperwork to Edison and did not receive the incentives after installing fans. These savings could not be counted and the producers did not receive their incentives. Checks were mailed to the producer although some paperwork was filled out by the end user and by the dealers. The process needed some smoothing and streamlining.

Recommendation 6. *Restructure the incentives.*

Incentives directed toward the dealer or distributor may help motivate them to work with the buyer to fill out the paperwork. If the dealer or distributor received the incentive, the producer would not be required to expend the funds then wait for an incentive check to reimburse them. Producers may find it easier to invest in the fans if the amount of their cash outlay were reduced. Incentives directed at the dealer may also have the effect of increasing the participation.

Conclusion 7. *Non-energy benefits are as important as energy savings.*

During both the process interviews and the impact evaluation team's site visits, producers commented about the importance of non-energy benefits, including for example, increased comfort of the livestock, enhanced productivity, increased air flow throughout the facilities, reduced heating requirements, diminished fungus, mold, and the need for fungicides. Some noted they were more important and valuable than the potential energy savings generated by the Program. Participants were able to add more fans and maintain energy consumption levels that were equivalent to prior levels. Others were willing to add load because it was offset by the increased productivity.

Recommendation 7. *Include non-energy benefits in program marketing.*

Program findings illustrated the importance and impact of non-energy benefits in participant market sectors. An effective marketing effort should be structured around the most widely accepted and discussed advantages to be offered by the fans, in addition to potential energy savings. Specific comments and quotes from participants could serve to illustrate the significance of these benefits, and graphical representations of these benefits may help to promote future program participation. A broad-based marketing approach (see Recommendation 8) addressing the most valuable market specific non-energy benefits would generate further interest.

Conclusion 8. *The word is slowly getting out.*

The agricultural community is really a small community where producers talk to each other. Participants hear about the program from colleagues; half had already heard about the efficient fans. Some said they would like to have heard about the Program from Edison, in addition to their vendors. Half the fan vendors knew about the technology before hearing about the Program, but only eight of almost 100 vendors participated. Nonparticipants appear to be self-selecting (two of twenty-three didn't think they qualified; twelve didn't need fans at that time). Participants and nonparticipants have participated in other Edison programs. There is movement by manufacturers toward increasing the energy efficiency of their fans, as shown through their interest in being included in the BESS Guidebook. In addition, implementers received calls from producers and vendors inquiring about continuing the Program. EnSave estimates another 7,500 fans could be eligible for replacement with efficient fans.

Recommendation 8. *Broad-based marketing is needed.*

Marketing the program to the greater agricultural community, as was the implementer's approach, appears to be a good approach. Continued marketing is needed. Additional effort is needed to recruit fan vendors. Showcase farms will help to demonstrate the technology within the agricultural community. Additional marketing from Edison would be well received, according to producers' comments.

4. AirCare Plus^{SM} Program

1. Program Description

Portland Energy Conservation Inc. (PECI), proposed AirCare Plus^{SM} in response to Southern California Edison's requests for innovative energy-efficiency proposals. Southern California Edison awarded PECI a $1,499,813 contract to implement AirCare Plus^{SM} under the 2004-2005 Innovative Designs for Energy Efficiency Activities (IDEEA) program. Portland Energy Conservation Inc. designed AirCare Plus^{SM} for small rooftop HVAC units installed in light commercial buildings and uses an off-the-shelf hand-held diagnostic computer to inspect, diagnose, and make retrofits that save energy, reduce downtime, and increase comfort and equipment service life. AirCare Plus^{SM} was designed to provide comprehensive services to a hard-to-reach market. The Program integrates the delivery of a package of small hardware retrofits and mechanical adjustments for 3–17.5 ton HVAC units. The diagnostic work was provided to the customer at no charge and incentives were offered for retrofitting rooftop HVAC systems.

PECI estimated that about half of small commercial rooftop units are covered by maintenance contracts that provide a minimum amount of service.[73] PECI developed tools that dovetailed with and extended current market practice to include diagnostics, system modifications and retrofits. In this Program, PECI proposed using their hand-held diagnostic computer to inspect, diagnose, and make retrofits that save energy, reduce downtime, and increase comfort and equipment service life. In addition to the tools, the Program included training and technical follow-up.

PECI's goal was to offer a program integrated with the current maintenance practices of the service providers; that is, the HVAC contractors trained to deliver the service. The AirCare Plus^{SM} diagnostics and retrofits were seen as a value-added service. PECI's goal was to train 65 technicians throughout Edison's service territory who would then deliver the HVAC analysis and retrofits on 5,600 rooftop HVAC units.

Program implementers and managers felt that in addition to offering new skills for contractors to serve an otherwise overlooked market segment, the innovative aspects of the Program were that the Program offered extensive data capturing capabilities to ensure accurate measurements and instantaneous feedback and troubleshooting for technicians while on the rooftop. Edison had not offered a diagnostics based retro commissioning program. The delivery approach proposed in this Program was unique. Diagnostics such as those proposed within this Program are not currently self-sustainable and require the support of utility incentives until such time as the market has been transformed to include enhanced diagnostics as standard practice.

[73] PECI, AirCare Plus^{SM} Proposal to Southern California Edison, page 5.

PECI delivered the Program through HVAC contractors who already had a maintenance service contract with their customers; thus, most customers were not involved in making a decision to participate in the Program. Customers included small restaurant and “fast food” chain accounts, schools, churches, real estate management firms, and other small businesses.

The service was delivered in two steps. The first step was the basic inspection in which an AirCare Plus^{SM} technician screened an HVAC unit to identify problems with the thermostat, airflow, refrigerant charge, and economizer using the hand-held tools. In this basic inspection, the Schrader cap was replaced, minor adjustments were made to the economizer (if necessary), and a preliminary screening was done to identify maintenance issues and further adjustments or retrofits required to improve the efficiency of the rooftop HVAC system. The second step was a follow-up visit to inspect the rooftop unit, and retrofit or adjust its components for optimal performance. The customer received a service summary report with site-specific findings and recommendations.

The Program addressed major components of the HVAC rooftop units which included:

- Refrigerant cycle
- Evaporator air flow
- Economizer efficiency
- Thermostat optimization

Retrofits that optimized the major HVAC components included:

- HVAC replacement
- Economizer control package
- AirCare basic package
- AirCare refrigerant tune-up
- AirCare 2-unit refrigerant
- Programmable thermostat
- AirCare air flow economizer adjustments[74]
- Electronically Commutated Motors ECMs
- Programmable thermostat upgrade plus economizer adjustment[75]

The diagnostic data collected on the HVAC unit are entered into the hand-held computer, which analyzes the data and directs the technician to the next step. Software diagnoses the as-found conditions, and then recommends adjustments to optimize the system, including the refrigeration cycle and the economizer package. The protocols are designed to optimize the work flow of the

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[74] Two services bundled together as a package.

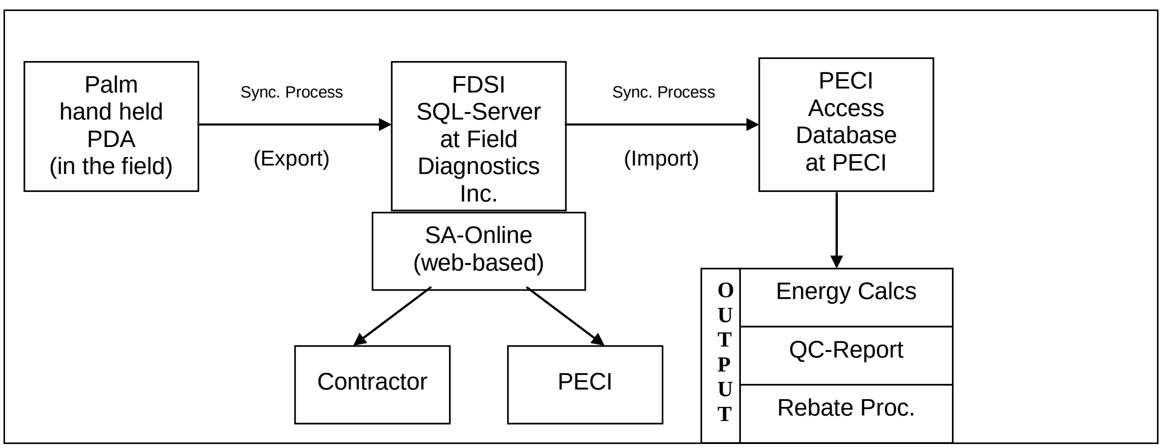
[75] Energy savings are realized though additional hours of economizer operation though better control capability. The upgrade is for thermostats that are not designed for 2 stage cooling. .

technician. The software is “brand-customized” so that trouble-shooting is related to the generic and specific economizer, e.g., Honeywell, Trane, Carrier, and Johnson controllers. Technicians are expected to have refrigerant in their service vans and can order programmable thermostats, electronically commutated motors, and new HVAC units, as needed, from their preferred vendor. For convenience, PECI provided the brass caps for the Schrader valves, applied to stop potential refrigerant leaks.

The procedures were designed so that, while on-site, contractors could upload the test data into a server via a wireless or WAN connection. The hand-held PDA also has a serial data port for connection to the Honeywell Service Assistant, and the PDA can connect via a cradle and PC to the Web.[76] PECI reported the data transfer and data processing flow in Figure 2–1 below. PECI recommended the PDA be synchronized daily via a WiFi internet connection.

The evaluation of this Program included both a process and an impact evaluation. Although this was a 2004-2005 program, the evaluation conforms to the 2006 Protocols at the Basic level. The purpose of the process evaluation was to document project progress, assumptions, and barriers to wider implementation, to assess customer satisfaction, and to document barriers to participation. The impact evaluation included review of Program records, engineering, and billing analyses.

Figure 2–1. Data Transfer Process



Source: PECI, M&V Report, June 2006, page 5.

As described by PECI in their Scope of Work, the “information will provide all details from the RTU and the implemented retrofit. Report information will be derived from this information, supplemented by information developed by engineers within the Program, based on data from the rooftop. The report will show installed kW and kWh based on Program assumption and will also show calculated energy savings based on specific site information.”[77] The reports are not

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[76] PECI, AirCare Plus[SM] M&V Report, Page 5, June, 2006. The primary tool is a Palm PDA. The Service Assistance is a Honeywell Product.

[77] PECI, AirCare Plus[SM] Scope of Work, page 2.

available on-site at the time of the contractor's service visit. Data is analyzed and compiled into a document that can be mailed to the customer by the HVAC contractor. The same data (once checked for validity) is used to process incentive checks.

Based on their experience prior to offering the Program in California, PECI determined that, to be successful, the contractors delivering AirCare must possess certain characteristics. These were:

- Culture that values full service and high quality.
- Size that is conducive to new Program launches.
- Culture that values both energy and non-energy benefits.

PECI proposed to develop a list of potential contractors, using references, local contractors' association websites, the yellow pages, and where applicable, any trade allies already participating in Edison programs. PECI proposed to screen participants for Program viability. They were interested in businesses with at least two technicians because their experience had been that this facilitates information sharing and results in long-term participation.[78]

Qualified contractors and technicians were then enrolled into a two-day training that included one day in-house and one day in the field at a site of a contractor's customers. The in-house training reviewed AirCare Plus℠, the fundamentals of HVAC in relation to energy savings, and identification of opportunities. The second training offered hands-on site implementations. An additional eight hours of on-site post training was also planned and provided as needed.

This chapter is organized into five sections. Section 2 presents the process evaluation, including the Program logic model, results of interviews with Program staff and participants, and free rider estimates. Section 3 describes the impact evaluation, the engineering and site visit results, and calculates realization rates, ex-post gross and net savings, and lifecycle savings. The final section (Section 4) presents the major conclusions and recommendations.

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[78] Ibid. page 3.

2. Process Evaluation

Process Evaluation Methodology

The purpose of the process evaluation was to document project progress, assumptions, and barriers to wider implementation, to assess customer satisfaction, and to document barriers to participation and describe current practices among nonparticipants.

Slightly more than 3000 rooftop units were serviced in this Program. The researchable issues addressed in the process evaluation included the Program's origin and original goals, and differences between the Program as designed and as implemented. Delivery and implementation issues such as experience with the diagnostic tools, HVAC contractor's satisfaction, and issues of free ridership and spillover were also addressed. Lessons learned, and reasons for nonparticipation in the AirCare Plus^{SM} Program were addressed.

The process evaluation of the AirCare Plus^{SM} Program was informed by interviews with implementers and Program managers, HVAC contractors who delivered the Program, and nonparticipants. Nonparticipants were defined as those contacted about the Program but chose not to participate.

Program Logic Model

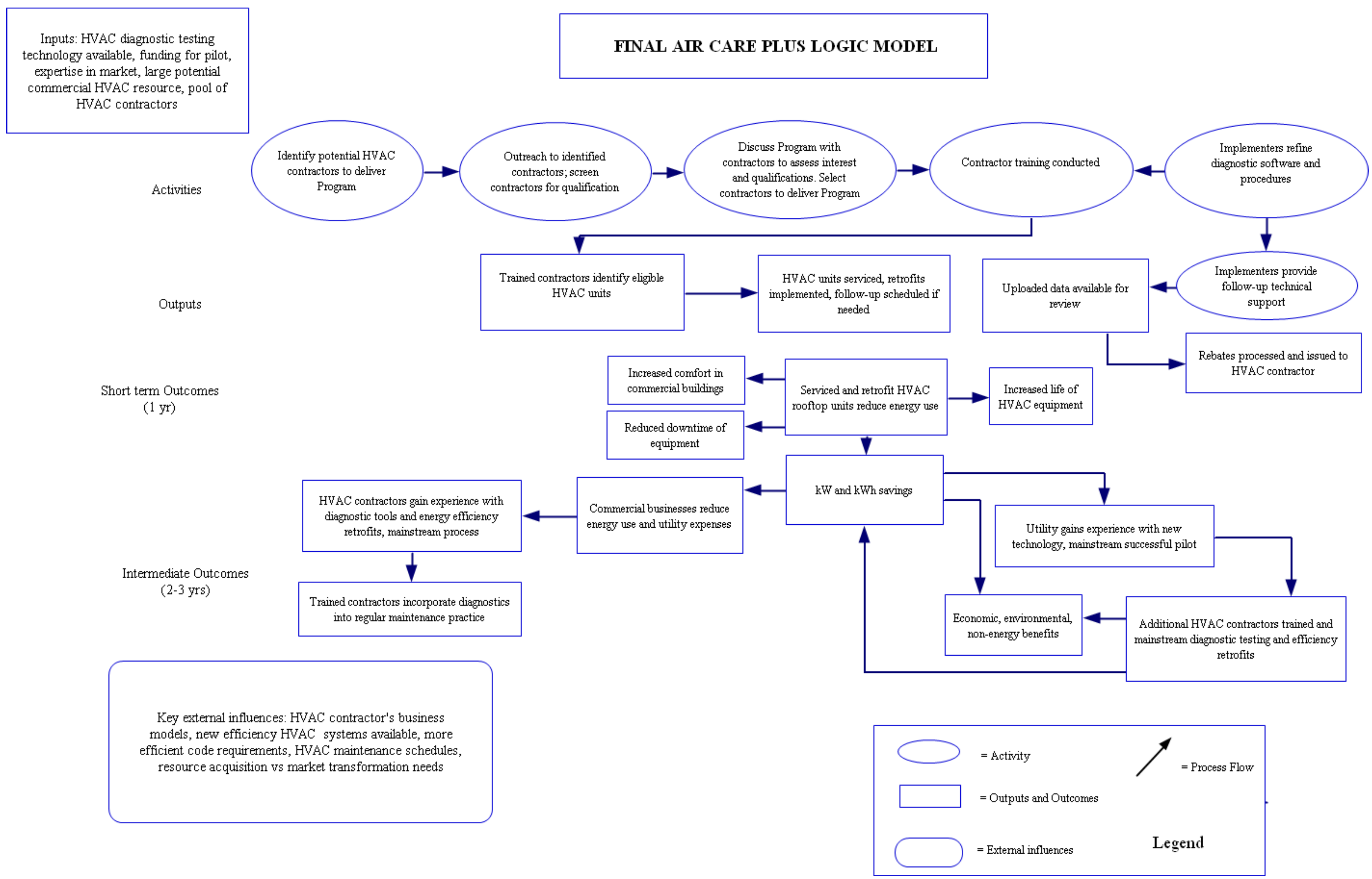
The Program logic model diagram is shown in Figure 2–1. The logic model shows the key features of the Program as understood by the evaluation team, indicating the logical linkages between activities, outputs, and outcomes. The primary activities involved outreach to HVAC contractors who could deliver the Program services. Once selected, the HVAC contractors were trained. At the same time, the implementers refined the software, adapting it to Edison climate zones, and refined the diagnostics.

The activities were expected to result in the following outputs: (1) the trained HVAC technicians would identify eligible HVAC units; (2) technicians would service and retrofit the HVAC units and schedule follow-up as needed; (3) technicians' uploaded data was made available for review and was reviewed by Program implementers; (4) once the data was reviewed and approved, the incentives were issues to the HVAC technicians; (5) in addition, implementers were available to provide on-going support to the technicians.

Short and intermediate term outcomes included immediate kW and kWh savings. Experience with a new market approach and technology would be gained by the HVAC technicians and the utility staff. In addition, retrofits would increase the life of the HVAC unit, increase comfort in commercial buildings, and reduce equipment downtime. Economic, environmental and other non-energy benefits were also expected.

The Program was implemented as designed. It failed to meet its goals, not because it departed from design, but because recruitment and participation lagged, there were data quality issues with the software, and there were issues with ex-ante assumptions and savings estimates, baseline modeling, and calibration. These issues are discussed in the process and impact evaluation results below.

Figure 2–1. Final Logic Model



Process Evaluation Sample Design

The Program was implemented by PECI through HVAC contractors who already have a maintenance service contract with their customers. For the most part, the customers themselves were not involved in the decision to participate in the Program. The evaluation sample plan included interviews with four Edison and PECI staff, 25 participating HVAC contractors and 50 nonparticipating contractors, as shown in Table 2–1.

The evaluation plan did not include surveys with end users, that is, owners of the businesses whose HVAC system received retrofits under the Program. Not all business owners were aware that contractors provided the AirCare service.[79] Contractors did not provide data to indicate which customers were aware that the service was provided, which were not, and with whom the contractor may have shared incentives. In addition, there was no list linking the contractor to customer.

Data collected for the process evaluation included interviews with 12 participating contractors and 22 qualifying nonparticipant contractors (Table 2–1).

Table 2–1. Survey Sample Goal and Achievement

Task	Goal	Achieved
Staff/Implementer interviews	4	5
Participant interviews (HVAC contractors)	25	12
Non-participant interviews (HVAC contractors)	50	22
Total interviews	79	41

PECI provided a list of 17 HVAC contracting firms that delivered the AirCare Plus^{SM} Program. The original number of 25 participant contractors was overestimated. Two contractors on the list provided were actually located in Washington, delivering the Program for another utility. All HVAC contractors delivering the AirCare Plus^{SM} Program in Edison's territory were called multiple times. Twelve of 15 contractors were reached for interviews (80% of contractors providing AirCare Plus^{SM} services). The two contractors delivering the Program in Washington over the last three years were also interviewed but their answers are not recorded here. Overall, their experiences using the technology were similar to the Edison contractors'.

PECI's tracking database was provided for contacting participant and nonparticipant contractors for the process evaluation. Records included lists of contractors contacted about the Program. The nonparticipant sample was randomly selected from a list of 125 contractors, with phone numbers included in the contact information, who received two mailings from PECI. Five

[79] PECI assumed that most owners were not aware that their HVAC rooftop units received enhanced maintenance services.

contacts were attempted for each contractor. Table 2–2 shows that 22 surveys were conducted. Nearly the same amount, 23, refused the survey. After repeated attempts, 46% remained unavailable (contact was unavailable, phone was busy, or answering machine was reached).

Table 2–2. Nonparticipant HVAC Contractor Sample Disposition

	Frequency	Percent
Sample provided by PECI	**125**	
Ineligible/unused sample	41	
Ineligible-didn't provide HVAC maintenance	10	
Wrong number/non-working number	31	
Eligible sample	**84**	
Completed surveys (Target 50)	22	26%
Not available	18	21%
Refused	23	27%
Busy/answering machine	21	25%

Research questions were developed as part of the work plan and then used to develop interview guides. The questions explored the decision-making process used by participating HVAC contractors.

The interviews took place in October 2006. Before interviewing participants, interviewers confirmed that the respondent was involved in the decision to participate and/or were directly involved and knowledgeable about the Program.

Process Evaluation Results

In this section, the Program is described as experienced by individuals who designed and implemented the Program, by the sample of businesses that participated in the Program, by the sample that dropped out, and by the sample who chose not to participate.

Program Design

HVAC Contractor Profiles and Baseline Operations

Participating and nonparticipating HVAC contractors were asked about their business practices and typical customers in an effort to see if there were differences between the two groups. This information could help to identify characteristics of contractors or customers best suited to this type of Program.

We asked HVAC contractors about the size of their firms, and about their typical customers. The size of the participant firm ranged from 4 to 107 people, for a total of 323 including 150 technicians (46% of all employees). The average size of the participating HVAC firm was 30 employees including 6 technicians. Overall, 38% of all technicians (57 of 150) were trained to use the AirCare Plus℠ diagnostic protocols.

Nonparticipant firms providing information (17 firms) employ between 3 and 35 people, for a total of 262 people, including 129 technicians (49% of employees). The average size of the nonparticipating HVAC firm was 15 employees including 8 technicians. On the whole, nonparticipant firms interviewed were smaller than participant firms. However, they still fell within the ideal size range that PECI was looking for, that is, firms large enough so that two technicians from the same firm could be trained.

As expected, the majority of participating HVAC contractors indicated that they service a number of customer types. (Table 2-3) All but one of the participant contractors indicated that the entirety of their practice involved servicing commercial clients. One participant contractor indicated they also did some residential work. By contrast, nearly half (7 of 13 offering answers) of nonparticipant contractors said they had residential customers in addition to the commercial customers. This is the most striking difference between the participating and nonparticipating contractors. Nonparticipants did not specifically mention retail customers. Other than these differences, they all served a variety of commercial customers. Future recruiting for service providers should continue to screen for contractors who primarily service commercial customers.

Table 2–3. HVAC Contractor's Typical Customers

	Participants (N = 12)	Nonparticipants (N=13)
Retail	7	
Banks	1	
Offices	1	2
Restaurants	4	1
Residential	1	7
Government	1	
Industrial	2	1
Supermarkets/grocery stores	1	1
Variety of commercial (small to large)	4	2

Source: Survey of participants (n=12), nonparticipants (n=13). Multiple responses allowed.

The AirCare Plus[SM] diagnostics would typically be provided to customers as part of regular maintenance work. To get a sense of the potential market for this program, contractors were asked how much of their overall business revenue was generated through the preventive maintenance services for rooftop HVAC units and what percentage of their overall business revenue was generated through rooftop HVAC on-call services, that is, services to troubleshoot or repair rooftop HVAC problems. Contractors were also asked what percentage of their customers bought standard service and what percentage bought the AirCare service.

As seen in Figure 2–3, 44% of participant HVAC contracting firms generate 80%-100% of their revenue providing maintenance services. By contrast, only 12% of nonparticipants generate equivalent amount of revenue providing maintenance services. Nonparticipants generate less revenue providing these services; 44% of nonparticipating contractors generate only 20%-40% of their business revenue providing maintenance services.

Figure 2–3. Preventive Maintenance Revenue

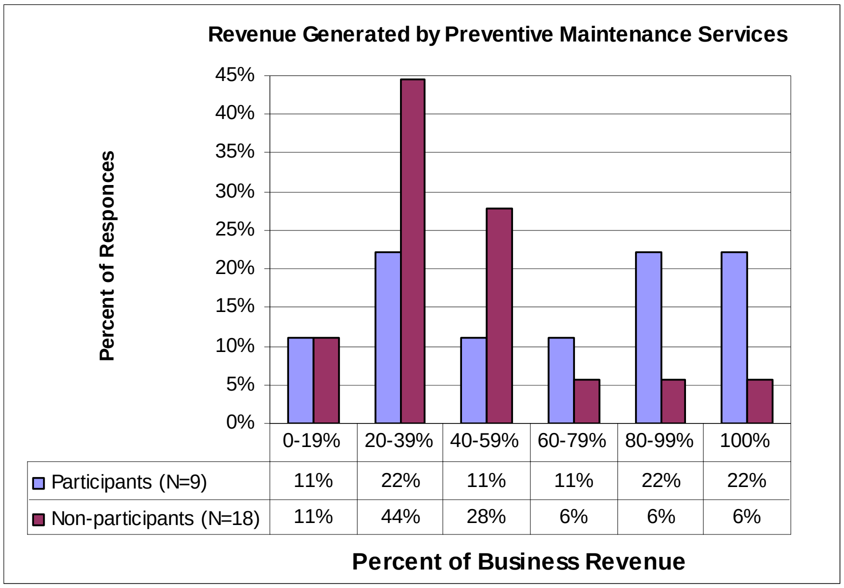
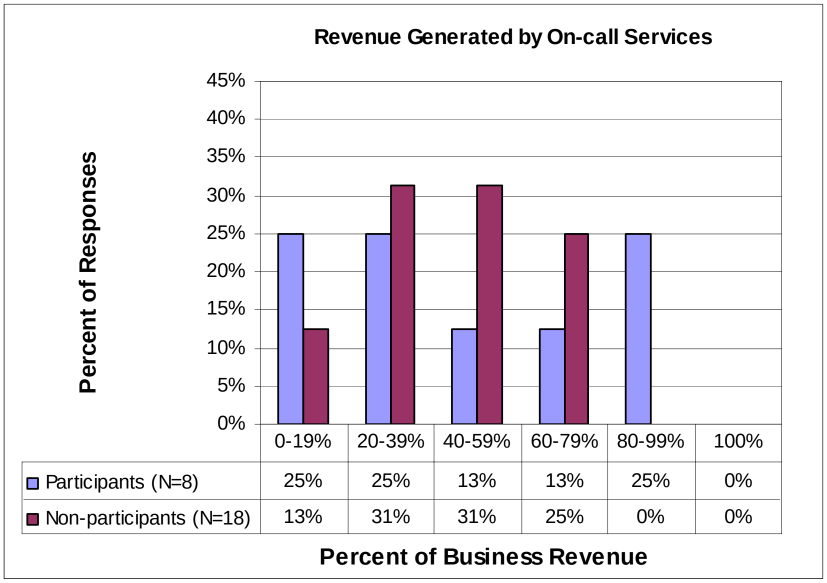


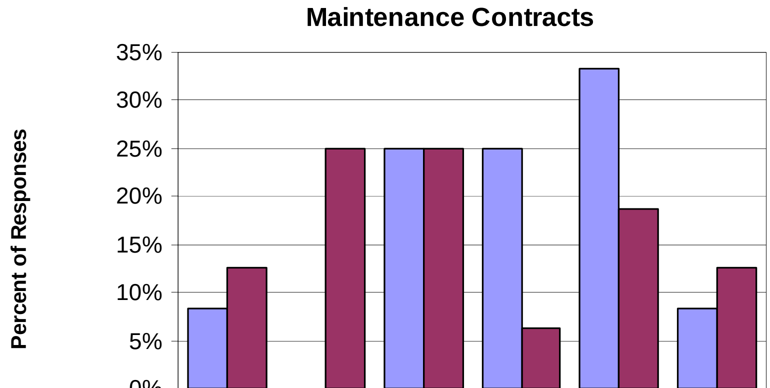
Figure 2–4 shows that neither participant nor nonparticipant contractors generate all revenue from on-call services (i.e., through unplanned service and repairs). However, 25% of participants generate 80%-89% of their revenue through on-call services. None of the nonparticipants generate more than 79% of their revenue through on-call services.

Figure 2–4. On-call Services Revenue



Ten of 12 participating HVAC contractors (83%) reported that 60% or more of their customers purchased maintenance contracts. Only 7 of 16 nonparticipating contractors (38%) reported that at least 60% of their customers purchased maintenance contracts. In both groups, five said at least 80% of their customers purchased maintenance contracts (31% of nonparticipant contractors and 42% of participant contractors) as shown in Figure 2–5. A larger proportion of the participating contractors' customers purchase maintenance contracts than do the customers of nonparticipants.

Figure 2–5. Percent of Customers with Maintenance Contracts



	0-19%	20-39%	40-59%	60-79%	80-99%	100%
Participants (N = 12)	8%	0%	25%	25%	33%	8%
Non-participants (N=16)	13%	25%	25%	6%	19%	13%

Percent of Contractor's Customers Purchasing Maintenance Contracts

Overall, the participants generated more of their income through maintenance contracts and, compared to the nonparticipants, more of their customers purchased maintenance contracts. The Program's focus on working with contractors who could add AirCare retrofits to existing services appears to be successful. The Program recruited more contractors who had customers with existing maintenance contracts.

Implementers are successfully recruiting contractors who work primarily with commercial customers, provide maintenance services, and who have existing maintenance contracts. Should the Program be expanded, additional contractors need to be recruited, since only 25% of the targeted number of contractors were recruited and trained. Should the focus on customers with maintenance contracts be retained, recruiting should continue to screen for contractors working with contractors serving the commercial sector and whose customers have existing maintenance contracts. Depending on the pool of contractors available, implementers should be prepared to recruit and engage contractors who are less familiar with maintenance and testing diagnostics.

Participant and nonparticipant contractors were asked about the types of maintenance services they typically provide their customers, outside of the AirCare Plus^{SM} Program. This provides a baseline against which to measure the AirCare Plus^{SM} methodology and determine how it differs from standard practice.

The types of maintenance services offered by the participating contractors was similar to that of the nonparticipating contractors. However, in addition to the pre-defined services listed in Table 2–4 below, participating contractors typically offered multipoint-type service plans which they referred to as *Full Service Maintenance and Repair*, *Preventative Maintenance Plan*, and *Multi-Point Service Check*. One of the participating contractors indicated that they typically use the AirCare Plus^{SM} methodology and tools for all their maintenance contracts.

Table 2–4 lists the items named by contractors (in response to unprompted open-ended questions) and is ordered by the participant contractor's most commonly named items. It appears that nonparticipant contractors leaned toward an initial assessment that included visual inspection, cleaning coils and filters, and refrigerant charge adjustment. On average (within this small sample), fewer nonparticipant contractors worked with the economizer, measured or adjusted airflow, or adjusted the thermostat.

Table 2–4. Typical HVAC Maintenance Services Offered

	Participants (N = 12)		Nonparticipants (N = 18)		Total
	Count	Percent	Count	Percent	
Clean or change filters	8	67%	13	72%	21
Thermostat replacement	6	50%	3	17%	9
Clean condenser coil	6	50%	8	44%	14
Initial assessment	5	42%	13	72%	18
Thermostat adjustment	5	42%	2	11%	7
Measure and adjust air flow	5	42%	6	33%	11
Refrigerant charge adjustment	3	25%	7	39%	10
Economizer retrofit	3	25%	2	11%	5
Economizer adjustment	3	25%	2	11%	5
Visual inspection of AC components	2	17%	6	33%	8
Economizer adjustment to work with programmable thermostat	1	8%	3	17%	4

Source: Survey of participants (n=12), nonparticipants (n=18). Multiple responses allowed.

Nine of the 12 participating contractors indicated that they did not record site measurements and/or estimate energy or demand savings when they did not use AirCare Plus^{SM} as part of the maintenance call. The three who indicated otherwise stated that they used some simpler approach such as an amp meter for estimating kWh saved.

Three of the 18 nonparticipating contractors reported that they used some form of infield computer diagnostics and protocol as part of their practice. Of the 14 who did not, three indicated that they had considered using the AirCare Plus^{SM} or similar practices. Three respondents reported they used other infield test instruments or devices from Robinair, Fluke, and Honeywell.

The Program implemented a behavioral measure—adjustment of incorrectly adjusted programmable thermostats—and installed programmable thermostats as a retrofit measure to replace nonprogrammable thermostats. Programmable thermostats have been mandatory for installation since 1978 and Title 24 requires their installation as a retrofit measure.[80]

To get a sense of what contractors are doing with regard to thermostats, contractors were asked what their technicians did when they found an overridden, nonfunctional, or improperly adjusted programmable thermostat. Ten of 12 participating contractors indicated that their standard procedure was to inform the customer, while two contractors simply adjusted the thermostat. Half the contractors who informed the customer suggested replacement and half said they tried to fix or reprogram the thermostat.

Eleven of 12 participating contractors reported that when they encountered a nonprogrammable thermostat, they discussed the benefits of a programmable thermostat with the customer and encouraged them to replace the nonprogrammable thermostat. One stated he replaced it with a programmable thermostat.

Of the nonparticipant contractors, eight of 19 responses (42%) stated they would inform the customer if they found a programmable thermostat that needed adjustment, while 12 (63%) stated they adjusted the thermostat. One contractor indicated that they did nothing. Others indicated that they did not know what the procedure was.

When the nonparticipant contractors found a nonprogrammable thermostat, 47% (8 of 17 respondents) stated they would install a programmable thermostat if the customer agreed, and 70% (12 of 17) said they would talk to the customer. Two contractors indicated that they did nothing.

It appears that contractors are aware of the need to replace nonprogrammable thermostats as well as correct misadjusted programmable thermostats. For the most part, they leave the decision to replace the thermostats with the customer.

No age and nameplate data was recorded for the units serviced under the Program. Most of the participating contractors indicated that the units they serviced varied widely in age from new to as old as 50 years. An age of 10-15 years was common. Nonparticipating contractors reported a similar average age for the units that they serviced, approximately 12 years.

Market Assumptions

PECI's proposal recognized that savings from HVAC rooftop units could be dwarfed by overall heating and cooling and other commercial facility charges. Building owners and lessors may not pay much attention to the HVAC systems and hire service contractors who respond to their calls but don't focus on energy costs and savings. Pilot testing of the Program in the Northwest showed that contractors were interested in AirCare Plus[SM] as a value added service but could not add the cost into their services unless the owner paid for the service. PECI notes that because

[80] Title 24, page 118 of section 149 references other sections. Section 122 page 66 implies programmable thermostats are required for alternations made to nonresidential buildings.

savings are modest, the Program must be delivered in a manner that dovetails with existing services.[81]

PECI developed a marketing delivery system around four points:[82]

- Research showed that contractors have discretion to make service modifications without involving the owner when the cost of the modification was kept below $300. AirCare Plus[SM] was designed to deliver energy savings packages that were low cost, so that they fell below the decision-making cost threshold of the owners.
- Services were bundled to combine savings from multiple components.
- The energy savings methodology allowed savings to be calculated, based on various modifications made to the unit.
- A summary report prepared for the building owners showed the work completed and potential for future savings, showcasing the contractor's value-added service and Edison's Program.

PECI recruited contractors using lists from Edison and NATE (North American Technician Excellence). PECI sent emails, postcards, and used their website to recruit contractors. Phone conversations and face-to-face meetings were conducted to screen candidates. PECI found that NATE-certified contractors often exhibited characteristics that enabled contractors to succeed. These included contractors interested in cutting edge technology, those with four to eight years of experience, business-savvy contractors, and those with experience with major accounts, e.g., chains. Larger firms are more likely to provide technicians who can be trained to deliver the Program. PECI noted that contractors who chose not to participate cited time and money concerns; nonparticipant interviews confirmed PECI's perception.

Marketing and Participation Decisions

PECI recruited contractors primarily using lists from Edison and NATE. Edison notes that PECI tried different approaches to marketing their program. Initially, the marketing model depended on the HVAC technician—the service provider—to market the Program to their customer base. However, if the contractors were not aggressive, Edison felt that PECI would not be able to achieve their participation and energy savings goals. Edison noted that one of the contractors preferred to take a "door-to-door" marketing approach. As implemented, some contractors performed services without informing the customer, and others promoted their enhanced maintenance services to the customer.

Edison provided PECI with a potential customer (end-user) list. The list could not be shared with HVAC contractors for confidentiality reasons. The list was used by PECI to verify whether the customers were within Edison's service territory after the contractors submitted their reports of units serviced.

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[81] PECI, AirCare Plus[SM] Technical Proposal, page 7.

[82] Ibid.

Participant and nonparticipant HVAC contractors interviewed were involved in the decision to participate in the Program. As shown in Table 2–5, participants and nonparticipants HVAC contractors reported they learned of the Program primarily by phone and email. Most of the participants were contacted through multiple channels. This was in contrast to the nonparticipants, where twelve of the 18 respondents did not remember being contacted.

Table 2–5. How Respondents Heard about the Program

	Participants (N = 12)	Nonparticipants (N = 18)	Total
Mail	2	4	7
Phone	6	2	10
Presentation attendance	0	1	1
Trade show	0	0	0
Prior program	1	0	1
Email	5	0	5
Website	1	1	2
In person	6	0	6
Flyer	1	0	1
Fax	1	1	2
Uncertain	1	0	1
No Contact recalled	0	12	12

Source: Survey of participants (n=12), nonparticipants (n=18). Multiple responses allowed.

Contractors who participated in the Program reported they were contacted anywhere from six to more than 24 months before the survey was conducted with the most common response being 18 months. Of the six nonparticipants who remembered contact, four could provide an estimate of timing; two were contacted in the one to two months before the survey and two were contacted 18 to 24 months earlier. Nonparticipants may not remember being contacted for several reasons: contact occurred much earlier; only one channel was used; and, marketing may not have been relevant to those serving the residential sector, which was not this Program's target audience.

Contractors who participated in the Program indicated that a number of potential benefits were explained to them. These benefits can be condensed into four broad categories:

- ***Energy savings for customer.*** Use of the technology and the potential improvements in HVAC performance would provide the contractor's customers with potential energy savings. This was the dominant benefit that participating contractors recalled being explained to them.
- ***Tool & technology related.*** The opportunity for the contractor to get early access to new and improved technology.
- ***Business development.*** The technology and related service would open up new and additional opportunities for the contractor. One of the participating contractors specifically mentioned that as it had been explained to them, the tool and service would allow them to "get a foot in the door" with new customer accounts.

- ***Rebates and incentives.*** The opportunity for the contractor to receive rebates for their participation in the Program.

Only six of 18 nonparticipant contractors responding to this question recall being contacted about the Program, and of those, four recalled benefits being explained. Two mentioned energy savings for their customers and one recalled the benefit was use of the tool which could be used to identify energy and equipment issues. The fourth stated the benefit was the diagnostic tool "was in one unit."

Table 2–6. Benefits Recalled

Benefit	Participants (N = 12)	Nonparticipants (N = 6)	Total
Tool & technology related	6	2	7
Energy savings for customer	7	2	9
Business development	4	0	4
Rebates & incentives	5	1	6
Unsure	1	2	
Total comments	22	7	26

Source: Survey of participants (n=12), nonparticipants (n=18). Multiple responses allowed.

In making the decision to participate in the AirCare Plus^{SM} program, more than 50% of participating contractors indicated that Southern California Edison's sponsorship of the Program was very important. Table 2–7 shows the response distribution. Respondents noted that the incentives were *"paramount; we wouldn't have done it without the rebates."* Others noted that Edison lent credibility to the Program. One contractor noted that it is important to have incentives offered by Edison because they help to gain entry to the customer, and that it "*helps to change the mind set of the typical customer."*

Table 2–7. Importance of Edison's Sponsorship

Not at all	4
Somewhat unimportant	0
Neutral	0
Somewhat important	1
Very important	6

Source: Survey of participants (n=11)

Participants and nonparticipants were asked why they made their respective participation decisions. Participants noted that the diagnostics fit with their business model and allowed them to upgrade their diagnostic abilities and offer in-depth diagnostics to customers at no charge. Others stated it helped them stay on top of technology. One participant noted she made cold calls to potential customers and it was a useful tool to promote the business.

Nonparticipants stated that they did not participate in this Program because they already offered services similar to AirCare diagnostics. One contractor said the employees could not figure out how to use the equipment; one stated they had not had a chance to read through materials, and one stated that it was not a good way to increase sales.

These responses show that, for the most part, there is interest in this technology and that it adds value to the services offered. Edison's rebates made it possible for contractors to offer the services. Those who chose not to participate did not feel the Program added value to their services.

Program Delivery and Implementation

Once a contractor had shown interest in participating in the Program, PECI enrolled them after discussing the quantitative and qualitative expectations for participation. After enrollment, a training schedule was determined, and appropriate field personnel attended the relevant training sessions. Training consisted of one day in the classroom followed by one-on-one training in the field at a customer's site. On-going mentoring was provided throughout the Program. PECI found it was most effective when two technicians from the same firm were trained. This enabled contractors to discuss the work with each other and provide feedback.

Eleven of the 12 participating contractors reported that they had received special training to use the AirCare Plus^{SM} technology. Of these, two indicated they were trained on-site and the remaining nine received both on-site and classroom training. One contractor was familiar with procedures and did not receive additional training.

On average, five technicians were trained for each HVAC contractor though it varied widely from two to as many as 15, or 16% to 100% of all technicians. Training was reported to take from four to 40 hours. Four of the contractors reported that it required a minimum of eight hours and that the average number was 14 hours. All but three of the participating contractors indicated that follow-up training was required. None of the participating contractors recalled a formalized or written test being administered by PECI after training, though several reported that there was some informal hands-on testing.

While none of the contractors reported having to pay for the training beyond the technician's time, three of the contractors indicated that they had to pay out of pocket for the test equipment in order to participate in the Program. One contractor noted his expenses were $10,000 to $15,000, or about $1,000 in tools per trained contractor. Others offered costs ranging from $1,500 to $3,000 per technician.

Contractors were also asked if any issues came up when training the HVAC managers or technicians. Six of the 12 participants reported relatively minor technical equipment issues. These included:

- Palm software didn't work
- The WiFi hotspots were hard to find or not there
- Economizer evaluation had some bugs and technical issues
- Data entry was an obstacle

All but one reported that the issues had been resolved. Resolution included downloading software, replacing an economizer diagnostic, or, when data could not be downloaded, contractors' going back to the office or taking the unit home and uploading data, or uploading from another WiFi spot.

Contractors commented that the training was *"pretty good overall,"* and they felt they could call PECI anytime; they said that implementers were *"constantly helping us on the phone."* One contractor commented that they thought the training went well because he picked a technician who was computer-savvy. Contractors had some suggestions to improve the training. These included:

- Switching from WiFi to broadband device access
- More in-depth training on efficiency, including basics of understanding airflow and duct sizing, include heating efficiency
- Streamlining classes and offering a practice site rather than using an actual customer's site, as well as more interactive hands-on training in the classroom ("*It's noisy and distracting on the roof")*
- Providing more depth about what's going on in the industry
- Lowering the equipment price for basic tools

Participating contractors used a variety of strategies for selecting potential customers. Overall, half (six) of the contractors indicated that they used the diagnostics for all (Edison) customers, or they simply proceeded using the diagnostic tools without informing the customer. Two said they provided services to all customers with equipment that met the four-ton minimum capacity, that is, the minimum capacity allowed for participation. Some contractors discussed the Program with existing customers and others recruited new customers. One contractor said they talked to their larger *"non-maintenance"* customers. Another contractor said he talked with customers he thought would be receptive and "*able to hear the good news*." One said he blanketed commercial centers and made cold calls to recruit customers.

Contractors were asked how they presented the AirCare Plus^{SM} program to their customers. As noted above, some contractors provided the service without talking to their customers. Contractors who did talk with or recruit new customers indicated that they discussed the energy-efficiency advantages as well as the fact that there was no additional cost for these diagnostics. One contractor said he tested his approach by offering services several ways and determined that his customers *"don't care about efficiency."* For example, he offered $50 off the price of new thermostats but customers were not interested.

Special Program features that the contractors emphasized included their ability to offer advanced diagnostics and give more information about energy savings opportunities, as well as provide the customer a print-out giving proof that they could save energy and money.

All 12 participating contractors indicated that they felt that AirCare Plus^{SM} service was appropriate and applicable for all their customers. When asked how the AirCare Plus^{SM} service would help their customers, all the participating contractors mentioned energy and cost savings advantages. Several also offered that the AirCare Plus^{SM} service increases customer awareness.

Participating HVAC contractors were asked if they charged customers a fee to provide the AirCare Plus[SM] service. All 11 respondents stated that they provided the service for free. Most did so for all customers; one provided services for free only for Edison customers. One contractor suggested that the Program missed many potential customers because the service was only provided to four-ton units and larger. Another contractor said that he *"shelved the Program for the summer of '05 and then picked it up again in the fall, as it took that much longer and they are busier in the summer."*

Half the contractors marketed the Program as expected by the implementers, that is, contractors offered services without discussion with customers first. No customer lists were maintained which would indicate which marketing method each customer received, or who was approached and declined. Marketing methods could be expanded and become more broad-based to increase participation rates.

Market Barriers

The HVAC industry is seasonal in nature, with summer months dominated by "no cool" and emergency on-call services. Maintenance and enhanced services are best offered during the shoulder months when contractors have more time in their schedules to spend on diagnostics. This seasonal nature impacts any program, particularly short-lived programs such as this one.

Substantial time was involved recruiting and training contractors, and providing follow-up until contractors were comfortable with the diagnostics and familiar with problems they might encounter in the field. PECI trained about one-quarter of the number of contractors they original proposed and expected to train. There was high turnover within the HVAC businesses and some lost trained technicians. Other contractors noted they couldn't figure out how to use the equipment.

Contractors noted that services add a minimum of 30 to 45 minutes to their basic inspection. This time had to be covered by incentives since the customer did not pay for the enhanced services. Any additional retrofits or follow-up had to fit with contractor schedules, which could have meant the follow-up was scheduled two to six months later.

Contractors who delivered the AirCare Plus[SM] program were required to purchase equipment and tools that could cost them from $1,500 to $3,000 per technician. In addition to the hand-held computer (a Palm PDA) that houses the software diagnostics, technicians were required to purchase other equipment, if it was not already in their tool kit. The specified high-quality equipment included a digital multimeter capable of reading current in milliamps DC and resistance in ohms. Temperature sensors used during the economizer service were required to meet Program requirements regarding sensor type and calibration documentation. Equipment requirements were designed to ensure collection of accurate data. A number of contractors commented about the high cost of equipment.

Contractors commented that there were a number of bugs that had to be worked out with the procedures and software.

The market barriers can be summarized thus:

- Seasonality can cut a short program even shorter.
- Recruiting and training takes time and effort.
- Enhanced diagnostics add time to the contractors' schedule.
- Equipment and special tools are costly.
- Bugs need to be worked out of the software and procedures before the Program comes to market.

Participants' Experience with the Program and the Technology

HVAC contractors were asked a series of questions about their familiarity with the various technology components prior to participation, and whether they used a diagnostic protocol similar to AirCare Plus^{SM}.

Two were using computerized diagnostics and five were familiar with, but not using, computerized diagnostics prior to participation. Three were using economizer-control package diagnostics, and five were familiar with, but not using, an economizer diagnostics. Three were using automated tools to analyze refrigerant charge and six were familiar with, but not using, automated tools. Six said they reviewed and modified thermostat schedules and three said they were familiar with, but did not modify, thermostat schedules. Seven said they replaced thermostats, and one was familiar with, but did not replace, thermostats (Table 2–8). Overall, eight respondents (66%) were familiar with four or five measures listed. Of these, three were also using all five.

Table 2–8. Technology Familiarity

Measure	Familiar with and using technology N=12	Familiar with and not using technology N=12
Computerized diagnostics	2	5
Economize control package	3	5
Automated tools to analyze refrigerant charge	3	6
Reviewed and modified thermostat schedules	6	3
Replaced thermostats	7	1

All contractors stated they had used diagnostic tools, but *not* AirCare Plus^{SM}, for preventive maintenance, to adjust the economizer and refrigerant charge, and to optimize the rooftop HVAC for energy savings. These methods and tools included:

- Standard service technician protocols.
- Manual and physical inspections, amp measurements, static pressure measurements.
- Meters and gauges, Fluke digital thermometers.

- Honeywell Palm Pilot.
- Common sense.

Contractors were asked how these methods compared to AirCare Plus[SM]. One stated he preferred the manual, non-computerized tools. Others stated they thought their methods accomplished the same thing but that AirCare required fewer pieces of equipment, was faster, and provided documentation.

Seven contractors said that they considered offering the AirCare Plus[SM] diagnostic protocol without the Program incentive, but decided not to offer it primarily for three reasons. These included the prohibitive cost and the logistics to implement it, and one stated it's *"better to rely on a good technician than a computer."* Three said they would have implemented the diagnostics in the next five years.

While contractors had varying levels of familiarity and experience using diagnostics that comprise the AirCare package, and some considered offering it, it appears that none of the respondents were planning to offer the service in the immediate future. At the same time, seven stated they would offer the diagnostic services with incentives, including two who would also offer the diagnostic services at their own expense. Two contractors stated they would offer the service at their own expense, but didn't mention offering it with incentives (Table 2–9).

Table 2–9. Future Use of Program Practices

	Percent	Frequency
Would not use Program practices at own expense or with incentives	0%	0
Would use Program practices at own expense	20%	2
Would use Program practices with incentives	50%	5
Would use Program practices either with incentives or at own expense	20%	2
Uncertain	10%	1

Source: Survey of participant contractors (n=10)

Only three contractors stated their customers asked for the AirCare type of diagnostic services. This did not seem to limit the contractors' interest in offering the diagnostics.

HVAC contractors were asked to incorporate the AirCare Plus[SM] practice into their normal business practice. Because the AirCare Plus[SM] practice can be different from the normal HVAC maintenance services provided, it is important to learn whether the contractors had initial concerns about the practice, and how the AirCare practice fit into their normal business model.

Seven of the 12 participating contractors indicated that they initially had some concerns about folding the AirCare practice into their normal business practices. These concerns included:

- Having enough service work volume to make participation worthwhile
- Verifying that the upfront commitments would be reasonable
- Providing the time and effort required for training, sales, and/or implementation
- Concerns about having to use a sales pitch.

Three nonparticipating contractors indicated concerns which included:

- Providing the time and effort required for training, sales, and/or implementation
- Unwillingness of customers to pay for service.

Participating contractors were asked about the level of effort that was needed to integrate AirCare Plus^{SM} diagnostics into their regular business objectives. Six of eleven (55%) said that it took little or no effort to integrate the practices. One noted that they *"will do anything that can help customers; we are always training, so it's easy to integrate.*" Three respondents reported that it took a modest amount of effort, and two that it took a great amount of effort. Comments from these contractors included that (1) the hardest part was identifying who the Edison customers were (so that they would service customers who were eligible for the rebate), (2) a sales and marketing push was required, and (3) that record-keeping and other steps took some time and effort.

Contractors' experiences were mixed when it came to determining whether AirCare Plus^{SM} practices were a good fit with their business model. Both participant and nonparticipant contractors' concerns about the Program can be summarized as worries about time and money.

Participating contractors were asked whether the technology addressed HVAC maintenance issues that were not addressed by common maintenance practices. Responses were split nearly down the middle. Six contractors said the technology did not address any maintenance issues that were not already addressed by common practices and the way their companies typically did business. Two of the six contractors thought there were "holes" in the AirCare Plus^{SM} process. Contractors stated the training presentations did not address technical issues with the economizer and with the "heating side."

Five contractors said the technology did allow them to offer more in-depth information to their customers. Most indicated that the AirCare Plus^{SM} technology allowed a more in-depth diagnostic capability as well as the ability to analyze efficiency. One contractor got involved in the Program because it allowed him to purchase the diagnostic equipment at reduced rates. Others noted that the more detailed diagnostics made the protocols and services they offered different from what they would typically offer.

Contractors were asked if HVAC maintenance issues not addressed by common maintenance practices could be addressed without AirCare Plus^{SM}. Contractors did not name specific maintenance issues. Of the eight answering the question, five indicated that the maintenance issues could not be addressed without the AirCare Plus^{SM} technology. Three who stated common maintenance practice can address HVAC issues noted it *"needs technicians and companies to be conscientious about their maintenance*." Another noted that *"it's really just math,"* and that their manuals had the information.

Contractors have mixed experiences with the technology and its ability to address maintenance issues. Some felt the diagnostics allowed them to address issues they could not address otherwise. Some contractors felt the diagnostics still had bugs and "holes" and did not add to their services. It appears that some contractors come into the Program with business practices that already included enhanced diagnostics or an approach similar to AirCare. Other comments related to the need for more training, including for example, training on economizer adjustments and economizer control packages that are Program measures.

Incentives paid to the service providers were based on the retrofit measures. The incentive for each measure activity is shown below in Table 2–10. After the rooftop HVAC was serviced and data was uploaded to PECI and subcontractor Field Diagnostics, data input by the technician was reviewed for accuracy. PECI reported that technicians were contacted when values did not appear correct. PECI reviewed 100% of all retrofits before incentives were paid. Once passing review, incentives could be paid for work completed within Edison's service territory. When the customer's Edison account number could not be located or obtained, the incentive could not be paid. PECI reported that contractors did complete work outside of Edison's territory and that those systems could not be incentivized. Contractors confirmed they did not receive rebates for units serviced (unintentionally) outside Edison's territory; service boundaries were not always clear to them.

Table 2–10. Measure Incentives

Measure Code	HVAC End Use Load	Measure Description[83]	Financial Incentive[84] Per Unit
1	Tune-up	Basic Inspection	$60.00
2	Tune-up	Refrigerant I - Refrigerant Tune-up on 1 compressor RTU	$100.00
3	Tune-up	Refrigerant II - Refrigerant Tune-up on 2 compressor RTU	$150.00
4	Tune-up	T-Stat Modification - Programmable Thermostat Modification	$30.00
5	Ventilation systems	Economizer Adjustments	$50.00
6	Tune-up	T-Stat Upgrade - Programmable Thermostat Upgrade (residential to commercial)	$150.00
7	Ventilation systems	Airflow	$100.00
8	Controls	Economizer Controls Package	$85.00
9	Air conditioning systems	HVAC Replacement	$500.00
10	Tune-up	Programmable Thermostat Upgrade plus Economizer Adjustment	$150.00
11	Air conditioning systems	ECMs - Electronically Commutated Motors	$60.00

HVAC contractors were asked if the incentives covered the incremental cost of providing services—that is, what percentage of their overall costs providing Program-related services was contributed by Edison through incentives. Eight of the twelve participating contractors (75%) did not know how much of their costs were covered by Edison through incentives. Of those who offered a figure, estimates varied greatly. Two thought 30% to 50% was covered, one stated

[83] Program activities are explained in Volume 2, Appendices. Program Measure Descriptions.

[84] Incentive Source: PECI final E3 Workbook, June 2006.

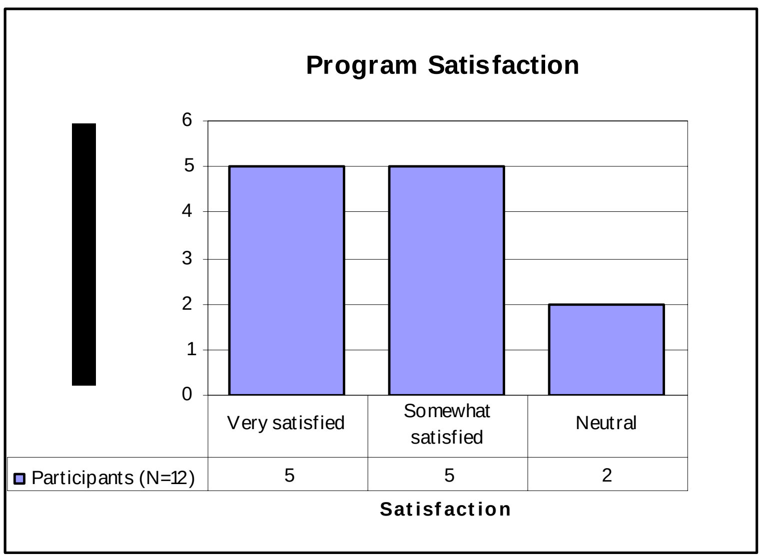
98%, and one said 100% of out-of-pocket expenses were covered. One contractor noted that Edison's incentives were the best they had encountered.

Participating contractors were asked if they shared incentives from PECI or Edison with their customers. Four of nine with responses (44%) indicated that they did not share incentives. Two indicated that they did share incentives (22%), while an additional three indicated that they sometimes shared incentives if the customer asked or if it was a new customer. As one contractor stated, *"the incentives are how we get paid."*

Contractors also noted the equipment outlay was expensive, from $1500 to $3000 or more, depending on how much equipment was purchased. For the most part the incentives covered the contractor's time at the site, and not all contractors had recovered the equipment cost. One contractor stated that they *"invested in the equipment but could not claim the rebates."* This contractor may have had issues with units serviced outside of Edison's territory or may have been unable to obtain or resolve the customer's utility account number.

Eighty-four percent of participating contractors were "very satisfied" or "somewhat satisfied" with the Program overall, as shown in Figure 2–6. Two contractors said they were "neutral."

Figure 2–6. Program Satisfaction



The participants offered a number of suggestions to improve the Program. Chief among them was to offer the Program for a longer time because it takes some time to get up to speed.[85] One suggested offering the Program for split systems. Contractors would like to be able to provide diagnostics for units smaller than four tons.

[85] Contractors began offering the Program to customers about September 2005 and the Program closed December 2005. Work for commitments made by December 31, 2005 had to be completed by June 30, 2006.

One noted that *“there is no sales tool for compressor replacement—Edison should coordinate rebates with the kind of equipment they are testing—didn't give us enough to fully serve the customers.”*

It appears that some contractors had difficulty uploading and downloading data. Some suggested that broadband applications be used to upload the program, feeling it is more reliable and available than the WiFi hotspots. Others commented that downloading data and getting the information immediately was a benefit and that they could *“tangibly show the customers benefits.”* Contractors would like to have results print out on the spot to present them to the owners.

One contractor noted that they had large staff turnover among trained technicians, and as a result, they were not able to participate in the Program. Another contractor said he was not able to collect the rebates for many of the systems he serviced. When services were provided for customers outside of Edison’s territory, no incentives could be paid. Program implementers noted this occurred a number of times.

Marketing was also an issue that was raised, with mixed comments. One contractor said marketing was not left up to them, and they would like Edison to market the Program more because it gives additional “*credibility in a smaller region.”* A second contractor said it was good that implementers had *“some marketing materials to share.”*

Lastly, one contractor stated that there are other diagnostic programs that work better than AirCare Plus℠ and he felt the Program was not *“top of the line.”*

Overall, suggestions can be summarized as follows:

- Edison should increase marketing. Marketing materials should be made available to the contractors so that they can market the Program on their own as well.
- Increase the length of time the Program is available. It takes more than one year to establish the procedures and protocols.
- Expand the Program to units with capacity less than four tons.
- Consider broadband data transfer. WiFi does not always work.
- Review suggestions to expand the Program to split systems, for compressor replacement, and for coupling the Program with other rebate/incentive programs.
- Establish a means to provide customers with a report during the site visit.
- Assist contractors in defining Edison service territory so that units are serviced that qualify for rebates.

Free Riders

Because over half of the customers, the building owners, were not informed of the enhanced treatment of their rooftop HVAC units, and no purchase decision was required for those customers who were informed, there is no free ridership in this program, and a net-to-gross ratio of 1.0 is assumed.[86]

Potential Spillover

Contractors were asked if they had added any other energy-efficiency services since hearing about or participating in the Program. Five contractors stated they added the following: *Check Me*™ for residential air conditioners, an "embedded diagnostic device" for on-site remote reading of instruments, fine-tuned data gathering for their customers, and replaced gas heating with electric systems. Of these five, only one said the Program was "very influential" in their decision to add services. One stated the Program was "somewhat influential" and one that it was "somewhat not influential." Two said their participation was "not at all influential" in their decision to add energy-efficient services. On the whole, there was very little spillover from the Program to other energy-efficiency activities.

In terms of participation in other Edison programs, only four participant contractors said they had previously, or were currently, participating in another Edison efficiency program. The programs included a residential rebate program, residential duct sealing program and the Proctor Engineering *Check Me!™* program for residential air conditioners.[87]

Eight of the 18 nonparticipating HVAC contractors indicated that they were currently, or had previously, participated in other Edison energy-efficiency programs. These programs included duct sealing and refrigerant analysis, rebate programs, *Check Me!™* and a maintenance program for commercial package units.

Lessons Learned by Program Staff, Future Plans

One of the consistent problems throughout the Program was the identification of Edison customer account numbers. This was a more time-consuming task than originally expected. PECI noted that the contractor did not always enter the address correctly or that it was missing. PECI searched their databases for account numbers. Where there were still missing or incorrect numbers, contractors were asked to correct the data. A list of missing account numbers was submitted to Edison in May. The list was returned in July with account numbers still missing and contractors were again asked to correct the addresses if possible. Incentives could only be offered for customers within the Edison service territory, so any customer records with missing Edison account numbers were considered to be outside of Edison's territory and could not qualify for the incentive. Contractors also noted that one of the hardest things was determining which were Edison customers. The issue with account numbers was a "*stickler in the end*."

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[86] Contractor free ridership was not assessed. It may exist and the next evaluation should look into contractor free ridership.

[87] Note that HVAC contractors used AirCare Plus for commercial roof top units, and use CheckMe! for residential air conditioners. It may be that Edison's program rules push contractors into using and maintaining two different diagnostics approaches depending on the customer class.

One of PECI's early tasks, along with software design subcontractor Field Diagnostics, was to adapt the software to fit the parameters of the Edison program, including climate zones, business conditions, program goals, and the measures. The software's Energy Savings Module uses standard energy savings calculations and hourly building simulation with the Honeywell Estimator. The deemed savings used in the Module were originally developed for climate zones and conditions in the Northwest and it was in use by contractors there.[88] Energy savings were assumed to be 20% higher in Southern California than in the Northwest, due to the warmer climate. In adapting the deemed savings, the savings for the Schrader cap replacement and air flow adjustment were removed.

Various software problems caused errors. Early in the Program, wrong or out-of-range data could be entered, and bugs in the software calculations produced output errors. Sometimes the user forced a transaction because of glitches in the program. The software was reprogrammed to include validation and identify user input error.

PECI reported that, early in the Program, running the Energy Calculation Engine resulted in unreasonable values. As PECI reported, the tables producing the energy savings required cleaning, recalculating and corrections where errors were found. Query and input errors were found in two tables.[89] PECI committed time and resources to debugging the energy savings module. Corrections to the inputs were made to correct the output. PECI reports that after cleaning and debugging the software, as of April 2006, the energy calculator could be used to calculate savings for the following: Basic Inspection with and without economizers; Refrigerant 1; Programmable Thermostat Adjustment; Economizer Adjustment; and the Economizer Control Package.[90] However, input tables for Air Flow Retrofit and Refrigerant II could not be restored and energy savings could not be evaluated or calculated, and final energy savings were extrapolated.[91]

Edison noted, and recommends for future programs, that the software should receive comprehensive field testing before being put into full service. The protocols, technical issues, and bugs need to be worked out in advance. Likewise, ensuring that the contractor can upload and download data from the field site would eliminate the need for contractors to return to their home bases to obtain a wireless connection.

PECI reported that a customer may have multiple rooftop units and it was plausible that not all the customer's rooftop units were serviced with the AirCare Plus^{SM} diagnostics. Technicians did not record the total number of units at each customer's location. It is not known how many units were serviced out of the total number of units. In addition, it was not known which units were associated with the Edison utility account number or the meter number. It is possible that multiple units, some serviced under the Program and some not, were on the same utility meter.

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[88] For example, Avista offered incentives to contractors using this technology in a similar program in Washington State.

[89] Energy Savings Module SEInput Table, and HT_Data Table.

[90] Program activities are explained in Volume 2, Appendices, AirCare chapter. Program Measure Descriptions

[91] PECI, M&V Report, June 2006, page 24.

This makes the Program difficult to evaluate using customer billing data. To improve the evaluability of the Program, the number of units installed at each location, the number of units serviced, and the units on each meter or account number (both serviced and not serviced) would be helpful.

The Program relies on the data that field technicians collect and input. Field data review during the Program focused on field-level reasonability tests. PECI feels additional data would be useful. For example, additional refrigerant retrofit data could track the initial charge level and the amount of charge added or removed and other nuances of the service work. Baseline operating conditions, age, and nameplate data should be collected.

PECI and Edison (as well as contractors) feel this program is best suited to a multiyear effort. It takes time to train the service providers, the HVAC contractors, so that they are familiar with the diagnostics. Ramping up essentially took one year. Program goals may have been better couched as second year goals.

Both Edison and PECI commented that the California market is seasonal in nature, which limits the timeframe for administering services. For example, the diagnostics cannot be completed unless it is at least 65^{o}F. because technically, the diagnostics are not accurate in lower temperatures. Emergency, on-call and "no cool" service calls primarily take place during the summer, which leaves less time for technicians to provide the AirCare Plus^{SM} maintenance diagnostics. Summer 2005 was a longer, hotter summer than usual and contractors were not as available as had been hoped. In essence, the "seasons" to deliver the Program are March through June, and September through November.

One fallout of the short Program duration was attrition of trained service providers. PECI reports that contractor attrition was high, about 50%. PECI also reported there is a high turnover rate among technicians in this industry. Indeed, one of the HVAC firms interviewed reported that turnover was high and that no contractors trained to deliver the Program were still at the firm. That business did very little work under the Program.

Program planning and management was a challenge. PECI did not anticipate the amount of work needed to adapt and debug the software, and provide field engineering and technical support. PECI committed resources to see the project through, even though the administrative budget was depleted early.

One issue mentioned by both Edison and PECI referred to the definition of a "committed customer." While services could be delivered through June 2006, the participant must be committed by the end of December 2005. Edison required signed commitment letters from all participants dated before 12/31/05. In the early Program, Edison felt the committed customer was the end user, that is, the owner of the units being serviced, and that commitment letters must be signed by them. However, as designed, the Program could be invisible to the customer; not all customers were informed that the enhanced diagnostics were being performed. That is, the HVAC contractor was not required to "sell" anything to the customer (and obtain signatures or money) so it was possible that the customer would not know anything about the diagnostics provided through the Program.

PECI suggested that the HVAC contractor was the end user since the contractor provided the services, and that the contractor should be able to provide a "committed" customer list. Many customers had existing service agreements, and Edison questioned whether customers with existing service agreements were "committed customers" merely because service agreements existed. In the end, Edison allowed the HVAC contractors to provide a letter of commitment and list of customers they intended to service. The letter of intent from PECI and the HVAC contractors demonstrated their best effort to perform services by the end of the Program. This letter and list of customers included all customers the contractor would contact by Dec. 31, 2005 and service by the end of June 2006. Still, the Program did not accomplish its goal for the number of retrofits to be performed, falling short by about 2500.

One of the issues involved here is that the contractors receive incentives for each unit serviced, but when the Program is invisible to the customer, there is no "proof" that the service was performed. The Honeywell tool (embedded in the AirCare software) was not designed to capture customer data. The flat file listed the final participants and any participant whose account number was missing was considered outside the service territory, and could not receive an incentive, as noted elsewhere in this report.

Edison reported that marketing approaches evolved as the Program progressed. The delivery approach, with contractors driving the marketing, was not as effective as it was hoped. Operating the Program over a short timeframe, and the practical aspects of signing up contractors to deliver the Program, introduced a steep learning curve for contractors. PECI reported that some service providers used the Program as a marketing tool for business development. As noted earlier, the seasonal nature impacted Program delivery.

PECI notes that in the future they would push harder to get customers involved. Particularly with this Program of short duration, it was an ambitious undertaking to put all the marketing demands on the service providers. If a similar program were offered over several years, however, the model of a contractor-driven program may work out the delivery bugs and seasonal constraints over time.

Edison noted that when the technicians provided the initial basic inspection on the HVAC units, the diagnostics could uncover additional work needed to improve the energy efficiency. A report of recommended additional measures was generated. Since contractors are on tight schedules, this often meant a return visit to complete the retrofit or address the additional recommendations. The complete service could not be provided in a one-stop visit. PECI confirmed that sometimes there could be a two-month or even six-month lag between the initial visit and the return service and retrofit. This lag between visits may have led to lost opportunities. It is key, therefore, to get the report of recommended measures to the customer soon after the initial visit. Some recommendations may be for expensive upgrades, including full replacement of the unit. These decisions can take time on the part of the customer.

The number of follow-up visits was not recorded. The follow-up visit was not counted as an additional Program "commitment," even though new measures could be installed, resulting in additional energy savings.

Scheduling follow-up visits was out of PECI's control. At one point PECI requested that Edison allow them to lower the savings goals and increase the incentive to sweeten the pot and entice contractors to schedule immediate follow-up visits. However Edison did not allow reduction of savings goals to increase incentives. Future programs should consider means to keep the lag time between initial and follow-up visits to a minimum.

Edison noted that Schrader cap replacement was an issue. Schrader caps were replaced on all systems thought to be leaking refrigerant charge. The Program did not require technicians to measure refrigerant charge until April 2006, two months before the close of the Program. However, Schrader caps were installed on about 1000 systems before testing was required. While contractors did not check for leakage, PECI felt that there was enough field evidence to warrant a preventive approach and replace Schrader caps in cases of potential leaks.

Edison did not physically inspect contractor's work on-site. First, it is Edison's policy that inspectors cannot go on roofs. Second, after the unit is serviced, there is not much to inspect, other than perhaps a contractor's service sticker. Edison conducted their data review and data quality checks from reports generated by PECI from contractor's data. In a retro-commissioning program, it is difficult to know if the data entered is correct. The files report that units were serviced, and it appears that adjustments were made. However, it is not possible for Edison Program Managers to know if the unit was serviced correctly. Managers are limited to spot checks of the data file comparing the database information to invoice data.

Edison is interested in additional means to verify savings. If, for example, Edison were to receive the technician's raw data (computerized diagnostic data), the engineering support group would need to develop inspection and evaluation protocol, and a method to confirm savings reports.

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3. Impact Evaluation

The Program ex-ante savings were estimated by adjusting equipment operating parameters from a Pacific Northwest program for use in Edison's service territory. Since the AirCare service was delivered as a package of measures—some with very small savings—key issues in estimating the Program ex-post net savings were assessing the feasibility of estimating measure-specific savings, and validating engineering estimates from the results of a limited billing analysis of retrofits where savings were likely identifiable on the participants' electric bills.

Impact Evaluation Methodology

The original research plan proposed to estimate the Program impacts by substituting the ex-ante assumptions with Program data in the contractor's proprietary software model, and conducting a limited billing analysis. Additionally, the plan included a review of secondary sources to validate the range of estimated measure savings. Site visits for verification were also proposed, but could not be conducted because customers' contact information was incomplete, treated rooftop units were not easily identifiable, and maintenance measures were not easily verifiable.

The implementation contractor's major ex-ante assumptions substituted with as-found data were these:

- Cooling capacity (tons), rated and estimated SEER/EER
- Number of rooftop units with undercharged refrigerant that would require a charge adjustment and Schrader cap replacement
- The amount of refrigerant undercharge and overcharge
- Age of rooftop units
- Equipment operating schedule
- Weather data
- The number of rooftop units with one or two compressors
- Building square footage, building type, building operating profile

This plan to estimate the Program ex-post gross savings using the as-found equipment parameters in the contractor's software model could not be fully implemented for the following reasons:

1. The contractor identified data quality and software algorithm issues that had to be rectified before re-estimating savings using the as-found equipment parameters. The implementation contractor made significant attempts to correct the identified problems but their reported savings estimates continued to appear unexplainable and inconsistent, even after a few reviews. Acknowledging data issues, the implementation contractor removed savings for two measures—Refrigerant II and Air Flow Correction—from the Program accomplishments.

2. The retrofit and building profile data were incomplete, eliminating the possibility of using an alternative modeling methodology. For example, the equipment age or required nameplate data were not recorded.

3. The contractor's software—Honeywell Estimator—did not appear transparent, and modeling seemed to lack calibration of the baseline usage from the billing data. When such calibration is lacking, software models often overestimate energy and demand savings. Nearly a third of rooftop units showed modeled energy use that implied over 4,000 equivalent full-load operating hours for commercial rooftop units, and the average was about 2,400 equivalent full-load hours. These calculated values are significantly higher than those typically found in commercial buildings, and the resulting baseline usage and deemed/reported savings are likely to be high.

4. When the treated area was recorded, it did not identify the entire area served by the rooftop unit. When some of the rooftop units at a facility were treated, these were not always clearly identified and associated with the utility meter.

5. The number of retrofits mentioned by the contractor as Program accomplishments did not match with those included in a separate file the evaluation team requested to support the contractor's Program savings estimates or the Program database. These discrepancies could not be resolved during the timeframe of this evaluation (Table 3–1).

Table 3–1. Discrepancies in the AirCare Program Data

Measure Code	Measure Description	Number of Retrofits		
		Contractor Reported Program Accomplishment	Program Flat File	Contractor's Savings Documentation File
1	Basic Inspection	3703	4013	1801
2	Refrigerant I	770	1049	48
3	Refrigerant II	39	49	37
4	T-Stat Modification	1027	1057	532
5	Economizer Adjust.	213	235	93
6	T-Stat Replacement	298	339	129
7	Airflow	575	625	
8	Economizer Package	187	246	37
	Total	6812	7613	2677

6. The implementation contractor used market characteristics data to report Program accomplishments for certain measures instead of using Program-specific data, and for the

refrigerant retrofit measure, used projected savings from a sample of retrofits to the untreated retrofit population.[92]

For these reasons, the contractor's reported Program accomplishments were not accepted as the Program impacts. The DEER savings estimates for the closest building type and measure were used,[93] assuming pre-1978 building construction so that the savings for the programmable thermostat measure can be included.[94] The evaluated engineering estimates might not be conservative for these reasons; however, the approach used was the only available option because the retrofit data were incomplete and unreliable.

We researched secondary sources to compare the evaluation estimated savings with savings reported elsewhere, and found that AirCare program savings estimates have not been reconciled with or compared with electric bills in other programs. The results from two AirCare programs implemented in the Northwest (Northwest Energy Efficiency Alliance and Avista Utilities) are not transferable to Edison's service territory because of the differences in the weather data. While the program implemented by the Northwest Energy Efficiency Alliance estimated savings from field measurements, the package of implemented measures was different, and dominated by two weather-sensitive measures: installation of an economizer package, and a programmable thermostat. The contractor adjusted deemed savings for the weather conditions in Edison's service territory, but the use of market characteristics data, liberal full-load operating hours, and unreconciled baseline usage, resulted in overestimated deemed and reported savings.

Two additional approaches were considered to estimate the Program ex-post gross savings: metering selected installations, and full billing analysis. However, three characteristics of this Program made it difficult to use these approaches without modification.

- Only three (two types of refrigeration retrofits, and thermostat replacement) out of eight measures implemented in this Program have deemed savings high enough to be measurable or noticeable on a customer's electric bill. All other measures save a small amount of energy that is unlikely to be noticed on the electric bill or detected accurately on a measuring instrument. In other words, the resolution of savings from a majority of measures is too small to be differentiated from the instrument measurement error.[95]

- Multiple rooftop units were serviced at a customer's site and some rooftop units were treated with more measures than others. The impact of retrofits and adjustments becomes less discernible on the electric bill as the facility size increases. Additionally, the Program

[92] For example, the percentage of undercharged and overcharged air conditioning systems typically found in the general market population was used instead of program-specific data.

[93] While DEER data are based on market characteristics, they have gone through public reviews and are widely accepted in CA for ex-ante and verified savings estimates. Given the data difficulties with PECI's proprietary data, the use of DEER data appeared to be a more reasonable alternative.

[94] DEER savings estimates are not provided for the programmable thermostat measure for buildings constructed after 1978 because the building codes have since required the installation of programmable thermostats.

[95] For example, for a 7.5 ton unit and two percent instrument accuracy, 300 to 400 kWh savings is noise. Not all measures lend themselves to measuring instantaneous difference in the pre- and post-retrofit KW. Time dependent savings will be affected by ambient and operating conditions.

targeted chain accounts such as Pizza Hut, Del Taco and schools that have high electric bills in relation to savings from the installed retrofits. Restaurants, for example, have high EUIs (especially with electric cook lines) which makes a billing analysis less feasible. Schools have relatively low EUIs, but reduced cooling hours if they don't run in the summer.

- It is technically feasible to record pre- and post-installation measurements for a short duration for measures that save a significant amount of energy, especially the thermostat replacement measure. However, a large number of representative installations will have to be metered to account for the variability among customers' usage. Estimating savings from the thermostat-replacement measure would require recording pre- and post-installation runtime hours for at least 3–4 weeks and analyzing its relationship with outside temperature. The baseline pre-installation data were not available, and relying only on post-installation data was unlikely to improve the accuracy of savings estimates, especially since available data were weak.[96]

For these reasons, the metering option was not used to estimate the Program impacts. This evaluation did use the billing analysis approach by identifying the measure impacts with low variability and then applying the estimated realization rates to the retrofits implemented at larger facilities. The Program evaluated ex-post gross savings based on the DEER data, and the billing analysis were similar. A more detailed description of these methods and the resulting Program impacts are described next.

Impact Evaluation Results

Table 3–2 presents annual ex-ante gross energy and demand savings goals and Program accomplishments using the contractor reported retrofits and deemed savings (ex-ante). Table 3–3 shows annual ex-ante net energy and demand savings goals and reported Program accomplishments. The Program net ex-ante savings were estimated using a 1.0 NTG ratio for all measures, except the HVAC replacement measure (0.8 NTG) that was removed from the package of measures offered to customers.[97] Similarly, the ECM measures were removed from the Program and the programmable thermostat upgrade plus the economizer measure was combined with other Program measures.

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[96] Post-only measurements of full load hours might help establish the annual cooling full-load hours. If collected, these data may improve program savings estimates.

[97] There was no assessment of HVAC contractor free ridership in this evaluation. The NTG ratio is based on assessment of end-users only. Future evaluations should assess free ridership using both populations.

Table 3–2. Comparison of Ex-ante Gross Energy and Demand Savings Goals and Reported Accomplishments

		Program Ex-ante Gross Savings				Program Reported Accomplishment (Gross)		
Measure Code - Measure	Number of Retrofits	Deemed Savings per Retrofit		Demand Savings	Energy Savings	Number of Retrofits	Demand Savings (kW)	
		kWh	kW	kW	kWh		kWh	kW
1. Basic Inspection -SC	4,742	400	0.07	331.94	1,896,800	3,703	1,481,200	259
2. Refrigerant I	1,494	1,750	0.2	298.80	2,614,500	770	1,347,500	154
3. Refrigerant II	166	2,200	0.5	83.00	365,200	39	85,800	20
4. T-Stat Modification	847	720		-	609,840	1027	739,440	-
5. Economizer Adjust.	752	925	0.42	315.84	695,600	213	197,025	89
6. T-Stat Replacement		3,600	0.42	-	-	298	1,072,800	125
7. Airflow	249	370		-	92,130	575	212,750	-
8. Economizer Package	576	1,150	0.42	241.92	662,400	187	215,050	79
9. HVAC Replacement	24	3,350	1	24.00	80,400		-	-
10. Programmable Thermostat Upgrade plus Economizer	38	1,645	0.42	15.96	62,510		-	-
11. ECMs	500	729	0.25	125.00	364,500		-	-
Total:	9,388			1,436	7,443,880	6,812	5,351,565	726

The Program did not accomplish its goal of the number of retrofits to be performed; therefore, the Program accomplishments calculated using the deemed savings and the actual number of retrofits recorded by the contractor did not meet the Program goals either.

Table 3–3. Comparison of Ex-ante Net Energy and Demand Savings Goals and Reported Accomplishments

	Program Ex-ante Net Savings		Program Reported Accomplishment (Net)		
Number of Retrofits	kWh	kW	Number of Retrofits	kWh	kW
9,388	7,427,800	1,432	6,812	5,351,565	726

Engineering Estimates of Ex-post Gross Program Savings

The Program ex-post gross energy and demand savings were calculated from DEER savings values for the applicable climate zone using the retrofit data provided by the contractor.[98] The following adjustments were required to use the contractor data and DEER savings estimates.

1. The Program retrofit data for the airflow adjustment and refrigerant II measures, representing 4% and 1.6% of the reported kWh savings respectively were unreliable,

[98] PECI file showsavings10-17-06.xls

according to the implementation contractor; these measures were removed from further analysis.

2. The basic inspection measure (the Schrader cap installation) was also removed from the analysis. The installation of the Schrader cap reduces the possibility of refrigerant leaks in the future, working as a preventive measure.[99] The implementation contractor did not identify charge adjustments required in ACs for which diagnostic assessments were performed through April 2006. Schrader caps were installed anyway. From April to June 2006, refrigeration charge adjustment was made for 12 retrofits but the percentage of charge adjustment could not be calculated because the nameplate and appropriate charge correction data were not available. The implementation contractor reported savings by projecting savings from the charge adjustment retrofits to all installations in which the Schrader cap was installed, including those for which the refrigeration charge was not measured. The evaluation team believes that claiming program savings for preventing possible future deterioration in equipment performance is not appropriate. This evaluation did not find any reliable and proven data that demonstrated current benefits from preventing future performance degradation. For these reasons, the Program was not credited with DEER-based savings from the basic inspection, and savings from the refrigerant charge adjustment measures were not credited because of lack of data

3. The Program implemented a behavioral measure—adjustment of incorrectly adjusted programmable thermostats—and installed programmable thermostats as a retrofit measure to replace nonprogrammable thermostats. From the technical perspective, energy savings may be realized from adjusting temperature settings to match the facility operating profile; however, residential sector studies have found that savings do not accrue from changing temperature settings of a thermostat. Similar studies have not been conducted for the commercial sector installations; therefore, the Program has been credited with savings from this behavioral measure, according to the guidance received from the CPUC.[100] This measure has not been modeled in DEER, but the installation of programmable thermostats in buildings constructed before 1978 has been modeled. Assuming that incorrectly adjusted thermostats would yield savings similar to the installation of a new programmable thermostat, the DEER savings estimates for the programmable thermostats were used for this behavioral measure.

   This assumption is likely to show more energy savings compared to modeling an existing incorrectly adjusted thermostat, but this was the only reasonable option to estimate the measure savings. This measure shows energy savings but increases peak demand (according to DEER modeling) because of increased load in the morning to attain set temperature.[101]

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[99] Refrigerant can still leak from other parts of a compressor.

[100] E-mail dated October 4, 2006 following a conference call with the MEC and CPUC.

[101] We used the DEER definition for peak. This example provides an explanation for increased demand as modeled in DEER. The explanation was provided by Jeff Hirsch.

4. The Program installed programmable thermostats to replace nonprogrammable thermostats. Programmable thermostats have been mandatory for installation since 1978 and Title 24 requires their installation as a retrofit measure. Thus, the baseline for a retrofit situation would be a programmable thermostat and there would be no above-code savings from this measure. However, according to the guidance from the CPUC, the Program has been credited with savings from this measure because the measure installation was induced by the Program. For the reason described in (3) above, this measure also saves energy while increasing peak demand.

5. The Program implemented two economizer measures, i.e., various types of adjustments to existing economizers and installation of a new economizer control package. In order to use the DEER data, the baseline for these measures was assumed as non-existing economizers.[102] With this assumption, the measure saving estimates would not be conservative but validation of savings with billing analysis is likely to remove possible liberal bias in the engineering estimate of Program impacts.

6. The facility type recorded in the Program database, in most cases, matched with those in the DEER database. The Program-classified Auditoriums were modeled as Assembly spaces.

The Program ex-post gross savings impacts using the DEER estimates are shown in Table 4–4. The Program implemented eight measures; three measures (Air flow, Refrigerant I and Refrigerant II) were eliminated because of data issues and one measure (Basic Inspection) was eliminated for concerns over its savings claim.[103] The number of retrofits used to calculate savings was from the data provided by the implementation contractor to support their estimates of savings. Because of data discrepancies described earlier, this is a conservative approach to estimate the Program impacts.

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[102] The DEER baseline assumes no economizer is not currently present.

[103] PECI included Refrigeration I and II savings in their reported accomplishments as shown in Table 3-2. During evaluation, we learned PECI was not comfortable with the validity of results of Refrigeration II measure and there were few performed. Therefore, we deleted that measure while estimating ex post gross savings. PECI did not do so in the results they reported so we have to compare with their stated accomplishments. For Refrigeration I, PECI said they corrected charge in installations serviced after April 2006. However, they failed to provide data on the amount of charge correction, charge capacity and other details that would allow us to estimate savings. We excluded these measures from engineering estimates but both measures were included in the billing analysis.

Table 3–4. Program Ex-post Gross Energy and Demand Savings by Measure

Measure Code	Measure Description	Number of Retrofits	Ex-post Gross Savings	
			kWh	kW
4	Thermostat Modification	532	518,689	-127.69
5	Economizer Adjustment	93	118,189	0
6	Thermostat Replacement (Programmable Thermostat)	129	140,128	-25.45
8	Economizer Package	37	49,460	0
	Total	791	826,466	-153.14

The Program ex-post gross energy savings are estimated as 826,466 kWh compared to the Program ex-ante gross savings goal of 7,443,880 kWh and reported Program accomplishment of 5,351,565 kWh. The Program ex-post gross demand savings were negative (increased demand expected). The Program ex-post gross energy savings realization rate compared to the ex-ante Program goals and reported Program accomplishment were 11 and 15.44 percent, respectively.

Billing Analysis

The Program ex-ante gross savings per measure, number of retrofits, and estimated savings from the installed measures are summarized in Table 3–5.[104] A majority of installations in the Program was Basic Inspections (53%). The Thermostat Adjustment (14%) and Refrigeration Retrofits I measures (13%) were other frequently-installed measures. The Program reported savings accomplishments were primarily from three measures, i.e., Refrigeration Retrofit I (29%), Basic Inspections (26%), and Thermostat Replacements (20%), accounting for 75% of reported savings of 6,179,315 kWh.

[104] The number of retrofits shown in this table is different from Table 3-2 because some retrofits did not have a site address or customer name that could be matched with billing records. These retrofits were removed from the billing analysis.

Table 3–5. Program Accomplishments and Estimated Savings

Measure Code	Measure Name	Ex-ante Savings per Measure	Number of Installations	% of Installations	Total Estimated Savings	% of Savings
BI	Basic Inspection	400	3,991	53%	1,596,400	26%
TA	Thermostat Modification	720	1,057	14%	761,040	12%
TR	Thermostat Replacement	3,600	339	4%	1,220,400	20%
REF1	Refrigeration I	1,750	1,008	13%	1,764,000	29%
REF2	Refrigeration II	2,200	49	1%	107,800	2%
AFS	Airflow Service	370	620	8%	229,400	4%
EA	Economizer Adjustment	925	235	3%	217,375	4%
ER	Economizer Controls	1,150	246	3%	282,900	5%
	Total	819	7,545	100%	6,179,315	100%

The Program implemented measures independently and as a package of measures. Therefore, the measure combinations were tabulated to assess the possibility of estimating ex-post gross savings for a measure for a comparison with the Program ex-ante assumptions (see Volume 2, Appendices). If a measure was implemented for a reasonable number of participating customers, its estimated savings could be used for measure bundles (adding up savings of constituent measures) that were infrequently installed. The most common measure installation combinations were:

- Basic Inspection (BI) Only (41.3%)
- Thermostat Adjustment (TA) Only (12.4%)
- Thermostat Replacement (TR) Only (7.8%)
- Air Flow Service (AFS) (6.4%)
- Refrigeration 1 (REF1) Retrofit Only (4.1%)
- Thermostat Adjustment (TA) + Economizer Adjustment (EA) (3.8%)
- Economizer Package (EP) (3.6%).

These measure combinations account for 80% of the measures installed in the Program.

The Program data flat file showed 994 participating sites of which the billing data was available for 948 sites. For the billing analysis, sites with at least six months of pre- and post-installation usage history were considered for further analysis. Both the pre and post periods include summer months. Because the Program implementation ended in June 2006, full annual usage data were not available for analysis.[105] A total of 505 participating sites met this qualifying criterion.

[105] Billing history through August 2006 was available when this analysis was completed.

For each participating site, the zip code was matched to the appropriate Edison weather station. Sixteen Edison weather stations were mapped to the zip code of participating customers. For each weather station, the average daily temperature data was used to create base 50-80 cooling degree days (CDDs), which were matched to each of the billing periods. Since most retrofits affected the cooling usage, the cooling load was estimated for varying CDD bases for both pre- and post-installation periods for each participant, resulting in 31 modeled cooling usage scenarios.

The model specification was as follows:

For each participant site *i* and calendar month *t*, and cooling base *c*,

$$ADC_{it} = \alpha_{ic} + \beta_{1c} AVGCDD_{itc} + \varepsilon_{itc} \quad (1)$$

where,

- α_{ic} is the intercept for each participant at cooling base *c*. This represents the base load (non-heating usage) in the pre- or post-installation period;
- β_{1c} is the cooling slope in the pre- or post-installation period for base *c;*
- ADC_{it} is the average daily consumption during the pre (post) Program period;
- $AVGCDD_{itc}$, is average daily cooling degree days (base *c*) pre (post) period based on customer location; and
- ε_{it} is the error term.

From the model above, the weather normalized annual consumption (NAC) for the pre- or post-installation period was computed as follows:

$$NAC_{ic} = \alpha_i * 365 + \beta_{1c} * LRCDD_{ic} \quad (2)$$

where, for each customer *i*, and cooling base *c*,

- NAC_i is the pre(post) period normalized annual consumption;
- α_{ic} * 365 is the annual model base load (non-heating usage) for each site at cooling base *c*;
- β_{1c} is the cooling slope in the pre or post period from the model;
- $LRCDD_{ic}$, is the annual long run (normal) cooling degree days (base *c*) for site *i*, based on location; and
- $\beta_{1c} * LRCDD_{ic}$, is the annual pre- or post-weather-adjusted cooling usage (base *c*) for site *i*, based on location.[106]

[106] Based on 10 years of Edison weather history. For example, in station 181 the normal base 65 cooling degree days were 4017. Similar long-run normal cooling degree days were computed for other bases from 50-80.

Each of the resulting models was screened for a positive sign for the intercept (base load) and cooling degree days (cooling load). If models had a negative sign, they were not reacting to cooling—possibly because of large electric usage or other changes occurring in the building. The best model selected was at the CDD base temperature that gave the highest model adjusted r-square, or equivalently, in this case, the lowest root mean square error (RMSE). Using these criteria, 429 (200 sites had just the Basic Inspection only; 229 participants had at least one additional Air Care Program measure implemented) out of 505 participating sites were found to have a valid cooling response model.[107]

The difference in the weather-normalized pre- and post-cooling usage was the weather-adjusted cooling savings, which were compared with the ex-ante savings estimates for the implemented measure bundle.[108,109] Table B-2 in Volume 2, Appendices, AirCare chapter, shows energy savings per participant from the measure bundle implemented at participating sites that showed reasonable cooling usage. The billing analysis savings estimates are heavily skewed by some large commercial and industrial accounts with high annual usage. The average ex-post gross energy savings are 23,486 kWh (34 percent of the estimated pre-installation cooling use) for all measure bundles, and 44,686 kWh if the Basic Inspection measure is excluded.[110] The average ex-ante saving per participant for all implemented measure bundles is only 4,413 kWh or 6.5 percent of the estimated cooling end use).[111]

Because the sample was unusual and results were not intuitive, we adjusted the analytic approach. The analysis was initiated unconstrained, and followed by a series of screening with established bounds. Prior to screening sites, the realization rates—dominated by large sites—for the implemented measure bundles vary from about -3,000 percent to 3,200 percent.

The overall realization rate is 532 percent but increases to 631 percent, if the participants who just had Basic Inspection done on their rooftop units are included.[112] The thermostat adjustment measure had a 3,189 percent realization rate. These two measures were among the top three measures in terms of the number of installations, however it was difficult to justify the savings estimates since they were not measures that were expected to yield savings. Since these measures likely wouldn't have shown any savings, we obtained results excluding these two measure types, and the overall realization rate was 36 percent. The corresponding average pre-installation usage was 304,073 kWh and the estimated savings were only about 1 percent of the cooling end use.

[107] The analysis examines results with and without Basic Inspection for completeness since that measure was not expected to save energy.

[108] Overall cooling usage ranged from 11-15% of total usage, depending on the screen used.

[109] Measure bundles refer to the set of measures implemented at each site.

[110] Basic Inspection should not save energy. The result here is likely an anomaly, most likely due to large facilities in the sample.

[111] The analysis initially was unconstrained and included all sites and measures installed at the site. We added screening and bounds be

[112] The bundle level precision levels on these estimates are extremely high – with precisions ranging from 63% to 1500%. The overall precision level is 338%.

The entire sample had twenty-two participants who had more than 1,000,000 kWh per year in pre-installation usage, and these participants might have significantly influenced the realization rate.[113] One participant from the thermostat adjustment group had weather normalized pre-installation usage of about 104 million kWh which was unusual in a program that targeted light commercial buildings.

In light of large variations in the realization rates based on the measure bundle savings, the evaluation team decided to screen participants using the site-specific realization rates; thus, eliminate participants with large realization rates from further analysis.[114] This approach was expected to show more reasonable savings and realization rates because measure bundles with small amount of savings in relation to large pre-installation cooling usage would not influence the overall results. The site-specific realization rate is defined as the weather-normalized cooling savings for each site divided by the ex-ante savings estimate for that participant.

In order to estimate unbiased Program savings realization rates, participants were screened using a fixed percentage range, above and below the estimated realization rate. Three screening ranges, i.e., ±200%, ±150%, ±100%, were used. For each range, the number of participants decreased. For example:

- 38 percent of participants were screened into the ±200% range;
- 35 percent were screened into the ±150% range; and,
- 27 percent were screened into the ±100% of the estimated realization rate.

This approach was also expected to show less variability in the realization rate as the screening range was tightened, i.e., participants included in the ±100% screening range were expected to have smaller cooling load; therefore, less variability in the estimated realization rates.[115]

These screens eliminated 39 participants who had large annual and cooling usage. Since the Program treated some but not all rooftop units at a participant's site, and expected savings from the measure bundles implemented at large sites were small, exclusion of large usage participants from this analysis is likely to show more reasonable results. Additionally, the billing analysis examined the resulting realization rates for three groups within each realization rate screen:

(1) all participants;,

(2) participants who had at least one more measure implemented in addition to the Basic Inspection; and,

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[113] Many of these outliers were later removed from the analysis, because they failed model screens.

[114] Pooled fixed effects SAE models and pooled pre post models model approaches were also attempted to obtain savings estimates. These modeling approaches did not show meaningful results.

[115] The 90% confidence precision levels dropped as the screen became more restrictive - from 100% precision for the ±200% screen, to 60% precision for the ±150%, and 68% precision for the ±100% screen, These precision levels are much smaller than the precisions without any screening that included the very large sites that skewed the results.

(3) participants who had at least one measure that was not the thermostat adjustment or the Basic Inspection measure.

The measure grouping was expected to allow a review of the results including and excluding the impacts of measures with very small or very large impacts

The results for each of the three screening methods are summarized in Table B-3, Table B-4, and Table B-5 in Volume 2, Appendices. AirCare chapter. The overall realization rate for all measure bundles for all participants was 13, 22 and 19 percent, respectively, for the ±200%, ±150%, and ±100% screens. The measure groups within each screen did not show significantly different realization rates compared with the overall realization rates. For the ±200% screen, the realization rate after excluding participants who implemented just the basic inspection measure is 13 percent, which is the same the overall realization rate for that screen. The realization rate improved to 17 percent by excluding participants who had only the thermostat adjustment measure installed. For the ±150% screen, the exclusion of each of the two measures showed a 24 percent realization rate, which was only slightly better than the 22 percent overall realization rate for that group. For the ±100% screen, the realization rate was 19 percent with or without the exclusion of each of the two measures.

The results did not find decreasing pre-installation total electric or cooling usage for the three screened scenarios. The estimated pre-installation electric usage for the ±200%, ±150%, ±100% screens was 168,262 kWh, 160,440 kWh, and 163,068 kWh respectively, and the corresponding cooling end use was 21,597 kWh, 20,279 kWh, and 20,637 kWh. The results in Table 3-6 exclude the thermostat adjustment only group (Table 3-6).

Table 3–6. Average Realization Rates for the Three Screening Methods

Measure Bundle	Number of Sites Installing Measure Bundle	Weather Normalized Pre Usage in kWh	Weather Normalized Pre Cooling Usage in kWh	Weather Normalized Post Cooling Usage in kWh	Weather Normalized Cooling Savings	Average Ex-ante Savings Estimate per Participant	Realization Rate[116]
All – 200% SCREEN	139	168,262	21,597	20,326	1,271	7,439	19%
All – 150% SCREEN	109	160,440	20,279	18,452	1,827	7,956	17%
All - 100% SCREEN	89	163,068	20,637	18,968	1,669	8,792	18%
OVERALL	112	163,923	20,838	19,249	1,589[117]	8,062	18%

The differences in the realization rates were perhaps due to the composition of measures within each screened group.[118] For example, for the ±200% screen, the thermostat replacement measure

[116] The realization rates are the weighted average measure bundle realization rates based on number of participant installations in each bundle.

[117] The standard error associated with this point estimate is 715 kWh. At the 90% confidence level the precision of this estimate is 74%. The average estimate is the best point estimate of program savings.

[118] See Volume 2, Appendices, for detailed measure bundle tables for each level of screening.

had a realization rate of 36% and the highest number of measure installations (32) among the three screened groups. The overall realization rate (19 percent) was the highest among the three groups. For the ±150% screen, the thermostat replacement measure had a higher realization rate (47 percent) and the highest number of installations for that measure (27). The overall realization rate was 17 percent for participants included in this screen. For the ±100%, the thermostat replacement measure had a somewhat lower positive realization rate (26 percent) and the fewest number of installations (22). The overall realization rate was 18 percent, which is very similar to the average of the other two groups.

The thermostat adjustment measure might have had a major impact on the realization rates of the results from each of the three screens but the thermostat replacement measure could also have had a significant impact on the realization rate of each screen. The measure impacts did not reveal a clear pattern; therefore, the Program impacts from the billing analysis were averaged for all measure bundles across all realization rate screens.

The average realization rates from the billing analysis for all measure bundles are summarized in Table 3–6. The billing analysis estimate for the Program realization rate is 18 percent for the screened participants. The estimated ex-post energy saving per participant is 1,589 kWh or 7.63 percent of the cooling load.

The average realization rate of 18 percent was applied to the ex-ante savings (6,179,315 kWh) of all participants to estimate the Program ex-post gross savings as 1,112,277 kWh, whereas, the engineering estimate of the ex-post gross energy savings is 826,466 kWh (74 percent of the billing analysis estimate). While the differences in the Program savings realization rates with or without the Basic Inspection and the Thermostat Adjustment measures were not significantly different, the average realization rate across all screens for these measures is 11 percent and -2 percent. The Basic Inspection measure is estimated to save 135 kWh per participant (the ex-ante estimate is 400 kWh per measure, which is not comparable). The Thermostat Adjustment measure increased usage by 80 kWh per participant, confirming findings from residential sector studies that have not shown savings from this measure. The magnitude of savings from the Basic Inspection measure is small, and insignificant as a standalone measure.

Final Program Impacts

The characteristics of measures implemented in the Program and weak Program data required using two methods to estimate the Program ex-post gross savings. These methods have their limitations; the engineering method discarded measures for which data were unavailable or the measure was technically unlikely to reduce energy usage. The billing analysis had to be performed on six months of pre- and post-installation usage data, and the participant population included large users who could distort the savings impacts and had to be dropped from the analysis. The results from both methods, however, confirm that the Program realization rate is low. The estimated participant savings at 7.63 percent of the cooling load appear consistent with the characteristics of implemented measure bundles. Had the Program achieved 100 percent of ex-ante savings, it would imply saving 43 percent of participant’s cooling load which is unlikely for the bundle of measures implemented. The evaluation team used the billing analysis results to report the Program energy saving impact. The ratio of energy savings from the billing analysis and the engineering estimate (1.35) was applied to the engineering estimate of Program’s peak demand changes to report the Program ex-post gross demand savings. Since customers were not involved in deciding about Program participation, the Program had no free riders. A net-to-gross ratio of 1.0 was used to estimate the Program ex-post net energy and demand savings.

The Program goals, ex-post gross and net energy savings, and respective realization rates are shown in Table 3–7. The Program evaluated ex-post gross energy savings are 1,112,277 kWh compared to the Program goal of 7,443,880 kWh, yielding 14.94 percent gross energy savings realization rate. The Program evaluated ex-post net energy savings are 1,112,277 kWh compared to the Program goal of 7,427,800 kWh, yielding 14.94 percent net energy savings realization rate. This realization rate is different from the 18 percent realization rate estimated in the billing analysis because the Program ex-ante savings used to calculate that realization rate were for a subset of Program participants whose location, and therefore the billing data, were available.

Table 3–7. Comparison of Programs Goals and Ex-post Gross and Net Energy Savings

	Program Ex-ante Gross kWh Goals	Program Ex-ante Net kWh Goals	Program Gross Ex-post kWh Savings	Gross Realization Rate (Percent)	Program Net Ex-post kWh Savings	Net Realization Rate
AirCare	7,443,880	7,427,800	1,112,277	14.94	1,112,277	14.94

The Program goals, ex-post gross and net demand savings, and respective realization rates are shown in Table 3–8. The Program ex-post gross demand savings are -207 kW compared to the Program goal of 1,436 kW, yielding -14.41 percent gross demand savings realization rate, or an increase in peak demand. The Program evaluated ex-post net demand savings are -207 kW compared to the Program goal of 1,432 kW, yielding -14.45 percent net realization rate.

Table 3–8. Comparison of Programs Goals and Ex-post Gross and Net Demand Savings

	Program Ex-ante Gross kW Goals	Program Ex-ante Net kW Goals	Program Ex-post Gross kW Savings	Gross Realization Rate (Percent)	Program Ex-post Net kW Savings	Net Realization Rate (Percent)
AirCare	1,436	1,432	-207	-14.41	-207	-14.45

The Program reported gross energy and demand savings are compared with the Program ex-post gross energy and demand savings (Table 3–9). The gross energy and demand savings realization rates are 20.78 and –28.51 percent, respectively.

Table 3–9. Comparison of Program Reported Accomplishment and Ex-post Gross Energy Savings

	Program Reported Gross kWh Savings	Gross Ex-post kWh Savings	Gross Energy Savings Realization Rate (Percent)	Program Reported Ex-post Gross kW Savings	Gross Ex-post kW Savings	Gross Demand Realization Rate (Percent)
AirCare	5,351,565	1,112,277	20.78	726	-207	-28.51

Ex-ante proposed, ex-ante reported and evaluated savings are summarized in Table 3–10 below.

Table 3–10. Savings Summary

	Proposal				Reported				Evaluated		
	Ex-ante Gross	Net to Gross	Ex-ante Net		Ex-ante Gross	Net to Gross	Ex-ante Net		Ex-post Gross	Net to Gross	Ex-post Net
kWh	7,443,880	.997	7,427,800		5,351,565	1	5,351,565		1,112,277	1	1,112,277
kW	1,436	.997	1,432		726	1	726		-207	1	-207

Lifecycle Savings

The measure bundles implemented at a participant's site included measures that did not have the same measure life, and the constituent measures were not expected to fail if the persistence of one of the measures was lost. In such a case, the shortest measure life of a constituent measure in a measure bundle could have been used. One possibility of assigning measure life was to use savings-weighted measure life for a bundle of measures the Program implemented for a participating customer. However, the measure bundle savings could not be used to estimate the Program impact at the participant level because of high variability in bundle savings across customers.

An alternative approach used in this evaluation was to review the measure life for a frequently implemented measure, on a stand-alone basis or as a constituent measure in a measure bundle, assess measure persistence, and then estimate measure life. The Program most frequently implemented the Basic Inspection, Thermostat Adjustment and Thermostat Replacement measures.

The Basic Inspection is a routine maintenance activity to be performed annually and it has shown minimal savings in the billing analysis. This measure was discarded from the engineering estimates of Program savings. This evaluation could not find the measure life for a diagnostic activity from secondary sources. Since this measure largely focuses on testing equipment to identify retrofits, the measure life was estimated at one year. The Thermostat Adjustment measure showed a small amount of increased usage which suggests that savings, if any, from this behavioral measure did not persist. This measure had the largest share of Program savings (62.76 percent) in the engineering analysis. The Thermostat Replacement measure has a measure life of 10 years, according to the DEER database, which does not suggest a recommended measure life for the Economizer Adjustment measure. The refrigeration retrofits and the Economizer Controls package have an estimated measure life of 10 years, using the DEER estimate of measure life for the RCx measure and HVAC controls (time clock as a substitute for the Economizer Controls package).

Since soft measures with a large share of Program reported savings—Basic Inspection and Thermostat Adjustment—showed small savings or had lost persistence already, their short measure life was not used to estimate the Program lifecycle savings. This evaluation assigned a 10-year measure life, which is appropriate for the majority of remaining Program measures except the Economizer Adjustment measure. The number of installations and estimated savings from this measure were small. Therefore, the Program lifecycle savings are unlikely to be affected significantly by using a 10-year measure life for this measure. The Program lifecycle ex-post net energy and demand savings for this Program are shown in CPUC required format in Table 3–12 below. The EUL and lifecycle net energy savings are shown in Table 3-11.

Table 3–11. Program Ex-post Lifecycle Net Energy and Demand Savings for AirCare Plus Measures

Ex-post EUL	Ex-post Lifecycle Net Energy Savings
10	11,122,770

Table 3–12. Program Lifecycle Ex-post Energy and Demand Savings

Year	Calendar Year	Ex-ante Gross Program-Projected Program MWh Savings	Ex-post Net Evaluation Confirmed Program MWh Savings	Ex-ante Gross Program-Projected Peak Program MW Savings	Ex-post Evaluation Projected Peak MW Savings	Ex-ante Gross Program-Projected Program Therm Savings	Ex-post Net Evaluation Confirmed Program Therm Savings
1	2006	5,352	1,112	.726	-2.07		
2	2007	5,352	1,112	.726	-2.07	-	-
3	2008	5,352	1,112	.726	-2.07	-	-
4	2009	5,352	1,112	.726	-2.07	-	-
5	2010	5,352	1,112	.726	-2.07	-	-
6	2011	5,352	1,112	.726	-2.07	-	-
7	2012	5,352	1,112	.726	-2.07	-	-
8	2013	5,352	1,112	.726	-2.07	-	-
9	2014		1,112	.726	-2.07	-	-
10	2015		1,112	.726	-2.07	-	-
TOTAL	2004-2023	42,813	11,123				
Definition of peak MW as used in this evaluation: Average demand reduction during the summer months, DEER definition of peak 2 - 5pm.							

4. Conclusions and Recommendations

A number of conclusions can be drawn from both process and impact evaluations. The Program did not reach its participation goals and energy savings goals, nor were the expected number of contractors trained. This program was difficult to evaluate for various reasons: lack of pre- and post-installation data, incomplete and inconsistent Program data, small savings compared to participants' usage, use of proprietary software lacking transparency, and insufficient track record of large scale implementation. Innovative and unproven technologies or concepts typically have these evaluation challenges; some resolvable and others perhaps unresolvable. This program could not use one standard evaluation approach; therefore, the Program impacts had to be estimated from two analytic approaches and the results were compared with common knowledge of energy use in commercial buildings. The evaluability of such programs can be improved at the program design stage and with early involvement of evaluators. The Program evaluation revealed many issues for which clear precedents and policy guidance was not available. The following recommendations will help improve the evaluability of such programs.

Conclusion 1. *The Program ex-ante assumptions erroneously included savings for measures that do not save energy.*

The impact evaluations conducted by this team for Edison's IDEEA programs have not credited programs with savings from diagnostic or testing activities, unless the program demonstrated that specific corrective measures based on the diagnosis were implemented. The program ex-ante savings for some of the IDEEA programs, including this program, have included savings from diagnostic activities that by themselves do not save energy. The policy guidance for such activities is clear, i.e., programs are credited only for the actions taken that save energy.

Recommendation 1. *Reaffirm and disseminate the policy guideline that states programs are credited for actions that save energy.*

Reaffirming and widely disseminating this policy guidance that reiterates programs are credited for energy saving activities would benefit future program designs. This program also implemented a preventive measure— Schrader cap installation—that claims to save energy in the future by preventing potential refrigerant leakage. Crediting the Program with savings from a preventive measure would be speculative. The CPUC's policy guidance on the eligibility of such measures for energy-efficiency programs would be helpful.

Conclusion 2. *Adjusting thermostats can increase usage.*

The Program implemented a behavioral measure, i.e., adjustment of incorrectly set existing thermostats to match the facility operating schedule. This measure does not have a proven record of energy savings in the residential sector, and data are not available on its likely persistence in the commercial sector. The billing analysis showed increased usage from the implementation of this measure that is consistent with the findings from evaluations of residential sector programs. According to the policy guidance the evaluation team received from the CPUC, this measure was retained in the engineering and billing analyses conducted for this program.

Recommendation 2. *Conduct a statewide study to estimate the impact of this behavioral measure in commercial buildings.*

In view of the finding from this evaluation, we recommend conducting a statewide representative study to estimate the impact of this behavioral measure in commercial buildings to confirm the finding from this evaluation and reassess the eligibility of the thermostat adjustment measure as an energy-efficiency measure for direct and indirect energy-efficiency programs.

Conclusion 3. *Early evaluation planning will improve evaluability of programs.*

The evaluability of programs such as AirCare Plus^{SM}, which implements maintenance measures or retrofits with small savings, can be improved with early evaluation planning. In order to select an impact evaluation method, a clear understanding of the eligible measures and of the package of measures is required. Then, measures would have to be grouped according to the magnitude of expected savings and the nature of savings, i.e., immediate impact or long-term, weather-dependent impact. This would help determine whether measurement or engineering-oriented approaches, billing analysis, or a combination of approaches are likely to be effective.

Recommendation 3. *Conduct early evaluation planning, collect and verify baseline conditions.*

Using any of the available impact evaluation methods would require quality pre- and post-installation data. Any baseline condition that is altered by the Program, e.g., temperature settings or economizer settings, must be recorded for all installations. These parameters cannot be verified after measure installation. Early evaluation planning that includes verifying such variables on a sample of installations would be helpful in improving the quality of data, but such verifications do not substitute accurate recording of baseline data for all installations. Similarly, basic and necessary equipment parameters unaltered after the measure installation (such as nameplate data for maintenance measures) can be verified post-installation; however, if such data are not recorded for a large majority of installations, it would be inaccurate to estimate these parameters from known observations. Certain post-installation treatment data are also not verifiable unless recorded in the Program database. For example, the amount of refrigerant added or removed is evidence of action taken as well as a necessary variable to estimate energy savings using the percentage overcharge and undercharge condition (and requires stamped charge capacity as well for a large majority of installations). Lack of critical baseline and post-installation data such as those described above made it impossible to use standard engineering methods to estimate the impact of this program. Future programs must identify the minimum required data ahead of time and implement a quality data collection plan.

Conclusion 4. *Ex-ante savings estimates were too high.*

The Program ex-ante estimates were developed from the experience of implementing a program in the Northwest. The adjustments made to the savings estimates used for the Northwest climate did not fully account for Edison's climate zones. As a result, the ex-ante measure savings estimates were too high. The implementation contractor then used a proprietary software model to report savings that were not calibrated to facility usage data; therefore, the Program accomplishments were overestimated.

Recommendation 4. *Calibrate and validate software models and make them transparent.*

Software models used for reporting Program savings should be validated and must be transparent. One way to accomplish this in early evaluation would be to calibrate software with a participant's billing usage to establish the baseline usage. Further refinement in the savings estimates prepared from the software could be had from using site-specific measurements for a sample of installations and adjusting the software model from measured savings.[119] A calibrated software model can be used to estimate the Program impacts, provided it is flexible enough to accept site-specific data from non-calibrated participants to estimate the savings impacts.

Conclusion 5. *Implementing a code-compliance measure could lead to double-counting savings and discourage installation of measures that exceed code.*

The Program implemented a code-compliance measure—installation of programmable thermostats to replace nonprogrammable thermostats. Installation of programmable thermostats in future programs would double-count savings with those from the codes and standards program.[120] Because the AirCare Plus[SM] program had a small impact, the overlap of Program savings with those from the codes and standards program is likely to be minimal. However, such impacts might be substantial in the future, and a method to eliminate double counting of savings between an IOU program and the codes and standards program needs to be developed. A more fundamental question, however, is whether energy-efficiency programs should offer measures that are required by Title 20 or Title 24 anyway, i.e., these measures are the baseline requirements for which there are no above-code savings.[121] Crediting the Program with savings from programmable thermostats would also open the door for promoting EPACT efficiency motors instead of super high-efficiency motors, or installation of SEER 13 air conditioners instead of air conditioners that exceed the minimum code.

Recommendation 5. *Conduct a policy review of code-compliant measure programs.*

We recommend that the CPUC conduct a policy review for installation of code-compliance measures in energy-efficiency programs.

Conclusion 6. *Billing analysis was effective for smaller participants but accuracy can be improved.*

The billing analysis method used for the evaluation of this program was effective in estimating the Program impacts for smaller participants. This method can be used in the future with

[119] Relying solely on bench-test results or field tests for a package of measures may not provide an accurate estimate of program savings because of the variability of site-specific conditions, unless field tests are conducted on a very large number of representative installations in all climate zones of Edison's service territory.

[120] A program that targets installation of code-compliant measures by design is different from one in which a contractor accidentally comes across an opportunity to install a code-compliant measure.

[121] The policy guidance available currently is: "Savings from a code-compliant measure installed via an IOU program can be credited to that program providing the evaluator can demonstrate that the measure was installed as a result of the program's efforts, is net of free riders, and is above and beyond the changes induced by the code change."

improved accuracy if the Program data can better identify the treated installations to a utility meter and record untreated equipment associated with that meter. For larger sites where a small rooftop unit is treated or a small area is treated, the cooling end use and the corresponding annual usage can be estimated and used in the billing analysis. If large customers participate in the Program, such end-use estimation might introduce approximations, and the Program impacts should be estimated and compared using another method. Records of rooftop units that identified all treated and untreated units associated with utility account numbers and meter numbers were not kept.

Recommendation 6. *Identify treated units and associate with meter and/or utility account number.*

Contractors should record all rooftop units and their associated meter and account numbers, recording the number of treated and untreated units. Additional data including unit age, nameplate data, and baseline operating conditions should also be collected.

Conclusion 7. *Record keeping and data quality issues impacted incentives and evaluation.*

Data collection and data quality and record keeping impacted not only the evaluability of the Program, but the contractor's ability to receive incentives for units serviced under the Program. Collecting and accurately recording account numbers and tracking down missing account numbers was a time-consuming problem. PECI verified account numbers contractors collected against a list of potential customers provided by Edison, but not all account numbers were identified. The end result was that contractors who performed work did not receive incentives where account numbers were not recorded. These units were assumed to be outside Edison's service territory.

Recommendation 7. *Improve data collection and record keeping.*

Contractors need to be aware of the boundaries of Edison's service territory if they expect to receive incentives for work performed under Edison's programs. If these accounts were actually within Edison's territory, there were incentives not distributed and energy savings that could not be claimed. Most importantly, the customer's account number must be collected and accurately recorded. Recording account numbers accurately was an issue not only in this Program but in virtually all other IDEEA Programs.

Conclusion 8. *HVAC maintenance is seasonal and the duration of the Program was too short.*

Ramping up the Program essentially took a full year. PECI and Edison feel this program is best suited to a multi-year program timeframe. It takes time to train the HVAC contractors so that they are familiar with the diagnostics. For contractors to fully incorporate and embrace the Program protocols into their current business model, the Program needs to last more than one year. HVAC maintenance is also seasonal. Contractors are busy with "no cool" calls during the summer and have more time for maintenance and diagnostics during the shoulder months. Timing is also an issue then, since it must be at least 65^{o} F for the equipment to work properly.

Recommendation 8. *Ensure Program timing and marketing takes into account the seasonal nature of the market.*

Conclusion 9. *More service providers and marketing may have raised participation levels.*

The goal for the number of trained contractors was 65 and only about 15 participated. Program installation goals and energy savings goals were not met. Contractor attrition was high. The length of the Program and the cost of the equipment may have been factors in technicians' decisions to withdraw from the Program or to not join at all. Contractors noted they did not have the time or money to participate. In addition, turnover within the industry is "naturally" high. Contractors delivered Program services without the knowledge of their customers and by marketing directly to customers. Contractors requested that Edison increase its marketing, and they appreciated marketing materials. No records were kept to determine the effectiveness of various marketing methods.

Recommendation 9. *Broad-based marketing is needed for this program to be successful as a mainstream component.*

Recruit and train additional contractors to deliver the Program. Broaden the marketing of the Program to include direct marketing to the customer. Increasing the number of service providers and the marketing methods should broaden participation. Marketing materials should be provided to the HVAC contractors delivering the Program. Edison should also market the Program to potential customers.

Contractors should keep records that document the marketing method, including whether the customer was aware of services provided, if they received direct marketing, and whether they received any portion of the contractor's incentives. Records should include customer contacts who refused the service. Contact records would allow Program managers, implementers, and/or evaluators to contact the customer and query them about their participation decision-making.

Conclusion 10. *Software and equipment performance issues were troublesome.*

Software and programming issues to accurately calculate energy savings are discussed in earlier recommendations. Contractors commented there were still bugs and holes in the Program software. In addition, the WiFi needed to upload and download data from the field was not always available. Some contractors had to return to their home base to transfer data. Some recommend broadband access.

Recommendation 10. *Expand the PDA data transfer capability to broadband.*

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5. Community College District Retrofit Program

1. Program Description

The CCRP provided a variety of energy-efficiency activities and equipment retrofits to create immediate energy and peak demand savings. Some of the measures include interior and exterior lighting retrofits, HVAC equipment upgrades, air and water distribution efficiency measures, commissioning, PC management software, and vending machine controls.

The CCRP as proposed was described in Program documents as innovative in several respects. First, it was described as innovative in its target market, community colleges. Community Colleges had received limited energy-efficiency funding in the past. The Program was designed to include a manageable number of colleges and to develop a long-term reliable infrastructure that could be applied to other colleges. Second, the Program was innovative in its timing, being coordinated with, and providing energy efficient enhancements for, existing retrofit projects then occurring on LACCD campuses with Proposition A and Proposition AA bond funds. The Program was also innovative in its call for commissioning activities on LACCD campuses.

The CCRP was also described as innovative in the technologies utilized, because it mixed new and established technologies. One of the key contacts described the Program as being innovative in the way the Program contractor "*acted in the role of a middleman.*" The contact elaborated that "*It was Intergy…looking for opportunities for community colleges to participate in this Program that was innovative.*"

For the LACCD district office, an installation of EZConserve's Surveyor Software was completed. Surveyor is a PC power management application used to power down unused PCs, thereby reducing PC power consumption. The installation of the Surveyor software was originally planned at three campuses but was only completed at one (Site 5). The only other measure installed at LACCD campuses was vending machine controls (VendingMisers, CoolingMisers, and PlugMisers) at two colleges (Sites 2 and 3). Vending machine controls were also installed at one other college (Site 4).

As mentioned above, CCRP activities in the SBCCD were focused on one campus (Site 1). The work at this site included interior and exterior lighting, central plant upgrades, conversion to a variable air volume (VAV) air distribution system, a revised control scheme for the EMS, fan and pump VSDs, and skylights to bring natural light into the gymnasium.

Work at Site 8 included the conversion of a distributed HVAC system into a central plant. Site 7 activities included retro-commissioning of the entire HVAC system to include revisions to the fan and pump schedules and the use of thermal ice storage to satisfy load. A science laboratory was retro-commissioned at Site 9, and interior lighting retrofits have been completed at Site 6.

Quantec, LLC and Summit Blue Consulting conducted a comprehensive process and impact evaluation of the Program. The process evaluation included interviews with the Edison Program manager, with Program implementation staff, and with contacts from the participating and nonparticipating colleges.

This report is organized into five sections. The next section (Section 2) presents the process evaluation, including the Program logic model, results of interviews with Program staff and participants, and free rider estimates. Section 3 describes the impact evaluation and the engineering and site visit results, and calculates realization rates, ex-post gross and net savings, and lifecycle savings. The final section (Section 4) presents the major conclusions and recommendations.

2. Process Evaluation

Process Evaluation Methodology

The topics and researchable issues addressed in the process evaluation included the CCRP's origin, its original goals, and differences between the Program as-designed and as-implemented. We also examined the Program's administrative processes, division of responsibilities, and Program marketing. Delivery and implementation issues such as project selection, participant satisfaction with installation and with the measures themselves, and issues of free ridership and spillover (discussed in the impact evaluation) were also addressed. The process evaluation also considered whether additional energy-efficiency opportunities remain on the campuses, whether new skills were developed or required by the projects, and the extent of understanding and implementation of continuous commissioning on the campuses. Finally, lessons learned, and reasons for nonparticipation in the CCRP were addressed.

Program Logic Model

Figure 2–1 includes a logic model of the Program as it was implemented. The logic model graphically displays the process by which the Program activities lead to specific outputs and outcomes. The context for the Program includes the inputs as well as the Program's external environment that influenced Program design. The external factors include the availability of public funds (Proposition A and AA bonds) for facility improvements at community college campuses, increases in the price of energy, increasing demands on aging educational buildings, and the California university/IOU partnership model. Inputs to the campuses to achieve the Program's intended results include the public bond funding, the commitment of facility planning staffs at the targeted community colleges, IDEEA funding for energy-efficiency retrofit incentives, and EZConserve's Surveyor Software.

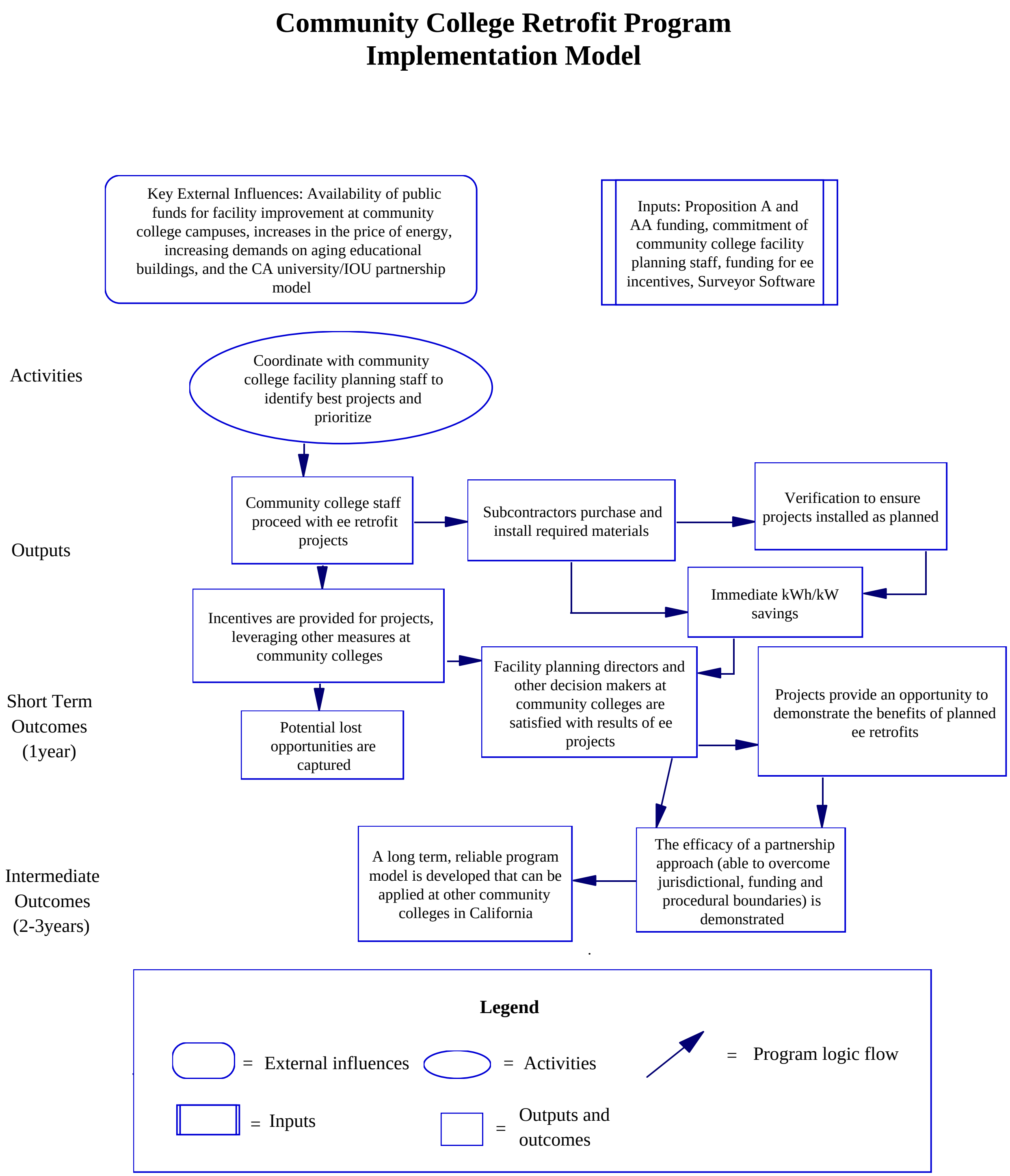
Program activities began by coordination with community college facility planning staff to identify and prioritize Program projects. Outputs flowing from project identification included community college staffs proceeding with energy-efficiency retrofit projects, the provision of Program incentives that leveraged additional measures, Program contractors and subcontractors purchasing and installing the required materials and equipment, and verification to ensure the measures were installed as described.

Program outcomes included immediate energy savings and load reduction, capturing potential lost energy-efficiency opportunities, the satisfaction of facility planning directors and other community college decision makers with the results of the projects, an opportunity to demonstrate the benefits of the planned retrofits, the demonstration of the efficacy of a partnership approach's ability to overcome jurisdictional, funding and procedural boundaries, and the development of a long-term, reliable, program model that can be applied at other community colleges in California.

Key differences between the as-designed and as-implemented models are the lack of commissioning, best practice development, and training results in the as-implemented model.

The primary outcomes however were unchanged, because the savings and the demonstration of a viable Program outcome still resulted from the Program as implemented.

Figure 2–1. Program Logic Model



Process Evaluation Sample Design

The process evaluation is based upon a review of Program documents and upon interviews with Program implementers, participants, and a sample of nonparticipants. The evaluation sampling plan included conducting telephone interviews with utility staff, three contacts from the Program implementation contractor (Intergy), two contacts from the subcontractor ESCOs that implemented the majority of the projects, contacts from six of the nine campuses on which projects were completed, and contacts from six of the campuses that were contacted but did not participate in the Program.

Lists prospective contacts were obtained from Intergy. These lists included contact information for the Edison Program manager, four staff from the implementation contractor, and five staff from Program delivery subcontractors. The utility Program manager, three staff from Intergy, and one representative from each of the two principal Program-delivery subcontractors (Siemens Building Technologies and Chevron Energy Solutions, Table 2–1) were interviewed.

Another list was obtained that included contact information for 18 staff from nine participating campuses, and a list of 14 individuals from 12 community colleges who were contacted about, but did not participate in, the CCRP. Staff from six participating campuses were interviewed. Staff from seven of the nonparticipating campuses were also contacted. The interviews with the contacts from the various lists were conducted from August 17th through August 25th, 2006.

Table 2–1. Sample and Interviews

Contact Type	Population	Completed
Utility staff	1	1
Implementation staff	4	3
Subcontractor/ESCO staff	5	2
Campus participants	18	6
Campus nonparticipants	14	7
Total	42	19

Process Evaluation Results

In this section, the Program is described as seen by the sample of the individuals who designed and implemented the Program, and as experienced both by the sample of those whose campuses participated in the Program and by the sample of community college staff whose campuses did not participate in it.

Program Design

The CCRP was initiated by the Program's implementation contractor, Intergy Corporation. The contractor had been working on community college campuses in Edison's service area, and had become aware of some of the prospective program projects at those campuses. To identify other projects, the implementation contractor ultimately contacted three Energy Service Companies (ESCOs) and four other equipment contractors to learn what they were working on at community college campuses. The implementation contractor packaged energy-efficiency projects from six LACCD and SBCCD campus locations into the Program proposal. The projects identified by ESCOs were described by key staff as ones that had stalled and were "sitting on the shelf," because the community colleges did not have sufficient funds to complete them. According to one contact, funding from the CCRP *"pulled the trigger"* on those projects.

Once the Program was selected and implementation began, two factors, each having an impact upon Program implementation, became evident relative to the pre-identified projects. First, it became evident that *"implementing these projects would take a longer timeline than the Program had."* Thus, some of the energy saving activities could not be done within the Program's timeline. Second, preliminary marketing activities for the 2006-08 statewide Community College Partnership program had begun to reach community college campuses by late summer or early fall of 2005,[122] resulting in some campuses dropping out of the CCRP in order to be eligible to participate in the statewide program.

The combined effect of these two factors required substantial changes to the Program to ensure its success. The implementation contractor worked with Edison to develop the revised scope. One change was the expansion of its retrofit activities to community colleges beyond the LACC and SBCC districts in order to offset the losses of energy and peak demand savings from projects that were discontinued or dropped out.

The other major change was to expand to additional campuses within the LACC and SBCC districts. Without a Program marketing budget as described in the following section, the additional work required to recruit more campuses into Program participation left insufficient resources to complete the full breadth of the CCRP's activities as described in the Program proposal. Specifically, plans for the development of a best-practices methodology and for training in best practices were discontinued, as were plans for continuous commissioning on the LACCD campuses and for training community college staff in commissioning. These Program changes are recorded in an amended scope of work filed with Edison in December 2005 and eliminated one of the Program's two goals, namely, the establishment of "a permanent framework for a comprehensive, long-term, energy management program at the Community Colleges in California."

Market Assumptions, Marketing, and Decision Making

The CCRP proposal included a complete set of pre-identified projects; therefore, marketing to other prospective Program participants was explicitly excluded from the Program activities set forth in the original Program design, and no funds were budgeted for marketing activities.

When it was discovered that the originally proposed projects would not fit into the Program timeline, it became necessary to identify additional projects at additional locations in order to be able to meet the Program's energy savings targets. The marketing involved to acquire additional

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[122] Project applications for the statewide program were accepted from October 15 through November 15, 2005.

projects consisted of the contractor’s staff or the subcontractors’ staffs contacting community colleges both at the pre-identified sites and at additional campuses. On occasion, Edison facilitated this effort with introductions to community college staff through the campuses’ utility account representatives. As much as possible, approaches to additional campuses were made by people working with the implementation contractor or subcontractors that were already acquainted with someone at a given campus. Where there was no pre-existing relationship, “cold calls” were made, with *“many of them not going anywhere.”*

The responses of the participating campus staff generally confirm this description of Program marketing. Three of the six campus contacts reported hearing of the Program from Intergy or one of its subcontractors. One of the remaining three said he learned of the Program from his utility representative, and another heard from his energy consultant who *“suggested that I call Intergy about the Program.”* The sixth participant reported that his former boss had told him to participate in the Program.

Two of the seven contacts from nonparticipating campuses reported learning of the Program from Intergy or a subcontractor, and another nonparticipant heard of it from a utility representative. One mentioned a telephone call about the Program, which is consistent with key staff descriptions of Program marketing. The remaining three nonparticipants could not remember the source of their awareness of the Program, and in some cases, could not remember hearing about the Program at all.

Program Delivery and Implementation

Three of the six interviewed participants described their roles in their projects as “project manager.” However, the roles of all six were primarily to serve as the point of contact between the campus and the contractor or subcontractor for the project, because the process of project delivery and implementation required little from the participating campuses.

To start the process, the Program contractor would determine whether the proposed project was eligible for incentives or rebates through any of the standard utility programs. If not, campus energy bills would be analyzed to confirm that energy savings would actually result from the project. Then the contractor would reach an agreement with the campus regarding the amount of funding the Program would provide for its project, and a performance contract would be executed between the campus and the contractor or one of its subcontractors, depending upon which of them would be implementing the project.

The Program contractor or its subcontractors reportedly executed almost all of the remaining project steps for the campuses. Looking more specifically at the various project steps—namely, project identification, project design, finalization of project details, purchasing materials and equipment, project installation, and project documentation—reveals the extent to which Program participation was simplified for the campuses.

Three of the six contacts from participating campuses reported they were involved in project identification, one of them saying he merely chose from a list of projects presented to him by the Program contractor. Others reported that campus involvement in the projects was limited to being available to unlock doors and identify utility locations, and one mention each was given of involvement in project installation and involvement in project documentation. Not surprisingly, this comprehensive approach to Program delivery and implementation was reported by participants to have "*worked well*," or to have been "*fantastic*!"

Completing the Program delivery, the implementation contractor would inspect the project with campus staff. Upon completion of a second inspection by utility and contractor staff, the implementation contractor would submit an invoice for payment to Edison, forwarding the entire payment to the campus upon its receipt. All but one of the six participating campuses reported that their Program payments had been timely. The sixth participant said the payment for his project had not been received because its paperwork had not yet been completed.

Market Barriers

The principal barrier to broader Program participation arose from an incomplete knowledge of the market during the Program design phase, and from unforeseen, subsequently occurring, market conditions. When the Program was designed, the implementation contractor was unfamiliar with the length of time projects can take to complete through the community college system. An unforeseen review process by state architects required for large projects on community college campuses was mentioned by key staff as a factor that contributed to delaying completion of some projects beyond the Program's timeline.

Another factor affecting both prospective participants and nonparticipants was the unexpected overlap of the marketing for the 2006-2008 statewide community college retrofit program. According to one contact, *"The statewide program offered the prospect of much higher incentives, resulting in some of the campuses dropping out of this Program to go with the statewide program."* According to another contact, *"the statewide program took Intergy by surprise and threw the Program off track."*

Factors reducing nonparticipants' Program involvement included being too busy with other activities at the time they were contacted about the Program. One nonparticipant reported, *"We were swamped at the time and probably put them off."* Another nonparticipant reported the campus was very busy with major construction, and said he had no recollection of even being contacted about the Program. These responses are consistent with a lack of Program awareness resulting from the minimal marketing effort.

Ongoing major campus projects affected one nonparticipant in another way. That contact reported, *"At the time of the call inquiring about Program opportunities, we didn't know if we had money for additional major projects."* Funding was also an issue for another nonparticipant. However, that particular situation was one in which the college president was reported to have been "*very tight with money*."

Non-recognition of the Program contractor's name was another barrier to participation. The contractor had to make "cold calls" to as many as 40 additional campuses to try to replace the anticipated energy savings that were lost from projects that could not be completed within the Program timeline, or from projects that opted to seek higher incentives through the statewide retrofit program. *"Many of the cold calls did not go anywhere,"* reported one contact. On one occasion, a campus contact *"couldn't tell whether the call was legitimate."* Subsequently, that contact learned from his campus's energy services provider the call was legitimate. He said, *"We were disappointed, but we have moved on."* The utility contact also mentioned Edison received inquiries from campuses about the Program's legitimacy.

Thus, while funding limitations were perceived as a Program participation barrier by some nonparticipants, the principal barriers to Program participation arose from an incomplete knowledge, during Program design, of the market, and the subsequent occurrence of overlapping marketing by a competing program. When the need to market the Program was perceived, resources to provide Program marketing were limited.

Participants' Experience with the Program and the Technology

This program was described by all six of the interviewed participants as "basically the same" as or "easier" than their campuses' normal capital planning, procurement, and installation process. One participant summed up his experience with Program delivery and implementation by saying, *"It was very easy. It was all done by the contractor."*

However, the process seems to have been too simplified for one of the participants. He said normally there is a lot of "back and forth" between the campus project manager, architects, and the implementation contractor. But for this project, for which he described himself as the *de facto* construction manager, he reported his knowledge of, and advice about, campus buildings and systems were overlooked until a problem was encountered, and then he would be asked for advice narrowly restricted to that problem. Later he pejoratively referred to the approach to his project as "*quick in and out*."

Because the Program's training activities were removed from the Program, it is not surprising that none of the six participating contacts reported that new skills were developed or required in order to complete their project. However, one contact reported training was required in order to use a project. He said two of his campus's maintenance staff had to take a week of training for their new energy management system.

Three of the six interviewed participants mentioned project difficulties or disappointments, but these were unrelated to the Program itself. Rather, these problems were indicative of the complexity of those projects. The difficulties included trenches having to be dug throughout a campus, creating *"traffic and access problems for the large population of disabled students,"* and for another project, a six- to eight-week unavailability of staff from the implementation subcontractor's firm. The disappointment was with one aspect of a central plant project that the contact thought needed "*more engineering*."

One of the six participant contacts reported he was dissatisfied with the accounting of the energy and dollar savings for his project, but his concern was that *"the rebate should have been much more based on the huge savings that will accrue."* Three others reported they were not in a position to say whether or not they were satisfied with the accounting for their projects' energy and dollar savings.

With one exception, the six participants reported they were satisfied overall (a rating of "4" or "5" on a five-point scale) with their projects. The exception was the contact who expressed disappointment with his limited role in the project. That contact was also the only one of the six interviewed participants who reported the Program's partnership approach did not work well for him.

Three of the six participants reported having conversations about their projects with contacts from other campuses. Two of them spoke with and encouraged other campuses in their districts to participate in the Program. The third contact had visitors from other campuses during project installation, to whom he explained his project.

Awareness of Energy Efficiency Technologies and Additional Opportunities

Generally, the participating contacts exhibited limited knowledge of energy efficiency technologies and practices. Four of the six participants reported that equipment installed during their projects included items with which they were unfamiliar or had never seen before. These items included T-5 lamps (two mentions), induction lighting, a turbo-core chiller, *"lots of central plant stuff"* because the contact had not installed a central plant before, and the VendingMisers themselves.

Additional energy-efficiency project opportunities reported to exist on the campuses of these participants included lighting retrofits (two mentions), cool roofs (two mentions), an HVAC replacement, a boiler replacement, and *"a huge solar project."* Another participant did not specify remaining projects on his campus, but implied their existence by saying his campus has *"adopted the LEED Green Building program."*

One participant reported that there are no additional energy efficiency project opportunities on his campus, saying the Program *"pretty much covered everything."* His comment is understandable in the context of the multiple projects that occurred on his campus through the Program. Those projects included interior lighting and occupancy sensor retrofits, exterior lighting retrofits, comprehensive central plant upgrades, variable air volume (VAV) conversions, economizer repairs, installation of skylights in the gymnasium, and boiler change outs.

Continuous Commissioning

Even though the CCRP was modified to exclude continuous commissioning from its activities, information about the awareness and understanding of continuous commissioning by community college staff was obtained during the interviews.

Four of the six participants reported they were not familiar with continuous commissioning, and one of the two remaining participants responded, *"The staff isn't even familiar with original commissioning."* The comment of a key staff contact expanded upon these participants' responses. In reference to familiarity with continuous commissioning by staff at a participating campus where staff were not among those interviewed he said, *"The staff isn't even familiar with how to replace a filter."* Two of the nonparticipants were also asked about their familiarity with continuous commissioning. Neither of them had any familiarity with the concept.

The reasons for the dismal state of awareness and understanding of commissioning on community college campuses are not clear from the interviews. However, one key contact made a comment that may offer a partial explanation. He said, *"The community college system is not incentivized to maintain its equipment. It's easier for them to purchase new machinery and equipment than it is to maintain existing equipment."*

Free Riders and Potential Spillover

A key question for impact estimation is to determine the Net to Gross (NTG) ratio for each project. The NTG reflects the percent of gross energy savings, that is, the net savings that can be attributed to the Program. In order to estimate energy savings directly attributable to the CCRP, the participating campus contacts were asked a series of questions during the process evaluation interviews designed to estimate whether and when their projects might have been installed without the Program. Projects that might have been installed at the same time as the CCRP effort should have an NTG of less than one.

The contacts were asked whether projects similar to their CCRP projects had occurred on their campuses during the preceding two years, and whether any of the equipment installed as part of their projects had been planned for installation before this Program. To gain further insight into the previously planned projects, those contacts with such projects were also asked when they believed their projects would have occurred if they had not been done through the CCRP.

Five of the six interviewed participants reported that none of the same equipment installed for their projects had been installed anywhere else on their campuses during the two years preceding their projects (Table 2–2). The sixth participant reported that T-8 lamps, which were included in his CCRP project, had been installed elsewhere on campus during the preceding two years.

Two of the six participants reported that at least some of the equipment installed as part of their projects had been planned for installation before participation in this program. One of them qualified his campus's planning by adding there were not definite plans because there was *"never enough money."* He estimated one of his projects would have been completed "within five years," and two others would have been completed "within ten years" without the Program. The other participant reported that all of the equipment installed through his project would have been installed when it actually was in the absence of the Program.

The campus contact who reported his project would have occurred when it did even without the CCRP was the only one who reported that energy-efficiency measures additional to those installed through the Program were installed as part of his project. These project additions (spillover savings) were the connection of three additional buildings to the project's new central plant, and the installation of two "stub outs" from the central plant for future connections to buildings.

Table 2–2. Indicators of Free Riders & Spillover Savings

Project Description	Similar Project in Past Two Years	Previously Planned And if so, Time of Installation without CCRP	Additional Equipment Installed with Project
Installed VendingMisers	No	No	NA
Centralization of mechanical equipment	No	Yes, same as with CCRP	Yes
Indoor lighting	No	Yes, within ten years	No
Outdoor lighting	No	Yes, within ten years	No
Central plant upgrades	No	No	NA
VAV conversions	No	No	NA
Economizer repairs	No	Yes, within five years	No
Skylights	No	No	No
Boiler change outs	No	No	No
Installed VendingMisers	No	No	NA
Science lab RCx	No	No	NA
Replaced lights with T5s and T8s	Yes, some T8s installed	No	NA

As noted above, one participant would have installed measures without the Program. Because representatives from five of the nine participating campuses were interviewed, and site visits were conducted at four of the nine sites, it is not known how pervasive free riders really are. Since the free rider interviewed represented 17% of gross evaluated kWh savings, evaluators used .83 NTG in estimating net savings for final Program impacts. Ex ante NTG was reported as .96 for both energy and demand.

Lessons Learned by Program Staff, Future Plans

In addition to the energy savings achieved by the Program, it provided some valuable lessons. For example, some key staff gained a better understanding of the process required for major retrofit projects on community college campuses. The Program also provided insight into an area of great need and opportunity on community college campuses, namely, the need for training and education in energy-efficiency technologies and in continuous commissioning, as well as the opportunity for energy savings from the implementation of continuous commissioning on those campuses.

The experience of the contact who was disappointed with his small role in his campus's project is a reminder that even though a given target market may lack sophistication regarding energy efficient-equipment or practices, it can nonetheless be a valuable resource for information about conditions in their facilities.

Another benefit provided by the Program was training for some of those involved with it, specifically, Edison's project inspectors. The utility's inspectors' previous experiences had been with residential, low-income programs. It was reported that having the Program contractor's engineers accompany Edison staff during project inspections provided them valuable training on non-residential technologies.

Finally, it is noteworthy that one of the most complex projects completed through the CCRP received recognition from *Flex Your Power*. That campus project received a 2005 *Flex Your Power Energy Efficiency Honorable Mention* for dropping its total electricity use by 28% through the measures implemented by its CCRP project.

Process Summary

The Community College Retrofit Program was designed and managed by the Program contractor to address energy savings and load reduction opportunities the contractor had seen on campuses in the LACCD and SBCCD. The Program was designed to implement specific projects at six pre-identified locations in those two districts.

Difficulty with the Program design became evident almost as soon as project implementation began. Some projects could be completed within the Program's timeline, and others dropped out of the Program. The Program contractor responded energetically to the loss of Program energy savings from those projects by working with Edison to develop an alternative approach, and by contacting other campuses in other districts with project ideas for them.

Complicating matters further, preliminary marketing activities for the 2006-08 statewide community college retrofit program began while the CCRP Program contractor was still recruiting additional campuses. From the perspective of the campuses, the anticipated statewide program competed with the CCRP because it offered the prospect of greater economic rewards than did the CCRP.

With these changed circumstances, the intentional omission of a marketing plan from the Program was the main reason for nonparticipation by more campuses. Many campuses simply did not hear of the Program, or did not know what it was if they did hear of it. Lack of Program resources, at least in part a result of the unforeseen requirement to market the Program to other campuses, resulted in the elimination of best-practices and continuous-commissioning activities from the Program.

These difficulties did not affect the process of project delivery and implementation, however. That process required little from the participating campuses. The Program was described by all of the participants as "basically the same" as or "easier" than their campuses' normal capital planning, procurement, and installation process. All of the participants reported the installed measures met their expectations, and with one exception, overall satisfaction with the projects was universal among the interviewed participants.

The CCRP exposed a great need and opportunity at community college campuses for training and education in energy efficiency technologies and in commissioning, and for the implementation of continuous commissioning on these campuses.

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3. Impact Evaluation

Impact Evaluation Methodology

The impact evaluation of the Community College Retrofit Program (CCRP) was designed to verify the gross ex-ante savings estimates provided by the implementation contractor, as well as to provide an estimate of the net savings attributable to the Program. No billing analysis was conducted for this impact evaluation. The major questions addressed in the analysis include:

- Are the implementation contractor's estimates of the gross energy and demand savings installed under the CCRP reasonable? Should any adjustments to these numbers be made?
- What percentage of the savings comes from free riders?
- Can additional savings be reasonably attributed to the Program due to spillover effects?
- What is a reasonable estimate of the net energy and demand savings attributable to the CCRP?

The CCRP installed energy-efficiency measures from three distinct project categories:[123]

- ***Performance Contracting Projects.*** These projects include comprehensive interior and exterior lighting upgrades, central plant upgrades or conversions, economizer repairs, air and water distribution controls, and commissioning. All of these projects were sub-contracted to either Siemens or Chevron. The savings from these projects are site-specific and determined by the subcontractor.
- ***Vending Machine Controls Projects.*** These projects involve the installation of occupancy sensors on vending machines to power down the machine when the surrounding area is vacant. All of these projects were installed directly by Intergy. The per-unit savings from these projects are deemed.
- ***Personal Computer Power Management Software Projects.*** These projects utilize a software tool that enables network administrators to remotely control the power management function of personal computers (PCs) linked to a central network. All of these projects were also installed directly by Intergy. The per-unit savings from these projects are deemed.

Because of the broad range of energy-efficiency projects implemented under the Program, the evaluation team employed diverse data collection and analysis techniques to determine ex-post savings, including on-site verification, interval metering, engineering analysis, and secondary research activities. However, nearly 100% of the installed projects were field-inspected by both

[123] A ‘project’ represents one line item from the Program flat file. As such, a project may include more than one measure type, for example ‘Central plant upgrades and VFDs’.

the implementation contractor and by Southern California Edison.[124,125] In order to avoid wholesale replication of Intergy and Edison's field-verification activities, the evaluation team designed the M&V plan with a focus on supplementing the existing knowledge base. Specifically, the evaluation team sought to provide higher resolution to the assumed per-unit savings for the deemed-savings measures through visual verification of operation, data logging, and the review of individual project reports. In support of this approach the project team conducted the following activities in support of the impact evaluation:

1. Conducted measure installation verifications
2. Conducted engineering analysis of project data
3. Computed ex-post gross and net savings based on data from field verification activities and the engineering analysis
4. Provided conclusions and recommendations

The M&V activity conducted generally adhered to the standard level of rigor as defined in The 2005 California Energy Efficiency Evaluation Protocols,[126] but it varied based on the project category and the availability of M&V data. The following sections describe the M&V methodology in more detail.

Measure Installation Verification

Ex-ante estimates of savings are often based on preliminary contractor- or customer-reported data. The objective of the site visits was to adjust the ex-ante savings estimates by verifying that the final measure installation, operation, and quantity match that specified in the project documentation. The steps exercised to achieve this objective included:

- Designed a sample and data collection plan for site visits
- Conducted field verification activities and observations
- Computed installation rate factors based on field verifications to adjust gross savings estimates
- Reviewed any data on verification activities completed by Edison

[124] Projects installed directly by Intergy were not "re-inspected" by Intergy; 100% of these projects were field-verified by Edison however.

[125] Edison reported that they visually verified all projects involving equipment installations or modifications. They did not field-verify projects involving services such as commissioning or HVAC diagnostics, however, since they could not *visually* verify that the service had been performed.

[126] TecMarket Works. 2005. "The 2005 California Energy Efficiency Evaluation Protocols", Second Draft. Prepared for CPUC Energy Division (December 7).

Installation Verification Sample

At the time the M&V plan was written, 17 projects at 9 campuses had been committed, but only 10 projects had actually been completed. Of the 10 completed projects, the evaluation team field-verified the installation and operation of nine projects. These nine projects represented 97% of the ex-ante demand savings and 99% of the ex-ante energy savings for the completed projects at the time.

The Sample Design and Site Data Collection Plan were guided by and consistent with the 2005 California Energy Efficiency Evaluation Protocols and the California Evaluation Framework.[127] Many of the verified projects were single measures (such as a central plant upgrade) in which the ‘population’ of measures could be verified. For projects involving multiple measure installations (such as lighting or vending machine controls) the evaluation team selected a random sample for verification.

Each of the nine projects for which the evaluation team conducted fieldwork received either a full visual or sampled visual verification of installation and operation on-site. Table 3–1 shows the projects that were verified by the evaluation team along with the verification strategy.

Table 3–1. Verification Strategy by Project

Site	Program Project Category	Project Description	Verification Strategy
Site 1	Performance Contracts	Interior Lighting Retrofits	Sampled Visual
Site 1	Performance Contracts	Exterior Lighting Retrofits	Sampled Visual
Site 1	Performance Contracts	Day lighting - Skylights	Full Visual
Site 1	Performance Contracts	Central Plant Upgrades	Full Visual
Site 1	Performance Contracts	VAV Air Handler Controls	Full Visual
Site 1	Performance Contracts	Economizer Repairs	Full Visual
Site 2	VM Controls	Vending machine controls	Sampled Visual
Site 3	VM Controls	Vending machine controls	Sampled Visual
Site 4	VM Controls	Vending machine controls	Sampled Visual

Each of the projects for which measures were sampled had an individual sample designed according to the methodology presented in “General Sampling Approach for Measure Verification.” The vending machine controls projects also included interval metering to determine actual impacts; this is described in more detail in “Site Data-Logging Activities” in the Engineering Analysis section of this report.

[127] TecMarket Works. 2004. “The California Evaluation Framework”. Mandated by the California Public Utilities Commission (June).

Site Verification Activities

Field activities typically included the following three components:

1. Evaluation field staff coordinated with the implementation contractor and primary customer contact to establish M&V activity dates and to identify site-level contacts.

2. Field staff visually inspected measure installation, operation, and quantity according to the field data-collection plan for each project.

3. Where meters were installed on vending machines, a detailed description of the logger's location, date and time of installation, and level of traffic around the machine were all recorded. A pick-up date was also suggested to each site contact and field staff called in advance of returning to retrieve the loggers.

Field verification activities took place between April 20, 2006 and June 30, 2006. A total of nine projects were visually verified according to the verification strategy provided in Table 3–1. Where data loggers were installed, return visits occurred before the end of the semester between May 15, 2006 and May 20, 2006 to recover the equipment, yielding an average logging period of just over 25 days.

The evaluation team completed all of the key activities outlined in the final research plan filed with the CPUC with the exception of the post-installation review of equipment impacted by the PC control software. This system was installed at one campus and despite numerous documented data requests, the customer failed to provide the implementation contractor or evaluation team with a post-installation inventory of PC-related equipment impacted by this installation. As a result, the evaluation team developed ex-post savings estimates based on the equipment identified by the implementation contractor during pre-installation audits. Table 3–2 provides the evaluation activities and objectives included in the final research plan objectives, and the tasks completed by the evaluation team.

Table 3–2. Evaluation Activities and Objectives

Evaluation Activities	Original Research Plan Objectives	Tasks Completed by the Evaluation Team
Program records review	Yes	Yes
Engineering calculations	Yes	Yes
Secondary literature	Yes	Yes
Billing data/metered data analysis	Review SPC results and secondary analysis on relevant meters	Not completed as information on relevant meters was not identified or provided by Intergy or the participating ESCOS[128]
Site visits	Review Edison reports and additional visits of most relevant sites	Completed
End use metering	Approximately 20 Vending machines will receive post-installation metering	29 Vending machines received post-installation metering. 26 meters provided useful data.
PC control data collection	Collect and analyze PC data	Pre-installation audit data was reviewed. No data was provided from the customer on post-installation network configuration[129]

Installation Verification Results

The primary objective of the verification activities was to establish the presence of Program measures and installations recorded in the project documentation provided by the implementation contractor. The full visual verification approach, as well as the sampling verification approach, confirmed that the quantity and operation of the installed measures matched the project documentation in 100% of projects. The projects that were verified in the field represent 22% of the Program's total ex-ante demand savings and 31% of the energy savings.

As previously noted, nearly 100% of the projects were field-verified by both the implementation contractor and by Edison. These inspections were generally thorough and included visual verification of the installation and operation of measures and/or a review of the data submitted by the subcontractor. In all cases, the inspections confirmed the contractor-reported data, and all inspected projects received a 100% pass rate by both Intergy and Edison. As a result of this and the evaluation team's field activities, the evaluation team recommends an installation rate factor of 100% for all measures and all projects.

Engineering Analysis

An engineering analysis was conducted for each of the 14 projects completed under the CCRP to assist in the development of adjusted realization rates for the Program. Specifically, the evaluation team conducted a detailed review of project documentation and performed data-

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[128] If the project was a Performance Contracting project, the ESCOs submitted documentation regarding the guaranteed savings calculation protocols. See discussion under "Performance Contracting Projects" in the "Impact Evaluation Methodology" section above.

[129] Although energy savings were likely aggregated by the software at a central server, repeated attempts to collect this data from the campus contact yielded no results. See "Review and Evaluation of Program Data" below.

logging activities for all vending machine controls measures. Although actual energy impacts were determined on a per-project basis, the results of the data-logging activities were applied to all the vending machine controls projects.

Review and Evaluation of Program Data

The final Program records submitted by the implementation contractor were analyzed for accuracy and consistency, as well as to ensure that the underlying assumptions for individual measures were reasonable. The key documents that were analyzed include:

1. ***The final Program flat file.*** This file documents activity at each participant site, including measure type and date of installation. This file also provides the gross ex-ante energy and demand savings values.

2. ***The final Program workbook.*** This document provides a reporting format for the CPUC and represents a summary of the information contained in the Program flat file, but it does not contain project-specific data. This file provides the net ex-ante energy and demand savings values.

3. ***Project-specific documentation.*** These files include any spreadsheets, verification forms, or other documents that may have been used to calculate energy and demand savings from specific EEMs.

In general, some of the installed projects were thoroughly documented by both the subcontractors and the implementation contractor, while other projects lacked details on energy savings calculations. Some projects provided detailed spreadsheets that allowed the evaluation team to trace calculations, while other projects only supplied documents that could not be analyzed, such as Adobe Acrobat files showing spreadsheets, where the spreadsheet was not provided, In most cases, the calculations and methodology leading to the energy savings estimates were too complicated to be reverse-engineered without calculations to trace. Volume 2, Appendices, provides examples of documentation provided for the impact analysis. In one case, only an Adobe Acrobat file was provided, requiring extensive interpretation to gauge whether the savings estimates were reasonable. The second example provided in the Appendices provided for this project included detailed, line-by-line measure analysis that could be traced and verified. In the case of the performance contract projects, the documentation often included detailed simulation results, end-use metering data, and/or pre and post consumption data by season, space-type, or piece of equipment. As noted previously, the quality of documentation provided by both ESCO and non-ESCO installation contractors varied greatly.

Although the installation of the PC power management software was planned for and committed at all three campuses in the LACCD, this project was only implemented at one college. The evaluation work plan called for collecting and analyzing the reports produced by the Surveyor software indicating actual computer runtime, but this data could not be obtained from the campus contact despite numerous emails, phone calls, and in-person visits. Since this data could not be collected to determine actual savings from this project, the evaluation team reviewed the database and observations recorded by the implementation contractor during their pre-installation audit activities, as well as secondary sources for inputs to the deemed per-unit savings value.

Site Data-Logging Activities

The vending machine controls projects involved the installation of the VendingMiser (VM), CoolerMiser (CM), or SnackMiser (SM) controls by Bayview Technologies Group, Inc.[130] These projects provide a simple and cost-effective way to reduce electrical loads by using an occupancy sensor to power down vending machines when the area surrounding the machines is vacant. The controls can be installed on three types of vending machines:

1. Refrigerated cold beverage vending machines
2. Refrigerated glass-front vending machines
3. Nonrefrigerated snack vending machines

The per-unit savings values used to determine the ex-ante energy savings were deemed based on the values used in Edison's Express Efficiency Program and the significant literature documenting the performance of the VendingMiser products.[131] These values were based on numerous studies in various buildings and locations but do not necessarily represent the average savings to be expected in a community college setting. As such, the evaluation team sought to reduce the uncertainty around the deemed savings estimates by conducting interval metering for a sample of vending machine controls installations.

The project installations were well-documented for each of the three colleges and included data points for location (building type), exposure (indoor or outdoor), type of machine, Miser type, and energy savings per unit installed. The evaluation team reviewed the installation documentation and designed a sample of units to be metered according to the general sampling methodology outlined above. The final data collection plan included a list of alternate units to be metered if the primary units could not be accessed. A total of 108 vending machine controls were implemented through the CCRP, of which 81% were the VendingMiser, 12% were the CoolerMiser, and 6% were the SnackMiser. The evaluation team installed interval meters on 29 units in total, which represents 27% of the population of installed units. Table 3–3 shows the distribution of installed vending machine controls along with the distribution of evaluation meters. Details for the logger sample and results are provided in Volume 2, Appendices, Community College Chapter, Vending Machine Control Impact Analysis.

[130] These three products from Bayview will be collectively referred to throughout this document as either vending machine controls or as Misers.

[131] Each of the VendingMiser products has a different deemed savings value associated with it. The VendingMiser deemed savings are 1,590 kWh/yr, the CoolerMiser deemed savings are 1,050 kWh/yr, and the SnackMiser deemed savings are 750 kWh/yr.

Table 3–3. Distribution of Installed Vending Machine Controls by Control Type

	Units Installed Through Program		Interval-Metered Units	
	Count	% of Total	Count	% of Total Units Metered
VendingMiser	88	81%	26	90%
CoolerMiser	13	12%	1	3%
SnackMiser	7	6%	2	7%
Total	108	100%	29	100%

The energy consumption meters were simple 'plug-and-play' devices[132] and were installed during the on-site verification visit. Field staff took detailed notes about the meter installations including location, Miser type, and a qualitative assessment concerning the level of traffic around the machine (heavy or light). In order to confirm baseline energy assumptions, some of the Misers were actually disabled in the field in order to get an accurate assessment of consumption with and without a Miser. For the metered units with VendingMisers installed, 10 were disabled for the entire monitoring period while 16 were left enabled.

Of the metered units with VendingMisers installed, the average metering period was just over 25 days, with nine meters left in the field for as long as 37 days, while one was in the field for just under one week. The average energy consumption for the VendingMiser-enabled units was 5.47 kWh/day, while the average consumption for the VendingMiser-disabled units was 7.40 kWh/day. Extrapolated to a full year, the metered data shows energy savings due to the VendingMiser to be 704 kWh/yr, well below the deemed savings of 1,590 kWh/yr used in the ex-ante estimates. Table 3–4 provides the number of meters installed for each of the enabled and disabled VendingMisers, as well as the average annual energy savings by level of traffic.[133]

[132] The Kill-A-Watt (KAW), manufactured by P3 International

[133] The analysis of the two metered units with SnackMisers installed shows that the disabled-controls unit consumes 225 kWh/yr, while the enabled-controls unit consumes 199 kWh/yr—indicating savings of just 26 kWh/yr. These results have not been employed in the savings adjustment due to the small sample size.

Table 3–4. Average Annual Energy Consumption and Savings for VendingMisers[134]

	Number of Meters	Average Metered Days	Average Annual Consumption (kWh)
Disabled VendingMisers			
Heavy Traffic	8	27.88	2,758
Light Traffic	2	28.50	2,475
All Metered Units	*10*	*28.00*	*2,701*
Enabled VendingMisers			
Heavy Traffic	12	24.33	2,238
Light Traffic	4	20.00	1,274
All Metered Units	*16*	*23.25*	*1,997*
Energy Savings			
Heavy Traffic	20		520
Light Traffic	6		1,201
All Metered Units	*26*		*704*

As indicated in the table above, the consumption varies widely based on the observed level of traffic around the machine. As such, the energy savings resultant from installing vending machine controls can be expected to be significantly less in high-traffic areas than in low-traffic areas because the machine has less opportunity to "power-down." These data are based only on the perception of field staff during the short time-span of installation, however, and are used here only to illustrate the difference that the level of traffic can have in the achievable energy savings.

In addition to installing interval meters in random locations around the campuses, evaluation field staff installed meters on similar machines with enabled and disabled VendingMisers that were adjacent to each other. The intent behind this methodology was to capture the difference in energy consumption data for units with identical traffic patterns. The "matched pairs" of metered vending machines (one enabled and one disabled) were always similar in type, i.e., refrigerated closed, refrigerated glass-front, or snack machine, and they were all controlled by VendingMisers. Comparing the "matched pairs" shows that energy savings are in the range of 481 to 730 kWh/yr, with an average savings of 585 kWh/yr. Table 3–5 shows the extrapolated annual energy savings from the seven 'matched pairs'.

[134] The total of 26 machines metered (including enabled and disabled units) constitutes a sample confidence / precision of 90% / 14% based on the Sample Mean Approach where the sample is a large fraction of the population (>10%) of 106 units installed through the program.

Table 3–5. Matched Pair Analysis of Annual Energy Savings for VendingMisers

Site	Disabled VendingMiser Consumption (kWh/yr)	Enabled VendingMiser Consumption (kWh/yr)	Annual Energy Savings (kWh/yr)
Site 2	2,135	1,654	481
Site 2	2,646	1,916	730
Site 2	3,906	3,285	621
Site 3	2,628	2,117	511
Site 4	2,296	1,712	584
Site 4	3,174	2,590	583
Site 4	2,461	1,877	584
Average	2,750	2,165	585

4. Impact Evaluation Results

The engineering analysis, including the review of Program data and the data-logging activities, was conducted according to the methodology outlined above. Although each project was analyzed individually, the *specific methods* employed to analyze the projects were based on its project 'category' as outlined in the "Impact Evaluation Methodology Overview" above. The ensuing discussion outlines the results of the engineering analysis by project category, followed by a presentation of the individual project analyses by campus.

Savings from Performance Contracting Projects

The evaluation team reviewed the records for each of the PC projects and found the level of detail for the documentation to vary widely. Documentation for some of the projects included spreadsheets detailing engineering analysis or simulation modeling, while documentation for other projects included only hard-copy printouts of an analysis that was not well-defined. Because the performance contract specifies penalties to the subcontractor if guaranteed savings are not achieved, however, the savings reported by the subcontractors are likely to be conservative. As a result, the evaluation team has recommended a 100% realization rate for all performance contracting projects that (1) include comprehensive and thorough documentation, (2) have reasonable inputs, outputs, and measure savings values, and (3) have no egregious errors in the calculations or assumptions. For projects that do not meet all of these criteria, the evaluation team has conducted a more in-depth review and recommended more reasonable savings values.[135]

Savings from Vending Machine Controls Projects

The evaluation team made a concerted effort to reduce the uncertainty surrounding the deemed per-unit savings due to vending machine controls projects through the use of interval metering on

[135] This analysis was based on the best available data at the time of evaluation. It is unclear to the evaluators whether any of the ESCOs conducted long-term M&V to determine actual savings beyond their guaranteed performance contract estimates.

a sample of installations. Comparing the energy consumption of all disabled VendingMiser installations to that of all enabled VendingMiser installations (random sampling approach) indicates an annual savings of 704 kWh/year (26%), while the "matched pair" analysis indicates the average savings to be 585 kWh/year (22%). Obviously, both of these analyses yield results well below the current per-unit deemed savings value of 1,590 kWh/year.

In order to calibrate this discrepancy in savings, the evaluation team reviewed a report on VendingMiser savings completed by ESource.[136] The report includes data from M&V efforts completed by Avista Utilities for VendingMiser installations in various locations, and it shows that savings range from a low of 111 kWh/yr to a high of 2,129 kWh/yr, with an average savings of 805 kWh/yr. The average savings value corresponds to 31% savings over the sample of installations, which is well below the average savings of 46% claimed by the manufacturer. Furthermore, the wide range in savings (6% to 77%) underlines how much occupancy (level of traffic) affects the achievable savings.

Given the results from the data-logging activities, as well as the secondary research confirming the wide range in savings and the lower overall average savings, the evaluation team believes that the savings from the vending machine controls installations should be appropriately scaled to a value representative of the typical community college in Edison's service territory. The random sampling approach (resulting in savings of 704 kWh/yr) is likely more robust because of its larger sample size and because the "matched pair" analysis is highly dependent on the individual machine traits; for example, one of the two machines might naturally consume more energy than the other. As a result, the evaluation team has applied a scaling factor of 44%[137] to the deemed per-unit savings values for each of the VendingMiser, CoolerMiser, and SnackMiser installations in order to better represent the occupancy conditions in community colleges in Edison's service territory.

In addition, although some level of peak demand savings are likely for vending machine controls, the implementation contractor rightly states that no protocol exists to quantify the level or reliability of the savings. One potential conservative approach to quantifying these savings would be to calculate the *average* demand savings over the year, i.e., the energy savings divided by 8,760, and apply an equally conservative coincidence factor. Because of the lack of protocol, however, the evaluation team recommends sticking to the even more conservative approach of claiming zero peak demand savings.

Savings from PC Power Management Software Projects

Like the savings from the vending machine controls, the achievable savings due to the Surveyor product are highly dependent on user behavior. The analysis proposed in the work plan suggested collecting the runtime reports produced by the central Surveyor controller in order to analyze actual reduced usage. As previously noted, however, the single campus implementing

[136] Cabanas-Holmen, Kirsten and Tertia Speiser. "Scaling Back Vending Machine Energy Use with the VendingMiser." ESource, ER-00-14, Sept. 2000.

[137] This scaling factor is calculated by dividing the average savings from the data-logging activities (704 kWh/yr) by the deemed VendingMiser savings value (1,590 kWh/yr).

the Surveyor product on their network did not accommodate the numerous attempts by the implementation contractor and evaluation staff to gather the runtime reports for the individual computers. As such, the evaluation of savings from the power management software relied on a database on installations by IP number, observations reported by the implementation contractor, and the significant sources of secondary data documenting savings from Surveyor. The per-unit savings value used in the ex-ante estimate of savings was 234 kWh/yr per license.

A quote from a report produced for the Northwest Energy Efficiency Alliance[138] highlights the uncertainty inherent in using a single value to describe the savings from a population of Surveyor installations:

> *"The per-unit energy savings [due to Surveyor installations] is exceptionally volatile and sensitive to influences such as PC type, monitor type, baseline user habits and/or company policy, and the aggressiveness of the power-management settings."*

The report further analyzes the savings from Surveyor case studies and reports, as well as case studies of savings from other power management software products. In particular, the report found the savings from the Surveyor case studies and reports to range from a low of 34 kWh/yr to a high of 695 kWh/yr across all market sectors, with an average savings value of 219 kWh/yr. Since Surveyor is often employed in school districts and universities, however, the report goes further to disaggregate savings by market sector. Specifically, it describes savings for Surveyor installations in colleges and universities to be in the range of 129-317 kWh/yr, with an average savings of 196 kWh/yr.

A second report from ESource[139] concerning the Surveyor product includes an estimate of savings from a single case study at Queensborough Community College that indicates that energy savings vary significantly based on whether the license is deployed on an administrative network or an academic network of computers. This report, which was one of the sources of information for the Summit Blue report, suggests the average savings on administrative networks to be 129 kWh/yr, while average savings on academic networks is 317 kWh/yr.

Given the lack of response from the single college implementing the Surveyor product, the evaluation analysis of savings must inevitably be based on secondary research alone. The secondary research, as presented in the above paragraphs, indicates savings to vary widely based on user behavior, PC type, and other important variables. The savings described by these reports come from case studies completed 3-7 years ago, at a time when the penetration of LCD monitors (the power draw of which have a very large affect on savings) was much lower. As such, the evaluation team believes the deemed savings value of 234 kWh/yr to be somewhat high and recommends using the value of 196 kWh/yr suggested in the Northwest Energy Efficiency Alliance report, cited above, for colleges and universities. The evaluation team believes this

[138] Summit Blue Consulting, LLC; "Long Term Monitoring and Tracking Report on 2005 Activities"; April 14, 2006; pg 71-80.

[139] Greenberg, Dan. "Network Power Management Software: Saving Energy by Remote Control." ESource, ER-04-15, Nov. 2004.

value to be a reasonable middle ground given the lack of response to requests for actual runtime reports.

In addition, although some level of peak demand savings are likely for PC power management software, the implementation contractor rightly states that no protocol exists to quantify the level or reliability of the savings. As previously noted, one could potentially quantify these savings by calculating the *average* demand savings over the year (i.e., the energy savings divided by 8,760) and apply an equally conservative coincidence factor. Because of the lack of protocol, however, the evaluation team again recommends sticking to the even more conservative approach of claiming zero peak demand savings.

Project-Specific Savings by Campus

The project-specific savings by campus below were derived using the methodology outlined above. The analyses were based on the best available data at the time of evaluation and included performance contract savings estimates from the ESCOs and the implementation contractor. It is unclear to the evaluators whether any of the ESCOs conducted long-term M&V to determine actual savings beyond their guaranteed performance contract estimates.

Site 1

This campus was the first to commit to having projects under the CCRP and the first to complete installation. The six projects implemented at Site 1 were the most of any campus and affected the lighting and HVAC end-uses. All six projects were performance contract projects and included:

- Comprehensive interior lighting retrofits
- Comprehensive exterior lighting retrofits
- Daylighting via skylight installation in the gym
- Central plant interconnection, revised control scheme, and VSDs on the chilled and hot water pumps
- Variable air distribution via VSDs on the supply and exhaust fans
- Economizer repairs

This project was visually verified during on-site visits from the implementation contractor, Edison field staff, *and* the evaluation team. Each verification visit resulted in a 100% pass rate, and the measure installation factor is 100%. Data for each of the measures was provided via hard-copy and spreadsheets. The evaluation team reviewed the documentation for each of the measures and found it to be comprehensive and thorough. The savings from the HVAC measures were analyzed using the TRACE software from Trane, and the inputs and outputs from this software were also provided via hard-copy. The evaluation team reviewed the inputs, outputs, and measure savings and found them all to be reasonable. As a result of this review and because the savings from these projects were guaranteed by the subcontractor, the evaluation team recommends a 100% realization rate for all projects at this campus. The final adjusted savings indicate a gross ex-post peak demand savings of 237.9 kW and gross ex-post annual energy savings of 1,822,918 kWh/yr.

Site 2

This college installed 21 VendingMisers, 13 CoolerMisers, and 7 SnackMisers on its vending machines throughout the campus. The installations were completed by the implementation contractor and visually verified by both Edison field staff and evaluation team staff and the measure installation factor is considered to be 100%. After applying the 44% scaling factor determined through interval metering of the installations, the gross ex-ante energy savings of 52,290 kWh/yr are reduced to a gross *ex-post* energy savings of 23,152 kWh/yr. No peak demand savings are recommended for vending machine control projects.

Site 3

This college installed 13 VendingMisers on its vending machines throughout the campus. The installations were completed by the implementation contractor and visually verified by both Edison field staff and evaluation team staff with a measure installation factor of 100%. After applying the 44% scaling factor determined through interval metering to the installations, the gross ex-ante energy savings of 20,670 kWh/yr are reduced to a gross *ex-post* energy savings of 9,152 kWh/yr. As previously discussed, no peak demand savings are recommended for vending machine control projects.

Site 4

This college installed 54 VendingMisers on its vending machines throughout the campus. The installations were completed by the implementation contractor and visually verified by both Edison field staff and evaluation team staff. As such, the measure installation factor is 100%. After applying the 44% scaling factor determined through interval metering to the installations, the gross ex-ante energy savings of 85,860 kWh/yr are reduced to a gross *ex-post* energy savings of 38,016 kWh/yr. No peak demand savings are recommended for vending machine control projects.

Site 5

This college installed the Surveyor product on a total of 1,983 computers, 716 of which were on an administrative network and 1,267 of which were on an academic network. The installations were completed by the implementation contractor and field-verified by Edison field staff. As such, the recommended measure installation factor is 100%. The secondary research as presented above indicates a more reasonable level of savings to be 196 kWh/yr. Consequently, the evaluation team recommends reducing the gross ex-ante energy savings of 464,022 kWh/yr to a gross *ex-post* energy savings of 388,668 kWh/yr. Furthermore, although some level of peak demand savings is likely, the implementation contractor rightly states that no protocol exists to quantify the level or reliability of the savings. As previously discussed, the evaluation team recommends the conservative approach of claiming no peak demand savings for PC Power Management Software Projects.

Site 6

This college completed interior and exterior lighting retrofits, including T-12-to-T-8 fixture retrofits, metal halide fixture retrofits, and CFL conversions. The installations were completed by a subcontractor and visually verified by both the implementation contractor and Edison field staff. Consequently, the measure installation factor is 100%. The project documentation included an itemized spreadsheet of installations with variables for baseline and EEM description, location and space type, quantity of retrofits, ballast type, lamp type, and energy and demand savings. The EEM case also included the ballast manufacturer and model number, as well as the lamp manufacturer and model number.

The evaluation team reviewed the project documentation calculations and found them to be correct. Next, the project team "looked-up" the ballast and lamp model number on the manufacturers' websites to determine whether the fixture wattage used in the EEM case was correct. Of the nine fixture types in the baseline and the ten fixture types in the EEM case, the fixture wattages for five were incorrect. Based on experience from evaluations of other programs in this market sector, the evaluation team also applied a coincidence factor of 93% to the peak demand reduction to account for coincidence with utility peak. The adjusted savings indicate a gross ex-post peak demand savings of 7.6 kW, versus a reported value of 7.7 kW and gross ex-post annual energy savings of 21,617 kWh/yr, versus a reported value of 20,370 kWh/yr.

Site 7

This campus implemented the single largest project completed under the CCRP. This single project was a performance contract project and affected the HVAC end-use. According to the implementation contractor, the college installed HVAC equipment *on their own* prior to the CCRP but "ran out of money" before they could have the system properly commissioned. As a result, many of the HVAC components (fans, pumps, etc) were running continuously even when not needed. Through the CCRP, the system 'fixes' included maximizing 'free' cooling by re-circulating chilled water and/or using thermal ice storage. Additional repairs were made to water valves, actuators, and other controls. Savings for this project are not for the HVAC units themselves but from commissioning the units to operate correctly. This commissioning work was completed as part of the CCRP. As with all previous projects, this project was conducted by a subcontractor and visually verified by both the implementation contractor and Edison field staff. Consequently, the measure installation factor is 100%.

The documentation for this project consisted of an exhaustive spreadsheet of individual measure savings, as well as savings due to interactive effects among the measures, compiled by the project subcontractor; and an email exchange detailing peak demand impacts. The evaluation team reviewed the spreadsheet values and calculation algorithms for each measure and generally found them to be reasonable. Much of the savings were based on reduced operating hours due to appropriate fan scheduling. The algorithm used to determine savings from fan VFDs correctly applied the fan affinity laws. The email exchange between the contractor and the subcontractor identified the source of the peak demand savings.

The evaluation team found two mistakes in the spreadsheet. One was a calculation mistake in which a value should have been divided instead of multiplied. The other mistake was not including motor efficiency in the calculation of savings from the fan scheduling EEMs. The calculation in the spreadsheet converted fan HP straight to fan kW without accounting for motor losses. The evaluation team applied a conservative motor efficiency value of 93% to any motor where efficiency was not included. The end result of these adjustments is a *increase* of 3.4% for the energy savings. The final adjusted savings indicate a gross ex-post peak demand savings of 209.0 kW and gross ex-post annual energy savings of 2,622,201 kWh/yr, versus a reported value of 2,535,823 kWh/yr.

Site 8

This college completed a conversion from distributed HVAC units for buildings throughout the campus to a central chilled and hot water plant serving the entire campus. The new central plant includes two 600-ton chillers, four gas-fired boilers, and ten variable-speed pumps for water distribution. Like many other projects, the installation was completed by a subcontractor and visually verified by both the implementation contractor and Edison field staff. Consequently, the measure installation factor is 100%. The savings were calculated via spreadsheet analysis in which the cooling capacity and efficiency of the existing system was measured against the capacity and efficiency of the proposed system.

The documentation for the project was sparse and difficult to follow, and multiple follow-ups on the part of the evaluation team yielded no additional documentation. Only two documents were provided as backup documentation: a printout of the lifecycle cost analysis completed and a printout of the spreadsheet analysis. Using these two pieces of documentation, the evaluation team recreated the savings analysis using the assumptions outlined. The assumptions appeared reasonable, and the calculated energy savings from the recreated analysis yielded a value 3% higher than that reported. Demand savings appear to overestimated by approximately 6%. As a result, the evaluation team recommends a realization rate of 103% for the energy savings and 94% for the demand savings. The final adjusted savings indicate a gross ex-post peak demand savings of 564 kW, versus a reported value of 600 kW and gross ex-post annual energy savings of 1,105,440 kWh/yr, versus a reported value of 1,067,000 kWh/yr.[140]

Site 9

This project was a retro-commissioning of the laboratory airflow system. The total system includes 52 chemical fume hoods and 288 airflow control valves serving the various laboratories and uses “single-pass” air for safe ventilation due to code requirements. As a result, all of the air circulated through the building must be conditioned. The project involved retro-commissioning the system to achieve proper airflow rates to eliminate over-ventilation. By ensuring that the room airflow balances maintain the proper pressure differentials, energy was saved in cooling, heating, and fan usage.

This project was completed by a subcontractor and visually verified by both the implementation contractor and Edison field staff. The backup documentation for the project was excellent and consisted an organized binder with tabs for energy savings, room airflow balances in the pre-commissioning (baseline) condition and the post-commissioning condition, a list of deficiencies, recommendations, and a determination of the cost to deliver air. Savings were calculated by determining the reduction in supply airflow over the entire range of flow, including Hood Open Cooling (HOC), Hood Open Heating (HOH), Hood Closed Cooling (HCC), and Hood Closed

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[140] At the time of the evaluation, the evaluators were unaware of any measured savings reported by the ESCO.

Heating (HCH). The reductions were summarized by room and multiplied by the energy per CFM supply per year to determine savings, assuming that 85% of the energy is electric and 15% is gas.[141]

A total of fourteen (14) rooms were commissioned but only 11 of these rooms were included in the savings analysis. The airflow balance in the other three commissioned rooms were found to be in violation of code, and commissioning actually led to an increase in energy usage. Note that this evaluation does not reduce savings for changes in energy usage resulting from actions taken to correct code compliance. The evaluation team also reviewed the calculations and found two data entry errors in which the exhaust airflow values were used instead of the supply airflow values. Correcting these inconsistencies leads to reduction in savings by 21%. The final adjusted savings indicate a gross ex-post peak demand savings of 34.2 kW, versus a reported value of 43.3 kW and gross ex-post annual energy savings of 299,594 kWh/yr versus a reported value of 379,391 kWh/yr.

Engineering Estimates of Ex-post Gross Program Savings

Table 3–6 presents the gross ex-ante savings reported in the final flat file submitted by the implementation contractor and the recommended values for adjusted gross ex-post savings by college. The ex-post peak demand savings of 1,053 kW represent a demand realization rate of 96% while the ex-post annual energy savings of 6,330,758 kWh/yr represent an energy realization rate of approximately 98%.

As discussed in the process evaluation results, surveys indicated that one participant would have installed measures without the Program. Because representatives from five of the nine participating campuses were interviewed, and site visits were conducted at four of the nine sites, it is not known how pervasive free riders really are. Therefore, the null hypothesis of .80 NTG for the IDEEA Program cannot be rejected. Implementers used .96 NTG in their net savings calculations. Since the free rider interviewed represented 17% of gross evaluated kWh savings, evaluators used .83 NTG in estimating net savings for final Program impacts.

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[141] The tool used to calculate savings was an engineering spreadsheet tool.

Table 3–6. Gross Ex-ante and Ex-post Savings by Project

	Reported Gross Ex-ante Savings		Verified Gross Ex-post Savings			
Site	Gross Peak Demand Savings (kW)	Gross Annual Energy Savings (kWh)	Gross Peak Demand Savings (kW)	Net Peak Demand Savings (kW)	Gross Annual Energy Savings (kWh)	Net Annual Energy Savings (kWh)
Site 1	237.9	1,822,918	237.9	237.9	1,822,918	1,822,918
Site 2	0.0	52,290	0.0	0.0	23,152	23,152
Site 3	0.0	20,670	0.0	0.0	9,152	9,152
Site 4	0.0	85,860	0.0	0.0	38,016	38,016
Site 5	0.0	464,022	0.0	0.0	388,668	388,668
Site 6	7.7	20,370	7.6	7.6	21,617	21,617
Site 7	209.0	2,535,823	209.0	209.0	2,622,201	2,622,201
Site 8	600.0	1,067,000	564.0	0.0	1,105,440	0
Site 9	43.3	379,391	34.2	34.2	299,594	299,594
Total	1,098	6,448,344	1,053	489	6,330,758	5,225,318

Final Program Impacts

Table 3–7 presents the first year ex-ante gross and net energy savings goals and reported Program accomplishments. Table 3–8 shows the first year ex-ante gross and net demand savings goals and reported Program accomplishments. The Program net ex-ante savings goals and reported accomplishments were estimated using a 0.96 NTG ratio. The Program reported achieving approximately 105 percent of their original kWh goals, and 122 percent of their kW goals.

Table 3–7. Comparison of Ex-ante Energy Savings Goals and Reported Accomplishments

	Ex-ante Program Gross Annual kWh Goals	Ex-ante Program Net Annual kWh Goals	Reported Ex-ante Gross Annual kWh Savings Accomplishments	Reported Ex-ante Net Annual Program kWh Accomplishments
CCRP	6,142,318	5,896,625	6,448,344	6,190,410

Table 3–8. Comparison of Ex-ante Demand Savings Goals and Reported Accomplishments

	Ex-ante Program Gross Annual kW Goals	Ex-ante Program Net Annual kW Goals	Reported Ex-ante Gross Annual kW Savings Accomplishments	Reported Ex-ante Net Annual Program kW Accomplishments
CCRP	903	867	1,098	1,054

The Program impacts are determined by two factors:

1. Program performance in terms of accomplishing Program participation goals
2. Estimated ex-post savings impacts for the installed measures compared to the ex-ante measure savings assumptions

The Program gross and net realization rates have been calculated as the combined effect of these two factors. The Program goals, ex-post gross and net energy savings, and respective realization rates are shown in Table 3–9. The Program evaluated ex-post gross energy savings are 6,330,758 kWh compared to the Program gross savings goal of 6,142,318 kWh. The Program evaluated ex-post net energy savings are 5,225,318 kWh compared to the Program goal of 5,896,625 kWh, yielding 87 percent net energy savings realization rate.

Table 3–9. Comparison of Programs Goals and Ex-post Gross and Net Energy Savings

	Ex-ante Program Gross Annual kWh Goals	Ex-ante Annual Net Energy Savings Goals	Evaluated Gross Ex-post Program kWh Savings	Gross Energy Realization Rate	Evaluated Net Ex-post Program kWh Savings	Net Energy Realization Rate
CCRP	6,142,318	5,896,625	6,330,758	103%	5,225,318	87%

The Program goals, ex-post gross and net demand savings, and respective realization rates are shown in Table 3–10. The Program evaluated ex-post gross demand savings are 1,053 kW compared to the Program goal for demand savings of 903 kW, yielding a 117 percent gross demand savings realization rate. The Program evaluated ex-post net demand savings are 489 kW compared to the Program net demand savings of 867 kW, yielding a 56 percent net realization rate.

Table 3–10. Comparison of Programs Goals and Ex-post Gross and Net Demand Savings

	Ex-ante Program Gross Annual kW Goals	Ex-ante Annual Net Demand Savings Goals	Evaluated Gross Ex-post Program kW Savings	Ex-post Gross Demand Realization Rate	Evaluated Net Ex-post Program kW Savings	Net Demand Realization Rate
CCRP	903	867	1,053	117%	489	56%

As mentioned earlier, the Program reported achieving 105% of kWh and 122% of kW goals. Realization rates compared to ex-ante evaluated results are shown in Tables 3–11 and 3–12 below. The Program evaluated ex-post gross energy savings are 6,330,758 kWh compared to the Program reported ex-ante gross savings goal of 6,448,344 kWh, yielding a realization rate of 98 percent. The Program evaluated ex-post net energy savings are 5,225,318 kWh compared to the reported ex-ante net of 6,190,410 kWh, yielding a 84 percent net energy savings realization rate. The Program evaluated ex-post gross demand savings are 1,053 kW compared to the reported ex-ante gross for demand savings of 1,098 kW, yielding a 96 percent reported gross demand savings realization rate. The Program evaluated ex-post net demand savings are 489 kW compared to the reported ex-ante net demand savings of 1,054 kW, yielding a 46 percent net realization rate.

Table 3–11. Comparison of Reported Program Accomplishments and Ex-post Gross and Net Energy Savings

	Ex-ante Program Gross kWh Reported	Ex-ante Net Energy Savings Reported	Evaluated Ex-post Gross Program kWh Savings	Gross Energy Realization Rate	Evaluated Ex-post Net Program kWh Savings	Net Energy Realization Rate
CCRP	6,448,344	6,190,410	6,330,758	98%	5,225,318	84%

Table 3–12. Comparison of Reported Programs Accomplishments and Ex-post Gross and Net Demand Savings

	Ex-ante Program Gross kW Reported	Ex-ante Net kW Savings Reported	Evaluated Ex-post Gross Program kW Savings	Gross Energy Realization Rate	Evaluated Ex-post Net Program kW Savings	Net Demand Realization Rate
CCRP	1,098	1,054	1,053	96%	489	46%

Final Program savings, NTG ratios and realization rates are shown in Table 3–13 and Table 3–14. The NTG was .83 for kWh and .46 for kW. Realization rates were calculated as the ratio of the evaluated net ex-post savings to the reported ex-ante gross savings. For the overall Program, the realization rate was 81% for energy and 45% for demand.

Table 3–13. Program Energy Savings

	Ex-ante Reported Gross kWh Savings	Ex-post Gross Program kWh Savings	NTG Ratio	Evaluated Ex-post Net kWh Savings	Realization Rate
CCRP	6,448,344	6,330,758	.83	5,225,318	81%

Table 3–14. Program Demand Savings

	Ex-ante Reported Gross kW Savings	Ex-post Gross Program kW Savings	NTG Ratio	Evaluated Ex-post Net kW Savings	Realization Rate
CCRP	1,098	1,053	.46	489	45%

Table 3–15 summarizes proposal, reported and evaluated Program savings.

Table 3–15. Savings Summary

	Proposal				Reported				Evaluated		
	Ex-ante Gross	Net to Gross	Ex-ante Net		Ex-ante Gross	Net to Gross	Ex-ante Net		Ex-post Gross	Net to Gross	Ex-post Net
kWh	6,142,318	.96	5,896,625		6,448,344	.96	6,190,410		6,330,758	.83	5,225,318
kW	903	.96	867		1,098	.96	1,054		1,053	.46	489

Lifecycle Savings

Table 3–16 and Table 3–17 show the economic useful lifetime of the measures is 10 to 16 years, depending on the measure, which would produce net life time energy savings of 76,696,527 kWh.

Table 3–16. Program Ex-post Lifecycle Gross and Net Energy Savings by Measure

	EUL	Reported kWh Savings	Evaluated Gross kWh Savings	Gross Realization Rate	Evaluated Net kWh Savings	Net Realization Rate
Performance Contracting Projects						
Site 1 – HVAC and Lighting Retrofits	16	1,822,918	1,822,918	100%	1,822,918	100%
Site 8 – Central Plant Upgrades	15	1,067,000	1,105,440	104%	0	0%
Site 7 – HVAC and Lighting Retrofits	15	2,535,823	2,622,201	103%	2,622,201	103%
Site 6 – Lighting Retrofits	12	20,370	21,617	106%	21,617	106%
Site 9 – Lab Retro commissioning	10	379,391	299,594	79%	299,594	79%
Vending Machine Controls Projects						
Site 2	15	52,290	23,152	44%	23,152	44%
Site 3	15	20,670	9,152	44%	9,152	44%
Site 4	15	85,860	38,016	44%	38,016	44%
PC Power Management Software Projects						
Site 5	10	464,022	388,668	84%	388,668	84%
Total		6,448,344	6,330,758	98%	5,225,318	81%

Table 3–17. Program Ex-post Lifecycle Gross and Net Demand Savings by Measure

	EUL	Reported kW Savings	Evaluated Gross kW Savings	Gross Realization Rate	Evaluated Net kW Savings	Net Realization Rate
Performance Contracting Projects						
Site 1 – HVAC and Lighting Retrofits	16	237.9	237.9	100%	237.9	100%
Site 8 – Central Plant Upgrades	15	600.0	564.0	94%	0	0%
Site 7 – HVAC and Lighting Retrofits	15	209.0	209.0	100%	209.0	100%
Site 6 – Lighting Retrofits	12	7.7	7.6	99%	7.6	99%
Site 9 – Lab Retrocommissioning	10	43.3	34.2	79%	34.2	79%
Vending Machine Controls Projects						
Site 2	15	0	0	NA	0	NA
Site 3	15	0	0	NA	0	NA
Site 4	15	0	0	NA	0	NA
PC Power Management Software Projects						
Site 5	10	0	0	NA	0	NA
Total		1,098	1,053	96%	489	45%

The distribution of lifetime savings in CPUC format is shown in Table 3–18 below.

Table 3–18. Program Lifetime Savings

Year	Calendar Year	Ex-ante Gross Program-Projected Program MWh Savings (1)	Ex-post Net Evaluation Confirmed Program MWh Savings (2)	Ex-ante Gross Program-Projected Peak Program MW Savings (1**)	Ex-post Evaluation Projected Peak MW Savings (2**)	Ex-ante Gross Program-Projected Program Therm Savings (1)	Ex-post Net Evaluation Confirmed Program Therm Savings (2)
1	2004						
2	2005	6,448	5,225	1.10	0.49		
3	2006	6,448	5,225	1.10	0.49		
4	2007	6,448	5,225	1.10	0.49		
5	2008	6,448	5,225	1.10	0.49		
6	2009	6,448	5,225	1.10	0.49		
7	2010	6,448	5,225	1.10	0.49		
8	2011	6,448	5,225	1.10	0.49		
9	2012	6,448	5,225	1.10	0.49		
10	2013	6,448	5,225	1.10	0.49		
11	2014	6,448	5,225	1.10	0.49		
12	2015	5,605	4,537	1.06	0.45		
13	2016	5,605	4,537	1.06	0.45		
14	2017	5,585	4,515	1.05	0.44		
15	2018	5,585	4,515	1.05	0.44		
16	2019	5,585	4,515	1.05	0.44		
17	2020	1,823	1,822	0.24	0.24		
18	2021						
19	2022						
20	2023						
TOTAL	2004-2023	94,270	76,691				

Definition of Peak MW as used in this evaluation: Summer peak

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5. Conclusions and Recommendations

The IDEEA Community College Retrofit Program achieved its participation targets after revisions to the Program approach. These revisions were discussed with the Program manager and were fully integrated into the Program work scope. As a result, all aspects of Program delivery and implementation were, for the most part, smooth and trouble-free, and Program participation was made simple and easy for the campus participants.

The CCRP evaluation provides some lessons learned that could be helpful for the statewide program going forward. The CCRP was barely underway when the statewide program was being designed, so lessons learned were not available to help inform the design of that program.

Conclusion 1. *Energy Service Companies (ESCOs) are effective delivery vehicles, but knowledge needs to be passed to the college staff.*

The Program provided insight into an area of great need and opportunity on community college campuses, namely, the need for training and education in energy-efficiency technologies and in continuous commissioning, as well as the opportunity for energy savings from the implementation of continuous commissioning on those campuses. The use of ESCOs for project management and installation is very effective, but college staff gain limited knowledge and understanding of energy efficiency and commissioning due to the hands-off nature of the relationship. Even though this relationship is governed by a 15-year, savings-performance contract, the limited knowledge transferred during project installation suggests it is unlikely campus staff will gain additional knowledge from the unforeseen activities that might be required of the implementation contractor under those contracts. Regarding the importance of two-way communication, one contact who was disappointed with his small role in his campus's project is a reminder that even though a given target market may lack sophistication regarding energy efficient-equipment or practices, it can nonetheless be a valuable resource for information about conditions in their facilities.

Recommendation 1. *Integrate college staff training into the energy-efficiency program.*

Energy efficiency and commissioning training should be integrated into programs with community colleges to increase awareness and understanding of the equipment and commissioning. Operations and maintenance trainings, such as those provided through the statewide Building Operator Certification and Training (BOCT) program should be integrated with programs at community colleges to enhance staff ability to operate and maintain the buildings after the efficiency improvements are made.

Conclusion 2. *Open communication between program sponsors and implementers is needed to ensure successful program outcomes.*

Communication with program staff when programs are not implementable as designed can ensure that programs are still implemented, and that they meet the strategic objectives of the program. When unforeseen preliminary marketing activities for the 2006-2008 statewide community college retrofit program competed with the CCRP, it jeopardized the potential for achieving savings through the Program. The new statewide program offered the prospect of greater economic rewards than did the CCRP. Revisions to the CCRP were discussed and fully integrated into the Program's scope of work to meet the initial Program objectives, delivering a smooth and trouble-free Program to participants.

Recommendation 2. *Keep lines of communication open and be flexible when surprises arrive.*

Conclusion 3. *Some projects will occur without financial incentives.*

While community colleges face significant financial barriers to installing energy-efficient equipment without assistance from utility programs, there are still some projects that will occur. This leads to lower net savings for programs. Therefore, as with any sector, to achieve the highest efficiency it remains important to work with the college staff to ascertain which projects really require additional support in order to be installed at all, and which need lesser or minimal support to be implemented.

Recommendation 3. *Determine which projects require financial support to proceed.*

Since some projects will proceed without funding, available incentives should be directed to the efficiency projects that would not proceed without financial incentives. This allows additional projects to be funded, and increases energy savings.

6. Convenience Store Energy Efficiency Delivery Program

1. Program Description

The Convenience Store Energy Efficiency Delivery Program (CSEED or the "Program") was developed and implemented by QuEST. The Program provided direct installation of energy efficiency measures to the underserved, hard-to-reach convenience store market segment throughout Edison's service territory. The Program offered an energy assessment and a comprehensive menu of lighting and refrigeration efficiency measures specific to convenience stores, combined with incentives to reach a short, one-year payback period, 100% financing if needed, and direct installation. By addressing market barriers through these means, CSEED was the first Program to comprehensively target this market segment. The direct install program did not offer prescriptive rebates, rather, it offered contractors incentive payments designed to buy down the cost of the project to reach a one year simple payback.

The need for the Program was high. A state of California nonresidential customer hard-to-reach study conducted in December 2001[142] showed that the convenience store market segment was the most difficult to reach and underserved segment in California.

QuEST designed the Program to address a number of market barriers that typically prevent independently owned convenience stores from investing in efficiency measures. These barriers, and QuEST's approach to address them, included:

- ***Access to financing.*** Independently owned convenience stores may not have access to capital for efficiency improvements. The Program offered 100% project financing so no immediate capital outlay was needed.
- ***Information or search costs.*** The typical convenience store operator does not understand the opportunities and benefits associated with energy efficiency. The Program offered targeted information in the marketing and audit phases of the Program to provide examples of the Program benefits and costs.
- ***Asymmetric information.*** Convenience store owners typically distrust contractors and others who are trying to sell them something, particularly when the seller is much more informed about the product and/or service. The Program addressed this barrier by being a part of the Edison Programs and utilized the Edison brand in its marketing materials and communications.
- ***Economies of scale.*** The costs of developing, engineering, and installing energy-efficiency measures in a *single* convenience store are high. The Program addressed this barrier and creates economies of scale by prepackaging and pre-engineering measures, and hiring contractors to perform multiple similar installations.

[142] California Statewide Nonresidential Customer Hard-To-Reach Study Final Report 2001.

- ***Bounded rationality.*** Convenience store customers are typically focused on advertising, sales, inventories, customers and other items associated with the core business of owning and operating a convenience store; energy usage is just a necessary operations cost. The Program addressed this barrier by providing measure development, engineering, and installation directly for the customer.
- ***High first cost.*** Cost is always a big issue for the convenience store owner. This barrier is addressed by the customized incentive feature of the Program which reduces the customer cost of measure installation down to a one year simple payback.
- ***Performance uncertainty.*** Convenience store customers are often skeptical about the actual energy savings that they will see from an energy-efficiency installation. The Program provided information directly to the customer and installed two pilot demonstration projects designed to be very closely monitored and metered at the very onset of the Program.
- ***Aesthetics.*** Convenience store customers are often skeptical about aesthetics, particularly with regard to lighting measures. The Program addresses this barrier by providing information to the customer and by performing installations in two pilot projects.[143]

QuEST developed the Program to address these barriers and keep costs to the customer in check by offering measure bundles designed to deliver cost-effective savings and achieve high levels of participation. The measures and measure bundles varied in price and complexity, and were designed to offer potential participants a range of choices.

Energy Controls & Concepts (ECC) was the prime subcontractor that conducted the energy audits using Enerpath's proprietary software. ECC also conducted lighting redesigns for the Program. National Resource Management, Inc. (NRM) was the Program's refrigeration subcontractor. Program measure installation was also completed with local electrical and mechanical contractors.

The Program's installation process was geared toward identifying and implementing changes in refrigeration, HVAC, and lighting systems to reduce energy use while maintaining aesthetics (a key factor for this segment), refrigeration temperatures, lighting levels and health objectives. Convenience stores with energy demand less than 50 kW were eligible for this program.

The Program included three components: (1) a facility assessment, (2) financing, and (3) direct installation. Customer enrollment in direct installation required participation in the facility assessment, which involved determining the potential for a cost-effective measure installation.

[143] QuEST, Final Report Narrative, July 2006. QuEST developed case studies for the two demonstration sites. The two stores were selected to be representative of the convenience stores in Edison's territory, based on location, size, savings potential, and customer cooperation. The two, located in Riverside and Sun City, were the first two participant sites. QuEST developed a web-based monitoring system accessible to those with the site monitoring URL. QuEST distributed 295 Case Study brochures for each of the two sites.

This process also involved a credit check, along with the customer's agreement to pay for their portion of the project. Measures that could be installed through the Program included:[144]

- Convert T12 lamps and magnetic ballast to T8 and electronic ballast.
- Replace T12 lamps and magnetic ballast with T8/ EB on display cases doors.
- Install occupancy sensor in public restrooms to control lighting and exhaust fans.
- Replace incandescent lamps with compact fluorescent lamps.
- Replace non-LED exit signs with LED exit signs.
- Add microprocessor control to air conditioning unit to control compressor cycling.
- Add and/or repair economizer on air conditioning units.
- Add evaporator fan controls to reduce fan speed during compressor off periods.
- Add microprocessor control to refrigeration condensing units.
- Add anti-sweat heater controls.

Table 1–1 and Table 1-2 detail the number of lighting and refrigeration measure installations recorded at the 32 participating sites. The Program savings fell below the original Program gross savings goals of 3,175,690 kWh and 182 kW. The Program achieved 60 kW and 743,249 kWh in savings.

Table 1–1. Summary of Program Participation

Participating Customers	32 Stores	Percent
Lighting Only	11	34%
Refrigeration only	4	13%
Lighting and Refrigeration	17	53%

[144] Several measures were listed in the original proposal, but not included in the final list of measures due to poor economic return. These included replacement of rooftop HVAC unit with high efficiency unit, tune-up or repair of existing HVAC or refrigeration system and controls, retrofit canopy HID lamps with pulse-start, T-5 or CFL lamps.

Table 1–2. Summary of Measures Installed

Measure Description	Number Installed
Install controls to depower coolers during off hours	13
Replace incandescent exit signs with LEDs	16
Install occupancy sensors in restrooms to control lighting and exhaust fan	23
Install controls on refrigeration evaporative fan motors	31
Install anti-sweat heater (ASH) door control for refrigerated cases	33
Replace incandescent lighting with CFLs	87
Replace inefficient refrigeration evaporative fan motors	148
Retrofit T-12 lamps and magnetic ballasts with T-8 lamps and electronic ballasts	468
Total Measures installed	819

Figure 1–1 charts the percentage each activity was expected to contribute to the overall CSEED Program goals, and the percentage contribution from refrigeration and lighting respectively. Considering all activities, (1) L-1 retrofit T-12 lamps, and (2) magnetic ballasts retrofit with T-8 lamps and electronic ballasts, contribute the most savings. Refrigeration measures were expected to contribute 55% of the overall Program savings goals and the lighting retrofits were expected to contribute 45% of the savings.

Figure 1–1. Activity Percentage of Total Program Goals

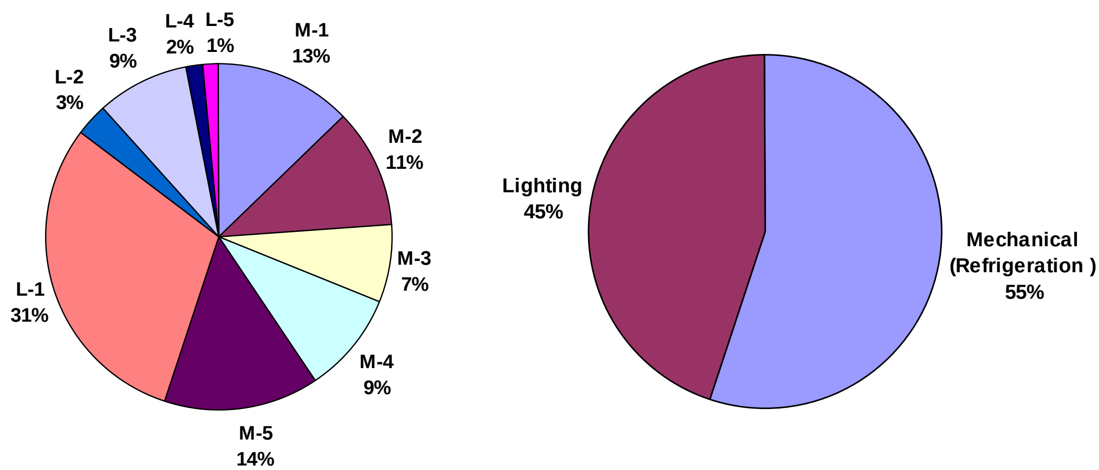
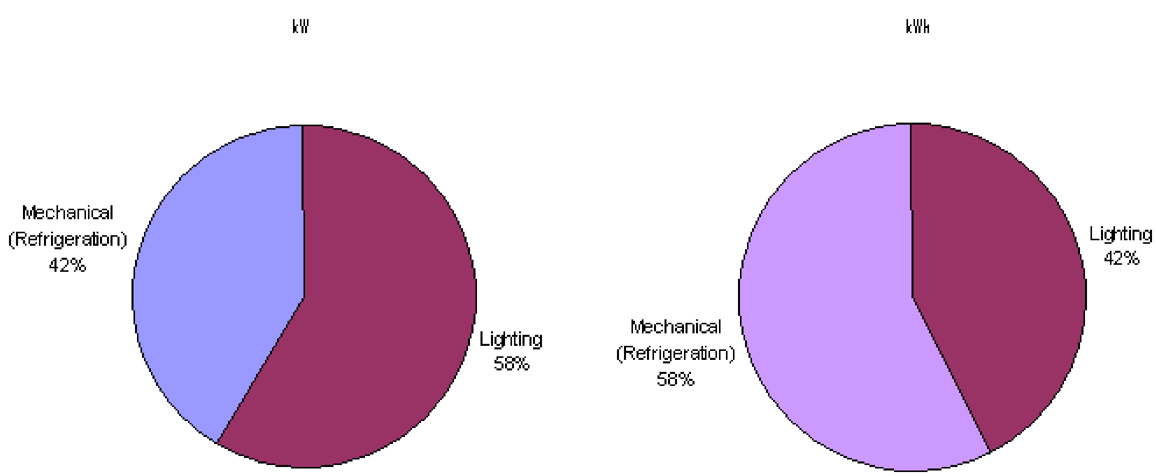


Figure 1–1A. Measure Description

Measure Description	Measure ID
Add microprocessor control for rooftop HVAC unit	(M-1)
Add/repair rooftop HVAC unit economizer	(M-2)
Add evaporator fan speed control for refrigeration system	(M-3)
Add microprocessor control for rooftop refrigeration units	(M-4)
Add anti-sweat heater control for refrigerated cases	(M-5)
Retrofit T-12 lamps and magnetic ballasts with T-8 lamps and electronic ballasts	(L-1)
Install occupancy sensors in restrooms to control lighting and exhaust fan	(L-2)
Retrofit display case T-12 lamps and magnetic ballasts with T-8 lamps and electronic ballasts	(L-3)
Replace incandescent lighting with CFLs	(L-4)
Replace incandescent exit signs with LEDs	(L-5)

Figure 1–2 details the distribution of kW and kWh savings attributed to the CSEED program as reported in the implementer's final tracking file submitted to Edison.[145] Lighting measures accounted for a majority (58%) of kW savings. Conversely, lighting measures only accounted for 42% of Program reported kWh savings. More detailed savings information pertaining to the number of measures installed at each site can be found in Table 3-1.

Figure 1–2. Distribution of Recorded Program Achievements



Overall, as anticipated, two measures, (1) L-1 retrofit T-12 lamps, and (2) T-12 lamps with magnetic ballasts retrofit with T-8 lamps and electronic ballasts, contributed the most savings. Controls on evaporative fan motors provided 22% of overall savings and anti-sweat heater door controls provided 21%. Figure 1-2.

[145] Data source: 0016-Convenienc-cseed_epflatfile_v4.xls

Quantec, LLC and Summit Blue Consulting completed a comprehensive process and impact evaluation of this Program. The purpose of the process evaluation was to document project progress, assumptions, and barriers to wider implementation, to assess customer satisfaction, and to document barriers to participation and describe current practices among the partial participants and dropouts. Partial participants are stores where an audit was conducted but measures were not installed. Dropouts are stores where a commitment was made to install measures but the owners subsequently decided not to participate.

The impact analysis was a detailed engineering analysis, including reviews, recalculation of engineering algorithms, detailed reviews of Program records including the contractor's data from CoolTrol data logging efforts,[146] and verification site visits, as well as a billing analysis. These approaches generally conformed to the basic rigor level for process and impact evaluation as defined by the 2006 California Evaluation Protocols, (census billing analysis) though technically, these protocols do not apply to evaluations of 2004-2005 programs.

This report is organized into five sections. The next section (Section 2) presents the process evaluation, including the Program logic model, results of interviews with Program staff and participants, and free rider estimates. Section 4 describes the impact evaluation and the engineering and site visit results, and calculates realization rates, ex-post gross and net savings, and lifecycle savings. Results of the billing analysis are also included in Section 3. The final section, Section 4, presents the major conclusions and recommendations.

[146] The CoolTrol system logged all hours of operation, including peak, off peak, and shoulder.

2. Process Evaluation

Process Evaluation Methodology

In this section, the Program is described as experienced by individuals who designed and implemented the Program, by the sample of businesses that participated in the Program, the sample that dropped out (partial participants), and a sample that chose not to participate.

Program Logic Model

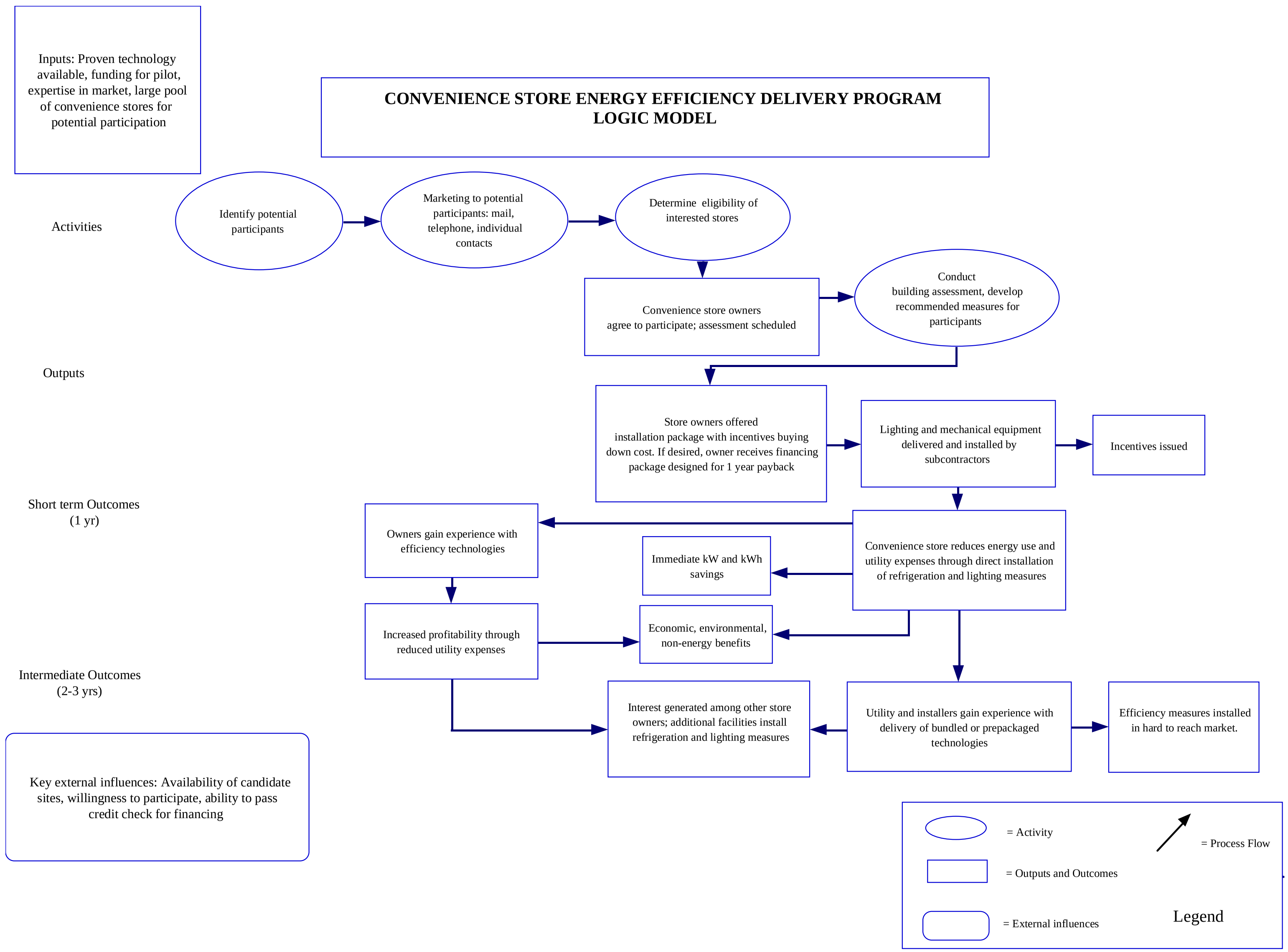
The Program logic model diagram is shown in Figure 2–1. The logic model shows the key features of the Program as understood by the evaluation team, indicating the logical linkages between activities, outputs, and outcomes. The primary activities involved identifying potential participants and marketing the Program to stores through direct mail and phone solicitation, as well as determining eligibility. Once the participant agreed to participate, the store was audited.

The activities were expected to result in the diagrammed outputs. Recommended measures and project cost, and financing if desired, were offered the participants. Incentives were given to the contractors to buy down the cost of the measure installation. Once the measure package and project cost were delivered, the participants committed to install the measures or chose not to install measures. Lighting and mechanical measures were installed for participants who chose to go ahead.

Short and intermediate term outcomes included immediate kW and kWh savings as convenience stores reduced their energy use and their utility bill. Store owners gained awareness of energy-efficiency technologies and experience with them. Experience with a new market approach and technology was gained by contractors and the utility. Economic, environmental and non-energy benefits were realized with the energy assessment and installation of measures.

The Program was implemented as designed. There were no major differences between the original proposal and the implementation.

Figure 2–1. Final Logic Model



Process Evaluation Sample Design

This section describes the approach used to sample the population of convenience store operators who participated in the Program and the sample that did not participate. Edison and QuEST (Quantum Energy Services and Technologies, Inc.) intentionally chose to work with convenience stores that were independently operated rather than chain stores. Independent franchise operators were also included as outreach targets. Gas stations that featured a convenience store were included in the sample.[147]

The sample selection for the process evaluation surveys was dictated by two factors. First, efforts were made to contact all participating owners and dropouts (partial participant dropouts). Second, the intention was to survey the decision-maker, i.e., the manager or individual who made the participation and equipment decisions for the site.

Table 2-1 shows the survey sample designed for the process evaluation and the number of surveys completed.

Table 2–1. Survey Sample Goal and Achievement

Task	Goal	Achieved
Program/implementer staff	4	3
Participating owners/managers (population included 32 stores with 25 owners)	25	25 stores (19 owners)
Partial participant dropouts — audits were conducted and commitment made to install measures but store did not install measures (population included 6 stores with 4 owners)		4 stores (4 owner-managers)
Partial participants—audits were conducted but no commitment was made and no measures were installed (295)	58 (90%+10%)	57
Non participants—contacted but no audit or measures installed (1100)	65 (90%+10%)	62
Total	152	145

Edison provided a list of about 3000 potential participants to QuEST, based on the customer's tariff, SIC and NAIS codes. QuEST screened the list for stores located in specific counties and used a telemarketer to market the Program to about 1100 potential participants in three counties. Audits were conducted for 295 convenience stores. A total of 38 stores committed to participate in the Program and 32 had measures installed.[148]

Surveys were conducted with participant, partial participant dropouts, partial participants receiving only an audit, and nonparticipant store owners. Participants were convenience store owners or operators who installed measures through the Program. The term "partial participant" describes a store owner or operator who received an energy assessment (audit) of their store but

[147] Exterior canopy light replacement was not a program measure.

[148] Implementers expected a higher participation rate; several market barriers are discussed below.

did not install any measures. Partial participants who were dropouts received an audit and committed to install measures, but subsequently decided not to install measures. Finally, a nonparticipant is someone who was contacted about the Program but did not schedule the audit.

As shown in Table 2-1 and 2-2, 32 stores owned by 25 people participated in the Program. Multiple attempts were made to reach all store owners. Nineteen owners were interviewed. These people owned 25 of the participating stores. The remaining seven participating stores were owned by six people. Three owners (four stores) remained unavailable after repeated attempts to contact them. One owner refused to be interviewed. Correct phone numbers for two participating stores could not be located.

Of the partial participant dropouts, four of the six owners were reached. These owners represented four stores.

Table 2–2. Surveys with Participants and Dropouts

	Number of Stores	Number of Store Owners
Participant Population	32	25
Participant surveys completed	25	19
Partial Participant Dropout Population	6	4
Dropout surveys completed	4	4

Surveys were conducted with a sample of store owners who were contacted about the Program, either by phone or mail. The sample included those who participated in the audit but did not install measures (partial participants), and those who were contacted but did not schedule an audit (nonparticipants). A minimum of five calls were made to reach people on the contact list. As seen in Table 2–3, 36 percent of the eligible sample refused to speak with the interviewers. Twenty-eight percent of the eligible sample spoke with interviewers.

Table 2–3. Sample Disposition of Partial Participant (Audit only) and Nonparticipant Surveys

	Frequency	Percent
Contact list from QuEST's database	1020	
Contacts with phone numbers	785	
Language barrier/residence	117	
Wrong number/non-working number	78	
Disconnect/computer/fax	139	
Ineligible	31	
Eligible sample	420	
Completed surveys	119	28%
Incompletes	10	2%
Refusals	150	36%
Not available/no answer/busy/answering machine	141	34%

Surveys were designed to ask some of the same questions across all participant categories, that is, participants who installed measures, partial participant dropouts, partial participants who only had the audit conducted, and nonparticipants. Research questions were developed as part of the work plan and then used to develop interview guides. The questions explored the decision-making process used by participating convenience stores. It also explored store owners' familiarity with the various technologies installed through this Program, as well as whether the stores had installed the technology in the past, and whether they might install the different technologies in the future.

Surveys were completed via telephone in October 2006 and were structured to be as concise as possible since most of the owners were also working at their stores and serving customers. Before interviewing participants, interviewers confirmed that the respondent was involved in the decision to participate in the Program, were directly involved and knowledgeable about the Program, or remembered receiving materials about the Program.

Process Evaluation Results

In this section, the Program is described as experienced by individuals who designed and implemented the Program, by the sample of convenience stores that participated in the Program, a sample that dropped out, and a sample that chose not to participate.

Program Design

QuEST reported that they were not able to address the HVAC microprocessor controls and economizer as originally intended, however, refrigeration measures were added. This was not a planned change, but part of natural evolution of the Program.

Generally speaking, convenience stores operate with low margins and can not afford loss of operation time for installation of new equipment. The Program was designed so that the proposed efficiency equipment could be installed while the store continued to operate, which was critical to this population.

Implementers planned the facility assessment process to provide Program information and audit reports at the end of the audit visit, so that the store owners and decision-makers could make participation decisions that day. Customers were also offered financing that would allow measures to be installed quickly and create an immediate positive customer cash flow. Customers were also offered maintenance agreements to maintain measure savings and effectiveness on an on-going basis.

For the most part, the Program was implemented as designed and able to address the objectives listed above for a number of participants.[149] Experience with this Program supports the continued need for investment in education and incentives for efficiency improvements in this hard-to-reach and underserved market segment.

- The Program was able to offer ***access to financing*** and address ***high first cost*** issues. ***Economies of scale*** were also addressed by offering measure bundles. As discussed later

[149] Several measures initially proposed were dropped from the list of eligible measures as noted in Footnote 144. Implementers reported this was a natural evolution of the program.

in this report, cost was the largest barrier to measure installation. However, the cost barrier was not overcome by all participants. Some still chose measures with a lower payback or a smaller price tag and did not install all recommended measures.[150] Partial participants still could not get over the cost barrier and did not install measures.[151] While cost was a barrier, access to financing was not the issue. Only one participant chose to take advantage of the Program's flexible financing, which offered up to 100% of installed measure cost, and finance the measures through the Program.

- ***Information and search costs*** and the ***bounded rationality*** of independent store owners were addressed by the Program. Some participants stated they did not know they could save energy and indeed, for some participants, the energy bill was just another bill to pay. Others felt the audit was very useful in providing information about their energy use and efficiency opportunities they did not previously have. Conversely, there were some people from all three participant groups who said they did not understand the Program or the information that was provided to them. Some remained unconvinced that the recommended measures would save energy.
- ***Asymmetric information*** was addressed for a number of participants. Edison's sponsorship was very important to their decision to participate and they noted it lent credibility to the Program. However, some nonparticipants reported there was still distrust for contractors and others who were "trying to sell them something."
- The Program was able to address concerns about ***performance uncertainty*** but this continues to remain an issue for some participants. A number of participants want follow-up and someone to review their energy bills and expected savings to show them how much energy they saved from the installed measures. None of the survey respondents mentioned the demonstration stores.[152] Information provided to the partial participants and nonparticipants was not able to sway them to fully participate.
- Respondents did not seem to be highly concerned about ***aesthetics***. Some did comment that the store was brighter after lights were installed. Only one said he did not install lighting because of aesthetics. Additional lighting would have been installed but a full array of lighting options was not available to satisfy all participants.

This is an appropriate market segment for this Program. Surveys show that respondents may not be aware of energy-efficiency measures, confirming one of the tenants of this Program, that is, that these small commercial customers have not received or benefited from energy-efficiency education, and that contractors typically do not focus on this market because they can be a "hard sell."

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[150] Of the 452 recommended measures not installed, 51% were T-12 to T-8 change-outs, 21% were incandescent to CFL change-outs, and 20% were inefficient evaporator fan motor replacement. The remaining 8% included exit sign change-out to LED and depowering bathroom fans and lights with occupancy sensors.

[151] According to respondents, the Program competed with other direct install lighting programs and customers were looking for free lighting or a "better deal." This was also a short term program making it difficult to build long-term relationships and build trust needed to reassure participants that this was not a "fly-by-night" operation.

[152] Location and timing of demonstration stores were not issues since these were located in towns with large participant populations and were the first two stores to participate.

To determine the extent of their exposure to various technologies, respondents were asked if they were aware of or familiar with the individual efficiency measures prior to the Program. The responses are summarized in Table 2–4. For the most part, participants were not aware of the energy-efficiency technologies, including the more common occupancy sensors and CFLs. Occupancy sensors were familiar to eight, or 50%, of the 16 respondents to that item, and six, or 33%, were familiar with CFLs. This market segment may benefit from additional general information mailings. The limited exposure also means that the auditors and the sales force may need to spend a little more time explaining the benefits and functions of the recommended technologies.

Table 2–4. Awareness of Program Technologies

	Familiar with Technology		Not Familiar with Technology		Uncertain	
Measure	Participant	Audit Only	Participant	Audit Only	Participant	Audit Only
T8 Lights	29%	74%	65%	17%	5%	10%
CFL	33%	40%	67%	45%		14%
LED exit signs	14%	72%	79%	14%	5%	14%
Occupancy sensors	50%	90%	50%	5%		5%
Evaporative fan motors	22%	73%	72%	13%	5%	15%
Microprocessor controls for HVAC	27%	76%	73%	15%	5%	10%
AC economizer repair system	14%	75%	79%	8%	5%	18%
Anti-sweat heater controls	31%	73%	62%	8%	5%	20%

Source: Surveys of participants (n=19), nonparticipants (n=42)

The audit-only partial participants appear to be more aware of the efficiency technologies than the participants were. As shown later, they also had already installed a number of the technologies as well, more than the participants had.

Partial participants, those receiving an audit but choosing not to install measures, were also asked if they had installed any of the energy-efficient measures prior to receiving the energy audit and measure recommendations. Partial participants had previously installed more measures than the participants (see Table 2–27), including measures that the participants had not previously installed. Partial participants were more aware of the various technologies, including the mechanical measures, than were the participants. Prior installation of measures may help to explain why they did not participate in this Program (Table 2–5). As seen in Table 2–5 and Table 2–6, there were significant opportunities for upgrading energy efficiency, even if store operators underestimated the number of existing efficiency measures in their stores.

Table 2–5. Self-Report of Prior Measures Installed

Measure	Percentage of Stores Reporting Measures Installed	
	Participants	Nonparticipants
T8 Lights	5%	17%
CFL	5%	0
LED exit signs	0%	10%
Occupancy sensors	5%	30%
Evaporative fan motors	0%	18%
Microprocessor controls for HVAC	0%	13%
AC economizer repair system	0%	10%
Anti-sweat heater controls	0%	10%

Source: Surveys of participants (n=19), nonparticipants (n=42)

The implementer's database (flat file) was used to generate Table 2–6. This table shows the number of stores with existing conditions where measures offered through the Program could improve efficiencies (Column A). The total number of existing conditions conducive to upgrade throughout the stores in Column A are shown in Column B. Column C lists the number of measures recommended, while Column D shows the number of measures installed. The percentage of recommended measures that were installed is shown in Column E. Installations for all but one measure came within 20% of the number recommended.

Table 2–6. Measures Existing, Recommended & Installed

	A	B	C	D	E
Recommended Measure Category	Number of Stores with Existing Condition	Number of Existing Conditions	Number of Measures Recommended	Number of Measures Installed	Percentage of Recommended Measures Installed
Install controls on evaporator fan motors (refrigeration)	29	39	35	31	89%
Replace inefficient evaporator fan motors (refrigeration)	29	235	186	148	80%
Retrofit T12 lamps to T8 fluorescent fixtures	27	669	656	468	71%
Install med temp anti-sweat heater controls	25	35	30	25	83%
Retrofit incandescent lamps to CFL	22	104	101	87	86%
De-power restroom light and fan with motion sensor	17	24	24	23	96%
Replace incandescent Exit signs with LED fixtures	8	19	19	16	84%
Install low temp anti-sweat heater controls	8	8	8	8	100%
De-power coolers during off-hours with time controls (refrigeration)	3	13	13	13	100%

Source: QuEST final data tracking files

Market Assumptions

The Program focused on a very specific segment of the retail market, that is, operators of independently owned (non-chain) convenience stores. QuEST's marketing approach combined marketing and recruitment processes that leveraged industry trade groups such as the National

Association of Convenience Stores (NACS), provided accessible demonstration sites, optimized customer information and incentives, and provided turnkey, direct installation.

Edison extracted a list of over 3000 customers from their CIS based on tariffs and SIC codes that QuEST specified. From those, the Program was looking for 75 participants. QuEST was able to filter the customers using usage profiles and geographic location, as well as identify some who had multiple stores. The original plan was to market the Program throughout Edison's territory. Because of the inherent cost of spreading the Program across all of Edison's territory, the marketing was limited to three counties including Riverside, San Bernadino and Orange County.

QuEST used a telemarketing firm to make outbound calls and audit appointments with interested customers. QuEST estimates about 1000 marketing calls were made. Customer data was uploaded to the ECC database so that a work order could be generated for auditors. The audit package consisted of EnerPath tools and expert software and equipment in a Web-based format. Audit results and reports could also be uploaded and given to the customer at the close of the audit. A total of 295 audits were completed, 38 stores committed to participate, and 32 completed measure installations (Table 2–7).

Table 2–7. Program Marketing and Participation

Participation Attrition	Number of Stores
Customers extracted from Edison's CIS	3125
Contacted by marketing firm	1100
Audits completed	295
Committed stores	38
Stores with measures installed	32

Participants were offered a financing package when they were first called to set up the audit appointment.[153] Implementers offered financing to overcome the perceived barrier that small store owners did not have access to affordable financing. However, only one participant chose to take advantage of the financing vehicle. Still, cost was an issue for participants, and learning that the financing vehicle did not really overcome this barrier was important information.

QuEST planned and successfully completed measure installations at two pilot projects at the onset of the Program. The pilot stores were representative of the convenience store market and the studies exemplified typical installations for the convenience store market. As QuEST noted in their proposal, the pilots served three purposes: "1) for customer demonstration purposes, to be used in the CSEED Program marketing and customer acquisition process; 2) for subcontractor demonstration purposes to aid contractors in the installation process; and, 3) to monitor savings

[153] Survey respondents were not asked if this was experienced as a "hard sell" approach either during the first telemarketing call or at the time of the audit. However, oftentimes the decision maker did not take the telemarketer's call, and was not on-site at the time of the audit, not all auditors were experienced salespeople, and closing the sale required callbacks to discuss financial aspects and measures with the decision-maker. The evaluation team did not observe the telemarketer calls. However, as noted in Table 2-8, more people remember hearing about the program through the mail and by in-person visits. Future evaluations should explore measure cost, marketing approaches, and financing options in more detail.

associated with the measures installed and to prove the CSEED Program's efficacy."[154] Measures were installed at no cost in these two stores in exchange for allowing the Program to monitor equipment performance. The two sites were heavily instrumented to allow real-time Web-based monitoring and extrapolation of results to the larger market. Temperature readings were taken for three areas at each site. Three electric power measurements were also planned, but only one of the two sites could collect all three measurements. Limited cellular technology restricted collecting two of the measurements at one site.[155] Monitoring at these two sites demonstrated the effectiveness of the individual efficiency technologies.[156] QuEST reports that their engineering estimates along with monitoring at these stores showed energy savings exceeded their initial ex-ante estimates by 14%.[157]

Marketing and Participation Decisions

Participants, partial participants, and nonparticipants completed a telephone survey. Respondents in all three categories were asked if they recalled being contacted about the Program, and how the information was delivered. The responses among the three groups are summarized in Table 2–8. Percentages are provided in terms of the number within each respondent group.

Program information was delivered in a variety of ways. Participants recalled receiving information in the mail (68%), via a phone call (32%), and in person (32%). One participant said a representative from the IGCS industry association contacted them. Partial participants, those who completed audits only, received initial information by mail (33%), in-person contacts (16%), and via phone (14%).

[154] QuEST, Revised Proposal, March 2005, pp 2-5, 2-6.

[155] QuEST, Final Report Narrative, July 2006, page 7. At that time, technology was limited to a 400 bps access speed, which limited the amount of data that could be displayed. The limitation was overcome by utilizing indoor space, outdoor and walk-in temperatures and the store main meter kW real-time readings and calculated values for the compressor and evaporative fan motor.

[156] Ibid, page 8. Baseline data was recorded with DENT Elite Pro power loggers at 15-minute intervals over three weeks. Post data collection show energy savings exceeding ex ante estimates at both demonstration sites.

[157] Ibid. page 2.

Table 2–8. Initial Program Contact

	Participants (n=19)		Partial Participants (Audit Only) (n=57)		Nonparticipants (Contact Only) (n=62)		Total	
	Frequency	Percentage of Respon-dents	Frequency	Percentage of Respon-dents	Frequency	Percentage of Respon-dents	Total	Percentage of all Respon-dents
Mail	13	68%	19	33%	13	21%	45	33%
In person	6	32%	9	16%	16	26%	31	22%
Phone call	6	32%	8	14%	6	10%	20	14%
E-mail			1	2%			1	1%
Other			2	4%			2	1%
Did not remember audit			15	26%				
Did not recall contact			4	7%	42	68%	46	33%

Source: Surveys of participants (n=19), partial participants (n=57), nonparticipants (n=62). Multiple responses allowed.

Over half, 68%, of the nonparticipants did not remember being contacted about the Program. Forty-five nonparticipants responded to the question regarding initial Program contract. Like the partial participant and participant groups, the group recalled in-person visits (26%), phone calls (10%) and mailed promotions (21%), again shown in Table 2–8.

While a large telemarketing approach was taken to solicit participants, it was the outreach by mail that was most frequently remembered among the participants and partial participants. The in-person visit was most commonly remembered among nonparticipants. An outreach approach that encompasses a variety of activities is more likely to solicit a greater number of responses that an approach based on only one or two strategies, particularly in a market with limited prior exposure to energy-efficiency programs.

Participants

Participants were asked if they recalled how the benefits of the Program were explained. Helping customers to save energy and money was the factor recalled most frequently by participants (84%) as shown in Table 2–9. Three respondents (16%) recalled the one-year payback period. Seven respondents (37%) said that they recalled “other” Program benefits. Comments about benefits and the “other” benefits cited included:

> *“Better lighting quality”*
>
> *“The Program would help to install lights”*
>
> *“Someone [would be] able to come and explain how much money they would save”*

"I would save about $400 a month and it would pay for itself in about 10 months to a year."

Table 2–9. Benefits Remembered by Participants

Reason	Frequency	Percentage
Save energy and money	16	84%
1-year payback expected on investment	3	16%
100% financing package was important	1	5%
Not explained	1	5%
Other	7	37%

Source: Surveys of participants (n=19), multiple responses allowed.

Participants were asked why they decided to participate in the Program. Their responses are summarized in Table 2–10 below. Saving energy was named by 79% of the respondents, and 74% said saving money was important to their decision to participant. The one-year payback and availability of financing were also mentioned as important reasons to participate. The "other" reasons listed included:

"Helping the environment"

"It did not cost too much, and change would be good for business."

"Had been thinking about it and financing helped"

Table 2–10. Participants' Reasons for Participating

Reason	Frequency	Percentage
Save energy	15	79%
Save money	14	74%
1-year payback expected on investment	1	5%
This is an experiment	1	5%
Financing package was important	1	5%
Other	3	16%

Source: Surveys of participants (n=19), multiple responses allowed.

Participants were asked if the financing package was important to their decision to participate. As shown in Table 2–11, 68% said that it was, and 21% said it was not. Participants were also asked if they would have participated without the financing package. Three of those who said the financing package was important and one who was uncertain said they would have participated without the financing package. Since final Program reports show that only one participant actually took advantage of the 100% financing package, the respondents were most likely thinking about the incentives which lowered the cost of the equipment purchase. Other questions and responses demonstrated that cost was the primary concern in this market segment.

Table 2–11. Importance of the Financing Package

	Frequency	Percentage
No	4	21%
Yes	13	68%
Uncertain	2	11%

Source: Surveys of participants (n=19)

Participants were also asked if Edison's sponsorship of the Program was important in their decision to participate. Edison's sponsorship was important for nearly everyone. Sixty-three percent said that Edison's sponsorship was "very important," as reported in Table 2–12. All but two felt Edison's involvement was "somewhat" or "very important." Respondents' comments included:

> *"[I was] more willing to believe Edison than a contractor"*
>
> *"Edison had credibility as they were providing the rebate."*
>
> *"It gave the Program legitimacy."*
>
> *"[I] trusted Edison more than an independent contractor; also financing was critical."*
>
> *"Rebates made it reasonable."*

Comments made at other times also indicated that it was important that the Program come from Edison because it seemed less likely that contractors were just trying to sell them something. Comments also noted that some owners are still leery of efficiency offers, stating they did not get rebates promised by other contractors.

Table 2–12. Importance of Edison's Sponsorship

Importance	Frequency	Percentage
Not at all important	1	5%
Somewhat unimportant	1	5%
Somewhat important	5	26%
Very important	12	63%

Source: Surveys of participants (n=19)

Overall, the participants' awareness of energy-efficiency technologies was not very high (Table 2–4). This may be one reason why Edison's sponsorship of this Program was important. As noted in their comments, Edison's sponsorship made it less likely that a contractor was just trying to sell them something. All four of the participants interviewed who owned more than one participating property rated Edison's sponsorship as "very important." The financing package was important to over half the respondents (68%), including three of the four who owned multiple stores.

Partial Participants—Audit Only

Among partial participants, those who received an audit but decided not to install any efficiency measures, the reasons they did not install measures were topped by financial issues including lack of funding, an unwillingness to spend the money "up front," and uncertainty that the technologies would save energy or money. These reasons are summarized in Table 2–13.

The "other" reasons respondents cited for not participating were that they were looking for a better program, that they did not understand how it could be financially feasible, that corporate would provide the services, and that they were worried that they would not have enough energy to keep ice cream frozen. Some of the responses included:

> *"It wasn't clear from the vendor to show me step by step how to make it financial feasible for me."*
>
> *"I was afraid they would cut [power] during peak hours and our candy and ice cream would be melted in the summertime."*
>
> *"I gave them a call and left a message and no one called me back."*
>
> *"I'm looking for a better efficiency program."*
>
> *"I didn't understand."*
>
> *"We already had most of the energy equipment already installed at our company."*
>
> *"[I] . . . was waiting for Edison to call back."*
>
> *"We were only given a few days to decide to participate before the Program ended; too quick to get funds together—also felt the amount quoted was too much money."*

Table 2–13. Partial Participants—Reasons for Not Participating

Reason	Frequency	Percentage
Didn't have funding/not in the capital budget	8	19%
Didn't want to spend money up front	7	16%
Didn't believe the technologies will save any energy or money	5	12%
Might do it in the future	4	9%
Didn't understand what it was about, misplaced information, or not aware of Program	4	9%
Interested, waited for information	3	7%
Was told did not need it or they had equipment already	3	7%
Just not interested right now/too busy right now	2	5%
Uncertain	2	5%
Other	6	14%

Source: Surveys of partial participants (n=43), multiple responses allowed.

It appears that three were interested in participating but there was no follow-up by implementers. The 15 with financial concerns and five who didn't think the technologies would save energy might have needed more individual attention or time spent with them to explain the Program benefits and financing options. Comments show that more clear communication about the efficiency technologies and follow-up may have led to additional participation. One of the challenges lay with the marketing and selling the program. Auditors were lighting designers and contractors, trained also to conduct the refrigeration audits. Primary implementers and their auditing subcontractors disagree about whether marketing and closing sales were also the responsibility of the auditors.

Nonparticipants

Nonparticipating store representatives were asked if they had followed-up on the information they had received about the Program. Thirteen respondents indicated that they had followed-up but then decided not to participate. These respondents were asked if they received any additional information when they did follow up. Three said that no one came back or that they did not receive information. Three respondents thought they participated, but cross-referencing with the list of participants showed that these stores did not in fact participate in the Program. Some of the comments indicate more clarity, discussion, and follow-up were needed to ensure potential participants understood the program and both installers and potential participants understood which measures could be installed. Comments included:

> *"I was told to pay $8000 a year to save $600 dollars; that does not make sense to me."*
>
> *"The guy came to my store and gave me a bid on what I needed to have done in my store. I was wondering when I would get my rebate back."*
>
> *"I requested he come in and he never came in to do the lights."*
>
> *"He came out and put new lighting in the ceiling and fixed my cooler and he told me some other things and he did not come back. I did participate in the Program, but all the work they said they were going to do, they did not."*
>
> *"I could not understand the report."*

The 13 respondents who decided not to participate were asked why they made that decision. Their primary reasons for this decision are reported in Table 2–14. Store owners don't understand what they are being told, they think they participated, they asked to participate, or they requested information and there was no follow-up. These responses indicate problems with communication and follow-up with auditors and implementers.

Table 2–14. Nonparticipants Who Followed Up: Reasons for Not Participating

Reason	Frequency	Percentage
Might do it in the future	6	46%
Didn't want to spend money up front; didn't have funding in budget	4	31%
Too busy	1	8%
Just not interested right now/too busy right now	1	8%
Didn't understand what it was about	1	8%
Decision maker is someone else and they weren't interested	1	8%

Source: Surveys of nonparticipants (n=13), multiple answers allowed

The 24 nonparticipants who said they did not follow-up after receiving the initial information were asked why they did not follow up. As shown in Table 2–15, 42% said they were too busy or not interested, another 17% said they didn’t understand what the Program was about. Others noted they were not the decision maker, did not have funding, or already installed the lighting. Cross-referencing with the participant list shows that the store owner who said he did install measures did not install them under this Program.

Table 2–15. Nonparticipants: Reasons Didn't Follow Up

Reason	Frequency	Percentage
Too busy/not interested right now/didn't look into it	10	42%
Didn't understand what it was about	4	17%
Not the decision maker	3	13%
Didn't have funding/not in the capital budget	2	8%
Already changed lights or had someone do fix-ups	2	8%
Didn't believe the technologies will save any energy or money	1	4%
Didn't remember receiving anything	1	4%
Did install	1	4%

Source: Surveys of nonparticipants (n=24), multiple answers allowed

Almost half said they were too busy to look into it. However, here again, as with the nonparticipants who did follow up and request information, respondents said they did not understand what the Program was about and they didn’t have funding. Better communication may have led these owners to install the efficiency measures.

Dropouts

Six stores had audits completed, committed to install measures, but dropped out before measures were installed. Of these, one owner of three stores sold the stores between the commitment to participate and measure installation. Three others were independent owners. Four of the owners and managers were interviewed. One owner committed to participate but his partners decided to decline participation. One decided that they had already installed all the measures they needed.

The last owner was not convinced that refrigeration measures could be integrated with existing measures. All three independent owners cited cost as a reason not to participate.

Incentives were customized on a case-by-case basis, with the objective to buy down the cost of the measure package to a one year payback. Since financing was available to these and all other owners, the financial package apparently was not acceptable or not explained well enough. Financing offered through the Program, was flexible, and offered up to 100% of installed cost. Future market studies should research financial packages to ascertain the parameters owners would find acceptable.

Program Delivery and Implementation

QuEST reported that the Program started about five or six weeks later than planned because it took longer than expected for Edison to approve marketing materials. Because of the late start, QuEST used an independent call center "to move the audit and recruitment process into high gear." The callers introduced the Program and scheduled audits. This was not an easy process. About 1100 stores were called to schedule 295 audits; i.e., 27% of the stores received an audit.

QuEST felt that with the number of issues vying for the attention of store owners, it was difficult to capture their attention. They also learned that some stores do not engage in new activities in the last quarter of the year because this is the busiest time of the year for them. Rolling out the Program late in the year reduced the number of participants and energy savings achieved.

Audits involved inspection of lighting, refrigeration, and mechanical equipment, as well as data entry. ECC (subcontractors to QuEST) provided the energy assessments and lighting design services. The auditors were trained by the refrigeration contractor (NRM) to conduct the mechanical portion of the assessment. Because of the complexity, audits could take one to three hours to complete. The audits and the Program were much more complex than the more common lighting-only programs. Given the short Program timeframe, QuEST felt contractors did a remarkable job completing nearly 300 audits in two months.

QuEST was hoping to deliver the audit information and secure the participation commitment in the same day for an efficient and expeditious process since the Program's overall time frame was shortened by the late start. Implementers anticipated that the one-stop audit/signature/sales approach would work in this Program; however, the one stop approach was not ideal for several reasons.

- Initial recruitment for Program participation commencing with audits was made by a telemarketing firm. Financing options were also offered during the phone call. Given the limited prior exposure to energy efficiency and difficulty reaching the owners and managers, this approach may need some fine tuning to fully explain the Program and bring in larger numbers of potential participants.
- The role of the auditor and potential responsibility for closing the sale at the time of the audit was not clearly defined. Implementers had some expectation that the auditor could close the sale in a one-stop approach. However, the auditor focused on completing the complex lighting and mechanical audits. While they produced the report with

recommended measures and costs, presenting it to customer, it appears that they were not trained to sell or close the lighting and mechanical jobs.

- A commitment to participate inherently meant the store was required to commit capital to purchase efficiency measures. This can't always be done "on the spot."
- Oftentimes the owner or decision maker was not present at the time of the audit, so any pitch to commit to participate would need to wait. This necessitated a call back to discuss the project with the decision-maker once the audits had been completed and submitted.
- Owners and management needed time to consider the audit information, the recommended measures, and the capital required in order to make a decision to participate, and then obtain the funding needed.
- During the time between the audit and the call back, sometimes potential participants changed their decision to participate. This occurred on two levels. Sometimes the participant decided not to install any measures and dropped out of the Program altogether. Other stores dropped individual measures.
- Owners were aware of other rebate and incentive programs, some requiring no cash outlay, including lighting programs offering 100% incentives. When they were presented with the recommended measures and asked to contribute to the project cost, and even with incentives applied, some owners refused, stating they were looking for a "better deal." Customers did not understand that neighboring utilities did not offer the same program, or that utility programs might focus on specific territories, so that incentive structures for various programs were not identical.
- The program did not offer prescriptive rebates, but offered incentives tailored to bring the simple payback for the measure bundle to one year. The incentives for similar stores could be different, which was not always easy to explain to potential participants.

Another issue influencing participation and measure installation was the high rate of turnover in this market segment. Some potential participants deferred decisions because they did not know if they were going to stay in business. Other businesses changed ownership between commitment and installation, and participation was cancelled.

QuEST and NRM also found that many owners deferred the decision to install or upgrade their refrigeration equipment to their refrigeration service contractors. However, these technicians often were not aware of efficiency technologies or familiar with the measures, and counseled their clients not to participate in the Program. Implementers found that the lack of awareness and training among the general population of refrigeration technicians reduced the number of measures installed. Educating this profession would likely increase market penetration of refrigeration controls.

There were few instances where recommended measures could not be installed for technical reasons. These were limited to instances where the type of existing control box could not accommodate the new refrigeration controls. Other measures were not installed because the owners changed their mind, either between the commitment and installation, or "on the spot" at the time the installers arrived to complete the work.

Customer training with refrigeration controls and measures was an issue. Instructing customers how to read and use the controls required more training than anticipated. The mechanical contractor provided training on-site at the time measures were installed. QuEST also followed up the installations with calls to customers to ensure the equipment was working.

Characterizing the market segment as "mom-and-pop" stores is a misconception. QuEST found that owners were sophisticated and showed continued interest in the Program. More than once the implementers treated stores where the owners were related. There were times where once one store was completed, the relative's stores followed in quick succession.

At the end of the Program, customers asked the implementers when the new Program would start. The overall short timeframe of the Program kept participation numbers down.

Participants

Participants were asked several questions about their experience with the Program's delivery and implementation. They were asked about measures recommended and not installed, as well as whether there were problems with the audits or installations.

Participants were asked if there were measures that were recommended and not installed. As shown in Table 2–16, seven participants (37%) reported they chose not to install recommended measures. In each case, the cost of the measures was the reason they were not installed. One of the participants stated he chose products with a one-year rate of return; some had a five-year simple payback which was too long. Even though financing was offered it did not address the concerns about cost, nor was it the solution.

Table 2–16. Measures Recommended and Not Installed

Measure Recommended	Number Who Did not Install Measure	Reason Not Installed
T-8 lighting	2	Not worth the expense; already scheduled for installation
Microprocessor controls for AC unit	1	Cost
Evaporative fan motors and controls	1	Couldn't prove to me that it would be worth the expense
Cooler Unit	1	Just fixed and didn't want to spend more money on it
Door anti-sweat heater	1	Just fixed and didn't want to pay again
Assorted	1	Chose only the lighting measures because of the cost involved with the other measures

Source: Surveys of participants (n=19), multiple answers allowed

The audit and installation processes were relatively smooth from the perspective of the participants. The majority of Program participants (89%) did not experience any problems with the contractors during the audit process. Comments from these people included:

> *"The audit [was] really good; audit and install [were] both done very quickly."*
>
> *"Everything went smoothly."*

"They were great; audit took just a few hours."

"They were cool people."

Two participants did note problems. One indicated that he had hoped to receive 8' lights, but that these were not available ,and now he has a mixture of old and new lighting. The contractor said he would get back to him and did not. The second felt it was a problem that the electrical contractor had to come back for more information.

Two other participants reported that there were problems with the measures themselves during installation. One noted that the *"contractor came with the wrong measurements twice, but correct equipment was installed in the end."* The second participant said that there was an *"electricity issue in the freezer, and fans vibrated; they fixed it right away."*

Participants were asked if issues came up during or since project completion that required the attention of staff. Most owners, 68%, did not experience any problems. Six owners noted assorted problems with the occupancy sensors, refrigeration controls, anti-sweat heaters, motors or fans, or evaporative coolers. Problems were addressed and repairs made as needed. Their comments are listed below.

Electrical problems with the occupancy sensors

"Some unit shut down so that the walk-in refrigerator was either too cold or too hot; three weeks later they installed a replacement to fix it."

"Motors and fans vibrated quite a bit and it had to be re-installed."

"Freezer goes into defrost mode, spikes at certain times, but they left an 800 number for follow-up."

"The evaporative cooler has had problems twice but the contractor came out and fixed them for free."

"The evaporative cooler has dust issues all over products now; this has never happened before."

"Door heaters sometimes fog over in the morning for 3-4 hours; this didn't happen before. Contractor has been called and he says it's working fine."

Participants were also asked if there were measures that were removed after installation. Three participants stated measures were removed, as detailed in Table 2–17. One removed almost 1/3 of the lighting because it was too bright (10 of 36 T8 lamps), one replaced a malfunctioning T8 lamp, and one had occupancy sensors stolen from the bathroom.

Table 2–17. Measures Removed After Installation

Measure Removed	Number Who Removed Measures	Reason Measure Removed
T-8 lighting	2	Lighting too bright; removed 10 of the 36 installed shortly after installation 1 light wasn't working properly and was replaced
Occupancy sensor	1	Stolen from bathroom shortly after installation

Source: Surveys of participants (n=19), multiple answers allowed

In summary, for the most part, the participants reported the audit went smoothly. Seven chose not to install measures because of the cost. Those who reported problems with installed measures, typically the mechanical measures, reported that the contractors repaired the problem. Few measures were removed after installation. One participant would have installed additional lighting had the measure been available. This owner would also have installed programmable AC thermostats. On the whole, for a Program of this size and complexity, the process went very smoothly.

Partial Participants—Audit Only

Participants who received an audit but did not install measures were asked if the audit was useful. Three (7%) said it was not useful, 32 (76%) said that the audit was useful and the remaining 17% said they were not sure if the audit was useful.

The partial participants who did not find the audit useful stated:

> *"I didn't see any saving on it."*
>
> *"It was a waste of time; we don't use a lot of energy."*
>
> *"We have the fluorescent lighting and for a company that does not do a lot of business, it just seems pointless."*

One of the respondents who was uncertain if the audit was useful commented:

> *"It was OK but we didn't like any of the recommendations. We didn't want to re-do the warehouse lights & ballasts—didn't like the look of one of the lights."*

Those who said the audit was useful all agreed that the audit provided them with information they did not have before. As one owner put it, *"If you save energy, you save money."* Some of the comments made by other respondents regarding why they found the audit useful included:

> *"I didn't know that you can save money on the energy bill."*
>
> *"[The audit was useful] because it helped me determine how I could save money on energy efficient equipment."*
>
> *"[It gave] good information regarding items using more energy."*

“It shows you what's going on in your store and how you can use only what you need and can save hundreds and thousand[s] of dollars.”

“They let us know how much energy each piece of equipment was using. Some companies say we will give you $300 worth of product if we store the Pepsi cooler in a separate fridge. They showed us the product they were giving us for free wasn't covering the energy cost.”

Overall, over three-quarters of the respondents found the audit useful and learned that there were things they could do to save energy. As noted in the previous section, the barriers to actually implementing measures were largely financial. Those who did not find the audit useful felt they did not use a lot of energy, and efficiency upgrades could not save much energy.

Market Barriers

The Program did not meet its participation or savings goals. Edison and QuEST noted it was harder to enroll customers than originally anticipated. Several barriers to participation and measure installation were identified. In summary, these were:

- Short time frame of the Program (number of months in the field)
- Timing of the Program (specific months in the field)
- First cost
- Education and knowledge about energy efficiency
- Competing efficiency programs
- Language barriers

One of the participation barriers was the overall timeframe of the Program. The implementers were in the field about four months overall. The implementers (including QueEST and their subcontractors) noted that it was a short program that “disappeared” and that customers need to see a standard program that is “always there.” This was the “Achilles heel” of the Program. Because of the short timeframe, implementers reported they experienced some customers who said it did not appear that Edison was serious. Implementers also noted that from their experience, one of the most common reasons customers did not participate was that they did not have time to obtain decisions or permission to participate at the corporate level.

The timing of the Program in terms of the specific months the Program was in the field was also an issue. For some small stores, owners are too busy to talk with anyone from October to January. These were primarily the months that QuEST was available to secure participation.

Implementers also found that auditors were not always able to obtain an agreement to participate at the time of the audit. In some instances too much time had passed between the audit and the pitch to close the sale. In other cases, when implementers went back to sign up the customer after the audit, they found that in the meantime, the customers had installed measures for free. This was because some geographic areas overlapped with other utility programs. In the future, new programs need the geographic area of the direct install program limited to areas where free measure programs are not located.

Some language barriers were encountered. The Latino and Hispanic populations spoke some English for the most part and did not present a problem. However, some of the Asian languages were problems. There were pockets of Korean, Vietnamese, and other Asian communities that were inaccessible because of the language barrier. Implementers were not able to talk with people in those communities. Education and marketing materials developed specifically for these communities could be helpful.

The primary barrier seemed to be customer decision-making related to measure cost and financial outlay. Perhaps additional market analysis and the ability to understand financial decision making would benefit future program designs so they have better acceptance.

Participant Market Barriers

Participants were asked if they had suggestions to improve the Program. In addition to offering more measures, comments largely concerned the need for better communication with implementers. There were six comments about reviewing the utility bill with customers so they could see the savings. Three suggested follow-up with store owners to see how they were doing and how the measures were performing. One also suggested follow-up to find out if owners wanted additional measures, and suggested follow-up with owners of multiple stores to see if they wanted measures at other stores. Three also suggested offering outdoor lighting, particularly lights suitable for outdoor overhead canopies found at gas stations. One suggested offering programmable AC temperature controls. There were also five comments complimenting the Program, stating that the installers did a good job, that it was well organized and well presented, and that the installation was great. Table 2–18 summarizes comments.

Table 2–18. Participants' Suggestions for Program Improvement

Comment	Frequency	Percentage of Respondents
Installment process was great, good presentation-explained well, everyone did a good job	5	26%
Review utility bill with customers to show them the savings	4	21%
Follow-up with stores to see how they are doing, revisit the stores, talk to customers. Follow-up to see if customers want more measures. More communication from contractor to avoid problems Follow-up with owners of multiple stores to see if they want measures in other stores	4	21%
Offer outdoor lighting like that found in gas station canopies.	3	16%
Many items remain too expensive; cost is an issue	3	16%
Offer programmable AC temperature controls and other technologies	2	11%
Offer more incentives	2	11%
Promote the Program, many owners don't know about it	2	11%

Source: Surveys of participants (n=19), multiple answers allowed

Some of the respondents' comments follow below.

> *"It was very easy to participate, explained well, and very organized."*
>
> *"Would like to see calculation of how much he saved with these applications from the utility."*
>
> *"Would like to add lights for the big canopy (above the automobiles)."*
>
> *"Couldn't tell me if the store would be darker or not, or if the total lumens would be less or more; the lighting has been good."*
>
> *"There was no follow-up, should go back to store and track what the impact has been, ask storeowners is this helping. Important to re-visit stores."*
>
> *"Keep in contact with the store afterward to verify that work was done and to ask them about their experience; follow-up with owners of multiple sites, maybe interested in other improvements; offer programmable AC temperature control."*

From the participants' perspective, the Program would benefit from offering additional measures and increased communication and follow-up with implementers.

Partial and Nonparticipant Market Barriers

The partial participants and nonparticipants were asked to talk about why they thought businesses like theirs do not install energy-efficient equipment. Financing and lack of information topped the list for both groups of nonparticipants. Because the managers were running a franchise or leasing the business, they felt cost-effectiveness was an issue or felt the corporate office would take care of it. Others noted the split incentive when operators lease an inefficient building. Several nonparticipants felt the store was too small to achieve savings. Nonparticipants also mentioned lack of trust in Edison or contractors. Table 2–19 summarizes the comments.

Table 2–19. Why Businesses Don't Install Efficiency Measures

	Partial Participants		Nonparticipants	
Comment	Frequency	Percentage	Frequency	Percentage
Cash flow, financing, limited funds	30	70%	18	40%
Lack of information	4	9%	9	20%
Cost-effectiveness; leasing or it is a franchise and not cost-effective	3	7%	3	7%
Disagree, thinks it makes sense in the long run	1	2%		
Do it with government money, save energy, save money, help the environment	1	2%		
Don't trust Edison and/or contractors; will spend the money and still be charged; they say one thing and don't deliver; have not received rebates promised			4	9%
Just built the station two years ago			1	2%
Don't know	4	9%	4	9%

Source: Surveys of partial participants (n=43), nonparticipants (n=45), multiple answers allowed.

Selected comments made by respondents are below.

> *"Because I don't think they trust what you say; you say one thing but don't deliver."*

> *"Because [of] the cost, and these benefits don't pay for it. It costs money to change it, and we don't have the money to change it."*

> *"I would like someone to come down and explain this to me. That is what I want.*

> *"Lack of education and lack of people willing to help us. Help us with the funding and help us with setting it up."*

> *"Not knowing the benefits and costs and not knowing the technology exists."*

> *"They are small stores and don't want to spend money on that. Business is slow."*

> *"They told me that when I installed the lighting that they would reimburse me for the money spent, and I still have not heard anything."*

> *"It's tough enough to be in business without installing new equipment."*

> *"I think that we would, but again we're now at the point where we want to decide if we want to stay open."*

> *"They buy the facilities because the building is old and if the building was new, we would already have the energy-efficiency equipment already installed. Since we lease the building, it wouldn't be cost-effective."*

The partial and nonparticipant groups were both asked if they had any suggestions for changes to the Program that would influence their decision to participate in future programs. Answers were categorized by topic. Their responses are provided in Table 2–20.

For both groups, cost again was the primary area of concern (the response for 35% of the partial participants and 27% of the nonparticipants). The second most common topic concerned requests for more information about energy savings. Respondents also commented that the timing had to be right in order for them to participate: *"It is something that just has to happen at the right time."* Others commented that they had no suggestions because the decision-making was not theirs or they did not know if they were going to stay in business.

Table 2–20. Suggestions for Program Changes

	Partial Participants		Nonparticipants	
Comment	Frequency	Percentage	Frequency	Percentage
Cost	15	35%	12	27%
More information about energy savings	7	16%	10	22%
Time/convenience	5	12%	2	4%
Education/marketing	3	7%	4	9%
May not stay in business; in process of selling store	3	7%		
Not their decision	2	5%		
Offer other technologies			1	2%
No suggestions	9	21%	13	29%

Source: Surveys of partial participants (n=43), nonparticipants (n=45), multiple answers allowed

Overall, cost and financing are the largest barriers to the installation of energy-efficiency measures in this market. Lack of information about energy efficiency and how to save energy is also a barrier. Communicating these ideas in an understandable fashion is important in this hard-to-reach market segment. A number of comments were made about the businesses being small, with no room for investment in equipment. For a few respondents, lack of trust in the utility or with efficiency contractors is an issue. These people do not feel they received the rebates promised to them. Timing is also an important issue; the small businesses are very busy. This Program seems to have the components needed to address the market barriers but communication and presentation of the information may need improvement to increase participation.

Participants' Experience with the Program and the Technology

It is important to note whether participants make changes in the manner in which they operate equipment or lighting since participating in the Program. Behavioral changes can potentially have an impact on energy use that could either negate or enhance savings attributed to the measure itself. Only two participants reported that they changed operation of their coolers or refrigeration. Both turned off the system periodically. These are shown in Table 2–21.

Table 2–21. Made Changes in Equipment Operations

	Frequency	Changed Operations
Evaporative fan motors	1	Let the cooler stop at times because it runs so efficiently
Other	1	Turns off refrigeration while restocking—made change as soon as learned it was an option.

Source: Surveys of participants (n=19)

Four participants reported that they had noticed changes in their equipment operation or performance, as shown in Table 2–22. Comments about lighting were that the store was brighter, and overall, *"things run better."*

Table 2–22. Noticed Changes in Operations

	Frequency	Noticed Changes in Operations
T8 lighting	2	Store is little bit brighter with T8s; Store is much brighter; Seems to have less wear and tear
Evaporative fan motors	1	Controller takes charge of the temperature and works within a better range
All measures installed	1	Things run better

Source: Surveys of participants (n=19)

Regarding their experience with the Program, participants were also asked how much energy they thought they were saving as a result of the equipment installed in the Program. As shown in Table 2–23, ten, or 55% of respondents, said they saw no change or did not know if there was a change in their energy use. Two, 11%, thought their use had increased. Six, 33%, thought their use had decreased between 5% and 40%.

Table 2–23. Perceived Energy Savings

Perceived Energy Savings	Frequency
Did not know	5
Saw no change	5
Increased energy use	2
Decreased energy use 5%	2
Decreased energy use 10%	1
Decreased energy use 20%-30%	1
Decreased energy use 35%-40%	2

Source: Surveys of participants (n=18)

Those who didn't know if there was a change and who perceived no change or an increase were interested in follow-up by implementers or the utility, to review their bills, and to be shown how the measures were saving energy.

Satisfaction

Satisfaction with the efficiency measures and the Program overall are indicators of success from the participants' perspective. Survey questions related to satisfaction with the efficiency measures and the Program overall were asked of participants. As seen in Table 2–24, the majority (14 of the 16 participants) who responded to the question about their satisfaction with the performance of the efficiency measures stated that they were "very satisfied" or "somewhat satisfied."

Table 2–24. Participant Satisfaction with Performance of Energy Efficiency Measures

Satisfaction	Frequency	Percentage
Very satisfied	10	63%
Somewhat satisfied	4	25%
Neutral	1	6%
Somewhat unsatisfied	1	6%
Very unsatisfied	0	0%

Source: Surveys of participants (n=16)

Eighteen of the 19 participants responded to the question about their overall satisfaction with the Program, as shown in Table 2–25. Nearly all (94%) were "very satisfied" or "somewhat satisfied" with the Program.

Table 2–25. Participant Satisfaction with Program Overall

Satisfaction	Frequency	Percentage
Very satisfied	9	50%
Somewhat satisfied	8	44%
Neutral	0	0%
Somewhat unsatisfied	1	6%
Very unsatisfied	0	0%

Source: Surveys of participants (n=18)

Free Riders

To assess the degree of free ridership in this Program, participants were asked a number of questions about whether they had installed measures or considered installation of measures with and without an incentive. Participants were asked about the same measures they installed through the Program, so participants were not asked about each possible Program measure.

First, participants were asked if measures installed within the Program were going to be replaced or upgraded anyway. Participants were then asked if these measures would have been of the same efficiency as those installed through the Program, had they not known about the Program. Only three participants were going to replace lighting, but none expected the lighting to be of the same level of energy efficiency as that installed through the Program (Table 2–26).

Table 2–26. Plans to Replace Program Measures Before Participating

		Likelihood that Equipment Would be of Same Efficiency as That Installed through the Program				
Measure	Number of Participants	Not at all Likely	Somewhat Unlikely	Neutral	Somewhat Likely	Very Likely
T8 Lights	2	1	1			
CFL	1	1				

Source: Surveys of participants (n=19)

Five of the Program measures had not been previously installed by any participant. As seen in Table 2–27, these included LED exit signs, evaporative fan motors, microprocessor controls for air conditioners, AC economizer repair system, and anti-sweat door heater controls. Only two participants had previously installed three measures. The measures included T8 lighting, CFL lights, and occupancy sensors.

Participants were also asked if they had considered installing measures without the Program and without incentives. Nine measures were considered by three participants. Participants were then asked about their timeframe for installing the measures considered. Three measures were considered for installation in the next one to two years, and five would never have been installed. The reason that these measures were not installed was the high cost of the measures. These responses are summarized in Table 2–27.

Table 2–27. Participant Measure Installations

	Installed Prior to Program without Incentive	Considered Installation without Incentive	Timeframe for Installation That Was Considered without Incentives						Reason Not Installed
			Same Year	1-2 Years	3-5 Years	More than 5 Years	Never	No Answer	High Cost
T8 Lights	1	3		1			1	1	2
CFL	1	1					1		1
LED exit signs	0	1					1		1
Occupancy sensors	1	2		1			1		2
Evaporative fan motors	0	1		1					1
Microprocessor controls for HVAC	0								
AC economizer repair system	0								
Anti-sweat heater controls	0	1					1		1
Total	3	9	0	3	0	0	5	1	8

Source: Surveys of participants (n=19)

Overall, very few participants either installed measures before the Program or considered installing them without the Program. None would have installed measures within the same year of the Program, and cost was the reason measures were not installed. There were no free riders among participants, and the NTG ratio was set to 1.

Potential Spillover

Questions pertaining to "spillover" assess whether the Program had an impact on other actions to save energy. Participants were asked if they operated other stores and if they had installed or considered the installation of energy-efficient measures at those locations. Table 2–28 shows that 11 of the 19 respondents (58%) indicated that they own or operate at least one other location. Twelve of 17 owners further reported that they would install energy-efficiency measures at those stores, either with an incentive, or at their own expense. Three indicated that they would install the efficiency measures at their own expense, and five would install them only with incentives. Two were uncertain.

Table 2–28. Likelihood of Installing Measures at Other Locations

	Frequency	Percentage
Not at own expense or with incentives	3	18%
Yes, at own expense or with incentives	4	24%
Yes, at own expense	3	18%
Yes, with incentives	5	29%
Uncertain	2	12%

Source: Surveys of participants (n=17)

Finally, the group was also asked if they had already installed efficiency measures at other locations after participation in the Program. Only one participant had installed other measures; this was solar electric equipment but he had disconnected it as *"Edison does not recognize net metering."* This owner said the Program was very influential in his decision to install other efficiency measures.

Within the participating stores, one of the owners stated that he was installing programmable AC thermostats, which were not a Program measure. He would have installed them through the Program had the measure been available. Previously, employees could manually adjust the temperature and he found it was consistently too cold. The AC unit was recently replaced with a new unit with password-protected temperature adjustment. The owner noted his electrician told him this would be more energy efficient.

Overall, there is very little spillover from this Program to the installation of additional efficiency measures.

Lessons Learned by Program Staff, Future Plans

QuEST noted that, administratively, that the process went well, and that there were no changes to the administrative process. They expressed that the paperwork was excessive, but that the implementation and performance of the flat file "went swimmingly." ECC developed a tracking system with provided the structure to automatically extract the data and deliver the flat files that Edison required.

There were three inspections, including those by the installer, QuEST, and Edison's quality assurance inspections. In addition, some sites received additional inspections as part of the impact evaluation. Edison committed to inspect the property within two weeks of notification. QuEST noted the average turn around time was 19 days. QuEST felt that the inspection process was cumbersome, and that perhaps the Program was "over inspected." One subcontractor felt the M&V was too complicated and should be removed.

Lighting was a non-starter for many stores. Implementers reported that many had already done lighting or they were tired of hearing about lighting. Some store owners felt "swindled or cheated or abused" by the prior lighting contractors. Conversely, there were stores that only installed the lighting measures because the mechanical measures were too costly.

QuEST and NRM, Program's refrigeration subcontractor, noted that there is genuine potential for savings with refrigeration controls. However, there needs to be some training and more information disseminated among refrigeration professionals and store operators. The store owners don't understand how the controls work and think that adding efficiency improvements to the controls will damage the compressor and "there would be hell to pay." NRM went the extra mile and explained how the controls equipment worked to owners and third parties.

Many stores have existing agreements with service companies. That industry is largely "in the dark" about advances that have been made in the industry. Educating those market actors about energy efficiency and available technologies would benefit refrigeration customers. Utility sponsored training sessions or seminars for this group could provide effective education. The ICGS may also be an appropriate forum for training and bringing together store owners. Hiring refrigeration service companies and training installers could provide some "on the job training" opportunities and reduce resistance to measure installations.

One of the problems with market transformation and persistence is that programs such as this, and sometimes standard offer programs, are not available on an ongoing basis. This affects the entire rate class and the ability to transform the market. QuEST feels the savings are genuinely available in this market.

After experience with the Program, implementers felt that the ideal customer was one with multiple locations, where the decision to participate is made at the corporate level and a directive to participate is issued to all stores. In addition, QuEST found the characteristics of convenience stores that make them good candidates for direct install programs of this nature include stores with walk-in coolers or freezers. Three-door freezers and up to twelve walk-in coolers work well. A minimum of three and up to nine cooler fans or evaporative fan motors are characteristics of a good candidate. Door heaters that are not broken can be addressed, and refrigeration equipment that needs controls can be addressed through this Program as well. QuEST also reported that convenience stores with gas stations that have exterior lighting and canopy lighting are good candidates, although for this particular program, replacing the HID canopy lights with pulse start, T-5 or CFL was not an offered measure.

QuEST and ECC planned to use the EnerPath™ software tools for the auditing and reporting activities. The audit tool facilitated the Program's extensive lighting and mechanical audits. With extensive collaboration between the implementers and subcontractors, the EnerPath™ tools were modified and customized to collect refrigeration data needed for the refrigeration subcontractors. The refrigeration subcontractor trained the lighting auditors to conduct the refrigeration audits. Sometimes the auditor would encounter unfamiliar equipment. They could take pictures with their cell phones and publish them to the website for the refrigeration contractors to view.

Even though the Program was limited to three counties, the Program was still a challenge to installers geographically. Scheduling installations could be difficult for both the stores and the contractors.

The refrigeration and mechanical contractors had a fixed-price contract. Subcontractors reported they could drive three hours for a five to eight hour job; on a fixed-price contract the geographic spread can be tricky. In addition, contractors would not know until arriving on-site whether the existing wiring was up to code or whether the installation would require something other than a standard retrofit. Contractors note they need to be able to respond to customers and deal with issues if there are problems to resolve, or heating/cooling issues.

Subcontractors noted a level of confusion among participants, where participants don't know if they are "getting taken" financially. When it is a small community and store owners know each other, it is confusing when stores receive different rebates. It doesn't look fair when one store receives a 60% rebate, for example, and another an 82% rebate, and another rebate approaches 100% of the installation costs. In addition, it can look "sleazy" when an audit is completed, the auditor goes back to their office to "crunch the numbers" and comes back to present the offer. This subcontractor feels it would look more equitable to offer incentives and rebates based on energy savings, or at least, to have set measure prices and rebates.

Based on past experience, the refrigeration contractor notes that owners are worried they will have no back up if new controls fail. The contractor leaves the existing controls in place and switches them off. This reduces the owner's fear; the installer noted owners rarely revert to the old controls. Store owners need to be educated about how their refrigeration systems work and how to care for their systems. Most are "too busy to worry about energy."

The Edison contact noted that while the proposal looked good on paper and the contractors were all accomplished and polished experts, the Program still did not meet its goals. One of the problems seems to be that the Program was delivered as a one-year program when it really needed two years. Implementers underestimated the difficulty of recruiting customers. They did however complete press releases, contact key industry associations, and market the Program as planned.

Many customers owned more than one shop and knew about direct-install lighting programs where customers did not have to pay anything. Store owners spread the word and expected free lighting. Either the programs need to be designed so territories don't overlap, or higher incentives need to be provided for programs where the measures are not free.

Compounding the issues with the decision-making process and the variety of Program rebates were changes in Edison's rate structure. Rates were increased during the same summer the Program was introduced. The rate increase was selective, and high users who exceeded a baseline could have received a bill double or triple in size. Tiered rates were based on usage over a baseline; the higher the usage, the higher the rate. Many customers felt the rate increase was "inequitable" since it was not shared equally. Edison surmises that rates could have played some part in the Program deployment if the business had an adversarial position against the utility.

The Edison Program Manager suggested future programs use quarterly goals so that results forecasts can be reviewed. If the program is not performing and cannot meet its second quarter goals, it should be cancelled and funds diverted to another program.

There were some performance issues with CFLs installed in walk-in refrigerators and freezers where it was too cold for the lamps to fire. These lights were changed out to the correct temperature range. No complaints were received about any refrigeration controls.

The innovative aspect of the Program was not the lighting measures but the narrow focus of the efforts on the convenience store market segment. It appeared that there was a very large base of potential participants. In the end, it seems customers were looking for a better deal, that is, free measures. Customers were not happy when they had to pay more than their neighbors the next block over. Different programs offered different rebate schedules, depending on the products installed. In the Express Efficiency Program customers could pay over 50%. In another direct install program, 100% of the cost was covered. Rebates in this Program varied since they were not prescriptive rebates, but incentives based on bringing the total cost of the measure bundle to a one year simple payback.

Fewer participants were enrolled than anticipated, but "not for lack of trying," as Edison noted. Enrollments were targeted based on the value of savings proposed. The target market included small shops with limited resources. Many customers went in for lighting measures but not the whole package of mechanical measures even though they could have benefited from refrigeration measures.

Determining the amount of money each participant would need to pay for measures was not a clear-cut process. Participants received a free audit, which would cost $100-$200 in a retail environment, and was part of the Program cost. Other aspects that determined the customer's capital expense were the number and type of measures committed, and the incentives available for those measures.

Edison noted that implementers had difficulty inputting data and reporting in the infancy of the Program; however, these questions were typical of virtually all the IDEEA Program implementers. Implementer's invoices and paperwork included the product descriptions and locations so that Edison could conduct inspections and verify installations.

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3. Impact Evaluation

Impact Evaluation Methodology

The impact evaluation included verification of equipment installation, engineering analysis and a billing analysis. The evaluation team selected 10 participating stores for a site visit. Stores were selected where measures installed through the Program had been in operation for at least one year prior to the inspection. The selection methodology provided a 90% confidence level and 20% error, based on the proportionate sampling approach.[158]

The objectives of the impact evaluation of the IDEEA Convenience Store Energy Efficiency Delivery Program (CSEED), implemented by QuEST, Inc., were to develop ex-post adjusted gross and net savings for the Program. The methodology and activities undertaken to achieve this objective are discussed below.

The general methodologies employed to measure and verify energy savings attributed to the Program included the following activities:

2. Complete measure installation verifications
    a. Develop a sample for field verification activities
    b. Conduct field verification activities and observations which includes the utilization of Natural Resource Management’s (NRM) proprietary data logging software which tracked the energy savings potential of refrigeration control retrofits installed at participating sites
    c. Review verification activity data completed by Edison
    d. Develop adjusted measure installation rates based on field activities and data reviews

4. Complete an engineering analysis to develop ex-post realization rates
    a. Complete a review and evaluated Program data
    b. Analyze data provided through field activities and in-depth participant interviews
    c. Complete analysis of data provided through logging activities
    d. Conduct analysis of participant energy bills
    e. Determine operating schedules of participant sites
    f. Develop project and Program realization rates

5. Develop adjusted gross and net Program ex-post savings

6. Provide conclusions and recommendations for the Program and the overarching Southern California Edison Innovative Design for Energy Efficiency Activities (IDEEA) Program

[158] Floyd Keneipp, Summit Blue, field plan memorandum to Edison. September 25, 2006

Each of these activities is discussed in detail in the following sections. Additional detailed information may be found in Volume 2, Appendices.

Measure Installation Verification

The objectives of the onsite verification activities were to conduct representative site visits and collect key energy Program performance metrics including:

6. Establishing the presence of energy-efficient measures by comparing the number of installations observed for a sample of sites with the number of installations recorded by the Program implementation contractor.
7. Providing input on the quality of installations observed—including whether or not they were operating correctly.
8. Where observed equipment did not match Program reported installations, determining if retrofits/installations were ever present, and/or the removal date and reason.
9. Recording key facility performance data, such as daily schedules, seasonal variations in schedules, and control strategies (Program-specific).
10. Downloading information from NRM's CoolTrol data logging system to verify refrigeration retrofit energy saving potential. As one of the primary refrigeration measures implemented through the Program, the CoolTrol system recorded temperature and usage patterns over an extended period of time to track savings.

The detailed measure installation verification instrument is provided in Volume 2, Appendices, as are product specification sheets for both lighting and mechanical measures.

Installation Verification Sample

The Program focused on implementing the following technologies at participant convenience stores located throughout Edison's service territory:

1. Lighting Measures
    - Retrofit T-12 lamps and magnetic ballast to T-8 and electronic ballast.
    - Retrofit T-12 lamps and magnetic ballast with T-8 and electronic ballasts on display cases doors.
    - Retrofit incandescent lamps with compact fluorescent lamps.
    - Retrofit non-LED (light-emitting diode) exit signs with LED exit signs.
    - Install occupancy sensor in public restrooms to control lighting and exhaust fan.
2. Refrigeration Measures[159]
    - Add evaporator fan controls to reduce speed during compressor off periods

[159] The evaporator fan controls was the only measure distinctly associated with the CoolTrol system. However, the system could track the operating hours of other stand alone measures as well (ASH door controls). Reference: CoolTrol Cut Sheets.

- Replace inefficient evaporator fan motors
- De-power coolers during off-hours with time controls
- Add anti-sweat heater controls[160]

Table 3–1 details the distribution of energy-efficient installations and savings that occurred under the CSEED Program according to the final Program flat file. Lighting retrofits accounted for 59% of Program recorded kW savings and 41% of Program recorded kWh savings. Subsequently, the refrigeration measures installed through the Program accounted for the remaining savings. The lighting retrofits involved comprehensive retrofits of both office type and store floor spaces with a combination of exit signs and interior and exterior compact fluorescent fixtures and T-8 linear fluorescent fixtures.

Table 3–1. Distribution of Program Savings by Project Type

Retrofit Measure[161]	Measure Reference Number	Sites Installed	Recorded kW Savings	Recorded kWh Savings	Percentage of Recorded kW Savings	Percentage of Recorded kWh Savings
Lighting Measures						
Retrofit to 1 Lamp EXIT Light Emitting Diode Fixtures	L-5	7	0.6	5,184	1%	1%
Retrofit to Compact Fluorescent Fixtures	L-4	19	3.4	29,442	6%	4%
Retrofit to T8 Fluorescent Fixtures	L-1, L-3	24	31.0	293,700	52%	36%
Depower Restroom Light Motion Sensor	L-2	16	0	16,927	0%	2%
Net Lighting Measure Reported Impacts			34.9	345,253	59%	41%
Refrigeration Measures						
Depower Coolers with Time Controls	M-4	3	0	11,765	0%	1%
Install Controls on Evaporator Fan Motors	M-3	21	0	180,079	0%	22%
Install ASH Door Controls	M-5	20	7.9	173,672	13%	21%
Replace Inefficient Evaporator Fan Motors	M3	19	17	101,824	28%	13%
Net Refrigeration Measure Reported Impacts			25	467,340	41%	59%
Total Recorded Program Savings			59.9	812,593	100%	100%

Because both the lighting and refrigeration retrofits represented a substantial proportion of energy savings, the evaluation team spread their verification efforts equally among the measures.

[160] The evaporator fan control was the only measure distinctly associated with the CoolTrol system. However, the system could track the operating hours of other stand alone measures as well (ASH door controls). Reference: CoolTrol Cut Sheets.

[161] Product specification sheets for both lighting and mechanical measures are included in Volume 2, Appendices.

Site Verification Activities

Field activities typically involved three components:

4. The evaluation team coordinated with the implementation contractor and primary customer contact to establish field activity dates and identify site-level contacts.
5. While onsite, the evaluation team conducted an area-by-area, measure-by-measure audit, noting retrofit count, type, operating conditions, etc., using the field instrument detailed in Volume 2, Appendices. Interviews were also conducted at the site representative's convenience.
6. Data from existing metering activities conducted by the implementation contractor were analyzed, and, as far as statistically possible, extrapolated to benchmark savings for the overall Program as well as verify customer responses to interview questions.

A total of 32 sites participated in measure installations for this Program, and ten participating sites were selected for verification activities. The evaluation emphasized verifying measures that contributed significantly to overall savings attributed to the Program. This sample design provided a 90% confidence and 20% error based on the proportionate sample approach where the sample size exceeded 10% of the population and standard error (z) equaled 1.645. The equation used is as follows:

$$\text{Sample Size} = N * [P * (1-P) * Z^2] / [N * E^2 + P * (1-P) * Z^2] \quad (1)$$

where

N = Population size

E = Error

Z = Standard error

P = Proportion of the population[162]

Field evaluation activities were conducted between in early October, 2006. The information collected was reflective of Edison's peak summer period definition of 6/2/2006 – 10/6/2006 because the inherent data logging capability of the CoolTrol system provided data on weather-sensitive refrigeration systems during the peak timeframe.[163] Volume 2, Appendices, provides more detailed sample information relating to site verification activities.

Due to the unique nature of the Program installations and the timeframe in which the evaluation was conducted, the evaluation methodology employed did not directly correspond to any of the IPMVP options. Instead, the evaluation team's efforts relied heavily on billing analysis, comprehensive engineering calculations, existing data logging analysis, and interviews with

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[162] Assumed 50%

[163] The CoolTrol system logged all hours of operation, including peak, off peak, and shoulder.

relevant participants and Program staff. This approach correlated most closely with a modified Option A: Partially Measured Retrofit Isolation, in that it utilized partial short term field measurements of energy use to verify or adjust ex-ante energy and demand savings estimates for measures installed. Some performance parameters were based on secondary data, and engineering adjustments were made to specific measure savings as needed.

The evaluation team completed all of the key activities outlined in the final research plan filed with the CPUC.[164] Table 3–2 provides the evaluation activities and objectives included in the final research plan objectives, and the tasks completed by the evaluation team.

Table 3–2. Evaluation Activities and Objectives

Evaluation Activities	Original Research Plan Objectives	Tasks Completed by the Evaluation Team
Program records review	Yes	Yes
Engineering calculations	Yes	Yes
Secondary literature	Yes	Yes
Billing data/metered data analysis	Yes	Yes
Site visits	Decision-makers at census of installed projects.	10
End use metering	As required	Supplemented with CoolTrol data logging capabilities at 9 sites.[165]

It should be noted that detailed data logger information for the refrigeration retrofits could only be collected from nine out of the ten sites visited because one participant did not allow the verification team to access the data logged on their CoolTrol system.

Installation Verification Results

As stated previously, the primary objective of the verification was to establish the presence of Program measures and installations recorded in the final installation reviews provided by the Program implementation contractor. To accomplish this objective, a detailed inspection was conducted at 10 of 32 participant sites. Through this activity and discussions with participants subsequent to field activities, and an engineering analysis of the verified installations, it was concluded that the installations recorded by the Program by were generally correct with several slight exceptions.

1. The “retrofit to 3-lamp T8 fluorescent fixtures using 83 watts each” measures were unable to be accounted for during the verification process at the only site reporting this measure. Further discussions with the site manager indicated that the site originally had plans to install the measure, but later decided against it for aesthetic reasons. Instead, 4-lamp T8 fluorescent fixtures were installed to ensure uniform lighting. No adjustments were made; this was a minor issue and occurred at only one site.

[164] IDEEA Work Plan final revision 1.doc

[165] On-site system readouts and verifications were also recorded.

2. Several of the “retrofit to 2-lamp T8 fluorescent fixtures using 48 watts each” measures were also not verified at a single site, as a different measure had been installed. Again, no adjustments were made; this was a minor issue and occurred at only one site.

Because the evaluation sample comprised over 30% of sites installed, and the discrepancies noted were minor and limited only to a single site, the evaluation team concluded that the Program records accurately reflect the original installations completed by the Program, and no adjustments to the original reported Program installation rates are recommended. Volume 2, Appendices, provides an overview of the installation verification results at the sites visited. The issue of persistence is addressed in the subsequent section.

A second objective of the verification activities was to review the quality of installations completed through the Program. Overall, field observations verified that both the lighting and refrigeration retrofits appeared to be well installed and operating correctly.

In general, lamp failure was calculated to be approximately 2% which was concluded to be acceptable for the lighting technologies installed. However, CFL retrofits involving 20-watt lamps appeared to have a higher failure rate than other technologies. There were approximately 7 failures out of 29 verified lamp installations, or about 24% of lamps being removed and replaced by incandescent lamps. This occurred in approximately three sites out of ten verified. As such, the savings attributed to this measure have been discounted accordingly in the engineering analysis. All of the refrigeration measures involving CoolTrol systems were operating at the time of the verification visits.

The evaluation team received detailed records on one site verified by Edison. As shown in Table 3–3, all measures that Edison verified agreed with Program records. Edison did not provide an indication of whether the measure to de-power coolers during off-hours was verified. This site was included in the evaluation team field verification sample.

Table 3–3. Program Records and Edison Verification Data

Program Measure Description	Recorded ‘As Built’ Quantities	Edison Verified Installations
Retrofit to 2-lamp T8 fluorescent fixtures using 100 watts each	27	27[166]
Install med. temp. ASH door controls	1	1
Install controls on evaporator fan motors	1	1
Replace inefficient evaporator fan motors	8	8
Retrofit to 2-lamp T8 fluorescent fixtures using 55 watts each	5	5
De-power coolers during off-hours with time controls	3	Not verified
Retrofit to 2-lamp T8 fluorescent fixtures using 81 watts each	1	1

[166] 54 lamps and 27 ballasts verified

Engineering Analysis

An engineering analysis was conducted to develop adjusted realization rates for the Program. This included a detailed review of Program records, documents, and data logging activities as described in the following sections.

Review and Evaluation of Program Data

The final Program records submitted by the Implementation Contractor to Edison were analyzed for accuracy and consistency, and to ensure that the underlying assumptions were reasonable. The key documents analyzed included:

- The final Program 'flat file' submitted September, 2006.[167] These files documented installation activities at each participant site, including the type and number of measures installed, and underlying energy savings assumptions, and the dates of the various installations. These files provided ex-ante Program gross energy savings values.
- The final Program 'workbook' dated June 6, 2006.[168] This document provided a reporting format for the CPUC and represented a summary of the information contained in the Program installation reviews. It did not, however, contain site-specific data. This file provided ex-ante Program net energy savings values.
- In addition to Program documentation, the evaluation team met with National Resource Management (NRM), Inc., the developer of the CoolTrol system, to review the system operation and savings calculation algorithms. NRM provided several webcasts to demonstrate the system operation and capabilities.
- The implementation contractor's savings calculations worksheet for all CoolTrol and refrigeration related measures.[169]

Several observations resulted from this review;

1. The CSEED Program was well documented. The CoolTrol system documentation and calculation methodology was consistent and detailed. Data from the CoolTrol system was easy to download and evaluate.
2. There was an unresolved discrepancy of 179,290 kWh and 13 kW between the final workbook and final flat file reported gross savings. Because the flat file provided more detailed documentation of Program installations verified by the evaluation team, the savings presented in this file were used as a benchmark for engineering adjustments.
3. Convenience store operating hours estimated by the Program correlated closely with the information collected during interviews with store operators.
4. Measure installation details on lighting installations were verified to be accurate through the review of nameplate data recorded while in the field and through the comparison of this data with Program records.

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[167] 0016-Convenienc-cseed_epflatfile_v4.xls

[168] 0016-Convenienc-sce_cseed_june06_workbookv02.11_final.xls

[169] NRM Incentive worksheet – Cstore.xls.

5. Initial equipment and operating conditions were assumed to be accurate through conversations with participant staff.

Lighting Retrofit Analysis

As previously noted, lighting retrofit installations correlated directly with Program records. Furthermore, verification efforts confirmed the accuracy of participant operating hour assumptions, as well as of the quality of installations observed. Furthermore, the appropriate savings algorithm documents[170] (provided by QuEST) were reviewed and deemed representative of Program parameters.

However, as noted previously. CFL retrofits involving 20-watt lamps appeared to have a higher failure rate than other technologies. There were approximately 7 failures out of 29 verified lamp installations, or about 24% of lamps being removed and replaced by incandescent lamps. This occurred in approximately three sites out of ten verified. Consequently, the flat file attributes 20,680 kW savings to this measure and the evaluation team has reduced savings by 4,963 kWh (24%).

Refrigeration Retrofit Analysis

Refrigeration System Operating Hour Analysis

In order to analyze the energy saving potential of the refrigeration retrofits installed through the Program, the evaluation team made extensive use of the data logging capability inherent in the CoolTrol system at the participant sites evaluated. Data from these system logs were analyzed, and extrapolated to benchmark savings for the overall Program. This system collected the following data used in evaluation efforts:

- The data logger was capable of storing a ten-year run time log of each output by month and year in minutes (solenoid,[171] evaporator fans, cooler door heaters, and freezer door heaters). Evaluators capitalized on this capability and used the data collected by the data logger.
- A fifteen-minute run time and temperature log of each input and output. Depending on the number of coolers being controlled, the log could have 60 to 120 days worth of data.

This data was used to assess the energy savings attributed to the CoolTrol system through an analysis of the system operating hours as recorded by the CoolTrol data-logging capabilities. Table 3–4 provides a description of the refrigeration measures that were analyzed through the CoolTrol data-logging capabilities. Detailed output from the CoolTrol log records can be found in Volume 2, Appendices.

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[170] 0016-Convenienc-cseed_epflatfile_v4.xls

[171] The solenoid data tracked when the CoolTrol system was calling for refrigerant, and the duration of the request.

Table 3–4. Program Refrigeration Retrofit Measures

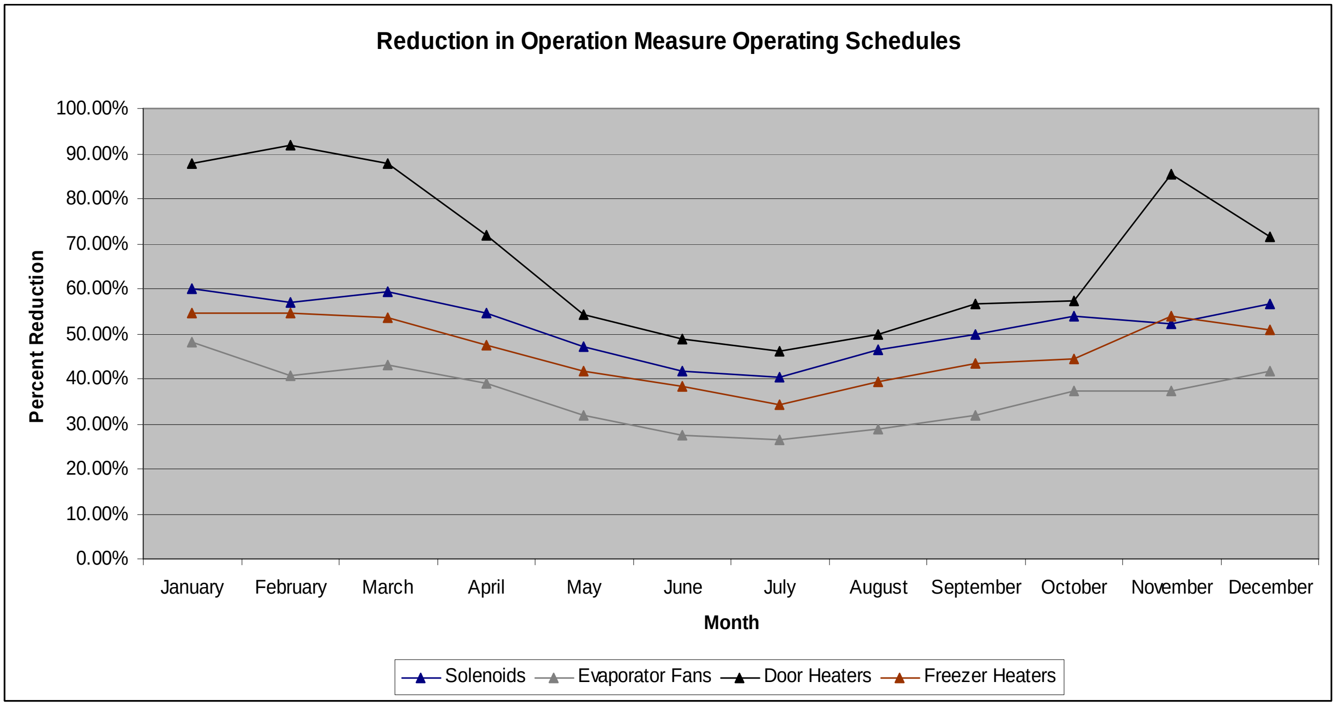
On/Off controls on evaporator fan motors
Anti-sweat door heater controls on freezer cabinets
Anti-sweat door heater controls on cooler cabinets
Replace shaded pole and PSC evaporator fan motors with brushless DC motors

Several key assumptions made in Program planning are that prior to the CoolTrol retrofit the evaporator fans as well as the freezer and cooler door heaters operated at all times, 8,760 hours per year. Program savings are dependent, in large measure, on the ability of the CoolTrol to reduce these operating hours. The evaluation team retrieved data from nine CoolTrol systems at nine separate stores and analyzed this data to calculate actual reductions in annual operating hours. Table 3–5 details the weighted average reduction in operating hours for the refrigeration measures at these sites. Figure 3–1 provides a graphical depiction of each measure's annual impact on annual operating hours for the various CoolTrol system components.

Table 3–5. Measure Reduction of Operating Hours

Month	On/Off controls on Evaporator Fan Motors	Anti-sweat Door Heater Controls on Cooler Cabinets	Anti-sweat Door Heater Controls on Freezer Cabinets
January	48.0%	87.9%	54.7%
February	40.7%	91.7%	54.6%
March	43.1%	87.7%	53.6%
April	38.9%	71.9%	47.5%
May	31.8%	54.1%	41.7%
June	27.5%	48.8%	38.4%
July	26.4%	46.0%	34.4%
August	29.0%	49.7%	39.5%
September	31.9%	56.7%	43.3%
October	37.3%	57.3%	44.4%
November	37.1%	85.4%	53.9%
December	41.8%	71.6%	50.8%
Calculated Average	33.3%	61.7%	44.6%

Figure 3–1. Annual Impact of Refrigeration Retrofits[172]



The average reduction in operating cycles was significant, but required the adjustment of initial Program saving assumptions. The calculations used to derive savings attributable to specific refrigeration measures installed through the Program were provided through NRM algorithm documentation.[173] Table 3–6 provides the Program-assumed reduction in operating hours for each of these three measures, and the ex-post reduction based on the data provided from the sample of CoolTrol systems evaluated.

Table 3–6. Program Assumed and Verified Reduction in Operating Hours

Retrofit Component	Program Assumed Reduction in Annual Operating Hours	Verified Reduction in Annual Operating Hours	% Change
On/Off controls on evaporator fan motors	3,658	2,921	-20%
Anti-sweat door heater controls on cooler cabinets	6,880	5,403	-21%
Anti-sweat door heater controls on freezer cabinets	3,590	3,902	9%

[a]Typical cooler with ten doors
[b]Typical freezer with four doors

[172] The solenoid data tracked when the CoolTrol system was calling for refrigerant, and the duration of the request.

[173] NRM Incentive Worksheet Cstore.xls

As discussed previously, the Program also replaced evaporator fan motors with high-efficiency motors. Savings associated with the high-efficiency motor retrofits are dependant on the reduction in motor operating hours attributable to the CoolTrol system. The Program originally assumed that fans would operate 5,102 hours per year after the CoolTrol system was installed. However, it was concluded that the efficient motors would operate 14% longer than originally planned because of the reduced impact in annual operating hours attributable to the CoolTrol system. As such, it is recommended that savings associated with the high-efficiency motors be applied over 5,839 hours annually, instead of the 5,102 hours assumed in Program planning.

The evaluation team considered that the algorithms used by the Program to calculate savings were reasonable, and that savings values could be accurately adjusted by revising the operating hours associated with each measure to reflect the reduction in annual operating hours recommended. The savings algorithm for each refrigeration measure, along with the impact of reduced operating hours, is provided below:

On/Off Controls on Evaporator Fan Motors (kWh):

$$[(FL_{pre} \times Hours_{pre}) + Motor_{pre}] \times [Hours_{red} \div Hours_{pre}]$$

Where:

FL_{pre} = *Average Evaporator Fan Load*

$Hours_{pre}$ = *Hours of Operation Pre-Installation*

$Motor_{pre}$ = *Additional kWh Consumption from Motor Heat*

$Hours_{red}$ = *Reduction in Run Time with CoolTrol*

Replace Inefficient Evaporator Fan Motors (kW):

$$FL_{pre} \times ECM_{save}$$

Where:

FL_{pre} = *Average Evaporator Fan Load (kW)*

ECM_{save} =*Measure Savings Factor*

Replace Inefficient Evaporator Fan Motors (kWh):

$$[(FL_{pre} \times Hours_{post}) + Motor_{post}] \times ECM_{save}$$

Where:

FL_{pre} = *Average Evaporator Fan Load (kW)*

$Hours_{post}$ = *Hours of Operation Post CoolTrol Installation*

$Motor_{post}$ = *kWh Consumption from Motor Heat Post CoolTrol Installation*

ECM_{save} =*Measure Savings Factor*

De-Power Coolers During Off-Hours with Time Controls (kWh):

$Hours_{com} \times Load_{cool} \times Night_{fact} \times Off_{fact}$

Where:

$Hours_{com}$ = *Annual Compressor Operating Hours*

$Load_{cool}$ = *Novelty Cooler Load (kW)*

$Night_{fact}$ = *Percent of Normal Load at Night*

Off_{fact} = *Percent of Day that Cooler is Off with Time Controls*

Anti-Sweat Heater Controls (kW):

$CL_{pre} \times ECM_{save}$

Where:

CL_{pre} = *Average Cooler Load (kW)*

ECM_{save} =*Measure Savings Factor*

Anti-Sweat Heater Controls (kWh):

$[CL_{pre} \times Hours_{pre}] \times [Hours_{red} \div Hours_{pre}]$

Where:

CL_{pre} = *Average Cooler Load (kW)*

$Hours_{pre}$ =*Annual Hours On Pre Installation*

$Hours_{red}$ =*Annual Operating Hours Reduced Post Installation*

Table 3–7 provides a summary of the ex-ante and ex-post kWh savings attributable to the CoolTrol system, and the retrofit to high-efficiency evaporator fan motors.

Table 3–7. Ex-ante and Ex-post Per Measure Savings

Measure	Ex-ante kWh Reduction	Ex-post kWh Reduction
De-Power Coolers During Off-Hours with Time Controls	905	1,341
On/Off controls on evaporator fan motors	5,809	4,638
ECM Evaporator Fan motor replacement	688	787
Anti-sweat door heater controls on cooler cabinets	5,944	4,668
Anti-sweat door heater controls on freezer cabinets	3,877	4,214

It should be noted that approximately 33% of CoolTrol and efficient motor retrofit savings were attributable to interactive effects with space cooling and refrigeration systems.[174]

Engineering Analysis Results

Based on the review of Program documents and site logging activities, the following conclusions were made by the evaluation team.

1. No adjustments were made to the number of installations recorded for the Program.
2. The persistence rate was concluded to be 76% for CFLs (20W) installed through the Program, and 100% for all other measures.
3. The participant facility operating schedules correlated directly with Program assumptions.
4. The calculated energy savings attributed to the CoolTrol measures and high-efficiency evaporator fan motors were adjusted based on the reduced operating cycle analysis and normalization of demographic weather data. .
5. No adjustments are recommended for lighting measures or for de-powering novelty coolers with timer controls.[175]
6. No adjustment to Program reported demand savings (kW) are recommended.

Table 3–8 provides the ex-ante and ex-post gross savings attributable to the retrofit of lighting and refrigeration measures.

[174] The algorithmic approach to calculating interactive effects is shown above. An example of interactive effects is the increased consumption attributed to motor heat (CoolTrol).

[175] Per algorithm above.

Table 3–8. Gross Savings Attributable to Lighting and Refrigeration Measures

Retrofit Measure	Ex-Ante kWh	Ex-Post kWh
Lighting Measures		
Retrofit to 1 Lamp EXIT Light Emitting Diode Fixtures	5,184	5,184
Retrofit to Compact Fluorescent Fixtures	30,494	25,530
Retrofit to T8 Fluorescent Fixtures	292,649	292,649
Depower Restroom Light Motion Sensor	16,927	16,927
Net Lighting Measure Reported Impacts	345,253	340,290
Refrigeration Measures		
Depower Coolers with Time Controls	11,765	16,664
Install Controls on Evaporator Fan Motors	180,079	139,573
Install ASH Door Controls	173,672	141,203
Replace Inefficient Evaporator Fan Motors	101,824	107,797
Net Refrigeration Measure Reported Impacts	467,340	405,237
Gross Savings	812,593	745,527

Impact Evaluation Results

Engineering Estimates of Ex-post Gross Program Savings

Table 3–9 provides the ex-ante gross savings reported in the final installation review documents submitted by for the Program, the verified gross savings, and the ex-post adjusted gross savings numbers. The recommended adjustment of 67,066 kWh is attributable to the persistence of lighting savings and revised operating schedules for evaporator fan motors, and medium temperature cooler and low temperature freezer door heaters. As discussed previously, no adjustments are recommended to either Program reported demand savings (kW) or energy savings associated with lighting measures.

Table 3–9. Reported Ex-ante and Ex-post Gross Savings

Project	Ex-ante		Ex-post	
	Gross kW	Gross Annual kWh	Gross kW	Gross Annual kWh
Program Total	59.9	812,593	59.9	745,527

Billing Analysis

To conduct the billing analysis, the evaluation team requested monthly energy consumption data and account information from Edison for each of the 986 accounts that either participated in, were audited by, or received information about, IDEEA’s constituent Convenience Store Energy Efficiency Delivery Program. Those who received information did not follow up with an audit or measure installation; this is an information-only group.

In an effort to ensure quality results, several filters were applied to the raw billing data prior to conducting the analysis. First, after matching each participant's pre- and post-installation periods (i.e., limiting the analysis to only the same months of the year in the pre- and post-periods), all participants without a minimum of six matched pre- and post-installation monthly meter readings were dropped from the analysis. While an entire year of data is preferred in order to understand the full range of annual energy use, sufficient time had not passed since the average participant installation (January 28, 2006) to impose such a stringent filter. Since audit-only and information-only customer categories do not have an installation date, the average participant installation date noted above was applied to each as a proxy installation date to establish pre- and post-periods for analysis.

Second, to assess whether factors other than the Program—such as changes in business hours or end uses utilized—may have significantly impacted energy consumption between the established pre- and post-periods, the ratio of raw energy consumption between the two periods was calculated. The resulting ratio indicated the magnitude of the difference in consumption between periods. For example, a ratio of 1.10 indicates a business consumed 10% more energy in the post-period than in the pre-period, while a ratio of 0.90 indicates the opposite. While the ratio looked only at raw change (no weather-normalization), it provides a reasonable metric for identifying and subsequently removing participants from the analysis exhibiting extreme changes in their consumption which are unlikely to be related to the Program. For the purposes of this analysis, an extreme change was defined as those participants in the top and bottom 1% of the ratio's distribution (0.69 and 1.11, respectively).

Third, to ensure an appropriate comparison between all three customer types, all audit-only and information-only customers exhibiting consumption levels outside the range exhibited by participating customers in the pre-installation period (193 < Daily kWh < 1,012) were removed from the analysis. By limiting the audit-only and information-only customers to only those of similar consumption, the two groups allow for a more accurate means of assessing the true impact of the Program upon participants' energy consumption.

The effect of the three filters discussed above upon the sample size of each customer group is captured in Table 3–10.

Table 3–10. Billing Analysis Data Attrition

	Participants			Audit-Only Customers			Information-Only Customers		
Metric	Accts. Removed	Accts. Remaining	% of Accts. Remaining	Accts. Removed	Accts. Remaining	% of Accts. Remaining	Accts. Removed	Accts. Remaining	%of Accts. Remaining
Total Accounts in Sample	- - -	32	100.0%	- - -	262	100.0%	- - -	692	100.0%
Minimum of Six Matching Months in Pre- and Post-Period	8	24	75.0%	40	222	84.7%	123	569	82.2%
Extreme Change in Consumption Between Periods*	1	23	71.9%	15	207	79.0%	84	485	70.1%
Limiting Control Group to Similar Energy Consumers**	- - -	23	71.9%	23	184	70.2%	66	419	60.5%
Final Sample		*23*	*71.9%*		*184*	*70.2%*		*419*	*60.5%*

*Those customers exhibiting ratios of pre- and post-consumption less than 0.69 or greater than 1.11 (1% and 99% of the distribution) were dropped from the analysis.

**Audit-only and information-only customers were limited to only those exhibiting consumption within the same range as the participants that were included in the final analysis (193 < Daily kWh < 1,012).

In addition to collecting and assessing participant billing data, weather data for the participating region was also gathered. The weather data utilized in this analysis was also provided by Edison, and participants and audit-only, and information-only Program customers were matched to the appropriate utility weather station based on their zip codes. In all, customers from all three groups resided in 119 unique zip codes that corresponded to 19 different utility weather stations.

Since the sites remaining in the analysis varied considerably in size (from 193 kWh to 1,012 kWh per day in the pre-period), a fixed effects regression model was utilized to assess the Program's impact. Fixed effect models help account for the disparity in customer consumption data and limits the impact of any single customer upon the aggregated results.

The fixed effects regression model employed utilized a pre-post indicator, average daily heating and cooling degree days, as well as dummy variables for each site to account for weather and determine the true impact of the Program upon daily energy consumption. The results of the analysis, as well as the number of customers in each group, is provided in Table 3–11. Note that while the regression was a daily consumption model (weather normalized), the results presented in Table 3–11 have been converted to present annual savings.

As evident in the table, participants saved an average of 7.4% of their pre-installation energy consumption, while audit-only and information-only customers saved 1.7% and 2.3% respectively. While it is not possible to utilize the audit-only or information-only[176] customers as a true control group with which to determine the Program's net impact (since they were contacted and possibly influenced by the Program), the group's mild savings suggest that either the overall trend across small convenience stores was to use less energy or that the Program was able to impact, albeit mildly, the energy consumption through only audits and efficiency information.

Table 3–11. Billing Analysis—Savings by Customer Group

Customer Group	n	Average Annual Pre-Installation Consumption (kWh)	Average Annual Savings (kWh)	Percentage of Pre-Installation Consumption Saved
Participants	23	185,866	13,701	7.4%
Audit-Only	184	166,773	2,790	1.7%
Information-Only	419	165,167	3,833	2.3%

Although the analysis was only conducted using 23 of the 32 participating sites (primarily due to limited post-installation billing data—see Table 3–10), if the average per site results presented in the previous table were applied to all sites and aggregated, the overall energy saving attributable to the Program total 438,445 kWh. As presented in the following table (Table 3–12), the savings determined through the billing analysis is approximately 58.3% of the 752,261 gross ex-post kWh estimated with the engineering analysis.

[176] Information-only customers were contacted by telemarketers and told about the program, soliciting their participation.

Table 3–12. Billing Analysis —Annual Savings by Customer Group

Customer Group	Billing Analysis	Engineering Analysis	Billing : Engineering Analysis Realization Rate
Total Annual kWh Savings	438,445	752,261	0.583

While the results of the engineering and billing analyses presented in the previous table differ significantly, the results of the two methodologies converge when the billing analysis sample is limited to only those sites that received on-site measure verification. Of the ten sites visited, eight were included in the billing analysis (the remaining two sites were excluded as they did not meet the data quality metrics enumerated in Table 3–10.)[177]

As shown in Table 3–13, narrowing the scope of the comparison to only those sites verified on-site leads to a near match in the findings of the billing and engineering analyses.

Table 3–13. Engineering and Billing Analysis Comparison

	Average Annual Savings—kWh (Billing Analysis)	Average Annual Savings—kWh (Engineering Analysis)	Billing : Engineering Analysis Realization Rate
Total Annual kWh Savings	22,274	22,905	0.97

Note: Subset of eight sites with measures verified on-site

Final Program Impacts

The Program impacts were estimated collectively for all measures installed through the CSEED Program. Table 3–14 presents the first year ex-ante gross and net energy savings goals and reported Program accomplishments.

Table 3–15 shows the first year ex-ante gross and net demand savings goals and reported Program accomplishments. The Program net ex-ante net savings goals were estimated and reported accomplishments were estimated using a 0.96 NTG ratio. The Program reported achieving approximately 31 percent of their original kW and kWh goals.

It should be noted that there was a discrepancy between the final installation review documentation and the most recent workbook. The installation review documents state gross annual kW and kWh Savings of 59.9 and 812,593 respectively. However, the final workbook claims gross annual kW and kWh savings to be 72.9 and 991,883 respectively. This discrepancy has not been resolved, but because the final flat file provides more detailed documentation on measures verified by the evaluation team. Those figures were used as a benchmark for the engineering analysis. The savings claimed in the final workbook were used in the Program impacts reporting below.

[177] A qualitative comparison of each group analyzed (with and without site visits) did not yield any obvious differences in measure installation that might explain the difference in realization rates between the two groups.

Table 3–14. Comparison of Ex-ante Energy Savings Goals and Reported Accomplishments

	Ex-ante Program Gross Annual kWh Goals	Ex-ante Program Net Annual kWh Goals	Reported Ex-ante Gross Annual kWh Savings	Reported Ex-ante Net Annual Program kWh Accomplishments
CSEED	3,175,690	3,048,662	991,883	952,208

Table 3–15. Comparison of Ex-ante Demand Savings Goals and Reported Accomplishments

	Ex-ante Program Gross Annual kW Goals	Ex-ante Program Net Annual kW Goals	Reported Ex-ante Gross Annual kW Savings	Reported Ex-ante Net Annual Program kW Accomplishments
CSEED	182	175	73	70

The Program impacts were determined by two factors:

1. Program performance in terms of accomplishing Program participation goals
2. Estimated ex-post savings impacts for the installed measures compared to the ex-ante measure savings assumptions

The Program gross and net realization rates have been calculated as the combined effect of these two factors. The Program goals, overall and for its constituent measures, ex-post gross and net energy savings, and respective realization rates are shown in Table 3–16. The Program evaluated ex-post gross energy savings are 745,527 kWh compared to the Program gross savings goal of 3,175,690 kWh. This was based on findings from the engineering analysis and field verifications, supported by billing analyses of verified sites. The Program evaluated ex-post net energy savings were 745,527 kWh compared to the Program goal of 3,048,662, yielding a 24.38 percent net energy savings realization rate.

Table 3–16. Comparison of Programs Goals and Ex-post Gross and Net Energy Savings

	Ex-ante Program Gross Annual kWh Goals	Ex-ante Annual Net Energy Savings Goals	Evaluated Gross Ex-post Program kWh Savings	Gross Energy Realization Rate	Evaluated Net Ex-post Program kWh Savings	Net Energy Realization Rate
CSEED	3,175,690	3,048,662	745,527	23%	745,527	24%

The Program goals, ex-post gross and net demand savings, and respective realization rates are shown in Table 3–17. The Program evaluated ex-post gross demand savings are 60 kW as compared to the Program goal for demand savings of 182 kW, yielding a 33 percent gross demand savings realization rate. The Program evaluated ex-post net demand savings are 60 kW compared to the Program net demand savings goal of 175 kW, yielding a 34 percent net realization rate.

Table 3–17. Comparison of Programs Goals and Ex-post Gross and Net Demand Savings

	Ex-ante Program Gross Annual kW Goals	Ex-ante Annual Net Demand Savings Goals	Evaluated Gross Ex-post Program kW Savings	Ex-post Gross Demand Realization Rate	Evaluated Net Ex-post Program kW Savings	Net Demand Realization Rate
CSEED	182	175	60	33%	60	34%

Realization rates compared to ex-ante evaluated results are shown in Table 3–18 and Table 3–19 below. The Program evaluated ex-post gross energy savings are 745,527 kWh compared to the Program reported ex-ante gross savings goal of 991,883 kWh, yielding a realization rate of 75 percent. The Program evaluated ex-post net energy savings are 745,527 kWh compared to the reported ex-ante net of 952,208 kWh, yielding 78 percent net energy savings realization rate. The Program evaluated ex-post gross demand savings are 60 kW compared to the reported ex-ante gross demand savings of 73 kW, yielding a 82 percent reported gross demand savings realization rate. The Program evaluated ex-post net demand savings are 60 kW compared to the reported ex-ante net demand savings of 70 kW, yielding a 86 percent net realization rate.

Table 3–18. Comparison of Reported Program Accomplishments and Ex-post Gross and Net Energy Savings

	Ex-ante Program Gross kWh Reported	Ex-ante Net Energy Savings Reported	Evaluated Ex-post Gross Program kWh Savings	Gross Energy Realization Rate	Evaluated Ex-post Net Program kWh Savings	Net Energy Realization Rate
CSEED	991,883	952,208	745,527	75%	745,527	78%

Table 3–19. Comparison of Reported Programs Accomplishments and Ex-post Gross and Net Demand Savings

	Ex-ante Program Gross kW Reported	Ex-ante Net kW Savings Reported	Evaluated Ex-post Gross Program kW Savings	Gross Energy Realization Rate	Evaluated Ex-post Net Program kW Savings	Net Demand Realization Rate
CSEED	73	70	60	82%	60	86%

Final Program savings, NTG ratios and realization rates are shown in Table 3–20 and Table 3–21. The individual components of the Program were assumed to have a net to gross ratio of 1 for evaluation purposes as compared to the final workbook's assumption of .96.

Realization rates were calculated as the ratio of the evaluated net ex-post savings to the reported ex-ante gross savings. For the overall Program, the realization rate was 75 percent for energy and 96 percent for demand.

Table 3–20. Program Energy Savings

	Ex-ante Reported Gross kWh Savings	Ex-post Gross Program kWh Savings	NTG Ratio	Evaluated Ex-post Net kWh Savings	Realization Rate
CSEED	991,883	745,527	1	745,527	75%

Table 3–21. Program Demand Savings

	Ex-ante Reported Gross kW Savings	Ex-post Gross Program kW Savings	NTG Ratio	Evaluated Ex-post Net kW Savings	Realization Rate
CSEED	73	60	1	60	82%

Table 3–22 provides a summary of savings including ex-ante goals, ex-ante reported, and ex-post evaluated savings.

Table 3–22. Savings Summary

	Proposal				Reported				Evaluated		
	Ex-ante Gross	Net to Gross	Ex-ante Net		Ex-ante Gross	Net to Gross	Ex-ante Net		Ex-post Gross	Net to Gross	Ex-post Net
kWh	3,175,690	.96	3,048,662		991,883	.96	952,208		745,527	1	745,527
kW	182	.96	175		73	.96	70		60	1	60

Lifecycle Savings

Program implementers assigned one EUL to a "comprehensive" measure package for each participant as opposed to distinctly accounting for individual measures. EUL for equipment in the measure package ranged from 8 to 16 years, with a savings-weighted average measure life of 14 years.[178] However, evaluation findings point out that a majority of participants did not install the full number of measures contained in the prescribed package and, instead, chose what measures they felt were most beneficial (predominantly lighting). Consequently, the evaluation team has derived appropriate EUL values at the measure level for the life-cycle savings analysis based on a comprehensive analysis equipment information provided by DEER. These findings are provided in Table 3-23, along with the evaluated savings.

[178] Quantum Consulting, Proposal for CSEED Program, Revised, March 2005. Page 1.4.

Table 3–23. Deemed Measure EUL and Program Ex-post Lifecycle Net Energy Savings

Retrofit Measure	Measure Reference Number	EUL	Number Installed	Evaluated kW Savings per measure	Evaluated kWh Savings per measure	Total Evaluated kW Savings	Total Evaluated kWh Savings
Lighting Measures							
Retrofit to 1-lamp EXIT LED Fixtures	L-5	16	16	0.6	5,184	9.6	82,944
Retrofit to compact fluorescent fixtures	L-4	2.5	87	3.4	25,530	8.5	61,198
Retrofit to T8 fluorescent fixtures	L-1, L-3	11	468	31	292,649	341	3,230,700
Depower restroom light motion sensor	L-2	10	23	0	16,927	0	169,270
Mechanical Measures							
Refrigeration measures	M-3, M-4, M-5	16	225	25	405,237	400	6,483,792
Total							10,027,904

The Program lifecycle ex-post net energy and demand savings for this Program are shown in CPUC required format in Table 3–24 below.

Table 3–24. CPUC Energy Savings

Year	Calendar Year	Ex-ante Gross Program-Projected Program MWh Savings	Ex-post Net Evaluation Confirmed Program MWh Savings	Ex-ante Gross Program-Projected Peak Program MW Savings	Ex-post Evaluation Projected Peak MW Savings	Ex-ante Gross Program-Projected Program Therm Savings	Ex-post Net Evaluation Confirmed Program Therm Savings
1	2004						
2	2005	992	746	0.07	0.06	-	-
3	2006	992	746	0.07	0.06	-	-
4	2007	992	733	0.07	0.06	-	-
5	2008	992	721	0.07	0.06	-	-
6	2009	992	721	0.07	0.06	-	-
7	2010	992	721	0.07	0.06	-	-
8	2011	992	721	0.07	0.06	-	-
9	2012	992	721	0.07	0.06	-	-
10	2013	992	721	0.07	0.06	-	-
11	2014	992	721	0.07	0.06		
12	2015	992	704	0.07	0.06		
13	2016	992	410	0.07	0.03		
14	2017	992	410	0.07	0.03		
15	2018	992	410	0.07	0.03		
16	2019		410		0.03		
17	2020		410		0.03		
18	2021						
TOTAL	2004-2023	13,886	10,028				

Definition of peak MW as used in this evaluation: Average demand reduction during the summer months.

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4. Conclusions and Recommendations

The Convenience Store Energy Efficiency Delivery Program provided a range of lighting and refrigeration efficiency measures to convenience store operators targeting three counties within Edison's service territory. Program participants were highly satisfied with both the level of performance of the efficiency measures and with the Program overall. Store operators who received only an audit reported that the audit was useful. Experience with this Program supports the continued need for investment in education and incentives for efficiency improvements in this hard-to-reach and underserved market segment.

Conclusion 1. *The Program did not achieve the participation and savings goals.*

While the Program successfully introduced new technologies to participants, the Program was undersubscribed and a number of recommended efficiency measures were not installed. The Program was much more difficult to enroll than anticipated for a variety of reasons. The Program started late and time in the field impacted marketing and enrollment. Some customers will not take on new projects in the fourth quarter of the year. The market has had little exposure to energy efficiency concepts and information; it is underserved and hard-to-reach. In addition, cost was a barrier and a number of committed sites dropped out or participants cancelled installation of select measures, or they selectively chose measures from the list of recommended measures. High turnover among store owners and concerns about keeping the stores in business also impacted decisions to install measures. There is great potential for savings in this sector and a continued need for investment in efficiency upgrades.

Recommendation 1. *Continue efforts to provide energy efficiency information and programs to this market sector.*

Expand efforts to provide basic energy efficiency information to this sector to increase awareness of energy-efficiency measures and savings potential. Provide standard offer efficiency Programs targeted to this market. Engage a number of marketing methods. Disseminate information gathered from the Program's two pilot demonstration sites.

Conclusion 2. *Selling the job and obtaining committed participants was more difficult than anticipated.*

The Program delivery took a one-stop audit/sale/signature approach which did not always work well, requiring a second visit from implementers to sell the job. If a one-stop approach is taken in the future where the auditor is expected to sell the job, thorough training in sales is needed. Integrating sales and auditing requires an in-depth understanding of the business, the complexities of the refrigeration market, and the decision making processes of independent convenience stores. While the audit tools outputted a detailed report that was presented to customers, some survey respondents noted they did not understand the Program or the information that was provided to them. Some reported they were unconvinced that the recommended measures would save energy. Other difficulties obtaining commitments to participate were related to timing and funding. Participation inherently meant the store owner was required to commit capital to purchase efficiency measures. Oftentimes the owner or decision maker was not present at the time of the audit which necessitated a call back to discuss the project with the decision maker. Owners and management needed time to consider the audit information, recommended measures, and capital requirements in order to make a decision to participate and obtain the funding needed. The Program was not fielded for very long, which also reduced the time available to market the Program and enroll participants.

Recommendation 2. *Review and improve the Program delivery and sales approach.*

This is a complex market that may need more than one marketing and sales approach. Clarifying the role of the auditor and salesperson is needed. Training and tools for people in the sales role are needed. Concurrently addressing other barriers is also needed. These include cost, timing, awareness. Moreover, helping customers better understand their utility bills, along with pre and post comparison of bills, could help with the sales process and post-participation satisfaction.

Conclusion 3. *Cost was a major barrier to measure installation and financing did not help to overcome the barrier.*

For all three groups—participants, partial participants and nonparticipants alike—concerns over budget matters and measure cost were prevalent. Participants reported that the availability of financing was important in their decision to participate and most would not have participated without the incentives to bring down the measure cost. The cost barrier was not overcome by all participants. Some chose measures with a lower payback or a smaller price tag and did not install all recommended measures. Partial participants reported cost was a major barrier and did not install measures. The 100% financing package designed to address this barrier was only used by one participant. Even though financing was offered, participants and partial participants still did not install all recommended measures.

Recommendation 3. *Explore other avenues to address the cost barrier.*

Since financing was available and there was only one taker, it appears the financial package itself was not acceptable. Future market studies should explore the cost issue. It is not clear whether the 100% financing was presented in an understandable manner or whether the financing package requires different parameters to be acceptable. It may be that financing is not an attractive option and this market segment prefers to fully fund the purchase up front.

Conclusion 4. *The Program had competition from other lighting rebate programs.*

Implementers and survey respondents noted that potential participants were aware of other lighting rebate programs including those that required no cash outlay from participants. Several did not participate specifically because they were "looking for a better deal."

Recommendation 4. *Designate Program territories.*

The Program would have benefited from operating in territories where fully funded direct install programs were not also offered.

Conclusion 5. *The Program was well documented.*

Implementers developed detailed databases that clearly documented Program activities. Subcontractors also customized the EnerPath audit tools for the Program. The two demonstration sites were well instrumented to allow real-time Web-based monitoring and extrapolation of results to the larger market. They served their purpose as pilots to educate both customers and contractors about the technologies through brochures and publications.[179] For those with access to the Web-monitoring site, it allowed real-time access to monitor consumption.

Recommendation 5. *Encourage this attention to detail for all Program documentation.*

The database and data tracking tools are a good model for others to follow.

[179] Implementers report distributing 295 case studies from each of the two demonstration sites. qUEST Final Report Narrative, July 2006, page 3.

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7. Cool Cash Program

1. Program Description

In response to Southern California Edison's requests for innovative energy-efficiency proposals, Honeywell DMC Services LLC proposed delivering a new pilot program that would target small to medium hotels in Southern California. Originally called the Cool Bill Program for Hotels and Motels and subsequently, Cool Control-Cool Cash, the program was a turnkey, retrofit program that would install power controllers and motion and infrared occupancy sensors for package terminal air conditioning systems (PTACs) at no cost to the participant and provide incentives for the replacement of pre-1993 PTAC units.

The power controllers and occupancy sensors reduce the energy required to cool hotel rooms by working together to sense the presence of a guest and then adjust the thermostat according to occupancy. An unoccupied room would be cooled to a higher temperature than an occupied room, resulting in energy savings.

Honeywell identified several reasons for pursuing the program, including:

- An opportunity to conserve energy wasted in motels and hotels that provide constant air conditioning to unoccupied rooms
- The infancy of the PTAC controller market and the volume of potential sites provide an opportunity to demonstrate effective technology and stimulate interest in a "wide open" market.
- The targeted hotel segment is unlikely to have an energy manager, and is unlikely to have the capital and knowledge to implement energy-efficiency upgrades independently.

In addition to the specific targeted market, Honeywell focused on climate zones with the highest number of cooling degree days, and the inland desert area that includes the many hotels in and around Palm Springs.

The evaluation of this program included both a process and an impact evaluation. Although this was a 2004-2005 program, the evaluation conforms to the 2006 Protocols at the Basic level.

The purpose of the process evaluation was to document project progress, assumptions, and barriers to wider implementation, to assess customer satisfaction, and to document barriers to participation and describe current practices among nonparticipants. As a result of data limitations,[180] a list of contacted hotels did not exist, so identifying nonparticipants was not possible—which precluded nonparticipant interviews. Thus the evaluation could not describe current practices among nonparticipants or explore the reasons some hotels might have chosen not to participate in the program.

[180] Contacts at Honeywell stated the electronic contact list was lost in a hard drive crash.

The impact evaluation included review of program records, site visits and inspections and a corroborating billing analysis. The program ex-ante savings were based on assumed equipment capacity profile and operating hours to develop the baseline HVAC usage to which a 45 percent savings fraction was applied. Key issues in estimating the program ex-post net savings were possible adjustments to be made to ex-ante savings using the verified operating parameters and ascertaining measure persistence through on-site verification.

This report is organized into four sections. The next section presents the process evaluation, including the program logic model, results of interviews with program staff and participants, and free rider estimates. Section 3 describes the impact evaluation, the engineering and site visit results and calculates realization rates, ex-post gross and net savings, and lifecycle savings. The final section presents the major conclusions and recommendations.

2. Process Evaluation

Process Evaluation Methodology

The purpose of the process evaluation was to document the Program's original goals and progress, and differences between the Program as designed and as implemented. The process evaluation also assessed delivery and implementation issues, and barriers to wider implementation. Participant satisfaction, and issues of free ridership and spillover were also addressed along with lessons learned, and reasons for nonparticipation. A Program logic model guided the research.

Program Logic Model

The program logic model diagram in Figure 2–1 shows the key features of the program as understood by the evaluation team, and indicates the logical linkages between activities, outputs, and outcomes.

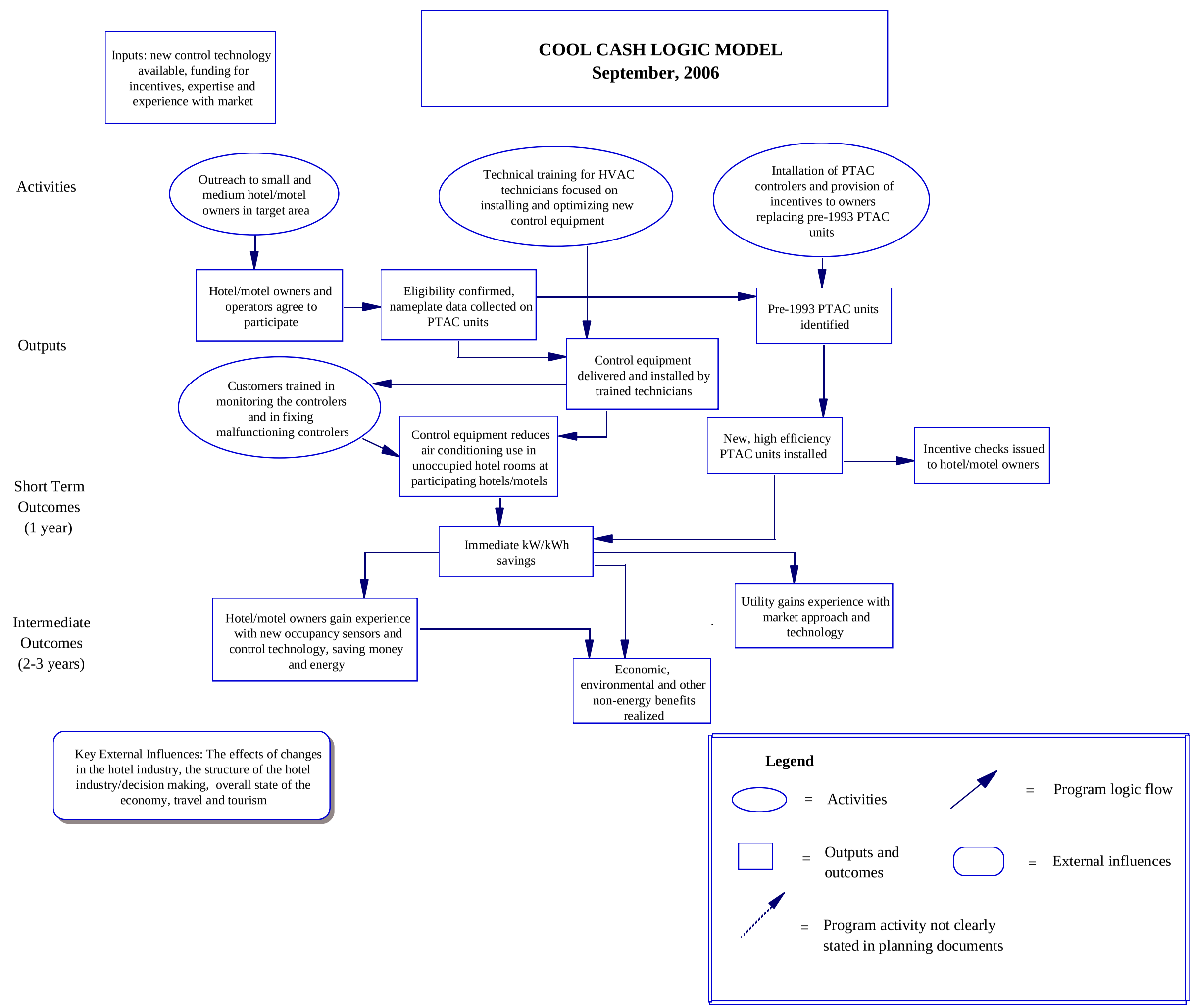
The program has three primary activities: (1) outreach to small and medium hotel owners in targeted areas, (2) technical training provided to program HVAC technicians, and (3) installation of PTAC controllers and provision of incentives for owners replacing pre-1993 PTAC units.

These activities are expected to result in the following outputs: (1) hotel owners being identified and agreeing to participate, (2) confirmation of eligibility/collection of data, and (3) identification of PTAC units for replacement.

These outputs in turn are expected to result in control equipment being delivered and installed by trained technicians, and customers being trained in monitoring the controllers and in fixing malfunctioning controllers--both of which should then result in control equipment that reduces air conditioning use in unoccupied hotel rooms at participating hotels.

Short and intermediate term outcomes include immediate kW/kWh savings, increased experience among hotel owners and managers with occupancy sensor and control technology, and economic, environmental and other non-energy benefits being realized. An added outcome for all IDEEA projects is that SCE staff gain experience with a new market approach and technology.

Figure 2–1. Cool Cash Logic Model



Process Evaluation Sample Design

The program was implemented by Honeywell in association with Smart Systems, who developed the sensor units. Nine hotels participated in the program. Data collected for the process evaluation include interviews with the three staff at Honeywell most involved in implementation, two contacts from Smart Systems, and contacts at seven of the nine participating hotels. The hotels represented by all seven contacts had received free occupancy sensors from the program. One hotel also received rebates for purchasing new, high efficiency PTACs.

Research questions were developed as part of the work plan and then used to develop interview guides. The questions explored the decision-making process used by participating companies to determine whether to participate, and also explored the participants' experiences with the technology since the installation.

The interviews took place in June and July of 2006. Before interviewing participants, interviewers confirmed that the respondent was involved in the company's decision to participate. All respondents were involved in the decision making process for the project, or were aware enough of the project details to provide meaningful information. In several cases, the manager or person most involved in the project at a given hotel had left the company; in these instances we spoke to the person or persons who were most able to answer questions about the hotel's experience installing and maintaining the sensors.

Program Design

According to contacts at Honeywell, the design for Cool Cash emerged after staff at Honeywell became aware of PTAC controller and occupancy sensor products being offered by Smart Systems Technologies. Honeywell contacts described knowing that Smart Systems was selling the technology to larger, more expensive hotels and resorts, but that they were having difficulty selling the same technology to independent, small hotels. Since these smaller hotels tended to be older, Honeywell estimated that they would be likely to have had less building insulation and older PTAC units than their larger counterparts.

To overcome barriers related to the first cost of the equipment, the program offered direct installation of power controllers and occupancy sensors to targeted hotels at no cost. Because of the summer cooling load in the targeted areas, any hotel found to have PTAC units manufactured before 1993 was to be encouraged to replace the units with high-efficiency models. Contractor incentives of $575-$650 were offered to encourage these replacements.

Market Assumptions

The location of targeted hotels was researched prior to implementation, and this information was included in the IDEEA proposal and in program planning and design documents. Honeywell staff reported reviewing databases of hotels in the appropriate climate zones (where the reduction in air conditioner run time would result in measurable energy savings). Contacts report beginning with a list from the American Lodging Association (ALA), which was combined with information from American Automobile Association (AAA) searches, Internet searches, and other local listings to create a list of approximately 60 hotels to approach.

The technical proposal indicated that the program would target "small- to mid-size lodging facilities," although the criteria for selection were not formally described in the proposal or communicated to SCE, nor were they documented internally. We asked contacts at Honeywell about specific criteria or building features that might have been used to assess whether or not a hotel was "small to medium." One contact at Honeywell reported that staff likely considered how old the buildings were, how many rooms they had, and their affiliation with national chains in an effort to identify hotels that were independently owned and fit the "small to medium" target. He described several features that could be used as potential proxy measures for size (for example, hotels with fewer than 120 rooms, ones that are not more than two stories high, or ones that are not part of a chain); however, outreach staff were not required to formally apply these criteria. The Honeywell program manager estimated the portion of area hotels that might fit these criteria at approximately 30%; however, no firm percentages of the market were calculated in the proposal. "We looked for [hotels] that weren't part of a chain, or if they were, they were independently owned and operated like a franchise. Those [hotels] will have local responsibility for profit and loss."

Size of Target Hotels

Even though the program staff operated without formal screening criteria by which each potential participant would be assessed, the final population of participating hotels generally resembled the targeted market segment described in the proposal. Five of the seven participants interviewed reported their hotels had less than 120 rooms (Table 2–1). The two hotels with more than 120 rooms both had fewer than 130 rooms.

Table 2–1. Size of Participating Hotels

Number of Rooms	Count
0-79	1
80-99	2
100-119	2
120-140	2
Total	7

Ownership of Target Hotels

While Honeywell staff had anticipated recruiting independent hotels, the majority of participants interviewed (five of seven) reported that their hotels were part of a chain. However, program staff had indicated hotels that were part of a chain might still be independently owned and operated, like a franchise, in which case the responsibility for profit and loss and presumably the authority to invest in energy efficiency would reside with local management. Among the five contacts who reported their hotels were part of a chain, two had local decision-making authority, and two required corporate approval. The fifth could commit to purchases up to $5,000—meaning he would have been able to approve participation in the program, but likely not the PTAC replacements his hotel completed at the same time. The chains represented by the five hotels varied by size: three belonged to chains with fewer than 100 affiliated hotels, and one belonged to a chain with nearly 700 properties. One contact didn't know the chain's size however; the chain's website indicated over 380 locations as well as being one brand in a larger corporation with three brands.

Age of Target Hotels

Honeywell staff had anticipated that the targeted smaller, independent hotels tended to have older buildings. In fact, the hotels that participated were either relatively new or quite old. Five of the seven hotels in the participant sample were over 20 years old (Table 2–2) and two were under ten years old. The most recently built hotel was four years old, while the oldest was about 50 years old.

Table 2–2. Age of Buildings

Age	Count
Less than ten years	2
20 years or more	5
Total	7

The findings from the evaluation suggest that age of building may be less important than whether the hotel is truly independent and able to make investments on its own.

Marketing and Participation Decisions

The outreach conducted for Cool Cash was different than the approach described in the original Technical Proposal--quicker and simpler, but neither tracked nor based on the previously developed list of targeted hotels. A Honeywell salesman worked with a representative from Smart Systems in the initial approach to prospective hotels. Smart Systems had already contacted many hotels in the area, so the sales team worked to make sure they did not tap into customers that were already in the process of buying the equipment, and that none of the hotels they contacted were "double dipping," or receiving equipment or incentives from another energy-efficiency program.

While contacts at Honeywell described having a strategy and list for outreach, the actual outreach ended up happening more organically and was basically completed in one day. "We found when we got out there it was just better to go door to door…in Palm Springs, on Highway 111, it's just hotel after hotel." Instead of approaching the specific hotels on the list, program representatives stopped at one end of the highway and began walking. "We'd stop in to see if the manager was there; if they weren't there we'd ask when they would be; if they were there, we'd pitch the program." The canvassing took place in May 2005, and at the end of the first day they had had enough interest that they did not need to keep walking.

Staff contacts reported having approached approximately 30 hotels to recruit the nine that ultimately participated. According to contacts at Honeywell, those that declined tended to be very small, to already have control technology, or to not understand the concept of the program.

“A majority (of those that declined) didn’t really understand the product and didn’t want to… they treated us like sales people. Others liked it but wanted to present it to the owner, and the owner shot them down.” Honeywell contacts report that no specific type of hotel appeared more or less willing to participate; instead, the determining factor seemed to be how likely contacts were to talk to the right person. “It’s hard to get to the right person when you walk in; if they have to sell it up (to their management) it depends on the individual, not really the type of hotel.”

Participant reports of how they learned about the program concur with reports from staff of marketing activities. Five of the seven participants reported having learned of the program through direct contact with program representatives (Table 2–3). The one contact who reported learning about the program independently learned by browsing the SCE website, wondering if there were any rebates for the PTAC units the company was planning to install (and did install with program rebates): “We had worked with Edison previously, went online, and looked at the website. Smart Systems had contacted the corporate office. We were in the process of looking at PTAC units; they iced the cake with the sensors.”

Table 2–3. How Participants Heard about the Program

Source	Count
Contacted by program representative	5
Browsed website on own initiative	1
Don’t recall	1
Total	7

A Smart Systems representative accompanied the Honeywell salesman in these initial in-person contacts. The Smart Systems representative was able to explain the sensors and address specific concerns related to the technology, while the Honeywell representative could explain the details of the program and sign up the hotel. “He knew [the technology] better than I did, so the two of us going door to door worked well,” said one Honeywell contact. “He could answer any questions about the technology.” The two performed room audits for interested hotels to calculate how well the equipment would serve each hotel.

Only four participants could recall program representatives describing specific benefits likely to result from installation of the control technology. Three each recalled being told they could save energy and save money (Table 2–4).

Table 2–4. Benefits Participants Recall Salespeople Mentioning (n=4; multiple responses allowed)

Recalled Benefit	Count
Saving money	3
Saving energy	3
Less maintenance	1
More control	1

Among the five participants who were able to describe their considerations in deciding whether to participate, all five reported that saving money was a primary consideration (Table 2–5).

Table 2–5. Considerations in Deciding Whether to Participate (n=5, multiple responses allowed)

Consideration	Count
Saving money	5
High bills/rising energy costs	2
Rebates on PTACs	1
Items offered free of charge	1
Concerns about guest comfort	1

Participants described the process their hotels followed to determine whether they would participate. All respondents reported having been involved in their hotels' decisions to participate in the program, but only two had the final authority to participate, since for five of them, the value of the project exceeded the limit of their authority (Table 2–6).

Table 2–6. Person with Authority to Commit to Program

Decision-maker	Count
Respondent	2
Owner	2
Higher authority in corporation	2
Only for projects under $5,000; else, higher authority	1
Total	7

On a similar matter, participants also described how their hotels generally go about making decisions about spending on projects such as air conditioner controls. In general decision making procedures are well established, but for two of the hotels they are not, as shown in Table 2–7.

Table 2–7. Spending Decision Process

Description	Count
I decide	3
I decide for items under $5,000; else, higher authority	1
Corporate office decides, reviews annually	1
Don't know	2
Total	7

Only one of the seven participants reported having an energy manager for their company, consistent with expectations described in the Technical Proposal that most of these hotels do not have energy managers.

None of the hotels had previously installed any devices similar to the sensors provided by the program in their buildings. Additionally, most participants (five of seven) reported that no other properties affiliated with their company had installed any similar sensor technology. One participant reported that affiliated properties elsewhere had installed similar sensors; another did not know if the sensors had been installed in other properties.

Four participants reported having been aware of the sensor technology before becoming involved with the program. Only one of these was aware of the specific technology offered by Smart Systems.

It is clear from the comments of the hotel contacts that they were concerned about the use of the PTACs when rooms were unoccupied. Prior to the installation of the new sensors, six of the seven participants interviewed described trying to keep air conditioners from running unnecessarily by having the cleaning crews or other staff turn them off (three mentions) or turn them down (four mentions) after guests leave. Two contacts volunteered that hotel staff sometimes failed to turn off the PTAC or to set the temperature higher. Thus they were interested in a technology that would be more automatic than staff memories.

Program Delivery and Implementation

Once a hotel had agreed to participate, the outreach/sales staff would enter a sample of rooms to see how many controllers would be required (for example, suites could require more than one), and to check the socket voltage.

Names of identified hotels and their contact information were passed to the Honeywell program coordinator who managed the installation details--including dates and times and what would be necessary from the hotel. She reported seeking to be present during the installation process, particularly at the beginning and end of the project. The length of time required per room varied depending on the technology installed. Rooms receiving a straight plug-in controller took only 15-25 minutes per room, while those requiring thermostats took approximately 45 minutes per room because of the wiring required.[181]

Contacts from Honeywell described installing more complex systems than they had intended, since the Technical Proposal described installation that was very straightforward (no thermostats or wiring); the program ultimately installed 224 thermostat-based systems that required wiring.

Contacts at Smart Systems noted that the program was designed with a specific, standard installation in mind, but that several hotels had rooms that were not quite standard: “Having a little more detailed site survey information on which to plan is helpful; we didn’t have any specifics.”

Honeywell contacts managed the installation schedule and dealt with the requirements of specific hotels. “Some hotels gave us blocks of rooms to do; others had us going back and forth . . . I coordinated and kept the installers moving. Summer season is the low season, but the rates are cheap, so the hotels are fuller than you’d think.” No problems related to scheduling or installations were reported by the participants, and this appears to have gone quite smoothly.

The program also offered incentives of between $575 and $650 for hotels that chose to replace pre-1993 PTAC units. While the original proposal anticipated replacing 100 pre-1993 PTACs, the final budget included enough to replace 36 units, so only one hotel (with 128 rooms) was

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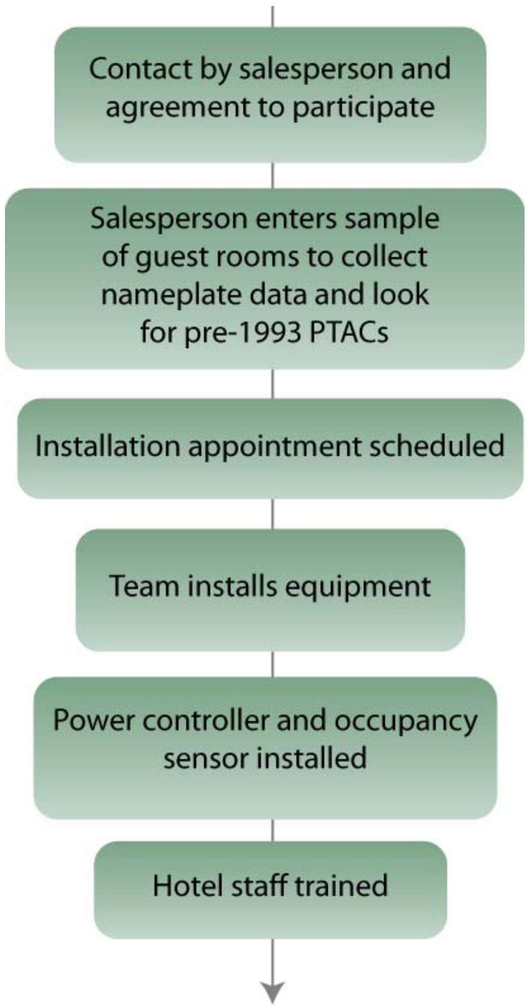
[181] Thermostats were hard-wired into the PTAC system temperature controller

able to take advantage of the PTAC rebates to replace older, inefficient units in 36 of the 128 rooms.

Figure 2–2 is a summary of the participation process.

Figure 2–2. Participation Process



Market Barriers

Program staff described what they understood to be the main market barriers to the use of the technology. They reported the primary reasons hotels and motels in California have not already embraced the technology to be budget and cost related. The product cost $200-$300 per room, which generally required it be budgeted in advance, and upgrades like this were not a priority compared to other enhancements. Program staff reported that hotel owners and managers perceived first cost as an enormous hurdle, regardless of the payback. “The payback may be quick, but the first cost is a problem,” said one contact. Another noted that expenses like this were not a priority: “They may budget for this, but something else will come up. We need more emphasis on energy; they need to use information about energy consumption to make the ROI point."

When asked about barriers (other than the cost of the equipment) that prevented hotels from accepting the program offer, Honeywell contacts reported that skepticism toward the technology on the part of hotel management was also a significant barrier. Given the cost of the technology per room installed (over $200 per room), hotel decision makers needed to believe the energy savings claims from the vendor. Any skepticism on their part would reduce their willingness to invest in the product on their own. Similarly, hotel contacts had to believe that guest comfort would not be compromised, or if the comfort level was lower, it was an acceptable level.

Without records or contact information for nonparticipants, the evaluation was limited to interviewing program participants—since these hotel contacts chose to participate, they would be far less likely to have the kind of skepticism staff reported encountering when recruiting participants generally. However, findings from participant interviews provide some insight into the overarching concerns among hotel owners and managers regarding the reliability of product performance and resulting savings as well as concerns about guest comfort. Two of the seven participants interviewed indicated the equipment had not met their expectations, primarily due to issues with guest comfort during sleeping hours and when returning to a room that has been unoccupied, but also because of uncertainty with payback and energy savings. According to one contact, "the summer months are the same—you cannot shut off the air conditioner and the summer bill is the same. It helps in the winter, but not very much . . . not nearly the cost of the equipment. It must be a 20-year payback."

Another barrier mentioned by contacts at Honeywell was the turnover among hotel staff. High turnover in the hotel industry requires extra efforts in training and communication with maintenance and management staff that may not be familiar with the technology or specific equipment. It is likely that training will remain an on-going issue, making it important that adequate information about system operation and troubleshooting be left with hotel staff and management.

When asked about the response from hotel contacts, or if any other barriers emerged that ultimately caused hotels to decline to participate, program contacts described contacting "harried managers" that refused to take the time to talk with them, skepticism about being offered a free product, and some remaining distrust about how it worked, and about occupant comfort. "We were offering them $12,000 worth of free equipment . . . the biggest reasons to say 'no' were fear that a customer would complain, and an 'I'm too busy, leave me alone' mentality. Plus, some are suspicious of a free product."

In summary, market barriers for independent hotel adoption of PTAC controllers and sensors included:

- First cost
- Institutional challenges of staff turnover
- Performance uncertainty
- Conflict with service goals (guest comfort)

- Equipment failure
- Technical complexity

Participants' Experience with the Program and the Technology

Five of the seven participants reported the equipment was working well (Table 2–8), though some problems were also reported, including guests becoming uncomfortable at night because of the sensors' failure to detect sleeping people. This was mentioned by three participants. Two of these reported their hotel had taken special measures to mitigate guest discomfort: one stopped using the sensors on a wing of rooms, to keep some cool rooms on hand for guests that may arrive late; the other installed ceiling fans to keep the air moving and provide some comfort as the PTAC controller began to cool a hot room.

Table 2–8. Participants' Experience with Measures

Experience	Count
Equipment working well	5
Problems with sleeping people	3
Some equipment failures, which Honeywell fixed	1
Total	7

Participants were asked if the equipment had met their overall expectations, and five of the seven reported it had. One of the two whose expectations were not met pointed out difficulties caused by the sensors' inability to detect sleeping people--this participant had not contacted Honeywell or Smart Systems to seek a resolution. The other participant whose expectations weren't met explained that his hotel could not effectively use the technology in the summer time because the rooms simply get too hot, making it too uncomfortable for guests; so he turned them off for the summer.

Four of the seven participants reported noticing energy or bill savings since the measures were installed; the other three were unsure. One of the four who noticed savings (the same who felt the sensors could not be used in the summer), remarked the savings had been extremely disappointing. He found the winter bill savings small and the summer savings nonexistent.

According to hotel contacts, guest reaction to the sensor technology ranged from assuming the air conditioner is broken or complaining to management (four mentions) to mere curiosity (two mentions) (Table 2–9).

Table 2–9. Participants' Customers' Reactions

Reaction	Count
Complaints/think air conditioner is broken	4
Curious	2
Don't notice unless it malfunctions	1
Total	7

We asked participants about how the equipment worked after it was installed and about any vandalism or tampering. Among the seven participants, three reported experiencing some equipment malfunctions: in one case battery failure, and in the other two, instances that required equipment be reset. Two of the remaining four contacts reported “operational issues” as staff learned about equipment settings, defaults, and how the equipment worked in practice. Only one hotel contact reported sensor vandalism or tampering—in this case the equipment had been dismantled.

The process interviews did not ask contacts to estimate the portion of their sensors that were working as expected. However, the impact findings suggest that the portion of inoperable sensors was as high as 22%, indicating that hotel contacts might not be aware of malfunctioning or inoperable sensors, or dead batteries.

Five participants were able to name features they felt worked best about the program. The most common response (given by three) was that the technology worked as expected, followed by comments appreciating the added control the equipment provided to hotel managers (given by two). Other features (mentioned once each) included energy savings, easy installation, unobtrusive sensors, and that the program implementers were easy to work with (Table 2–10).

Table 2–10. What Worked Best
(n=7, multiple responses allowed)

Feature	Count
The technology works	3
Gives us more control	2
Big savings	1
Honeywell, Smart Systems easy to work with	1
Unobtrusive sensors	1
Easy installation	1

When asked what didn’t work about the program, or if they had any suggestions to help the program improve, only three participants offered comments. These contacts described having to work through the learning curve required to use the technology. For instance, one explained that the technology malfunctions from time to time and that it was important to train staff regarding how to reset the sensors when this happens. One reiterated issues with guest discomfort, particularly when the sensor failed to recognize sleeping occupants.

Free rider/Spillover

The NTG questions that were asked participating hotel contacts included whether and when the sensors or PTACs might have been installed without the program, whether any sensors or PTACs had been installed in their hotel in the preceding two years or elsewhere in the hotel chain, and whether any were planned for installation before this program. Responses to these questions are provided in Table 2–11 for the sensor technology and in Table 2–12 for the PTACs.

Table 2–11. Decisions about Installing Sensors Outside of the Program

	Case/Site Number[a]						
Question	6	4	1	3	8	5	7
Would you have installed any occupancy sensors/PTAC controllers without the program incentive?	No	No	No	No	Yes	No	Maybe
If yes, the same number?	NA	NA	NA	NA	Yes[b]	NA	Yes
Were the units already planned or budgeted for?	NA	NA	NA	NA	Yes	NA	No
Have any of these measures (the sensors) been installed elsewhere in this hotel in the previous two years?	No	No	No	No	No	No	No
Has the company installed the same or similar technology in other hotel buildings?	DK	No	No	No	Yes	No	No
On a scale of 1-5, where one is not at all important and five is very important, how important was the program in your decision to install the sensors/controllers?	4	3	3	4	5	4	5

[a] Corresponds to site numbers in the impact section

[b] Described being in the process of installing PTAC power controllers, but heard from Smart Systems, and chose that product.

Table 2–12. Decisions about Installing PTACs Outside of the Program

	Case/Site Number*						
Question	6	4	1	3	8	5	7
Would you have installed the PTAC units without the program incentive?	Yes	NA	NA	NA	NA	NA	NA
If yes, the same number?	Yes	NA	NA	NA	NA	NA	NA
If yes, the same level of efficiency?	Yes	NA	NA	NA	NA	NA	NA
Were the units already planned or budgeted for?	Yes	NA	NA	NA	NA	NA	NA

* Corresponds to site numbers in the Impact section

Participants' reports supported program staff's belief that the installation cost is the main barrier in this market segment. Participants used a five-point scale, where "1" is not at all important, and "5" is very important, to describe how important the program incentive (free installation) was to their installing the sensors. Five of the seven rated the incentive as important or very important.

Only one of the participants installed PTACs with program incentives. This contact described being in the market for PTACs, searching for incentives and having budgeted for the PTAC replacement. The purchase invoice for PTACs replaced at this hotel showed that all units were purchased and installed at the same time. This hotel was considered a freerider relative to the PTAC units, however not the occupancy sensor/PTAC controller. Another participant described being in the market for PTAC controllers prior to contact with the program, and reported that they had been budgeted for. This contact is a likely freerider relative to the occupancy sensor/PTAC controller.

Potential Spillover

One contact reported their company had installed the same technology in other hotel buildings, some prior to their participation in Cool Cash, some after participation. She could not provide specific dates or locations; noting that this information is decided and controlled by the corporate offices of the large hotel chain the building was part of.

In another case, the program ran out of incentive money before installing sensors in all of the rooms of one participating hotel. As part of the impact evaluation activities a contact from this hotel (one the process team was unable to reach) asked the evaluation contact whether incentives were available that would allow him to install the sensors in rooms in his hotel that had not been treated. The contact stated that if funds were available he would do it right away; otherwise he planned to wait for a year or two to do it on his own. It is not clear from either of these comments that the program has resulted in any quantifiable spillover.

The implementation contractor reported the installation of 92 additional PTAC units by one participant as program spillover. This participant is a freerider who installed program funded and non-funded units at the same time. In calculating net program savings, participant spillover has not been considered for either technology.

Lessons Learned by Program Staff, Future Plans

Contacts at Honeywell and Smart Systems reported learning a great deal from their experience with the Cool Cash pilot program.

Program staff have learned to be very careful about the “low end of the food chain” in the hotel market, reporting that vandalism and damage occurred in these hotels more frequently. Staff hypothesize that that there is a different client base for these rooms and that the occupants tend to be rougher with rooms; cheaper rooms attract longer-term stays by residents undaunted by altering or disabling equipment in the rooms. Staff reported incidents of occupants poking pens into sensors, or trying to pull the controller out of the wall to plug the PTAC unit in directly, and removing batteries from the sensor. While this type of incident was only reported by one of the seven participants we interviewed, the impact team found additional indications among the nine hotels where they conducted on-site visits.

Another lesson Honeywell and Smart Systems learned was to install hardwired thermostats for sensors and controllers wherever possible. Hardwired sensors do not require grey boxes on the wall that attract curiosity, and are likely to lead to a longer useful life by removing the issue of battery failure and replacement. Hardwiring also assures a longer effective useful life because it removes those same issues. Contacts also stated they would seek a flat sensor (with no camera-like lens) for future installations—something less likely to be noticed or tampered with by guests.

Program staff also reported learning of limitations of the technology. While sensors are supposed be able to detect sleeping people, if occupants do not move at all when they sleep the sensor sometimes cannot detect occupancy.

For the future, Honeywell contacts reported wanting to incorporate other features into the sensor, for example, the ability to detect when a lanai or balcony door is open and adjust the thermostat settings accordingly, and a lighting system that converts the bathroom lighting into a nightlight.

Honeywell contacts reported that the technology remains a viable energy saving measure in hot inland climates and that similar technology is being promoted in Las Vegas. Contacts from Honeywell and Smart Systems all stated that the program could be implemented on a statewide basis, but that coastal areas would be unlikely to be cost effective because of lower air conditioning requirements.

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3. Impact Evaluation

Impact Evaluation Methodology

The primary impact analysis approach used was an engineering assessment including site visits and measurements. These results were used to determine total program savings. A billing analysis was also undertaken to corroborate the engineering analysis. Free ridership ratios were calculated using self reports. Two sites had some degree of free ridership, and their savings were adjusted accordingly.

The program tracking database and the implementation contractor’s invoices had information on the name plate data of PTAC units in hotel/motel rooms where controllers were installed. The name plate data on new PTAC units installed was available, but the name plate data on the replaced PTAC units was not recorded before removing the older PTAC units, although the program data file does contain a field for such information. The program design did not require pre-installation metering to develop baseline data, and none were recorded. The controllers, however, had the capability to record the occupancy status of a room and the associated hours, as well as the status of PTAC operation (On/Off) and the associated hours.

Energy and demand savings from the installation of controllers were influenced by numerous factors such as the room occupancy, occupants’ preference for temperature setting, weather, hotel practice for PTAC operation, and location of room. Some of these variables have to be monitored over a long time before and after the installation of controllers in order to develop an accurate savings estimate. Without the baseline metered data, post-installation metering alone would not have provided adequate data to estimate savings with reasonable confidence within the timeframe and resources available for this evaluation.

Since the installed controllers were capable of recording important data for this evaluation, the available recorded data were used in conjunction with the verified equipment and operating parameters to estimate program savings using the engineering method in which the recorded data and verified parameters were substituted for the assumptions used to estimate ex-ante savings. In addition, billing analysis was performed using the 12-month pre- and post-installation billing history to validate engineering estimates. A secondary source search was conducted to compare the estimated program savings with reported savings from experience elsewhere and with the Database of Energy Efficiency Resources (DEER).

Data collection and verification visits were conducted of all nine program participants, to download cumulative data recorded by PTAC controllers since installation. The implementation contractor had downloaded controller data approximately three months after the installation of controllers, and the controller manufacturer had estimated the savings fraction from this data. By using data recorded over a longer duration, we expected to average out unusual situations and validate the savings fraction. The data download was planned to be drawn from ten percent of the 800 installed controllers, and in such a way as to ensure that temperature settings were not altered and the controllers were operational.

We interviewed the participant contacts to obtain information on the baseline practice of controlling temperature in hotel/motel rooms when a guest checks out and the room was not re-rented. It was necessary to ascertain the participants' practice because controllers would be more effective only in a rented room when it was unoccupied and the PTAC unit was operating. The name plate data for PTAC units in the sampled rooms were verified and found to match the invoice data of the implementation contractor. The participants had not made any changes to their facilities since the installation of controllers. During the verification visits and through process evaluation interviews, the change in hotel occupancy rate was estimated for most hotels.

Ex-post gross and net savings were estimated from the verified parameters, recorded occupancy and equipment operation profile, and interview responses.

A regression-based statistical analysis of energy bills was also performed. With a participating population of ten motels, this approach by itself--as the primary savings methodology--would be open to some criticism. However, with building-level monthly data available, the approach was nevertheless used as a way of triangulating the results of the engineering analysis.

The program deemed savings were estimated based on expected distribution of the size of PTAC units, full-load cooling and heating hours, and a usage reduction factor based on prior experience. The program impacts were estimated using two methods—engineering estimation and billing analysis—to ensure that final impacts were reasonable. We recommend crediting the program with the energy savings estimated using the engineering method.

Impact Evaluation Results

The program installed two types of technologies in hotel rooms: (1) a combination of an occupancy sensor and controller/thermostat, and (2) new PTAC units. Table 3–1 shows the ex-ante gross and net energy savings goals and reported program accomplishments. Table 3–2 shows the ex-ante gross and net demand savings goals and reported program accomplishments. Ex-ante net program savings goals and reported accomplishments were estimated using a 0.8 NTG ratio.

Table 3–1. Comparison of Ex-ante Energy Savings Goals and Reported Accomplishments

	Ex-ante Program Gross kWh Goals	Ex-ante Program Net KWh Goals	Reported Ex-ante Gross kWh	Reported Net Ex-ante Program kWh
Controllers	1,376,232	1,100,986	1,376,232	1,100,986
PTAC units	39,960	31,968	142,080	113,664
Total	1,416,192	1,132,954	1,518,312	1,214,650

The program reported gross and net energy savings are more than the ex-ante program goals because the reported program accomplishments include an additional 92 PTAC units installed by one customer as program spillover effect, according to the implementation contractor. The spillover adjustment was not made in reporting gross and net demand savings accomplishments.

Table 3–2. Comparison of Ex-ante Demand Savings Goals and Reported Accomplishments

	Ex-ante Program Gross KW Goals	Ex-ante Program Net KW Goals	Reported Ex-ante Gross KW	Reported Ex-ante Net Program KW
Controllers	802	642	802	642
PTAC units	36	29	36	29
Total	838	670*	838	670*

*Totals do not add due to rounding.

The program goals, ex-post gross and net energy savings, and the gross and net savings realization rates are shown in Table 3–3. The program evaluated ex-post gross energy savings are 168,874 kWh compared to the program goal of 1,416,192 kWh, yielding 12 percent gross energy savings realization rate. The program evaluated ex-post net energy savings are 144,478 kWh compared to the program goal of 1,132,954 kWh, yielding 13 percent net energy savings realization rate, which is higher than the gross savings realization rate because only one controller participant was a freerider. The program ex-ante savings estimates were based on a 0.8 NTG ratio. One participant, who installed new PTAC units, was a freerider; therefore, there were no ex-post net energy savings from PTAC units.

Table 3–3. Comparison of Programs Goals and Ex-post Gross and Net Energy Savings

	Ex-Ante Program Gross kWh Goals	Ex-Ante Program Net KWh Goals	Evaluated Gross Ex-Post Program kWh Savings	Gross Realization Rate	Evaluated Net Ex-Post Program kWh Savings	Net Realization Rate
Controllers	1,376,232	1,100,986	158,471	12%	144,478	13%
PTAC Units	39,960	31,968	10,403	26%	-	0%
Total	1,416,192	1,132,954	168,874	12%	144,478	13%

The program goals, ex-post gross and net demand savings, and the gross and net savings realization rates are shown in Table 3–4. The program evaluated ex-post gross demand savings are 56.38 KW compared to the program goal of 838 KW, yielding 7 percent gross demand savings realization rate. The demand realization rates are significantly lower than the corresponding energy savings realization rates because of low diversity factor for the controller operation. The program evaluated ex-post net demand savings are 54 KW compared to the program goal of 670 KW, yielding 8 percent net realization rate. A small amount of negative gross demand savings that resulted from replacing old PTAC units with higher capacity new PTAC[182] units was not included in the net ex-post demand savings estimate because the participant was a freerider.

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[182] Nameplate of existing PTAC units was retrieved from maintenance files of the hotel that replaced old units with new PTAC units

Table 3–4. Comparison of Programs Goals and Ex-Post Gross and Net Demand Savings

	Ex-Ante Program Gross KW Goals	Ex-Ante Program Net KW Goals	Evaluated Ex-Post Gross Program KW	Gross Realization Rate	Evaluated Ex-Post Net Program KW	Net Realization Rate
Controllers	802	642	58.00	7%	54	8%
PTAC units	36	29	-1.62	-5%	0	0%
Total	838	670	56.38	7%	54	8%

A summary of the savings analysis is shown in Table 3–5 and Table 3–6.

Table 3–5. Savings Summary

		Proposal				Reported				Evaluated	
	Ex Ante Gross	Net to Gross	Ex Ante Net		Ex Post Gross	Net to Gross	Ex Post Net		Adjusted Gross	Net to Gross	Net
kWh	1,416,192	0.8	1,132,954		1,518,312	0.8	1,214,650		168,471	0.86	144,478
kW	838	0.8	670		838	0.8	670		56	0.96	54

Table 3–6. Realization Rates Summary

	Proposal (%)			Reported (%)	
	Gross	Net		Gross	Net
kWh	12	13		11	12
kW	7	8		7	8

Engineering Estimates of Ex-Post Gross Program Savings

Ex-post Gross Savings

The data required to estimate program savings using the engineering method and billing analysis were collected from the program database, site-verifications, interviews of hotel staff, data stored in controllers, and weather data.

Engineering Method

The program ex-ante savings were based on the number of controllers installed (802) but the program budget was limited to the installation of 800 controllers and 36 PTAC units. Two extra controllers installed were not paid for by the program; therefore, 800[183] controllers and 36 PTAC units were used as the basis for engineering calculations.

The ex-ante assumptions on the capacity of PTAC units to be controlled and full-load operating hours were adjusted with the verified equipment capacities and recorded equipment runtime hours stored in the controllers (Table 3–7).

Table 3–7. Ex-ante and Verified Equipment Capacity and Runtime

	Ex-ante PTAC Capacity (KW)[184]	Average Verified Capacity (KW)	Ex-ante Full Load Hours[185]		Recorded Average Runtime Hours[186]
			PTAC Age 2 – 5 Years	PTAC Age 5 – 9 Years	
Cooling	1.5	1.19	1947	2336	870
Heating	1.5	1.99	365	438	152

The baseline ex-ante HVAC usage was higher than the evaluation estimate because the PTAC unit capacity and average runtime hours were significantly higher than the verified parameters. The verified heating capacity of PTAC units was higher than the ex-ante capacity but the recorded heating runtime hours were less than the ex-ante operating hours; therefore, the verified baseline HVAC usage was much lower compared to the ex-ante estimate.

The controllers stored data on the occupancy status of a room, i.e., the presence or absence of a person. These data were used to estimate the occupancy rate for each participating hotel/motel.

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[183] The program contract was limited to installation of 800 controllers. The two extra controllers installed were not paid for by the program; therefore their impact was removed. Spillover was not estimated for the program.

[184] Ex ante estimates are from the implementer program proposal specifications.

[185] Smart System controllers record the state of PTAC units (on or off, occupied or unoccupied). We used that data and also compared it with implied hours from the HVAC usage data

[186] Average is based on recorded runtime of 27 percent applied to the post-installation seasonal cooling (3,225) and heating (562) hours for Palm Springs.

The average room occupancy rate for the participant population was 46 percent.[187] Using the verified equipment capacity and recorded runtime hours for each hotel,[188] a revised baseline HVAC usage was estimated. For each hotel, ex-post gross verified savings were estimated by applying a savings fraction to the estimated revised baseline HVAC usage.

The program ex-ante assumption for the savings fraction was a 45 percent reduction in equipment runtime. The controller manufacturer calculated a reduction in runtime using the data stored for the occupancy sensor and equipment operating status. The methodology assumed that the hotel was not shutting off PTAC units when a guest checked out. From on-site verifications and process evaluation interviews, we found that several hotels were certain about shutting off PTAC units in unrented rooms. Some hotels stated that it was their policy to shut off PTAC units in unrented rooms but the cleaning crew occasionally forgot to turn them off. Two hotels reported setting the temperature control on low cool but allowing PTAC units to operate during the unrented period. We conservatively estimated that PTAC units in 50 percent of unrented hotel rooms were being shut off.[189] The manufacturer's calculated savings fraction was halved. The adjusted savings fraction and the revised HVAC baseline usage were used to calculate ex-post gross verified energy savings.

During site verifications, we recorded the operational status of the sensor/controller combination. The combination was considered nonoperational in the following situations:

1. The occupancy sensor and controller/thermostat were not communicating with each other.[190]
2. Either equipment was missing or removed.
3. The controller was bypassed.

Out of 95 sensor/controller-thermostat combinations verified, 21 were non-operational, i.e., a 22 percent persistence loss. Ex-post gross verified energy savings were reduced to account for this persistence loss. While a room occupant could adjust the comfort temperature setting, the temperatures to which a PTAC unit would be allowed to drift during unoccupied state were set by the manufacturer of controllers in consultation with participants; therefore, a room occupant could not tamper with the drift temperature setting.

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[187] For two hotels, controller failures were significantly more than other participants. The data for other hotels were averaged, or data from prior downloads were used for these hotels instead of using their controller data.

[188] Pre- and post-installation occupancy pattern is random and assumed to be the same under both conditions. The difference is that PTAC units were assumed to be operating to establish the baseline but cycling during post installation period. The billing analysis was used to corroborate engineering analysis.

[189] Several hotels reported this practice during onsite inspections. Allowing for some uncertainty that employees sometimes forgot to shut off ACs in unrented rooms and two hotels were maintaining rooms on low setting during the summer, we used 50 percent as our estimate

[190] Some combinations were reset/adjusted to work; however, they were considered nonoperational for the purpose of estimating persistence loss. The combination would not work if either unit was defective, batteries were missing, dead or installed incorrectly; or components were adjusted incorrectly.

Ex-post gross demand reduction for controllers required estimating diversity factor during the summertime as the probability of a PTAC unit operating in unoccupied rooms—rented as well as unrented. The controller data analysis showed that PTAC units did not operate more than ten percent of the time when rooms were unoccupied. Using this data for rented and unrented rooms (50 percent PTACs not shut off), gross demand savings were estimated. Table 3–8 shows estimated ex-post gross energy and demand savings.

Ex-post gross energy savings from controllers without persistence loss are 213,008 kWh or 20.6 percent of HVAC usage. After accounting for persistence loss, gross ex-post energy savings from controllers are 144,478 kWh or about 14 percent of HVAC usage. Most secondary sources have cited a runtime reduction of 40-45 percent; however, these sources have not mentioned the baseline condition, i.e., whether the PTAC units in unrented rooms were left operating or shut off. In a study performed by the City of Austin, occupancy-based thermostats reduced the PTAC runtime by 21 percent compared to a standard thermostat under identical conditions in a hotel setting.[191] This savings fraction compares well with the engineering estimate of 20.6 percent gross savings for this program. A long-term M&V study for this technology is underway in Las Vegas but the results are not yet available.

[191] E-mail dated June 2, 2006 from Paul Lusting of the City of Austin. The controlled units were 1.5 ton DX split system air conditioners.

Table 3–8. Engineering Estimate of Ex-post Gross Energy and Demand Savings

Hotel Site Number	Rooms Treated	Weighted Average Cool Watts per PTAC	Weighted Average Heat Watts per PTAC	Estimated Hotel Occupancy	Percent Runtime	HVAC Usage (kWh)	Adjusted Savings Factor	Ex-post Gross kWh Savings from Controllers	Verified Persistence Loss Fraction	Ex-post Gross Verified Savings (kWh)	Ex-post Gross Demand Savings
1	65	979	1746	50%	24%	64,561	0.05	3,228	0.83	549	4
2	108	1330	3500	67%	26%	176,582	0.21	37,082	0.25	27,812	9
3	62	1300	2330	54%	24%	81,245	0.205	16,655	0.28	11,992	5
4	84	1226	1061	23%	24%	91,346	0.225	20,553		20,553	6
5	90	1322	1272	52%	32%	143,608	0.19	27,286		27,286	7
6	128	1460	2200	45%	25%	188,970	0.248	46,864		46,864	11
7	124	1051	2810	34%	21%	129,287	0.235	30,383	0.77	6,988	8
8	96	805	740	44%	38%	109,104	0.225	24,548	0.43	13,993	4
9	43	1175	1160	50%	29%	51,269	0.125	6,409	0.62	2,435	3
Controller SavingsTotal						1,035,972		213,008		158,471	58
PTAC Savings	36									10,403	-1.62
Program Total										168,874	56.38

Ex-post gross energy and demand savings for 36 new PTAC units installed in the program were estimated from the pre- and post HVAC usage using identical runtime percentage, adjusted for the difference in equipment rating. The replaced unit, manufactured in 1985, had 11,300 BTUh capacity (1415 cool input watts and 3200 heat input watts). These units were replaced by 14,600 BTUh capacity PTAC units (1460 cool input watts and 2200 heat input watts) manufactured in 2005. The pre- and post-installation HVAC usage was estimated at 1,483 and 1,194 kWh, with gross savings per PTAC unit as 289 kWh. For 36 PTAC units, the engineering estimate for ex-post gross energy saving was 10,403 kWh. Adding these to ex-post gross verified kWh savings from controllers (158,471 kWh), the program evaluated ex-post gross energy savings are 168,874 kWh.

Because larger units were installed in the program, ex-post demand savings were -1.62 KW (45 watts per unit for 36 PTAC units). These were deducted from 58 KW ex-post gross demand savings from controllers; therefore, the engineering estimate for program ex-post gross demand savings is 56.38 KW.

Billing Analysis

To conduct the billing analysis, Quantec first requested monthly energy consumption data dating back to June 2003 from SCE for each of the nine hotel sites that participated in the Cool Cash program. SCE was able to provide complete billing data for all nine participants.

The installations for Cool Cash were completed between June and August 2005. As a result, complete data were available for each of the nine participating sites--12 months of pre- and post-installation data.

For each hotel, the zip code was matched to the appropriate SCE weather station. For these sites one weather station was representative of all nine sites (#181). The average daily temperature weather data was used to create base 50-80 cooling degree days (CDDs) and heating degree days (HDDs). The HDDs and CDDs were matched to each of the billing data periods.

In this billing analysis it was critical to isolate each hotel's HVAC component of usage. To isolate the HVAC usage, our modeling approach is similar to a PRISM cooling-only model,[192] with cooling reference temperatures varying from 50-80 degrees. In this modeling approach, 31 models were run for each cooling base--for each of the nine account level models, and for both pre period and post periods--for a total of 558 (31*9*2) models. For each hotel *i* and calendar month *t*, and cooling base *c*,

$$ADC_{it} = \alpha_{ic} + \beta_1 AVGCDD_{itc} + \varepsilon_{itc}$$

[192] Combination heating and cooling models were also created. These yielded very similar results. However, the slopes on the heating terms were predominantly negative, which is counterintuitive. As there are more heating degree days, usage should increase. Moreover, the heating components of usage where the signs were correct were very small. As a result, a cooling-only model approach was chosen.

where

- α_{ic} is the intercept for each participant at cooling base *c*. This represents the base load (non-heating usage) in the pre or post period,
- β_1 is the heating slope in the pre or post period,
- ADC_{it} is the average daily consumption during the pre (post) program period,
- $AVGCDD_{itc}$, is average daily cooling degree days (base *c*) pre (post) period, based on hotel location, and
- ε_{it} is the error term.

From the model above, the weather normalized annual consumption (NAC) for the pre or post period is computed as follows:

$$NAC_{ic} = \alpha_i * 365 + \beta_1 * LRCDD_{ic} + \varepsilon_{it}$$

where for each customer *i*, and cooling base *c,*

- NAC_i is the pre (post) period normalized annual consumption,
- α_i * 365 is the annual model base load (non-heating usage) for each hotel,
- β_1 is the cooling slope in the pre or post period from the model,
- $LRCDD_{ic}$, is the annual long run (normal) cooling degree days (base *c*) for hotel *i*, based on location,
- $\beta_1 * LRCDD_{ic}$, is the annual pre or post cooling usage component for (base *c*) for hotel *i*, based on location,[193] and
- ε_{itc} is the error term.

Based on the site visits and study, the occupancy rate was higher in the post-installation than in the pre-installation period. This would tend to over-exaggerate the post usage--and show less savings. The hotel occupancy was higher by 7.5 percent during the post-installation period and thus the post-installation HVAC load was reduced by 7.5 percent, i.e., adjusted as 92.5 percent of estimated HVAC usage to make it comparable to the pre-installation period.

The site level & overall summary regression results are presented in Table 3–9.[194] For comparison purposes, the billing analysis numbers from the engineering analysis approach are

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[193] Based on ten years of SCE weather history for station 181, the normal base 65 cooling degree days were 4017. Similar long run normal cooling degree days were computed for other bases from 60-75.

[194] The best pre and post models at each of the 9 sites were chosen as the models with the lowest RMSE – or equivalently the highest R-square – across the 31 varying bases. The final best models had reference base temperatures ranging from 59-79 , with an average of 69 degrees. Intuitively, in all models, both the base load (intercept) and cooling slope (β_1) were positive. The cooling components of usage ranged from 13% to 36%, depending on hotel, with an average of about 25% of total usage.

also presented there. The savings for the billing analysis varied by site, but the overall savings and realization rates were very similar between the two billing analysis methods.

As is evident from Table 3–9, savings observed in the analysis ranged dramatically by site, but in all cases were much lower than the expected engineering savings. In fact only two sites had realization rates over 25%. For the remaining seven sites the savings were either nonexistent, or usage was actually increasing.

One site (Site 5 more than doubled their HVAC usage from the pre-installation period. Examining the total usage, the post-installation usage increased by 37% from the total pre-installation usage. This increase is not attributable to the program, and may be possibly due to much higher occupancy in the post period or controller failure relative to the baseline practice or higher than observed persistence loss. If this site is considered to be an outlier, and excluded, the final savings estimate increases to 119,523 kWh (an 8% realization rate).

Table 3–9. Cool Cash Billing Analysis – Savings by Site (kWh)

Hotel Site Number	Weather Normalized HVAC Pre Usage	Weather Normalized HVAC Post Usage	Weather Normalized HVAC Post Usage (Adjusted for Occupancy - HVAC)	Billing Analysis Savings (Normalized for Weather Only)	Quantec Billing Analysis Savings (Normalized for Weather + HVAC Occupancy)	SET Billing Analysis Savings (Normalized for Weather + HVAC Occupancy)	Ex Ante Reported Savings
1	78,930	57,365	53,063	21,566	25,868	28,261	111,540
2	418,932	395,234	365,591	23,698	53,341	51,375	188,760
3	73,834	92,528	85,588	-18,694	-11,754	-8,394	106,392
4	100,851	98,418	91,036	2,433	9,814	15,745	144,144
5	41,757	117,971	109,124	-76,215	-67,367	-62,205	154,440
6	319,487	250,798	231,988	68,688	62,889[b]	39,109	277,368
7	114,281	151,688	140,312	-37,407	-26,030	-24,586	212,784
8	109,879	112,127	103,717	-2,248	6,161	8,683	164,736
9	24,903	37,990	35,140	-13,086	-10,237	-2,828	73,788
Unadjusted Billing Analysis Savings Estimate				-31,264	42,686	45,160	1,433,952
Adjustments for two controllers[c]				-32,197	41,753	44,227	
Savings from PTAC UNITS[d]				10,403	10,403	10,403	
Final Adjusted Billing Analysis Savings Estimate				-22,197	52,156	54,630	
Final Adjusted Billing Analysis Savings Estimate (w/o Site #5)				54,018	119,523	116,835	

[a] The occupancy adjustment was made to the cooling component of usage.
[b] This savings estimate excludes the savings for 36 of the 128 PTACS installed at the site, which would have been done anyway.
[c] For consistency, same adjustment to savings from SET's study for controllers removed.
[d] For consistency, same adjustment to savings from additional controllers installed by a hotel, through program spillover.

Reconciliation of Engineering and Billing Analyses

As described above, pre- and post-installation HVAC usage was estimated for each participant by reviewing electric usage during the heating/cooling season and shoulder months. The post-installation HVAC usage was then adjusted for warmer cooling season and somewhat cooler heating season during the post-installation period.[195] The hotel occupancy rates had improved post-installation which would have increased the HVAC load. The post-installation HVAC usage was adjusted for the increased hotel occupancy. Since the billing data already reflects persistence

[195] Data from Edison's weather stations in Palm Springs were used, which showed 3225 CDD and 562 HDD (base 65) in 2006 compared to 2962 CDD and 544 HDD in 2005.

loss, no adjustments were made for that reason. However, two more adjustments were necessary: (1) increasing the post-installation HVAC usage for one hotel that installed 92 additional PTAC units outside the program, and (2) deducting energy savings from two additional controllers installed but not paid for by the program.

The billing data show ex-post gross energy savings of 54,630 kWh compared to the engineering estimate of 168,874 kWh. The difference in these estimates might be from the changes in non-HVAC base load (hotels reported no such changes), room occupancy rates, or higher persistence loss compared to the persistence loss verified from the sample. A more likely reason for the difference is the savings estimate for one hotel where post-installation usage had increased substantially. The billing analysis showed negative savings for this hotel, but the engineering estimate (savings fraction applied to post-installation HVAC usage) showed positive savings. After removing this hotel from the participant population, ex-post gross verified savings from the engineering method are127,595 kWh, whereas the savings from billing analysis are 116,835 kWh. Because all uncertainties associated with the billing data may not have been fully accounted, the program has been credited with the savings estimated using the engineering method. Table 3–10 shows ex-post gross estimated energy savings from the billing data.

Table 3–10. Ex-post Gross Program Energy Savings from Billing Data (kWh)

Hotel Site Number	Number of Installed Controllers	Estimated Pre-installation HVAC Usage	Unadjusted Post-installation HVAC Usage	Adjusted Post-installation HVAC Usage after Weather Adjustment	Adjusted Post-installation HVAC Usage after Occupancy Adjustment	Estimated Savings per Hotel
1	65	79,860	60,240	55,782	51,599	28,261
2	108	308,896	300,649	278,401	257,521	51,375
3	62	64,296	84,864	78,584	72,690	(8,394)
4	84	88,620	85,080	78,784	72,875	15,745
5	90	46,800	127,260	117,843	109,005	(62,205)
6	128	259,661	214,304	198,446	183,562	39,109
7	124	93,206	137,519	127,343	117,792	(24,586)
8	96	95,368	101,202	93,713	86,685	8,683
9	43	28,912	37,056	34,314	31,740	(2,828)
Total	800	1,065,619	1,148,174	1,063,209	983,469	45,161
Adjustment for two controllers						44,227
Savings from PTAC units						10,403
Program ex-post gross savings						54,630

Ex-post Net Savings

Findings from the process evaluation showed that one participant was a free rider for controllers and one was a free rider for PTACs. Because there were only 9 participants in the program, we were able to adjust the savings, and calculate a NTG after the fact, rather than applying a proportion based on survey responses. After adjusting the program ex-post gross savings for one freerider participant each for controllers and PTAC units, ex-post net energy and demand savings are 144,478 kWh and 54 KW.

Ex-post Net Lifecycle Savings

In estimating ex-ante lifecycle savings, a 15-year measure life was used for controllers and PTAC units. The measure life for PTAC units with SEER rating 11 or more has been updated to 18 years. The ex-ante assumption about PTAC measure life was more conservative. However, the participant who installed PTAC units was a freerider; therefore, net lifecycle savings do not accrue for that measure.

The two components of the controller technology combination have different measure lives. The thermostat controller or the controller box technology operates in ways similar to a programmable thermostat, which has a measure life of 11 years according to the DEER database of measure lives. These controllers, however, must operate together with an occupancy sensor. A failure of either component will make the system inoperable. The occupancy sensor has a measure life of eight years, which is the weakest link in the entire system that must operate together. Therefore, an eight-year measure life was assigned to the controller measure. We note that the installed occupancy sensors require a periodic battery replacement to function effectively. It is assumed that users will replace batteries as needed to realize the full eight year measure life. Table 3–11 compares ex-ante and program evaluated EUL, and lifecycle ex-ante and ex-post gross and net kWh savings.

Table 3–11. Program Lifecycle Savings

	Ex-ante EUL (Years)	Lifecycle Ex-ante Gross kWh Savings	EUL Used (Years)	Lifecycle Ex-post Net Program kWh Savings
Controllers	15	20,643,480	8	1,155,824
PTAC units	15	599,400	18	-
Total		21,242,880		1,155,824

Table 3–12 shows program savings in the CPUC required format.

Table 3–12. Program Savings (CPUC Format)

Year	Calendar Year	Ex-ante Gross Program-Projected Program MWh Savings	Ex-post Net Evaluation Confirmed Program MWh Savings	Ex-ante Gross Program-Projected Peak Program MW Savings	Ex-post Evaluation Projected Peak MW Savings	Ex-ante Gross Program-Projected Program Therm Savings	Ex-post Net Evaluation Confirmed Program Therm Savings
1	2004						
2	2005	1,416,192	144,478	838	54	-	-
3	2006	1,416,192	144,478	838	54	-	-
4	2007	1,416,192	144,478	838	54	-	-
5	2008	1,416,192	144,478	838	54	-	-
6	2009	1,416,192	144,478	838	54	-	-
7	2010	1,416,192	144,478	838	54	-	-

Year	Calendar Year	Ex-ante Gross Program-Projected Program MWh Savings	Ex-post Net Evaluation Confirmed Program MWh Savings	Ex-ante Gross Program-Projected Peak Program MW Savings	Ex-post Evaluation Projected Peak MW Savings	Ex-ante Gross Program-Projected Program Therm Savings	Ex-post Net Evaluation Confirmed Program Therm Savings
8	2011	1,416,192	144,478	838	54	-	-
9	2012	1,416,192	144,478	838	54	-	-
10	2013	1,416,192	-	-	-	-	-
11	2014	1,416,192	-	-	-	-	-
12	2015	1,416,192	-	-	-	-	-
13	2016	1,416,192	-	-	-	-	-
14	2017	1,416,192	-	-	-	-	-
15	2018	1,416,192	-	-	-	-	-
16	2019	1,416,192	-	-	-	-	-
17	2020			-	-	-	-
18	2021			-	-	-	-
19	2022			-	-	-	-
20	2023			-	-	-	-
Total	2004-2023	21,242,880	1,155,824				

Note: Definition of peak MW as used in this evaluation: Average demand reduction during the summer months.

4. Conclusions and Recommendations

The program quickly reached its recruitment and installation goals and provided SCE an opportunity to test a new market and delivery method for PTAC power controllers and occupancy sensors. While control technology is increasingly common in hotel rooms nationwide, it is not penetrating the small-to-medium, independently-owned hotels, presumably because these hotels do not have the ability to absorb the upfront cost of installing the sensors in every guest room.

Conclusion 1: *The program was not completely implemented as planned*

The Technical Proposal had a very clear marketing plan. Cool Cash was to demonstrate a delivery mechanism "designed to successfully reach an economically challenged and hard-to-reach customer sector." Specifically, these were to include "smaller" hotels and motels—those most likely to lack the staff and financial capital required to identify and undertake energy efficiency projects without free or dramatically subsidized products and installation. However, the Purchase Order did not require the marketing plan be implemented nor did it require a marketing plan be developed, essentially minimizing language relating to how to market to hotel chains in the final Purchase Order agreement.

The program used limited screening criteria to identify potential hotel participants without clearly defining 'small" and did not reference organizational structure. Consequently, five of the seven participating hotels were chain hotels, only two were independent hotels, although some were franchised; one chain hotel (that was seeking to install PTACs) actually found the program themselves, and was not recruited through the program marketing process. While all of the participating motels could be considered small/medium size per the program Purchase Order, all of the chains were aware of the sensors.

With no requirement to develop and follow a marketing plan, the outreach undertaken consisted of a day of canvassing, beginning on one end of Highway 111 and continuing down the road until the program was fully subscribed. This outreach proved to be an effective way to quickly subscribe a program, but the final participant group did not effectively test the value of this technology for the small independently owned hotels the program proposal initially targeted.

Recommendation 1: The Purchase Order should require a marketing plan be developed and followed

Innovative programs need a sound marketing plan that can be implemented so that the innovative program can be tested under conditions that can be evaluated and assessed for effectiveness.

Conclusion 2: *Baseline practices matter.*

Interviews with hotel contacts indicate that prior to learning of the program, most were already concerned about PTAC operations when rooms were unoccupied, and were already taking some action. Six of the seven managers had assigned staff to turn equipment off. The low savings identified in the impact evaluation suggest that the baseline practices were already effective at saving energy, and thus reduced the potential savings from the control technology.

Recommendation 2: *Establish baseline practices.*

In addition to seeking truly independent hotels, it is important to develop a screen for selection of participants that establishes baseline practices for potential participants.

Conclusion 3: *Guest discomfort limits the effect of the technology.*

Just over half of the participants we interviewed reported receiving complaints from uncomfortable customers following the installation of the sensors. Complaints included rooms being hot when customers returned, or rooms heating up at night when guests were sleeping. However, some of these hotels continued to embrace the technology, taking steps to overcome the technological limitations. They consulted Honeywell and Smart Systems to adjust settings, and were happy with the results. One of the participants who reported receiving customer complaints described the volume of customer complaints to be about one customer per month.

Recommendation 3: *Further developments of the sensor technology are needed to overcome comfort complaints, especially differentiating between sleeping and absent occupants.*

Some capability may be needed to stop the controlling of the PTACs during nighttime hours when guests are likely to be sleeping, yet still allow them to control PTAC operation at night in vacant rooms. Another development would be to build capability to set different drift temperatures and cycle times for the summer and winter seasons. Allowing the room temperature to increase less during the summer time cycling period would reduce savings but increase guest comfort.

Conclusion 4: *The major market barrier is first cost.*

Without the benefit of an energy manager in the corporate office, smaller, independently-run hotels are put off by the cost of the technology and unable to see the business case for its use. None of the participating hotels would have installed the sensors without the program's funding their installation. Skepticism on the part of hotel management toward claims of savings was also an important barrier.

Recommendation 4: *A generous incentive or direct installation will be necessary for smaller hotels.*

This direct install program demonstrated that these controllers can be installed in small hotels when no cost share is required. Should Edison consider a similar technology in the future, a direct install or a generous incentive will be necessary to encourage the installation of the sensors in small and medium-sized independent hotels

Conclusion 5: *Even participants pleased with the technology and the savings experienced operational problems.*

The sensors were provided for free, yet some participants did not have enough faith in the technology to work out solutions to problems they encountered. One participant reported that the first time a sensor malfunctioned the hotel staff had no idea what to do. A simple reset resolved the issue. In some cases it appeared that the sensors' default settings may not have been appropriate for the particular hotel's needs, yet some did not seek assistance, and one turned the sensors off for the summer.

Recommendation 5: *Train hotel staff.*

Training of hotel staff is necessary. Hotel staff should be aware that the sensors can malfunction from time to time, and know how to reset them. Follow up with participants who install the technology to find out how well the sensors are working, and whether there are operational issues that might be mitigated or eliminated by adjusting settings. Because of reportedly high turnover in the targeted hotels, it may also be warranted to provide follow up with participating hotels over the longer term, to ensure the new hires understand the technology and how it should be used.

Conclusion 6: *Hotel management does not appear to be aware of how well the sensors are actually operating.*

The process interviews revealed just a few reports of sensors that had been tampered with, or that had failed, while the impact evaluation found failure rates of approximately 22%. The overall satisfaction with the measures as reported by most participants in the process evaluation is likely an indication that hotel management is simply unaware of the rate of sensor failure in their own hotels.

Recommendation 6: *Create a system for staff to monitor sensors.*

Identify a feedback mechanism that can easily inform hotel maintenance or management staff of the status of the sensors and train them on how to use it. Satisfaction with the measure may drop, but overall energy savings estimates will be more reliable if there is a way to assure that sensors are kept in operable condition. In addition to staff training, two technology improvements would help users better monitor the sensor operation and minimize persistence loss. First, a central energy management control module, preferably wireless, should be developed that shows the status of sensor/controller combination. When a guest checks out or the equipment malfunctions, the control panel can give a visual signal to the operator. Second, numerous failures of occupancy sensors and the battery replacement requirement for them make a case for a hard-wired occupancy sensor installation. This would increase the installation time but improve installation persistence.

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8. Energy Efficiency for Oil Producers Program

1. Program Description

The Energy Efficiency for Oil Producers program was a constituent program of Southern California Edison's 2004-2005 Innovative Designs for Energy Efficiency Activities (IDEEA) Program, and ran from June 2005 through June 2006. In 2004, in response to the request for innovative energy efficiency proposals issued by Southern California Edison (Edison), Global Energy Partners (Global) proposed a program aimed at increasing the energy efficiency of oil extraction facilities operated by small to medium independent California oil producers. The program design was similar to a program implemented by Global in 2002 and 2003, the Energy Efficiency Services for Energy Consumption and Demand Reduction for Oil Production (2002-2003) program. The 2004-2005 IDEEA Energy Efficiency for Oil Producers (2004-2005) program built on the experience of the earlier program. This program was mainstreamed and is currently being implemented for the 2006-2008 time period (2006-2008 program).

Historically, small- to medium-sized independent oil producers have been infrequent participants in utility energy efficiency programs. Global noted in their proposal that there are significant market barriers to their participation, and small- to medium-sized independent oil producers are considered a hard-to-reach market. A ubiquitous characteristic of these producers is a lack of the staff resources necessary for researching, identifying and implementing energy efficiency improvements to their production facilities. The producers similarly lack the staff resources necessary for contemplating participation in a utility program.

The 2002-2003 program was the first known attempt to recruit participants from this hard-to-reach market, and was very successful. It was seen as significant that Global had discovered an innovative approach to recruitment, and that the approach had proven effective. The 2004-2005 program targeted independent oil producers with production rates not greater than 20,000 barrels of oil per day (bopd). Many participants were recruited from the 2002-2003 program.

A goal for both the 2002-2003 and 2004-2005 programs was to educate producers to recognize the value of energy efficiency and the opportunities to improve the energy efficiency of their facilities.

Participants in the 2004-2005 program could chose among a list of prescriptive measures with pre-set incentives, or they could pursue an energy efficiency project of choice, with the incentive amount based on the metered savings for the project. Incentive levels were set at 5 cents per first-year kWh saved by the project, up to a maximum of 50% of the project cost, but incentives for motors, drives, and controls were set at 8 cents to match the incentives available through Edison's standard performance contracting program (open to all commercial and industrial customers, including oil producers).

Some of the program technologies included:

- Conversion of outdated pumping systems
- Well pumping optimization through pump-off controllers
- Other motor controllers
- Proper sizing of motors, pumps, and specification of premium efficient motors
- Variable frequency drives and controllers
- Water reduction technologies
- Splitting water injection systems into high pressure and low pressure systems

The program's original budget was just over $1.5 million, with nearly $1 million slated for direct implementation. When the entire original incentive budget was exhausted within the first six months of the program, an additional $1 million was added to the incentive budget.

Global's proposal listed performance goals, including seeking potential participants' interest in pursing projects on 3,680 wells, and a surveying and qualifying 368 of those wells. The survey/qualify process included verifying that the wells were in Edison service territory, that the producer was interested and had the money to complete the project, and that the well was a good candidate for the measure. These goals were later reduced to 2,140 recruited wells and 214 surveyed and qualified wells.

Global's proposal expected that program activities would lead to 184 certified installations, saving a total of 14,720,000 kWh of electricity, and 1,840 kW. These goals were also subsequently reduced. The revised goals called for 107 certified installations, 13,848,000 kWh in energy savings, and 1,731 kW of demand savings. No installation goals for individual measures were identified.

Global reported program activities resulted in 1,344 customer wells recruited, 858 wells surveyed and qualified, and 158 certified measure installations.

Comprehensive process and impact evaluations were conducted. The process evaluation involved interviews with program staff and implementers and operators. The impact analysis was a detailed engineering analysis, including reviews and recalculation of engineering algorithms, detailed reviews of program records and verification site visits at 35 oil well sites, with an M&V component. These approaches generally conformed to the Basic rigor level for process and impact evaluation as defined by the 2006 California Evaluation Protocols.

The next section of this report (Section 2) presents the process evaluation component of the evaluation. The process evaluation includes a discussion of the program logic, design and implementation, contractor and participant decision making and satisfaction. Section 3 reports the impact evaluation methodology and results from the engineering assessment of the program. Finally, Section 4 presents the major conclusions and recommendations.

2. Process Evaluation

Process Evaluation Methodology

The purpose of the process evaluation was to document the program design and its development, including any differences between the proposed program design and the program that was implemented. The background and rationale for the program were examined, and a program logic model was developed. Interviews with program staff and producers were implemented to gather information on market assumptions and barriers to project implementation, as well as implementation issues such as marketing and recruitment efforts, project identification and selection, and free ridership and spillover.

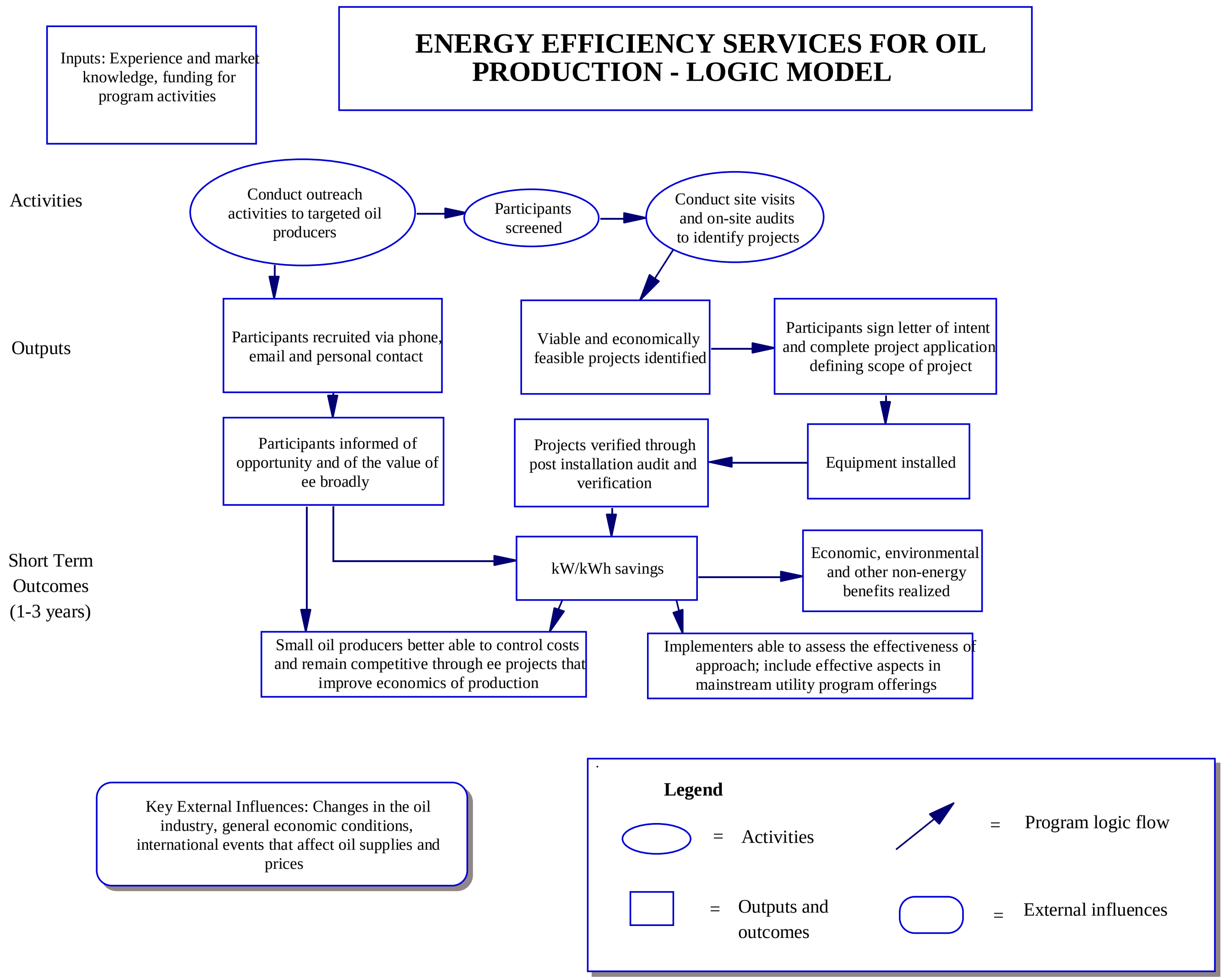
Program Logic Model

The program logic model diagram in Figure 2–1 shows the key features of the program as understood by the evaluation team, indicating the logical linkages between activities, outputs, and outcomes. The program has three primary activities: conducting outreach to targeted oil producers, screening participants, and conducting site visits and on-site audits to identify projects.

These activities are expected to result in participants recruited and informed of the opportunity and the value of energy efficiency, viable and economically feasible projects being identified, and participants signing letters of intent that lead to completed project applications.

Short and intermediate term outcomes include the installation of eligible equipment, projects that are verified through post installation audit and verification, kW and kWh savings and other economic and environmental benefits. Ultimately, the program goal is to make independent small and medium oil producers better able to control costs and remain competitive through energy efficiency projects. An added outcome for all 2004-2005 IDEEA projects is that Edison staff gain experience with a new market approach and technology.

Figure 2–1. Final Logic Model



Process Evaluation Sample Design

The program was implemented by Global between January 2005 and December 2005. Nine oil companies participated in the program, completing installations at 158 wells. Data collected for the process evaluation included interviews with two staff members at Global, including the program manager and the field liaison. Interviews were attempted with all nine of the participating producers and were completed with representatives of five. The five companies whose representatives were interviewed completed 56 projects through the program. The six contacts interviewed at those five firms were familiar with a total of 36 projects. In addition, at each of the five sites visited by the impact evaluation team, a field operator was interviewed.

Research questions for the process evaluation were developed as part of the work plan and then used to develop interview guides. Interviews with staff explored the origins of the program design, including how the 2004-2005 IDEEA program design differed from that of the earlier 2002-2003 program Global had implemented, and then discussed how the program was implemented and the lessons learned from the program implementation process.

Interviews with participating producer representatives explored the companies' decision-making processes, both with regard to becoming involved in the program and with regard to selecting energy efficiency projects. These interviews also explored participants' experiences working with the program and their perspectives on the projects they had completed. No list of non-participating owners could be identified, and therefore, none were interviewed. Table 2-1 shows the number of planned and completed interviews for the process evaluation.

Table 2–1. Sample Goal and Achievement

Task	Goal	Achieved
Program/implementer staff	4	3
Participating owners	6	5
Participating operators	15	5
Non-participating owners	4	0
Total	29	13

The interviews took place between June and August, 2006. Table 2–2 shows number of projects which with the key contacts were familiar as well as the number of projects completed by that firm in the program. In the case of Firm 2, the key contact had recently joined the firm and could only speak to those completed since his employment; the remaining projects had been completed prior to his tenure. Additionally, as is invariably the case, it was often difficult to get contacts to discuss each project; they tended to focus on some projects and not others, depending on which ones stood out in their mind.

Table 2–2. Projects Represented in Sample

Firm	Respondents' projects	Respondents' firms' projects
Firm 1	1	1
Firm 2	5*	22
Firm 3	1	1
Firm 4	13	13
Firm 5	16	16
Total	36	53

*Contact had only been with the company for a small portion of the program period. He was listed as the program contact for 21 projects, but was primarily familiar with a certain type, of which his company had completed five installations. The exact number of projects he was involved with is not known.

Interviews with the field operators at participant facilities were brief. For the process component, interviews with the operators focused on their level of contact with the program, potential disruptions to their operating procedures caused by program activities, and whether they had experienced any problems with their equipment since installation.

The process evaluation team posed a series of questions to participating contacts to aid in determining the Net to Gross (NTG) ratio for each project. The participating producer contacts were asked whether they had previously considered implementing any of their projects, and if so, why they had not pursued them before, and when and if they would have ever pursued them had working with the program not been an option. Participants were also asked how important the financial incentive was in their decision to pursue the projects.

Process Evaluation Results

Program Design

The 2004-2005 program is firmly grounded in Global's experience with the 2002-2003 program. For instance, the incentive approach for the 2004-2005 program was developed during implementation of the 2002-2003 program as they adjusted the program to meet the market response. Implementers had experienced difficulty getting producers to understand the prior incentive formula, and became aware that it needed to be simplified. They designed the new incentive formula to mirror the formula used by Edison's Standard Performance Contracting program. Limiting the rebate to 50% of the project cost was seen as a way to make sure participants would be sufficiently invested in their projects.

Global staff asserted that the design for the 2004-2005 program was essentially the same as that of the 2002-2003 program. One major difference was that, while both the 2002-2003 and the 2004-2005 programs limited eligibility to producers with production rates less than 20,000 bopd, the 2002-2003 program had targeted the smallest producers, intending for about 60% of participants to have production rates less than 6,000 bopd. This stipulation was not part of the 2004-2005 program. Another difference was that while the 2002-2003 program attempted to focus on projects with a one-year payback, that focus reportedly caused some difficulties, and was removed from the design of the 2004-2005 program.

In addition, some refinements to the program design were detailed in Global's technical proposal to Edison. The marketing plan reflected the fact that Global had existing relationships with a number of willing potential participants. Additionally, the education and outreach plan included case studies developed from the 2002-2003 program activities.

Market Assumptions, Marketing, and Decision-Making

Global's proposal explains that through their experience implementing the 2002-2003 program they had found conventional marketing efforts and activities (e.g. brochures, targeted letters, telephone and email) to be ineffective for the targeted market. The program implementers report that small to medium independent producers *"require individual attention to make them aware of the program and help them identify and develop potential energy efficiency projects."* Multiple visits to producers' facilities are sometimes required, where program staff explained the program and potential benefits to technical and managerial staff. Global's proposal portrayed the individual attention as necessary for targeted producers to get and stay serious about working with utility energy efficiency programs. The strategy of providing individual attention to producers was the program's key innovation.

The marketing plan for the 2004-2005 program centered on exploiting not just the knowledge gained from implementing the 2002-2003 program, but also the resources. The success of the 2002-2003 program recruitment efforts left Global in possession of a list of already-identified qualifying producers eager to participate should the program again be available. This aspect of the marketing plan represents a difference from the 2002-2003 program. During the 2002-2003 program, staff planned to and did expend considerable effort identifying interested potential participants. For the 2004-2005 program, at least initially, no marketing efforts were required beyond announcing the program's renewed availability to those previously identified producers.

Global staff report in 2002-2003 they had needed to spend a lot of time and effort marketing and recruiting participants, however, the 2004-2005 program was much less challenging since they were able to rely on their previous recruitment efforts first. According to program implementers, recruiting participants was similarly easy for the second round of funding.

> *"Like any good sales organization, we go back to who we've been successful with first. We did that. We were able to commit our first round of funding almost exclusively with past participants."*

Since the initial recruitment strategy was to rely on previously identified interested producers it is clear that much of the proposed marketing strategy was not innovative. However, the tactics Global refined in the 2002-2003 program were portrayed as essential for the "deal-closing" process – in other words the tactics are necessary for keeping even interested producers paying attention to the projects and seriously pursuing them. The 2004-2005 program confirmed that this level of outreach was necessary. In addition, they published papers in trade magazines and gave four workshops at events associated with the Petroleum Technology Transfer Council to further spread the word about the program.

Participating producers confirmed program staff reports that recruitment efforts focused on previously-identified contacts. All five of the participants we interviewed indicated they had been aware of the 2002-2003 program, but only one of these firms reported having completed a qualifying project through that program, see Table 2-3. One contact had experience with the 2002-2003 program through a previous employer that had participated in the 2002-2003 program, but his current employer had not been involved with the 2002-2003 program. One firm had identified several projects as part of the 2002-2003, but had not pursued them before participating in the 2004-2005 program.

Table 2–3. Level of Involvement in 2002-2003 Program

Involvement Level	Count
Aware of 2002-2003 program	3
Identified project ideas	1
Completed projects	1
Total	5

Participation in other energy efficiency programs was minimal, just two of the five contacts reported their firms had participated in utility energy efficiency programs.

Not all participants could remember how they found out about the renewed opportunity to participate in the 2004-2005 program, but those who could remember reported learning directly from Global staff. All five contacts described that they felt free to explore participation options without any approval from superiors. Three contacts reported having the final authority to commit to projects, though one of these contacts reported that others were also involved. This contact explained that his group (production engineering) was given authority on the project because of the function of the equipment in question: production engineering is in charge of "down-hole" equipment and facilities engineering is generally in charge of surface equipment. One of the other contacts with final authority was an owner of a very small firm. One of the two participants reporting management approval was needed to commit to projects indicated the level of management approval needed rose with the project cost, with approval from the company president required for very expensive projects.

The reasons for participating varied, though all participants reported being attracted by the rebates. In explaining their motivation, all five participants also reported having in mind specific ideas for projects which they thought would probably qualify for rebates. One contact remembered being told about improved energy efficiency. Another participant's firm had recently purchased a new field with a number of wells using an extraction technology known to be inefficient, and was looking to upgrade them.

Global staff explained that as a result of the 2002-2003 program effort not only did Global have contacts but they also had developed a reputation.

> *"The thing that was successful in 2002-2003, and continues to be in 2004-2005 and beyond, is the fact that we, Global, have almost become a branded entity. Because we were operating with and for Edison, people have started to know who we are. People will call us now having heard of the work we've done in the past. People have heard about successful projects and get referred to us."*

This was confirmed by some of the participants. One participant reported his project was precipitated by equipment failure, and that his firm has learned to contact Global whenever this occurs in case rebates are available for the purchase of high-efficiency replacement equipment.

Program Delivery and Implementation

Table 2-4 shows the range of the number of wells owned by the participants in the program we interviewed. Since producer eligibility was based on production (20,000 bopd), not number of wells operated, this information does not confirm or disconfirm the eligibility of sampled participants, but it does reflect that small and medium producers and no large producers were recruited.

Table 2–4. Size of Producers

Number of Wells Operated	Count
1 to10	1
11 to 200	1
201 to 500	1
501 to 1,000	--
Over 1,000	1
Not available	1
Total	5

The process of project identification envisioned in Global's proposal called for a series of simple, discrete steps:

1. Global identifies an interested producer.
2. Global visits the producer's facility to help identify appropriate measures, and identify good candidate wells to receive the measures.
3. Global quantifies the costs and savings of the various options, and reports this to the producer.
4. The producer submits an application to the program describing the projects they have selected to pursue.
5. Global evaluates the application, checks calculations and cost-effectiveness, and determines a preliminary rebate amount.
6. The producer signs a Participation Agreement, and Global reserves rebate funds for the project. The producer may begin work on the project.
7. After completion of work, Global commissions and certifies the installation. For custom projects, metering is done to determine savings for final rebate amount.
8. Rebate payments are made to producers.

The project-identification process reportedly used by program staff differed somewhat from that described in the proposal. Staff reported they usually visited the producers' facilities to discuss prospects for projects, but the projects were usually not identified through an audit of the facility or a technical analysis study performed by Global's field staff as might be inferred, but rather a brainstorming session with producers, program staff, and vendors. Program staff reported deviation from the steps given in the proposal was primarily due to the fact that so many of the participants were already quite familiar with the program. Producers usually had already put some thought into what they wanted to do beforehand, obviating some of the project-identification efforts foreseen by the proposal.

Participants' reports confirm staff descriptions of the project development process. Four out of five participants reported having come up with their own ideas for the projects they completed through the program as shown in Table 2–5. One of the five participants reported the idea for the project originally arose from a presentation Global made in 2002 or 2003 which the firm had considered pursuing, but chose not to because of the project economics. Though Global indicated vendors were present in the discussions, no participants volunteered comments about vendors when reporting on how they identified their projects (participants were not specifically probed about vendors).

Table 2–5. Origin of Project Ideas

Origin		Participant
General	Specific	
Global presentation (1 participant total)	Considered during 2002-2003 program	1
Participant came up with on their own (4 participants total)	Equipment failure	1
	Project Type 1: Newly acquired inefficient field (15 of 16 projects) Project Type 2: Need variable speed for planned slow ramp-up of production (1 of 16 projects)	1
	Analyzed wells looking for low producers	2
Total		5

The amount of technical assistance needed from Global for support of projects depended on the particular producer and the specific project. Projects with which Global had a lot of experience required significantly less effort for technical analysis. Additionally, technical analysis was far less important when producers were already completely convinced that they wanted to pursue the project. Program staff said Global did not rule out any projects for lack of cost-effectiveness; if the producer believed a project was cost-effective, the producer could pursue it.

When asked what kind of support Global had provided them through the process of evaluating their options and selecting the projects they would pursue, some participants reported not requiring any such assistance, while three participants said Global had been "helpful" or "very helpful." One participant reported Global provided them with data for calculations. Another reported Global sat in on most planning meetings and helped with organization and project management.

Greater involvement with vendors in the program was recommended by an evaluation of the 2002-2003 program. The involvement of vendors, especially in the project identification process, was reported by program staff to be helpful because the targeted producers rely on their vendors for technical expertise to varying degrees. The trusted advice of the vendor can be useful in overcoming doubts.

For custom projects, savings are measured in different ways, depending on the available options. Global uses the producers' electric meter and bill in those rare cases where wells are separately metered. Otherwise, Global uses portable meters installed before and after retrofits, comparing consumption readings to arrive at the savings estimate.

Staff reported no problems related to equipment delivery, but they did report scheduling was sometimes an issue, because of the inherent need of many of these types of projects for rigs that can "pull" the wells. According to staff this was especially a problem for smaller producers. Staff also reported that for water-shutoff projects there are only a handful of companies capable of doing some of the supporting analyses, and this can cause delays.

No scheduling problems were reported by any participants, though one participant mentioned having to schedule projects such that no more than a few were going on at a time. Only one firm reported changes to operating procedures that were necessary to accommodate new equipment were benefits. This firm reported the new controller was easier to use and saved staff time.

Market Barriers

Because recruitment was virtually effortless, with so many interested participants having already been identified, no significant barriers to recruitment were encountered. As reported earlier, all participants reported they were first attracted to the program by the rebates.

According to implementers, the overriding market barrier dissuading targeted producers from implementing energy efficiency projects was a lack of internal staffing resources. In addition to preventing producers from implementing more energy efficiency projects, this barrier was also active in making the small to medium independent producers a difficult recruitment target for energy efficiency programs. Not only did the targeted producers lack staff who have the time, authority, or ability to maintain an awareness of energy efficient process upgrades, but the tightness of staffing resources at targeted facilities actually makes them unable to manage an energy efficiency upgrade project through to completion once it's been started.

> *"They just don't have the people to do their own project management. If they get the people, they're not there long. They get swept up into a vendor or a competitor. If you have people that can stick around, we'd see repeat participation."*

Implementers explained that the lack of staff resources was especially true of the smallest producers, where the owners may not even be involved in managing or operating the facility. Said one contact: *"they sit by the mailbox and wait for checks."* Such an organizational structure prevents anything other than conventional options from ever being considered.

Confirming program staff's opinion about lack of staff resources, only one participating firm reported there was someone on staff responsible for tracking electric energy costs.

Program staff noted that once the barrier of staffing resources is overcome, producers are extremely receptive to energy efficiency upgrades.

> *"The producers are willing to make investments in efficiency. They have the financial resources. It is really a human resources thing."*

Furthermore, implementers reported that the economics of many of the measures are so good already that the impact of rebates on project payback is often insignificant. This suggests, notably, that the upfront monetary cost of energy efficiency projects is not as important a barrier to this market as it is in most other markets. However, program staff noted the rebate money is essential to the economics of some of the more risky types of projects, like water shutoff.

> *"If you look at a lot of these measures, the paybacks on some are fairly short anyway."*

Implementers explained that while money for projects is not in most cases an important barrier for this market, the rebate money does play a variety of important roles. It attracts new producers into the program and keeps past participants interested in pursuing more projects. Once a producer has been attracted to the program by the rebates, there is a potential for that producer to begin thinking about how to make their facility more efficient, something that may not have happened otherwise. As knowledge of the rebates' availability has spread, Global has begun to receive calls from producers who have heard by word-of-mouth about the rebates and are interested in finding out if they qualify. Also, Global staff reported that news of the rebates can get back to corporate management, who will then sometimes encourage production staff across the company to consider participating.

Additionally, implementers reported the rebate money served to rearrange the priorities of producers and their staff, such that the efficiency projects become prioritized over other possible expenditures of money and staff time. Staff also reported that some lesser known measures may be seen as more legitimate in the eyes of producers because the utilities are willing to fund them.

When considering whether rebates should be reduced or eliminated at some point, implementers pointed to past experience as a guide. *"When we had a three or four month hiatus in the program [between 2004-2005 and 2006-2008], it was amazing how people stopped doing stuff. Anecdotally, that appears to be the litmus test."* Global learned of the participants' inaction after the 2004-2005 program ended and as they were conducting marketing and outreach for the 2006-2008 program. When asked whether some participants might continue investing in efficiency having been introduced to technologies and the value of efficiency, implementers believe the answer is "no."

However, when asked whether some producers might continue working with Global to pursue energy efficiency projects if Global's technical assistance and project management support was still available but the rebates were not, Global staff reported having wondered themselves if some might do so. *"If you look out far enough, from an energy efficiency policy perspective, and said what if we started winding down the amount of money for rebates, would you get the same amount of work done? We don't really know."*

Participants' Experience with the Program and the Technology

All five participants expressed appreciation for the program, and several complemented program processes for being simple and appropriate. Two participants commended Global for their responsiveness and effective communication. All five participants reported that throughout their experience with the program, they had a clear understanding of the participation steps.

Most (4 of 5) participants reported they had experienced energy savings since their projects' completion (Table 2-6), but few of these had specific knowledge. One noted his understanding was based on Global's word. One contact was confident that some of his firm's projects had not yielded the expected energy savings, however, he reported this was because his company underestimated the new well's production. He added that estimates are often wrong and the firm was not giving up on the technology.

Table 2–6. Realization of Energy Savings

Response	Count
Yes	4
Some yes, some no	1

Reports from field operators at participants' sites describe a positive program experience with minimal disruption. All five operators surveyed rated the projects' disruptiveness to their normal operating procedures as "1", the lowest rating on the five-point scale. All five reported that no significant changes in their operating procedures were necessary to accommodate the new equipment, though one operator mentioned that the new equipment made certain tasks easier. Also, all five operators reported that program staff were professional and courteous and did their best to minimize disruptions.

Operators reported no problems related to scheduling, obtaining equipment, or installation. Four of the five operators reported that all of their equipment had been functioning as expected since installation, while the fifth operator reported that a piece of equipment had turned out to be faulty, but the issue was corrected without incident.

Free Riders

Participants were asked whether any of the projects they completed with the program had been considered before, and if so why they had not pursued the project before, and why they went forward with the project now. Four of the five participants reported having considered at least some of the ideas before. All four of these mentioned the rebate when explaining why they pursued their projects at this time, as shown in Table 2-7. One remaining participant who had not considered the idea before replacing failed equipment.

Table 2–7. Why Firm Pursued Project at This Time

Firm	Ideas Considered Before?	Why Project Pursued at This Time	
		Mentioned Rebate?	Other Factors Mentioned
Firm 1	Yes	Yes	None
Firm 2	Yes	Yes	None
Firm 3	Yes	Yes	Price of technology came down, found better candidate wells
Firm 4	Some yes	Yes	Acquired field with particularly inefficient wells
	Some no	No	Needed variable speed for slow ramp-up in production
Firm 5	No	No	Equipment broke

Participants were also asked if they believed any of their projects were likely to have happened even without the rebates, and if so, which projects might have been initiated independently, how likely they were to have happened, when they would likely have been initiated, and how the projects might have done differently. Participants were also asked about the importance of the financial incentive.

According to responses to these questions, it appears that many projects would not have happened without the rebates, while at the same time, some probably would still have happened. Four of the five participants indicated they probably would have completed at least some of the projects on their own, but it appears these firms would have pursued considerably fewer projects than they did. These results are presented in Table 2-8.

When examining Table 2-8, it is important to note the number and type of projects being discussed. For example, while Firm 5 is quite likely to have completed one VFD project without incentives, they are extremely unlikely to have replaced any of their outdated systems with RBPs when they did, or ever outside of the program. The RBPs accounted for the lion's share of their projects. In addition, Firm 2 indicated they would have completed their high-efficiency motor and pump projects without rebates. The respondent reported primarily contacting Global when they encountered equipment breakages. Considered alongside the report of their policy to always use high-efficiency motors and pumps regardless of rebates, it appears virtually certain the motors and pumps portions of the project would have happened without the program's funding. However, Firm 2 had completed many other 2004-2005 program projects of others types before the contact arrived at the firm; he had knowledge of only a few of the most recent projects.

Table 2–8. Free Ridership Summary

Firm	Firm 1	Firm 2	Firm 3	Firm 4	Firm 5	
Project*	Install VFD controller and POC	Install high efficiency motor and pump	Water shutoff	Install high efficiency motor and pump	Install VFD	Replace System with RBP
Projects completed of type	1	21	1	13	16	16
Projects discussed by contact	1	5	1	13	1	15
Would you have initiated any projects on your own	No	Yes	No	Yes	Yes	Don't know
Reported probability they would have been pursued	--	High	--	High	High	Low
Ever done similar projects before	No	Yes	No	No	Yes	No
What would have happened without rebate	--	Broken equipment still would have been replaced with high-efficiency per company policy	--	Retrofits only on wells with extremely low production	VFD	KOBE replacements
Why projects would/would not have been pursued	Rebate essential	Company policy, "just good business"	Rebate essential	Economics can work even without rebates	So suitable for application that economics work without rebates	Marginal economics without rebates
When projects would have been pursued	--	Same time	--	Probably later than they were	Same time	Maybe eventually, maybe never
Reported importance of rebates	High	Low	High	High	Low	High

* The numbers listed with each firm's project(s) represent the number of projects the firm completed of that type and the number of projects the respondent was the primary contact for. For example, in Firm 2, this respondent was the primary contact for 21 projects, but the contact referred primarily to only five projects.

It should be noted that, while Firm 1 would not have pursued any of their projects without the program, the representative volunteered that his firm would probably install pump-off controllers on other wells in the future even if no rebates are available because of their experience of the technology with Global. "Runaway winners" was his assessment of the economics of pump-off controller projects, even without rebates.

The technology is being adopted within the industry and some measures offered by the program are likely to be considered outside the program process. Because of ongoing involvement of the participants, all could be considered free riders or none could be free riders. Therefore, we cannot reject the null hypothesis that the NTG ratio is .80, and .80 is used as a placeholder.

Potential Spillover

Three participants reported they had begun additional energy efficiency projects through participation in current utility-sponsored programs. Only one contact reported pursuing energy efficiency projects by themselves on other wells since participation. This was the contact who reported their firm always uses high-efficiency motors on new wells.

Lessons Learned by Program Staff, Future Plans

Program staff did not report learning any new lessons through the implementation of the program, but they did find confirmation of lessons learned in the 2002-2003 program. That is, there is value in their innovative marketing approach, where a field liaison goes out to producers' production shacks, attends meetings and encourages well operators to keep moving on projects. The key is interacting with producers and vendors on an ongoing basis. "*Projects will languish and die otherwise.*"

In addition, according to implementers, persistence on their part and long-term programs are very important in this market. Oil producers typically have long, often multi-year, time-frames from project consideration to project completion.

3. Impact Evaluation

Impact Evaluation Methodology

The objectives of the evaluation of the IDEEA Energy Efficiency Services for Oil Production Program, implemented by Global Energy Partners, were to develop ex-post adjusted gross and net savings for the Program. The general methodologies employed to measure and verify energy savings attributed to the Oil Production Program included the following activities.

1. Measure installation verifications.
    a. Developing a sample for field verification activities.
    b. Conducting field verification activities and observations which included reviewing information from the pre-existing logging infrastructure at participant sites as provide by the implementation contractor.
    c. Reviewing any data on verification activities completed by Edison.
    d. Developing adjusted measure installation rates based on field activities and data reviews.
2. Engineering analysis to develop ex-post realization rates.
    a. Completing a review and evaluated program data.
    b. Analyzing data provided through field activities and in depth participant interviews.
    c. Completing analysis of data provided through pre-existing logging activities.
    d. Conducting analysis of participant energy bills.
    e. Determining well operating schedules of participant sites.
    f. Developing project and program realization rates.
3. Developing adjusted gross and net Program ex-post savings.

Each of these activities is discussed in detail in the following sections. Key researchable issues included:

1. Determining whether or not it was reasonable to base energy saving estimates on the average of the pre and post oil production rates.
2. Determining the persistence of savings over time.
3. Determining the correlation of various well parameters and their impact on gross savings.

Measure Installation Verification

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

1. Establishing the presence of energy efficient measures by comparing the number of installations observed for a sample of sites with the number of installations recorded by the program implementation contractor.

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 removal date and reason.

4. Recording key facility performance data, such as daily schedules, seasonal variations in schedules, and control strategies (program specific).

5. Recording information from pre-existing logging activities at participant sites (e.g. voltage, amperage, frequency).

The field plan and detailed measure installation verification instrument is provided in Volume 2, Appendices, as are details on the primary energy efficient measures installed through this program.

Installation Verification Sample

Table 3Table 3–1 details the distribution of energy efficient measures and savings that occurred through the Oil Production program according to the final program records.[196]

Table 3–1. Distribution of Program Installations and Savings

Measure	Projects	Gross Ex-ante Energy Savings (kWh)
HE motor and Pump	16	6,556,818
Pump off controllers	87	6,403,588
Variable speed drives	7	3,387,833
Replace system with RBP	34	1,272,658
Motor Controllers	8	584,965
Water shut off	3	175,358
Larger ESP cable	3	77,089
Total	158	18,458,305

[196] GEP IDEEA Flat File Data (07-14-06).xls

Pump-off controllers and high efficiency motor and pump replacements accounted for the majority (70%) of program savings. As a result, a corresponding level of emphasis was placed on these measures when developing the verification field sample. However, it should be noted that one variable speed drive, one water shut off, and 38 pump-off controller installations failed to provide meaningful savings and were subsequently disregarded when developing the verification field sample.

Site Verification Activities

Field activities typically involved 3 components.

1. Evaluators coordinated with the implementation contractor and primary customer contact to establish field activity dates and identify site level contacts.

2. While onsite, the evaluation team conducted an area-by-area, measure-by-measure audit, noting (where non-submersible) retrofit count, type, operating conditions, etc. using the field instrument detailed in Volume 2, Appendices. Interviews were also conducted at the site representative's convenience.

3. Data from existing logging activities were analyzed, and, as far as statistically possible, extrapolated to benchmark savings for the overall program as well as verify customer responses to interview questions.

In developing the sample of sites to verify, more emphasis was placed on verifying measures that contributed significantly to overall savings attributable to the Program (e.g. pump-off controllers and high efficiency motor and pump replacements). It was concluded that the evaluation team would verify sites totaling no more than 20% of the evaluation study sample, resulting in an approximate overlap of 14 sites.

Because a majority of the program's seven participants installed multiple retrofit measures, it was decided that the sampling methodology would focus on verifications at the measure level, as opposed to the site level. As such, a total of 30 out of 118 measures achieving applicable savings through the program were scheduled to receive verification activities according to the rationale previously described. Table 3–2 details the distribution of expected verification activities.

Table 3–2. Expected Verification Activities

Measure	Expected Verifications
HE motor and Pump	10
Pump off controllers	12
Variable speed drives	2
Replace system with RBP	1
Motor Controllers	3
Water shut off	1
Larger ESP cable	1
Total	30

Field evaluation activities were conducted between July 5th and July 14th, 2006 to ensure that the information collected was reflective of Edison's peak summer period definition of 6/2/2006 – 10/6/2006. In addition, at the time of verification, it was anticipated that all expected installations were completed and finalized. Volume 2, Appendices, Oil Production chapter, Oil Production Program Field Activity Sample Details, provides additional sample details.

The evaluation methodology employed did not directly correspond to any of the IPMVP options. Instead, the evaluation team's efforts relied on comprehensive engineering calculations, existing logging analysis, and interviews with relevant participants and Program staff. The approach correlated most closely with a modified Option A: Partially Measured Retrofit Isolation, in that it utilized partial short term field measurements of energy use to verify or adjust ex-ante energy and demand savings estimates for measures installed. Some performance parameters were based on secondary data and engineering adjustments were made to specific measure savings as needed.

The evaluation team completed all of the key activities outlined in the final research plan filed with the CPUC.[197] Table 3–3 provides the evaluation activities and objectives included in the final research plan objectives, and the corresponding tasks completed by the evaluation team.

Table 3–3. Impact Evaluation Activities and Objectives

Evaluation Activities	Original Research Plan Objectives	Tasks Completed by the Evaluation Team
Program records review	Yes	Yes
Engineering calculations	Yes	Yes
Secondary literature	Yes	Yes
Billing data/metered data analysis	It is expected that a billing analysis can be conducted on approximately 80 out of 237 wells. This sample will be dependent upon the possibility of identifying meters for which meaningful impact data van be isolated	No billing analysis due to the fact that no meters dedicated to retrofit wells could be identified during field verification activities.
Participant surveys	Participant surveys are planned for all well owners and well operators with installations that participate in the field verification work. The survey topics will be designed to collect data necessary to reduce uncertainty in the impact analysis.	5
Site visits	Verification site visits will occur at approximately 15% of sites, excluding the 48 pump-off controllers (POCs) at site #15 and various KOBE replacements at sites #12 and 18#. 20% of POCs are expected to be verified at #15 locations, and 10% of KOBE installations are expected to be verified at both sites #12 and #18.	35
End use metering	No pre- or post-measure installation data logging will be conducted	No pre- or post-measure installation data logging was conducted by the evaluation contractor

197 IDEEA Work Plan final revision 1.doc

Overall, verification activities exceeded expectations. However, there were slight deviations from the individual measures expected to be verified, primarily because some of the participants had schedule changes during the field verification visits and could no longer meet with the evaluation team. Detailed installation sheets and reports were requested from all sites that could not be physically verified and were subsequently provided.

Installation Verification Results

As stated previously, the primary objectives of the verification activities were to establish the presence of program measures and installations recorded in the final installation reviews provided by the program implementation contractor. To accomplish this objective, a weighted analysis of means, dependent on measure savings, was used to derive an appropriate installation adjustment factor using observation data collected during the site verifications. Discussions with participants subsequent to field verification activities, and an analysis of the observed installations indicated that the recorded installations were correct, for the most part, based on the verification work conducted at 35 wells. However, some discrepancies were noted, and the installation rates were adjusted accordingly. Table 3–4 provides an overview of the installation verification results at the sites visited:

Table 3–4. Installation Verification Results

Measure	Recorded Installations	Verified Installations
HE motor and Pump	14	14
Pump off controllers	12	12
Replace system with RBP	2	2
Motor Controllers	4	4
Larger ESP cable	3	3
Total	*35*	35

A second objective of the verification activities was to provide input on the quality of installations completed through the program. Overall, field observations verified that well retrofits appeared to be well installed and operating correctly.

Although all of the wells visited were verified as retrofitted through the program, the installation rate was not entirely reflective of what was present at the time of inspection. This issue of persistence is important. Two retrofit measures were verified to be installed, but were not in place at the time of inspection. Conversations with system operators noted that one of the circuit rider motor controllers[198] was deemed inoperable. Another circuit rider motor controller was completely removed at the time of verification activities. No other measure persistence discrepancies were observed as shown in Table 3-5. The corresponding calculations of adjusted

[198] A Circuit Rider improves the efficiency of the motor by providing surge suppression, capacitance, and line noise filtration. The Circuit Riders use capacitors to supply reactive power to the motor instead of pulling current through the line. The result is a reduction in line current and, therefore, line losses, and an increase in voltage and power factor for a reduction in demand and energy use.

installation and persistence rates attributable to the program are provided in the *Engineering Analysis* section of the impact analysis.

Table 3–5. Persistence of Measures Verified

Measure	Recorded Installations	Verified Installations	Measures Still in Place
HE motor and Pump	14	14	14
Pump off controllers	12	12	12
Replace system with RBP	2	2	2
Motor Controllers	4	4	2
Larger ESP cable	3	3	3
Total	35	35	33

Engineering Analysis

An engineering analysis was conducted to develop adjusted realization rates for the program. This included a detailed review of program records and documents and data logging activities as described in the following sections.

The evaluation utilized available Edison data, collected during their visual verification of installation and operation of participant sites, in the overall savings estimate. Edison independently selected wells for a visual verification of equipment installation and operation. For sites where measures could be viewed above ground, Edison randomly conducted visual post-installation inspections. However, Edison only selected a few wells, as most of the measures installed through the program are submersible pumps and water shut offs that cannot be visibly inspected. In this case, a review of project costs and calculations was conducted.

Review and Evaluation of Program Data

The final program records submitted by the implementation contractor to Edison were analyzed for accuracy and consistency, and to ensure that the underlying assumptions were reasonable. The key documents analyzed included:

- The final program ‘flat file’ submitted July 14th, 2006.[199] These files documented installation activities at each participant site, including the type and number of measures installed, and underlying energy savings assumptions, and the dates of the various installations. These files provided ex-ante Program gross energy savings values.
- The final program ‘workbook’ dated July 21st, 2006.[200] This document provided a reporting format for the CPUC and represented a summary of the information contained in the program installation reviews. It did not, however, contain site specific data. This file provided ex-ante Program net energy savings values.

[199] GEP IDEEA Flat File Data (07-14-06).xls

[200] 0010-Energy Ser-global energy partners workbook June 06 (revised 07-21-06).xls

- The Implementation Contractor's post-inspection reports and worksheets for the individual projects[201] completed by the Program. These files provided measure and project level ex-ante energy savings documentation.
- Engineering analysis provided by Global on the sample of projects verified by the evaluation contractor.

Several observations resulted from this review.

1. The GEP program was fairly well documented. Consistent and detailed reporting formats were used to present both base case and measure data on all well retrofits. Savings estimates were provided for all wells in the corresponding calculation sheets.
2. Program implementation operating hour assumptions correlated closely with information collected during participant interviews. Moreover, measure installation details (voltage, amperage, frequency) were verified to be accurate through the review of nameplate data recorded while in the field and through the comparison of this data with manufacturer information.
3. As part of the program implementation process, Global metered the pre-installation and post-installation usage of well motors. This metering information provided a benchmark for the impact analysis.
4. There was an unresolved discrepancy of approximately 202 kW between the workbook gross coincident peak kW[202] attributed to the program and the flat file gross coincident peak kW attributed to the Program.

Installation and Persistence Analysis

The adjusted installation rate was derived by accounting for the aggregated kW and kWh savings for each measure. The following methodology was used to calculate a weight attributed to each measure which was then multiplied by the respective installation rate.

$$\text{Weight (Per Measure)} = [(RkW \,/\, TkW) + (RkWh \,/\, TkWh)] \,/\, 2$$

where

RkW = recorded kW for the specific measure,

$RkWh$ = recorded kWh Savings for the specific measure,

TkW = total recorded kW savings achieved through the program, and

$TkWh$ = total recorded kWh savings achieved through the Program.

Table 3–6 details the weight applied to each measure installed.

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[201] GEP IDEEA Final Report (Revised 07-22-06).doc

[202] Net peak savings presented in the Workbook were converted to gross savings using the 0.80 NTG factor assumed by the program

Table 3–6. Derived Measure Weight for Projects with Applicable Savings

Measure	Projects	Net Energy Savings (kWh)	Weight
HE motor and Pump	16	5,245,454	24.5%
Pump off controllers	49	5,122,870	38.1%
Variable speed drives	6	2,710,266	11.7%
Replace system with RBP	34	1,018,126	17.9%
Motor Controllers	8	467,972	5.0%
Water shut off	2	140,286	1.3%
Larger ESP cable	3	61,671	1.5%
Total	118	14,766,644	100.0%

After a weight was applied to each measure, the corresponding installation rates were derived by dividing the verified installations by the recorded installations. Persistence rates were derived utilizing the same methodology. The weights were applied to the installation rates, and subsequently normalized in order to determine the final installation and persistence rate attributable to the program. Table 3–7 details the adjusted installation and persistence rate calculations.

Table 3–7. Derived Installation and Persistence Rates

Measure	Recorded Installations	Verified Installations	Unadjusted Installation Rate	Measures Remaining	Unadjusted Persistence Rate	Normalized Weigh	Net Installation Rate	Net Persistence Rate
HE motor and Pump	14	14	100%	14	100%	28.2%	28.2%	28.2%
Pump off controllers	12	12	100%	12	100%	43.8%	43.8%	43.8%
Replace system with RBP	2	2	100%	2	100%	20.5%	20.5%	20.5%
Motor Controllers	4	4	100%	2	50%	5.7%	5.7%	2.9%
Larger ESP cable	3	3	100%	3	100%	1.7%	1.7%	1.7%
Total	35	35		33		100.0%	100.0%	97.1%

The overarching installation rate for the Oil Production program was calculated to be 100%, while the persistence rate was slightly lower at 97% due to the removal and inoperability of certain circuit rider and motor controller retrofits. These persistence rates only were applied to adjusted gross ex-ante savings in order to arrive at the gross ex-post savings for the program.

Well Measure Retrofit Analysis

In order to analyze the energy saving potential of the well retrofits installed through the program, the evaluation team made extensive use of logged data provided by the participant sites. This data included electrical data (amp, volt measurements, etc.), as well as well production metrics such as water and oil production. This data was analyzed, and, as far as statistically possible, extrapolated to benchmark savings for the overall program. Key researchable issues included:

1. Determining whether or not it was reasonable to base energy saving estimates on the average of the pre and post oil production rates.
2. Determining the persistence of savings over time.
3. Determining the correlation of various well parameters and their impact on gross savings.

In general, it was discovered that energy savings calculations attributed by Global to each measure in the 2004-2005 program correlated to the methodology used in the 2002–2003 program. In addition, since some facilities had participated in the previous years' program and possessed essentially the same well parameters, the same evaluation methodology to determine savings was deemed appropriate.

A brief overview of each measure, along with the methodology used to calculate savings by Global and the evaluation team is provided below.

High Efficiency Motors and Pumps

High efficiency motors are 2% to 8% more efficient than standard motors. In the oil-producing industry, it is conventional to run motors until they fail and replace them with the same technology. Rarely are premium-efficiency motors installed due to high initial costs and lack of information.

The evaluation team's methodology differed from Global's in three respects. First, Global incorporated a pumping efficiency metric of kWh per barrel of fluid pumped per 1,000 feet of pumping depth. However, after reviewing the analysis methodology used in the evaluation of the 2003 program, the evaluation team concluded it was reasonable to exclude pumping depth and the changes in depth from the energy savings calculations.[203] Second, the evaluation team's methodology was based upon the barrels of oil pumped rather than total fluid (water plus oil) pumped because oil quantity is the critical economic driver. Hence the evaluation team felt that it

[203] Evaluation of the Energy Efficiency Services for Electricity Consumption and Demand Reduction in Oil Production Program. Quantec Consulting LLC, June 30, 2004.

was reasonable to account for the amount of oil pumped, as opposed to the total fluid, in the calculations. Third, Global's calculation used the total fluid pumped per day *after* project implementation as the basis for calculating energy savings. Findings indicated that that the pumping rate could affect the well life because the quantity of oil (or total fluid) in the reservoir would not change with an efficiency improvement, although the pumping rate might. As a result, the average of the pre and post production rates was used in the calculations. Equation (1) provides details on the approach used to calculate the annual energy savings from the installations of high efficiency motors and pumps.[204]

Evaluated Annual energy savings (kWh/yr) = ((kWh/bbl)oil, pre – (kWh/bbl)oil, post) x (bbl oil, pre + bbl oil, post)/2 x 365 days/yr x Availability (1)

where

kWh/bbl oil, pre = pre-implementation kWh required to pump one barrel of oil,

kWh/bbl oil, post = post-implementation kWh required to pump one barrel of oil,

bbl oil = barrels of oil pumped per day, and

Availability = percent of time well is not down for maintenance.

Based on these differences in calculation methods, Global estimated gross energy savings of 6,556,817 kWh/year and gross demand savings of 748.3 kW. The evaluation team's analysis yielded savings estimates of 5,447,052 kWh per year and 549.7 kW.

Pump-off Controllers

Pump-off controllers are used to automatically shut down the pump until enough fluid has accumulated in the well to produce a full barrel. The benefits of this equipment stem mainly from the following.

1. Increased estimated useful life (EUL) because the pump is no longer trying to lift fluid from a well when none in present, which puts a strain on the rod.

2. Decreased energy consumption of the pump because it operates less frequently, but maintains the same production rate.

In order to calculate energy savings for this measure, Global multiplied the difference in average daily energy consumption in the pre and post conditions by the number of days in a year. To calculate demand savings, they divided energy savings by an assumed load factor of 80% times the number of hours per year.[205] This approach yielded savings of 6,403,587 kWh and 731 kW.

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[204] Evaluation of the Energy Efficiency Services for Electricity Consumption and Demand Reduction in Oil Production Program. Quantec Consulting LLC, June 30, 2004.

[205] Evaluation of the Energy Efficiency Services for Electricity Consumption and Demand Reduction in Oil Production Program. Quantec Consulting LLC, June 30, 2004.

Consistent with the evaluation of the 2003 program, the evaluation team used a slightly different approach to calculate energy savings. Instead, they applied the assumed 80% load factor to the peak demand reading for each well pump to estimate average demand. The resulting value was then used to estimate the energy savings for each well, based on the observed differences in operating hours observed in the field. This value was then multiplied by an availability factor of 98% to account for interruptions in operations (maintenance and breakdowns). Equation (2) provides details on the approach used to calculate the annual energy savings for pump-off controllers.

$$\textit{(2) Evaluated Annual energy savings (kWh/yr)} = (kW) \times (Lf) \times [(Op)pre - (Op)post] \times 365 \text{ days/yr} \times .98 \quad (2)$$

where

(kW) = peak demand reading,

(Lf) = load factor,

(Op)pre = operating hour per day pre-installation, and

(Op)post = operating hour per day post-installation.

The evaluation team also calculated demand savings in a modified way. To estimate the average demand savings for each well, the average demand (accounting for the assumed load factor and peak demand reading) was multiplied by the observed change in operating hours for each specific well and averaged over 24 hours.

The evaluation team's estimate of energy savings was 6,160, 267 kWh/year and 574.3 kW.

Variable Speed Drives

Variable speed drives alter the speed of the motor, better matching it to variable loads. They have no impact on well production rate but reduce energy use by providing the ability to reduce the energy input to a motor when it is not fully loaded.

Global's calculations estimated annual savings by averaging the pre and post well readings by the number of days over which the data were recorded. Global then subtracted the daily post energy use from the daily pre energy use and multiplied the resulting value by 365 days/year. Similarly, Global estimated average demand savings by dividing estimated annual energy savings by 8,760 hours and an assumed load factor of 80%. Global estimated annual energy savings of 3,387,832.0 kWh and demand savings of 386.7 kW.

The evaluation team believes that the energy savings analysis for this measure was mathematically astute and utilized the same basic approach to estimate energy savings. However, a slight adjustment was made for availability, because the metered data was gathered over such a short time that that it was not likely to reflect downtime or maintenance. Equation (3) provides details on the approach used to calculate the annual energy savings for variable speed drives.

$$\textit{Evaluated Annual energy savings (kWh/yr)} = [(\sum(kWh)\ pre - \sum(kWh)\ post) / Nr] \times 365\ days/yr \times .98 \quad (3)$$

where

$\sum$(kWh)pre = aggregated kWh readings pre-installation,

$\sum$(kWh)post = aggregated kWh readings post-installation, and

Nr = Number of days metered.

Subsequently, Global's estimated energy savings for this measure were multiplied by an availability factor of 98%. The evaluated annual energy savings for this measure were calculated to be 3,320,075.4 kWh and the demand savings were calculated to be 379 kW.

Motor Controllers

The motor controlling equipment installed has three main components.

1. Surge suppression
2. Capacitance
3. Line noise filtration

The motor controller isolates the motor or circuit from receiving or dispersing transient surges while reducing harmonics. In addition, the capacitors supply reactive current, effectively eliminating the need to have the utility company to supply this current. Finally, the motor controllers filter out AC line noise problems, which lead to a much cleaner AC current.

The circuit riders did not impact well production rate, just demand and energy use. As such, no adjustments for well conditions were made in the energy savings analysis. The energy savings analysis from Global averaged the minimum and maximum amperage readings gathered from each well and multiplied this value by the average metered voltage in kilovolts and the assumed power factor (80%). In addition, the phase of the motor was accounted for as well. Global then calculated the pre and post demand to derive demand savings and multiplied the corresponding value by 8,760 hours to estimate the annual energy savings. Based on this analysis, Global estimated annual energy savings for this measure to be 584,965.0 kWh/year and 66.7 kW.[206]

The evaluation team's approach was relatively similar. Global's energy savings calculation for each pump assumed the difference in kW from pre-installation to post-installation was the amount of savings for every hour of the year. However, the assumption that all pumps will operate 8,760 hours per year was agreed to be overly optimistic given the inevitably of breakdowns and maintenance operations. As such, the evaluation team added an availability

[206] This methodology is inappropriate, but, given the constraints of the project, the implementer ex-ante values are accepted.

factor of 98% for each pump to reflect downtime for unforeseen problems. Equation (4) provides details on the approach used to calculate the annual energy savings for motor controllers.

$$\textit{Evaluated Annual energy savings (kWh/yr)} = [((AkW)\ pre - (AkW)\ post)] \times AV \times PF \times 3^{1/2} \times 8{,}760 \times .98 \quad (4)$$

where

(AkW)pre = Average of the minimum and maximum amperage readings pre-installation,

(AkW)post = Average of the minimum and maximum amperage readings post-installation,

AV = Average metered voltage in kilovolts, and

PF = Assumed power factor.

The Evaluation team estimated annual energy savings for this measure to be 573,265.7 kWh and demand savings to be 65.3 kW.

Larger Electric Submersible Pump (ESP) Cables

ESPs are artificial-lift systems that utilize an electrically driven down-hole pumping system. The ESP system consists of a number of components that turn a staged series of centrifugal pumps to increase the pressure of the well fluid and push it to the surface. The energy to turn the pump comes from a high-voltage alternating-current source to drive a special motor that can work at high temperatures and pressures. In order to reduce voltage losses, the electric motors are operated at high voltages. Larger ESP cables are installed to replace smaller cables in order to reduce voltage drop due to line loss, and energy consumption.

In order to calculate annual savings, Global measured the difference in kW consumption pre and post installation and multiplied this value by 8,760 hours/year. The evaluation team slightly modified this calculation to account for an availability factor of 98%. Equation (5) provides details on the approach used to calculate the annual energy savings for larger electric submersible pump (ESP) cables.

$$\textit{Evaluated Annual energy savings (kWh/yr)} = [(\sum(kW)\ pre - \sum(kW)\ post) / Nr] \times 8{,}760 \times .98 \quad (5)$$

where

$\sum$*(kW)pre* = aggregated kW readings pre-installation,

$\sum$*(kW)post* = aggregated kW readings post-installation, and

Nr = Number of days metered.

Hence, Global calculated the annual measure savings to be 77,089.0 kWh and 8.8 kW, while the evaluation team estimated annual energy savings to be 75,547.2 kWh and 8.6 kW.

Water Shut Off

Excessive, unproductive water production has been a major problem in the oil production industry. In southern California, the use of water flooding is a common practice. Water flooding entails injecting water into the reservoir formation to displace residual oil. The water from the injection wells physically sweeps the displaced oil to adjacent production wells. However, during the water injection phase, the injected water can quickly break through to the producing wells causing a quick rise of water production and a quick drop in oil production. In such cases, water shut-off treatments have a significant value in effectively lowering water production, increasing oil production, and reducing energy consumption.

However, Global was involved in just 3 water shutoff projects. Of these projects, one was successful, one provided marginal energy savings, and another provided no energy savings. Global's energy savings calculations were reviewed and deemed representative for the 3 projects. Furthermore, given the difficulty in predicting energy savings from these projects, the evaluation team made no overarching adjustments to the energy savings methodology for this measure.[207] Global's and the Evaluation Team's annual energy savings estimate were concluded to be 175,358.0 kWh and 20.1 kW.

Converting a KOBE System

Conventionally, the KOBE system utilizes production fluid as the power transfer medium instead of a steel rod as is used by traditional pumps. In a KOBE system, the working fluid is transmitted from a surface unit via surface piping to actuate a standard rod type pump in the well. The working fluid is cyclically applied and relieved at the surface unit to create a pumping action in the well. Because the production fluid is also used as working fluid, the KOBE system continuously cycles fluid from the surface, down the well, and back to the surface and does not require any large storage tanks. A major drawback of the KOBE system is the large electric requirements associated with the inefficiencies of the fluid piping system.[208]

Again, the Global's savings calculations were reviewed for accuracy, and no engineering adjustments were deemed necessary by the evaluation team. Subsequently, Global's and the Evaluation Team's annual measure savings estimate was concluded to be 1,272,657 kWh and 145.3 kW.

Engineering Analysis Results

Based on the review of program documents and site logging activities, the following conclusions were made by the Evaluation team:

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[207] Volume 2, Appendices

[208] GEP IDEEA Final Report (Revised 07-22-06).doc

1. The adjusted final installation rate was determined to be 100%.

2. The adjusted persistence rate was calculated as 98%.

3. The well operating schedules correlated directly with Program assumptions.

4. The assumptions used to calculate the energy savings attributed to the well retrofit measures were adjusted based on field observations.

5. In general, evaluated measure savings correlated closely with estimated savings.

Impact Evaluation Results

Final Program Impacts

The program impacts were estimated collectively for all measures installed through the Oil Production Program. Table 3-8 presents the ex-ante gross and net energy savings goals and reported program accomplishments.

Table 3-9 shows the first year ex-ante gross and net demand savings goals and reported program accomplishments. The program net ex-ante net savings goals were estimated and reported accomplishments were estimated using a 0.80 NTG ratio. The program reported achieving approximately 104 percent of their original kWh goals, and 58 percent of their kW goals.

Table 3–8. Comparison of Ex-Ante Energy Savings Goals and Reported Accomplishments

	Ex-Ante Program Gross Annual kWh Goals	Ex-Ante Program Net Annual kWh Goals	Reported Ex-Ante Gross Annual kWh Savings	Reported Ex-Ante Net Annual Program kWh Accomplishments
Oil Production	17,310,000	13,848,000	18,458,305	14,766,644

Table 3–9. Comparison of Ex-Ante Demand Savings Goals and Reported Accomplishments

	Ex-Ante Program Gross Annual kW Goals	Ex-Ante Program Net Annual kW Goals	Reported Ex-Ante Gross Annual kW Savings	Reported Ex-Ante Net Annual Program kW Accomplishments
Oil Production	2,164	1,731	2,308	1,846

The program impacts are determined by two factors.

1. Program performance in terms of accomplishing program participation goals.

2. Estimated ex-post savings impacts for the installed measures compared to the ex-ante measure savings assumptions. Because of the limited budget available for this evaluation, and the consistency of the measures and market between this program and its

predecessor,[209] many of the methodologies and approaches approved in the previous evaluation[210] were employed in this evaluation.

The program gross and net realization rates have been calculated as the combined effect of these two factors. The program goals, overall and for its constituent measures, ex-post gross and net energy savings, and respective realization rates are shown in Table 3-10. The program evaluated ex-post gross energy savings are 17,024,223 kWh compared to the program gross savings goal of 17,310,000 kWh. The program evaluated ex-post net energy savings are 13,619,378 kWh compared to the program goal of 13,848,000, yielding a 98.35 percent net energy savings realization rate.

Table 3–10. Comparison of Programs Goals and Ex-Post Gross and Net Energy Savings

	Ex-Ante Program Gross Annual kWh Goals	Ex-Ante Annual Net Energy Savings Goals	Evaluated Gross Ex-Post Program kWh Savings	Gross Energy Realization Rate	Evaluated Net Ex-Post Program kWh Savings	Net Energy Realization Rate
Oil Production	17,310,000	13,848,000	17,024,223	98.35%	13,619,378	98.35%

The program goals, ex-post gross and net demand savings, and respective realization rates are shown in Table 3-11. The program evaluated ex-post gross demand savings are 1,742 kW as compared to the program goal for demand savings of 2,164 kW, yielding an 80.5 percent gross demand savings realization rate. The program evaluated ex-post net demand savings are 1,394 kW compared to the program net demand savings goal of 1,731 kW, yielding an 80.5 percent net realization rate. It should be noted, however, that there was a discrepancy between the final workbook and the final flat file reported kW savings of approximately 200 kW, or approximately 9% of estimated demand savings. This discrepancy was attributed to a simple oversight and the evaluated and corrected Program kW savings are accounted for in Tables 5–17 and 5–18 below.

Table 3–11. Comparison of Programs Goals and Ex-Post Gross and Net Demand Savings

	Ex-Ante Program Gross Annual kW Goals	Ex-Ante Annual Net Demand Savings Goals	Evaluated Gross Ex-Post Program kW Savings	Ex-Post Gross Demand Realization Rate	Evaluated Net Ex-Post Program kW Savings	Net Demand Realization Rate
Oil Production	2,164	1,731	1,742	80.50%	1,394	80.50%

Realization rates compared to ex-ante evaluated results are shown in Table 3-12 and Table 3-13 below. The program evaluated ex-post gross energy savings are 17,024,223 kWh compared to the program reported ex-ante gross savings goal of 18,458,305 kWh, yielding a realization rate

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209 2003-04 Energy Efficiency Services for Electricity Consumption and Demand Reduction in Oil Production Program

210 Evaluation of the Energy Efficiency Services for Electricity Consumption and Demand Reduction in Oil Production Program. Quantec Consulting LLC, June 30, 2004.

of 92 percent. The program evaluated ex-post net energy savings are 13,619,378 kWh compared to the reported ex-ante net of 14,766,644 kWh, also yielding 92 percent net energy savings realization rate.

The program evaluated ex-post gross demand savings are 1,742 kW compared to the reported ex-ante gross demand savings of 2,308 kW, yielding a 75 percent reported gross demand savings realization rate. The program evaluated ex-post net demand savings are 1,394 kW compared to the reported ex-ante net demand savings of 1,846 kW, yielding a 75 percent net realization rate. Again, it should be noted that these realization rates are lower than expected as a result of the discrepancy in the final workbook submitted for evaluation efforts.

Table 3–12. Comparison of Reported Program Accomplishments and Ex-Post Gross and Net Energy Savings

	Ex-Ante Program Gross kWh Reported	Ex-Ante Net Energy Savings Reported	Evaluated Ex-Post Gross Program kWh Savings	Gross Energy Realization Rate	Evaluated Ex-Post Net Program kWh Savings	Net Energy Realization Rate
Oil Production	18,458,305	14,766,644	17,024,223	92.23%	13,619,378	92.23%

Table 3–13. Comparison of Reported Programs Accomplishments and Ex-Post Gross and Net Demand Savings

	Ex-Ante Program Gross kW Reported	Ex-Ante Net kW Savings Reported	Evaluated Ex-Post Gross Program kW Savings	Gross Energy Realization Rate	Evaluated Ex-Post Net Program kW Savings	Net Demand Realization Rate
Oil Production	2,308	1,846	1,742	75%	1,394	75%

Final Program savings, NTG ratios and realization rates are shown in Table 3-14 and Table 3-15. The individual components of the program were assumed to have a net to gross ratio of .80, equal to the final workbook assumptions.

Realization rates were calculated as the ratio of the evaluated net ex-post savings to the reported ex-ante gross savings. For the overall program, the realization rate was 74 percent for energy and 60 percent for demand.

Table 3–14. Program Energy Savings

	Ex-Ante Reported Gross kWh Savings	Ex-Post Gross Program kWh Savings	NTG Ratio	Evaluated Ex-post Net kWh Savings	Realization Rate
Oil Production	18,458,305	17,024,223	0.80	13,619,378	73.78%

Table 3–15. Program Demand Savings

	l Ex-Ante Reported Gross kW Savings	Ex-Post Gross Program kW Savings	NTG Ratio	Evaluated Ex-post Net kW Savings	Realization Rate
Oil Production	2,308	1,742	0.80	1,394	60.39%

Ex-ante proposed, ex-ante reported and evaluated savings are summarized in Table 3-16 below.

Table 3–16. Savings Summary

	Proposal				Reported				Evaluated		
	Ex-ante Gross	Net to Gross	Ex-ante Net		Ex-ante Gross	Net to Gross	Ex-ante Net		Ex-post Gross	Net to Gross	Ex-post Net
kWh	17,310,000	.80	13,848,000		18,458,305	.80	14,766,644		17,024,223	.80	13,619,378
kW	2,164	.80	1,731		2,308	.80	1,846		1,742	.80	1,394

Lifecycle Savings

Tables 4-17 and 4-18 detail program savings by measures installed. The individual measure savings values were derived from the final flat file submitted by GEP. It should be noted that the recorded gross demand savings in the final flat file are approximately 200 kW lower than what is reported in the final workbook (2107 kW vs. 2308 kW). This discrepancy served to decrease overall realization rates and they have been subsequently recalculated. Because there is no way to reconcile the two numbers at this point, the final workbook numbers were used for the CPUC lifecycle reporting.

The EUL for individual measures were derived utilizing DEER and engineering estimates. Corresponding lifecycle savings were calculated by measure, and rolled up to the program level as shown in the required CPUC format in Table 3-19.

Table 3–17. Program Ex-Post Lifecycle Net Energy Savings by Measure

Measure	EUL	Flat File kW Savings	Evaluated Gross kW Savings	Realization Rate
HE Motor and Pump	15	748.30	549.70	73.46%
Pump Off Controllers	10	731.00	574.30	78.56%
Variable Speed Drives	10	386.70	379.00	98.01%
Replace System with RBP	10	145.30	145.30	100.00%
Motor Controllers	10	66.70	65.30	97.90%
Water Shut Off	10	20.10	20.10	100.00%
Larger ESP Cable	15	8.80	8.20	93.18%
Total		2,106.90	1,741.90	82.68%

Table 3–18. Program Ex-Post Lifecycle Net Demand Savings by Measure

Measure	EUL	Flat File kWh Savings	Evaluated Gross kWh Savings	Realization Rate
HE Motor and Pump	15	6,556,817	5,447,052	83.07%
Pump Off Controllers	10	6,403,587	6,160,267	96.20%
Variable Speed Drives	10	3,387,832	3,320,075	98.00%
Replace System with RBP	10	1,272,657	1,272,657	100.00%
Motor Controllers	10	584,965	573,265	98.00%
Water Shut Off	10	175,358	175,358	100.00%
Larger ESP Cable	15	77,089	75,547	98.00%
Total		18,458,305	17,024,223	92.23%

Table 3–19. Program Ex-Post Lifecycle Net Energy Savings

Year	Calendar Year	Ex-ante Gross Program-Projected Program MWh Savings	Ex-Post Net Evaluation Confirmed Program MWh Savings	Ex-Ante Gross Program-Projected Peak Program MW Savings	Ex-Post Evaluation Projected Peak MW Savings	Ex-Ante Gross Program-Projected Program Therm Savings	Ex-Post Net Evaluation Confirmed Program Therm Savings
1	2004						
2	2005	18,458	13,619	2.308	1.39		
3	2006	18,458	13,619	2.308	1.39		
4	2007	18,458	13,619	2.308	1.39		
5	2008	18,458	13,619	2.308	1.39		
6	2009	18,458	13,619	2.308	1.39		
7	2010	18,458	13,619	2.308	1.39		
8	2011	18,458	13,619	2.308	1.39		
9	2012	18,458	13,619	2.308	1.39		
10	2013	18,458	13,619	2.308	1.39		
11	2014	18,458	13,619	2.308	1.39		
12	2015	18,458	4,418	2.308	0.45		
13	2016	18,458	4,418	2.308	0.45		
14	2017	18,458	4,418	2.308	0.45		
15	2018	18,458	4,418	2.308	0.45		
16	2019	18,458	4,418	2.308	0.45		
17	2020						
18	2021						
19	2022						
20	2023						
TOTAL	2004-2023	276,875	15,828				

Definition of Peak MW as used in this evaluation:

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4. Conclusions and Recommendations

The process and impact evaluation generated a number of conclusions and recommendations:

Conclusion 1. *The Program's key innovative marketing strategy was not tested.*

Implementers reported that the most important barrier to energy efficiency investments is a lack of staff resources among producers, and this program's key innovation is a marketing strategy designed to overcome this barrier. The 2004-2005 program design relied almost exclusively on previously identified interested contacts; the effect of the innovative marketing strategy on the recruitment component of program marketing was therefore confirmed, not tested.

Recommendation 1. *Clearly define the extent of the program and follow the implementation plan, and document any changes in program design.*

This program demonstrates the need for a process to transition successful innovative programs into mainstream availability. Such a process should be developed. In addition, it is important contractors understand that they are expected to follow program implementation plans and to inform Edison when they intend to deviate from that plan.

Conclusion 2. *Financial incentives for already economically viable measures may be better spent on marketing, project management or technical analysis.*

This program puts approximately two thirds of implementation resources toward financial incentives for participants, even though program staff report that the upfront cost of energy efficiency projects is not a very important barrier for this market. Staff report that the economics of projects are often so good already that the rebates hardly affect them and that the producers are very open to investing in efficiency once the barrier of staffing resources is overcome.

Recommendation 2: *A far less generous incentive structure might encourage the same amount of efficiency investment from this market while saving ratepayers thousands of dollars.*

Program designers should consider reducing or eliminating incentives over time. While reducing incentives "across the board" might be in order, reducing incentives on measures whose economics work especially well even without rebates, or reducing incentives for repeat participants (while continuing to provide free project management and technical analysis assistance to all), or some combination of those two approaches might be best. Money saved by reducing the incentives might be better spent on additional marketing and field activities. Changes to the incentive structure should be made judiciously so that effects can be evaluated.

Conclusion 3. *Prior programs and recruitment efforts brought repeat participants and questions of equitable distribution of incentives.*

Global was overwhelmingly successful at finding willing participants in the program, having been able to do so largely on the strength of prior recruitment efforts. However, incentives distributed repeatedly to the same few companies could create concerns about equity. It could be argued that the repeat-participants should not get “first crack” at the incentive funds, which occurs under the current program design.

Recommendation 3. *Add Program rules that encourage broad participation.*

Program rules should be added to encourage the program to recruit more broadly from the population of targeted well owners and operators. A yearly cap on the amount of incentives that could be received by one firm would be one possible way to address this issue. It could be argued that, in addition to addressing concerns of equity, involving more new firms in the program might increase the impact the program exerts on this market.

Conclusion 4. *Some measures offered by this program appear to be standard practice in the industry.*

Although the process evaluation was not able to quantify the impact, feedback from at least three of the five firms interviewed indicated that VFDs, and efficient motors and pumps were already part of their retrofit toolkit. Because the Oil Production program had been operating before the IDEEA program, and has since been integrated into Edison’s industrial program offering, it might be expected that none of the participants would do anything on their own, knowing the program is being offered. However, the fact that they would have done some program measures on their own, indicates that some rethinking of the offering would be advisable.

Recommendation 4. *Review eligible measures and drop standard practice measures*.

A review of eligible measures should be undertaken, and measures which are common practice in the industry should be dropped, or incentive levels lowered.

Conclusion 5. *Recordkeeping and documentation could be improved*.

Improving the quality of installation documentation would assist in evaluation activities, specifically measure location information. Many of the participant companies have relatively high turnover rates. As a result, it was often difficult and cumbersome to locate a site representative that could actually identify where the retrofits were installed in the field.

Recommendation 5. *Provide more detailed installation information on the location of the retrofit installations.*

Location-specific information for treated systems and measures should be included in program tracking, even if it is only included in a “comment” field.

9. EnergySolve Demand Response Program

1. Program Description

EnergySolve Demand Response, LLC (EnergySolve) designed and implemented the EnergySolve Demand Response Program. Westinghouse's RetroLUX-D T-5 energy-efficient fluorescent lighting was installed through this Program as a retrofit for existing 4' and 8' T-12 lamp fixtures and magnetic ballasts.[211] Westinghouse's technology is a two-way, wireless, dimmable, energy-efficient T-5 fluorescent lighting unit that snaps into the fixture without the need to access the ballast. Because it is seldom economically viable to retrofit fixtures equipped with T-8 lamps, implementers planned the retrofit program for small commercial facilities using T-12 lamps.

The Program was designed to encourage the use of this new technology in small commercial facilities throughout Southern California Edison territory. Chain stores were initially selected, given their inherent potential for possible expansion. According to the EnergySolve proposal, smaller retail facilities utilizing approximately 28 kW were the targeted market segment. The Program was offered with no up-front cost to the customer.

EnergySolve describes the Program design as similar to the provisions of Edison's Standard Performance Contract, providing direct incentives for new technology installations. For more than two years prior to the Program, EnergySolve worked with Westinghouse to design the system that would enable the T-5 retrofit of T-12 fixtures,[212] refine the demand response capability, and field test the lighting in stores in two other states. EnergySolve anticipated that the Program could capture both energy efficiency and demand response in a single program design.[213]

The RetroLUX-D T-5 lighting units, consisting of the lamps and ballasts, were shipped directly from Westinghouse to the store locations. A subcontractor to EnergySolve (AMP Electric) installed the lights.

The RetroLUX-D T-5 dimmable fluorescent fixture has a unique adjustable lamp-centering system that allows the lamp to center within the existing fixture body. It has a self-contained dimming electronic ballast and a programmed-start ignition that provides for longer lamp life. The snap-in T-5 retrofit leaves the existing ballast in place and energized, and converts the feed from the magnetic ballast to the required power needed to drive the T-5 lamps. A second installation method leaves the electronic ballast in place and bypassed (usually snipped and abandoned in place), and the primary power feed is re-routed to the T-5 retrofit ballast. The retrofit that leaves the existing ballast energized consumes an additional six watts to eight watts

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[211] 8' T-12 lamps are replaced by two 4' T-5 lamps fitted into a holster. The RetroLUX comes fitted with 28 watt lamp installed. The RetroLUX T-5 system uses the existing T-12 diffusers.

[212] T-5s are shorter than T-12s; Westinghouse has patented their holster to retrofit the T-5s into the T-12 fixture.

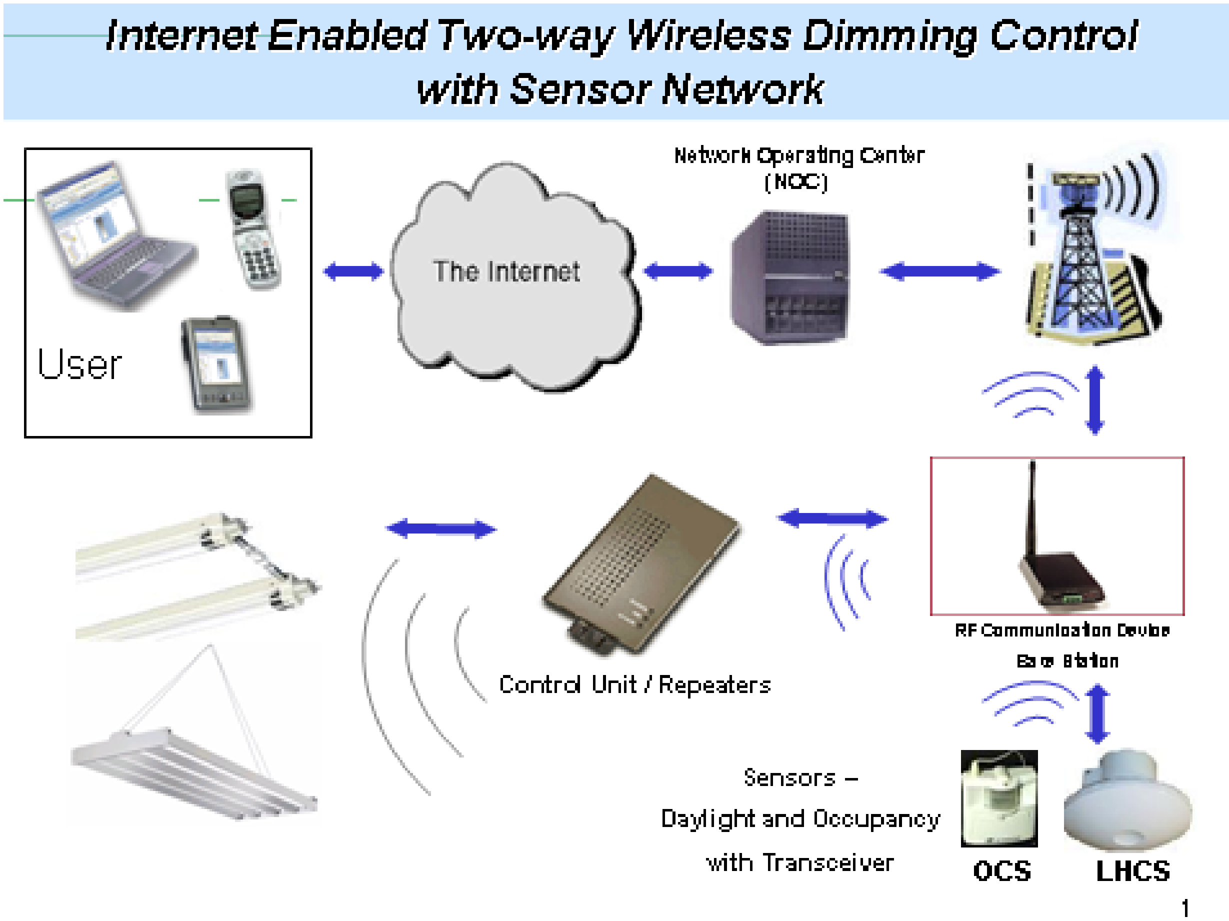
[213] EnergySolve IDEEA Proposal, page 5.

per fixture due to ballast losses converting the magnetic ballast feed to the required power. The retrofit with abandoned and bypassed ballast does not incur the additional ballast losses.

The dimming system consists of a two-way radio frequency wireless signal (between the ballast and controller) initiated from a central controller. The fixtures have unlimited control—they can be dimmed by zoning on an individual basis or as an entire facility. The dimming capability of the system allows stepped dimming with six increments ranging from 100% to 0% of power. Dimming is defined at the zone level, with a zone defined by as few as one fixture. A Web-based address can also act as the central controller, and initiate the dimming. This Web-based controller can be controlled by any entity with access to the secure Web-based controller address.[214] Users can initiate dimming for a variety of reasons, which may include voluntary cost-reduction efforts from the facility operator, or as a response to an external request, such as a utility's demand response initiative. All systems installed through this program use voluntary dimming, with dimming control residing solely with the facility owner/operator. Figure 1–1 is a schematic of the two-way wireless dimming control and sensor network.

[214] The controller has an IP address, but not the individual fixtures. Controllers and fixtures communicate via two-way radio frequency wireless signals.

Figure 1–1. T-5 Wireless Dimming Schematic



Source: EnergySolve Demand Response Proposal materials

Implementers also installed the Westinghouse lighting with an automatic energy logging system, called a Utility Bill Analysis and Reporting (UBAR) system, developed by EnergySolve. The UBAR measures the energy-efficiency savings and the demand response savings at any given time. The UBAR system calculates and reports on the savings, and it can be used to track the program, perform program reporting, invoice for billing, and track invoices paid.[215]

The UBAR system allows flexible expansion of the energy reporting functions. The UBAR tool polls the state of the network every 15 minutes to identify the dimming settings for each zone at all facilities on the network. It includes transceivers attached to the lighting fixtures, a cellular phone base station with internet capability, and a centralized network-operating center (NOC). The NOC sends information over the internet to the UBAR system every 24 hours. Users can access the information stored at the NOC via the internet. In this way, the system can monitor energy use at several different locations.

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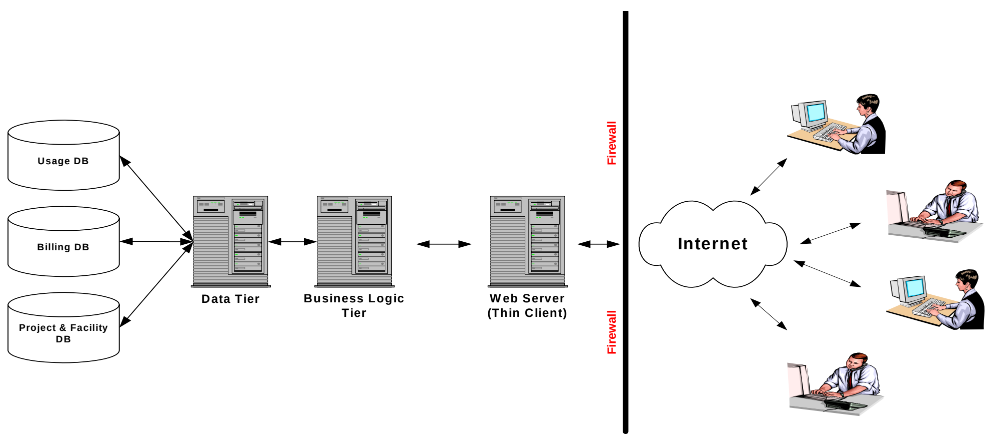
[215] EnergySolve Demand Response Proposal, page 3/28/05.

The UBAR system allows estimates of energy savings based on how long each zone is operating at any one of the six dimming steps.[216,217] The reporting tool allows the user to query the system and design reports that can be saved down to the individual user level or be made available to all users. Initially the UBAR data had to be extracted ‘manually’ with specific data requests. The system was revised so that data from the UBAR system could be extracted automatically. EnergySolve ensures the integrity of the UBAR system information using authentication, encryption and a firewall.[218] Figure 1–2 shows a general schematic of the UBAR system.

Figure 1–2. UBAR System



Source: EnergySolve Demand Response Proposal materials

EnergySolve expects lighting system savings from two components:

- The permanent kW reduction resulting from replacing a 34 or 40W T-12 lamp with a 28W T-5 lamp (with or without the ballast disabled).
- Demand savings both from the energy efficiency savings during peak hours and from demand response through dimming.

The evaluation of this Program included both a process and an impact evaluation. The process evaluation involved interviews with Program staff, implementers, Program participants, nonparticipants and dropouts. The impact analysis included a billing analysis, a detailed

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216 Full output is the baseline used to compute savings from dimming steps.

217 EnergySolve, Round 2, Stage 2 Proposal, Page 14, 3/5/05. EnergySolve reports the ex ante “electric energy savings (kWh) are determined through calculation and comparison of (1) per fixture type base line kW consumption; and (2) retrofit per fixture type kW consumption. The difference in kW consumption is calculated, multiplied by the quantity of fixtures in each facility and then multiplied by the annual operating hours to determine kWh. The fixture kW consumption is the fixture published rated kW which has been verified by EnerySolve DR testing.”

218 EnergySolve, UBAR System Architecture and Security, Page 1, 2/4/05. The UBAR system consists of a three-tiered environment including a thin client browser based interface tier, a transactions manager business logic tier, and a data tier. The UBAR system can access customer’s utility billing data, used to estimate savings.

engineering analysis, including reviews and recalculation engineering algorithms, detailed reviews of Program records and verification site visits, with an M&V component. Although this was a 2004-2005 program, the evaluation conforms to the 2006 Protocols at the Basic level. Preference will be given to metered data and engineering calculations (IPMVP Option A).

This report is organized into four sections. The next section (Section 2) presents the process evaluation, including the Program logic model, results of interviews with Program staff and participants, and free rider estimates. Section 3 describes the impact evaluation, the engineering and site visit results, and calculates realization rates, ex-post gross and net savings, and lifecycle savings. The final section (Section 4) presents the major conclusions and recommendations.

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2. Process Evaluation

Process Evaluation Methodology

The purpose of the process evaluation was to document project progress, assumptions, and barriers to wider implementation, to assess customer satisfaction, and to document barriers to participation and describe current practices among nonparticipants.

EnergySolve installed 2,522 fixtures at 142 sites. The researchable issues addressed in the process evaluation included the Program's origin and original goals, and differences between the Program as designed and as implemented. Delivery and implementation issues such as experience with the lighting technology, user satisfaction with the dimming technology, and issues of free ridership and spillover, as well as lessons learned were also addressed.

The process evaluation of the Program was informed by interviews with implementers and Program managers, participant corporate managers and site managers, and lighting contractors.

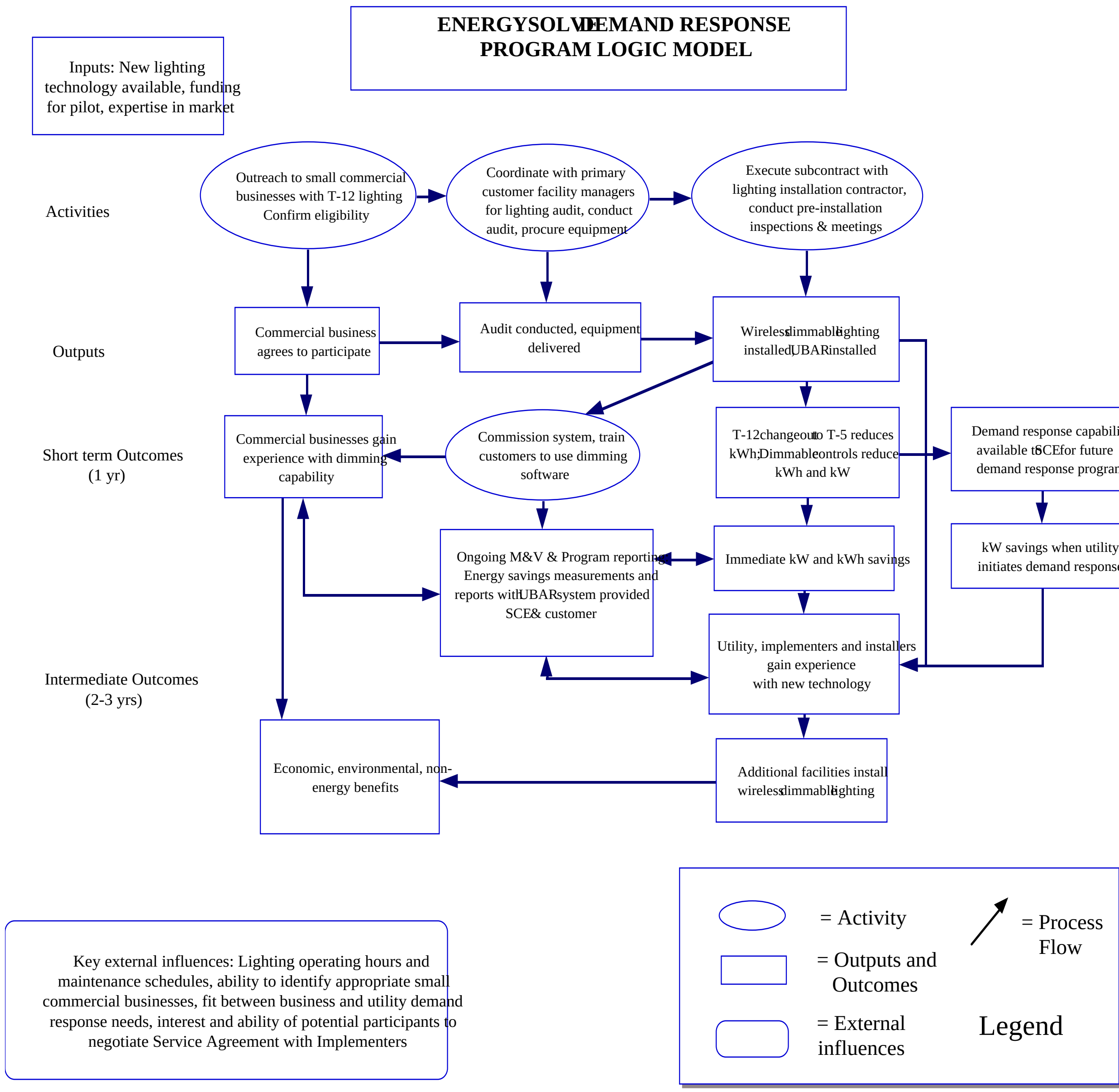
Program Logic Model

Figure 2–1 presents the Program logic model. The logic model shows the key features of the Program as implemented and as understood by the evaluation team, indicating the logical linkages between activities, outputs, and outcomes. Initial activities included outreach to potential Program participants, installation of the T-5 lights and related technology, and installation verification.

Inputs into the Program included the expertise offered by manufacturers and implementers, the availability of funding and the lighting technology. Externalities included the implementer's ability to identify candidate facilities, the operating hours and maintenance schedules, the fit between the business and Edison's demand response needs, and the interest and ability of potential small commercial businesses to negotiate a Service Agreement with implementers.

The first level of activities included final contract negotiations with the primary participants, marketing the Program to potential participants, and hiring and training an installation contractor. The activities were expected to result in the following outputs: businesses would agree to participate and service agreements would be negotiated, the facility would be audited, and the equipment would be ordered, delivered, and installed.

Figure 2–1. Final Logic Model



Short-term outcomes include the system commissioning, training of local managers, and subsequently, the customer's ability to gain experience and familiarity with the system and technology. Short and intermediate term outcomes include immediate kW and kWh savings. Also, the utility, manufacturer, implementers and installers all gain experience with a new market approach and technology. This will result in the installation of the technology in additional facilities. Ultimately, there are additional economic, environmental and non-energy benefits from the implementation of this technology as well.

Process Evaluation Sample Design

The process evaluation is based upon a review of Program documents and interviews. Interviews were conducted with the Edison Program manager and two EnergySolve project managers, corporate executives for each of the two participating chain stores, and 21 local store managers representing both of the businesses where the T-5 lighting was installed. Surveys were also conducted with one participating lighting contractor and three nonparticipating lighting contractors. Table 2–1 summarizes survey sample goals and achievements.

Table 2–1. Survey Sample Goal and Achievement

Task	Goal	Achieved
Program/implementer staff	4	3
Participant corporate representatives	2 (1 from each company)	2
Participating independent lighting contractor In-house lighting contractor	1 (census) 1	1 (census)
Nonparticipant lighting contractors	2	3
Company A Site managers (satisfaction only)	8 (census)	10
Company B Site managers (satisfaction only)	39[219]	11
Total	57	30

Only one lighting contractor installed the RetroLUX D-T-5 lighting in this Program. Originally, the implementers thought that they would have an installer on staff, but this did not happen. Evaluators interviewed the Program's sole lighting contractor as well as three randomly selected nonparticipating lighting contractors operating in Edison's territory. Evaluators interviewed nonparticipants to determine the extent of their experience with T-5 dimmable lighting.

Corporate level managers for both participating companies provided contact lists for their local office managers. Company A provided a list of 34 local managers. At the onset, evaluators understood there were only eight site managers and planned to contact the census.

Company B provided a list of 28 managers. When the sampling plan was developed, we understood that each site had its own manager. However, the corporate manager at Company B noted that each contact person was a district manager who provided oversight to 14 or 15 stores, including more than one where the lighting was installed.

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[219] Sample size designed to achieve 90/10 confidence and precision, based on based on the 90 installations completed by March 2006.

For both Company A and Company B, multiple attempts were made to contact all local Managers. Tables 2–2 and 2–3 show survey sample dispositions for Companies A and B, respectively.

Table 2–2. Company A Sample Disposition

	Frequency	Percent of eligible sample
Sample provided by Company A	34	
Wrong number/non-working number	15	
Eligible Sample	19	
Completed surveys (Target 8)[220]	10	53%
Unused sample	6	32%
Not available	3	16%

Table 2–3. Company B Sample Disposition

	Frequency	Percent of eligible sample
Sample provided by Company B	28	
Wrong number/non-working number	6	
Refused	4	
Eligible sample	18	
Completed surveys (Target 39)[221]	11	61%
Not available / Answer machine	7	39%

Research questions developed as part of the work plan were then used to develop interview guides. The questions explored the participants' decision-making process, and explored the participants' experiences with the technology since the installation.

The interviews took place in September 2006. Before interviewing participants, interviewers confirmed that the respondent was involved in the decision to participate and/or was directly involved and knowledgeable about the Program and lighting technology.

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[220] Targeting the census was based on data provided by implementers and corporate decision-makers regarding the total number of local managers. The corporate level contact provided phone numbers for 34 local store managers, however 15 numbers were disconnected or wrong. A population of 34 and interviewed sample of 10 provides results with 90% confidence level and 22% confidence interval.

[221] Target of 39 was based on 90 Company B managers at installations completed by March 2006. However, there were only 28 Company B managers. A population of 28 and interviewed sample of 11 provides results with 90% confidence level and 20% confidence interval.

Process Evaluation Results

In this section, the Program is described as experienced by individuals who designed and implemented the Program, by the sample of businesses that participated in the Program, the sample that dropped out, and the sample choosing not to participate.

Program Design

EnergySolve describes the Program design as similar to the provisions of Edison's Standard Performance Contract, providing direct incentives for new technology installations. EnergySolve anticipated that the Program design could become "a model for future performance-based incentive programs that capture both energy efficiency and demand response in a single program design."[222] For more than two years prior to the Program, EnergySolve worked with Westinghouse to design the system that would enable the T-5 retrofit of T-12 fixtures,[223] refine the demand response capability, and field test the lighting in stores in two other states

EnergySolve recognized the extensive efforts to replace inefficient T-12 fluorescent lighting in the Edison territory through rebate and performance-based programs. Implementers noted that retrofit T-8s installed in those programs do not have dimming capability and thus in those cases, no future demand response option would be available to Edison. EnergySolve designed their marketing plan to solicit participation of the hard-to-reach smaller retail businesses. EnergySolve defined eligible customers as those with T-12 lights that have the ability to act on demand response requests from Edison.

One of the main features of the Program originally proposed was the demand response capability that the system offered. With this technology, Edison could control the lighting remotely in situations where demand reduction was needed. However, Edison did not implement the technology. Rather, they chose to have the capability in place and test it later.

The marketing plan called for installing a total of 6,180 T-5 lamps in 60 facilities. The original plan included finalizing contract talks with the initial primary customer's 39 facilities, then marketing the Program to other customers and installing the lighting in the final 21 facilities. The Program as implemented deviated from the design since only two companies participated rather than 22. Implementers expected the participants within the set of 21 facilities would include a number of different companies rather than just one company. In addition, implementers also expected that participants would operate year-round. The second participant operated offices that were not open all year; seasonal operation conformed to the tax season where offices were closed during the peak demand period.

EnergySolve reported that by the Program's end (with expenditure of incentives), 5673 fixtures were installed at 176 sites (3151 lamps at 34 Company A sites and 2522 lamps at 142 Company

[222] EnergySolve IDEEA Proposal, page 5.

[223] T-5s are shorter than T-12s; Westinghouse has patented their holster to retrofit the T-5s into the T-12 fixture.

B sites). Commitments were in place for additional fixtures; EnergySolve rolled these to the next Program year and installed them when that Program opened and incentives were again available.

Market Assumptions

EnergySolve's marketing plan had two parts: the first part introduced the new technology to the market by implementing it throughout Edison's territory in 39 offices of EnergySolve's existing primary client. This large national company was using EnergySolve's Utility Bill Analysis and Reporting system to pay its utility bills and report on energy use, and had tested the lighting in some of their out-of-state offices.

EnergySolve designed the second part of the marketing plan to introduce the new technology to a variety of other market segments, testing the receptivity of the new technology in those segments. EnergySolve planned to select the facilities based on how they represented market segments that were still predominantly using T-12 lighting. They planned to look for smaller retail locations, that is, companies that required about 28 kW, and that had a showroom, storage area, offices and/or workshop areas using T-12 lamps. The company was interested in working with chain stores, with the belief that chains would be easier to replicate and/or expand future efforts. The marketing effort would involve several steps: solicit and screen customers, conduct an audit, submit a proposal to the potential client, and negotiate and close the agreement.

The Program provided direct incentives to the third-party implementers, who passed them on to participants as reductions in product purchase price. EnergySolve invoiced Edison on a per-fixture basis, which made it possible for implementers to purchase the lamps and go forward with the installations. EnergySolve invoiced installations completed before September 1, 2005 at $93.00 per fixture (not to exceed a limit of 3,090 fixtures) and $31.00 per fixture for installations after August 31, 2005. EnergySolve proposed to provide Edison with information about the wattages of replaced fixtures, the wattages of the new fixtures, operating hours, and the demand response levels. Since this is a demand-responsive, wireless, dimmable, new technology, the $31.00 per-fixture incentive was selected to provide the customer a significant enough net savings (approximately 40% of the gross savings) so that they will use the new technology. The $93.00 per fixture was selected to enable the payments for facilities completed before September 1, 2005 to be equal to Edison's Summer Lighting Program payments.[224]

Participating companies entered into an agreement with EnergySolve so that Energy Solve owned and maintained the new technology for about five years and the participating company paid for the system with expected energy savings.[225] The agreements also specified that after five years the participating store could either extend the service agreement or purchase the equipment at fair market value.

The initial installations "snapped" in the lamps utilizing the old ballast and did not "snip" power to the old ballast. After five pilot installations, Edison's technical team conducted a study of

[224] EnergySolve Demand Response, Proposal to Southern California Edison, pages 12 and 16, 3/28/05.

[225] Ibid. Page 10. EnergySolve offered pre-qualified facilities a usage fee under a Service Agreement of no more than 60% of the expected savings given the incentive levels proposed and the creditworthiness of the customer.

potential savings of the snap versus snip installation methods. Edison determined the remaining installations should be snipped. EnergySolve noted that the retrofits were cost-effective, even with the additional labor cost associated with snipping the ballast.

The T-5 RetroLUX systems are available from Westinghouse on a special order basis. Three nonparticipating lighting contractors were interviewed. Of these three, two had heard of dimmable T-5 lighting systems, and one had not. The two who were aware of the technology had not received any orders for dimmable T-5 lamps, and therefore had not installed any.

EnergySolve chose one contractor to install the lighting for the Program. The lighting contractor chosen had been in the business for about 15 years when EnergySolve contacted him. He was aware of the T-5s but not their dimming ability. Both EnergySolve and Westinghouse engineers spent time with him personally and on the phone as the installations got underway. The lighting contractor noted that the retrofit lighting contractor who installed these lights should be experienced, because they would have to retrofit many different types of fixtures and configurations. He felt it was important to have one or two people with experience on the job to oversee installation technicians who might not be as informed.

EnergySolve reported that the ideal contractor has safe work practices, is considerate of the customer, and can work well with the public. They said that it was also important that contractors have experience in the field, and that they have *"seen a lot of things"* since they would undoubtedly encounter a variety of lighting configurations. The lighting contractor echoed this sentiment, noting that the installer must be a lighting retrofit contractor and not just an electrical contractor who does lighting. It takes someone who can *"think outside the box."*

Marketing and Participation Decisions

The Program had two participants, both chain stores. A corporate manager at each company who was involved in the decision making process was interviewed.

Company A conducted pilots in New Jersey and Ohio before participating in the California Program. This company was already "on board" when the Program was proposed, and was included in the marketing discussions as the "primary customer." Thirty-four stores participated in the IDEEA Program. These 34 retail stores are open year-round, operating full business hours. Each store has a general manager, but there is not a designated "energy manager." The stores typically consisted of one large open area and a couple of small offices.

The Energy Manager from Company B learned about the Program when attending an Edison-sponsored workshop that provided information on energy-efficiency services. After talking with EnergySolve representatives, and with approval from his Company's headquarters, Company B's energy manager decided to install lighting at five pilot offices open all year, and monitor them for 30 to 60 days before making the decision to proceed with other stores, ultimately committing to install lighting at over 200 offices.

There are about 225 Company B offices, and 142 were retrofit with the Westinghouse RetroLUX-D T-5 lighting in the first year of the Program. The typical Company B office is a 1,000 square foot facility with 12 to 20 four-lamp T-12 fixtures. These facilities have between two and three dimming zones that usually involve a front work area and a back office. Most offices had employee-training rooms. The offices are largely seasonal offices, with schedules changing on a quarterly basis. Some offices had "off-season training" when offices would have otherwise been closed; training rotated from office to office from year to year. The offices primarily had four different operating profiles depending on the type of work done at the particular office. Only about 15% of the sites are year-round offices. About 50% are open December through April. This is important because original estimates of savings assumed year round operation, and not seasonal operations. Because of this, the potential and actual energy savings were reduced as well as the potential benefit from demand response dimming.

While Program implementers may have preferred to broadly introduce the lighting in other sectors and install the lighting in facilities with longer operating hours than the seasonal facilities of Company B, installing lighting at over 200 facilities offered a good test of the demand response capabilities. Company B was particularly interested in the dimming capabilities and monitoring consumption with the UBAR system. However, by installing lighting in the company's many offices, incentives were expended, and the Program was not marketed to other market segments as originally planned. Since the technology was not introduced to other market segments, receptivity to this new technology could not be tested beyond the two participating Companies.

The Program was structured like a direct install program and incentives were paid to the implementers to buy down the cost of the lighting. EnergySolve's plan was to enter into a service agreement directly with each participating office (location) where the new lighting was installed. Lighting was offered to customers at no initial cost, and payments for the lighting and maintenance were performance based, i.e., based on energy savings, which made lighting *"reasonable but not given away*." In order to provide sufficient incentives to the customer to enter into the service agreement, EnergySolve sets its usage fee at no more than 60% of the expected energy-efficiency savings, leaving a net savings to the customer of 40% of the expected savings. With the service agreement, EnergySolve owns the lighting for approximately five years before the customer can buy the fixtures at fair market value. EnergySolve is responsible for spot and group relamping and the customer is not involved in any product warranty disputes (should any arise) during the service agreement term.

Company A purchased the RetroLUX-D system outright and chose not to use the service agreement. Company B negotiated a six-year contract with a monthly fixed fee that was based on the number of fixtures, and covers the wireless technology, replacement and maintenance. The five pilot stores received larger rebates than the follow-after stores. There are not enough participants to state whether one financial model is better suited to the market.

Program Delivery and Implementation

EnergySolve trained one lighting contractor to conduct all audits and install the T-5 lighting; they reported that specialized training took about one day. The lighting contractor conducted a room-by-room, fixture-by-fixture audit noting fixture count, type, voltage, lamp wattage, conditions, etc., to develop an inventory list and labor costs. Contractors reviewed the Program with facility managers during the audit. Westinghouse shipped the RetroLUX-D T-5 lighting systems directly to the store locations. In the beginning of the Program, the manufacturer visited the sites many times to walk through the installations and troubleshoot any difficult installations or problems. In addition, the lighting contractor stated he was often on the phone with implementers and the manufacturers, particularly early in the Program. Training for the lighting contractors may take one day of specialized training, but the actual "on-the-ground" training was a longer process.

Once the installations were complete, each facility was commissioned by EnergySolve contractors who inspected the work and ensured lighting was installed according to equipment specifications and standards. EnergySolve contractors conducted an initial training of about 20 minutes for the building managers at each store. The training demonstrated equipment and provided instruction on the dimming capability. Once the system was commissioned and staff trained, contractors deemed the equipment operational.

The lighting contractor worked one-on-one with the district and store managers to educate them on techniques to interface with the Web. Westinghouse provided the user manual. The installer felt no one had difficulty understanding the manual and some were surprised that dimming could be executed from the Web. While it may have appeared that local managers received adequate training to fully utilize the system, survey responses discussed more fully below indicate that the local managers do not use the dimming capability.

The energy manager at Company B said that at the beginning of the installations, two T-5 lamps were plugged into a saddle that fit the existing T-12 fixtures (the "snap" method of installation), but the lamps experienced some problems related to power inconsistencies using the old ballasts which caused the lamps to flicker. After 20 or 30 offices were retrofitted, they decided to cut the power to the old ballast, and power a new ballast (the "snip" method). This "snip" method of installation effectively avoided the six to eight watt ballast penalty incurred with snap-in retrofits as discussed earlier. Contractors returned to the completed installations and made changes. The energy manager said that EnergySolve was very responsive and came out within one day to fix any problems.

The Company B energy manager stated that he thought the installations would be completed more quickly, but that only one lighting contractor was trained and available to complete installations. He was waiting for completion of all installations before using the 15-minute interval data with the UBAR system and training all the district managers. In the meantime, he gathered data from electric bills, going back two or three years to track usage.

The energy manager stated that while he monitors and controls dimming for all the stores from the Web, some sites employ dimming at their own discretion. There are five dimming levels. The UBAR polls the sites to set the dimming switches. Once he sets the dimming mode it will typically be left in that position. The manager said that he was disappointed in the savings so far, but also noted that most of the offices were not utilizing the full dimming capability yet.[226]

[226] EnergySolve, Round 2, Stage 2 Proposal, Page 5, 3/28/05. The EnergySolve proposal discussed expected savings including: (1) energy efficiency savings of at least 50% by replacing T-12s with T-5s in 40 to 60 small commercial facilities; (2) demand savings both from the energy efficiency savings during peak hours and from

The Program benefits and experience at the pilot stores convinced the Company B energy manager to install the lights at other stores. The benefits included energy savings, improved lighting, consistent lighting, and improvement of the look of the offices. Once the decision was made to continue, the logistics to install lighting at the remaining stores were challenging. Offices for this company were spread over a large geographic area. Installers worked in “districts” to group the deliveries and streamline their efforts. The process for retrofitting a Company B outlet generally required one day to complete the pre audit, installation, and final post inspection. A second day was typically required to establish a network connection to the dimming zones.

The energy manager noted that some new diffusers were needed where the old diffusers had discolored, and that change-out was not part of the contract with EnergySolve. Change-outs were scheduled with various offices. Employees said they liked the lights, that they were easier on their eyes, and that the color seemed more vivid. The energy manager’s experience was that lights could be on at lower levels than before and still be adequate for the task.

Market Barriers

Company A’s manager believes there is an inertia problem and a general lack of awareness regarding energy efficiency and the availability of, as well as the need for, products like dimmable T-5 lights. He stated that it is important to increase general awareness through marketing.

Company B’s energy manager felt cost was a barrier, but that the incentives covered a good portion of the cost. He suggested that there is a large learning curve when installing lights on a massive scale.

The service agreement offered by EnergySolve overcomes first cost barriers and installs the lamps at no risk to businesses, an effective marketing tool. Edison’s incentives helped with payback and got the attention of customers.

The individual store managers were asked if there were specific market barriers that existed that might prevent the widespread installation of dimmable T-5 fixtures. Only one manager provided an answer, responding that time is a constraint. The remaining store managers indicated that they felt there were no market barriers to widespread adoption of dimmable T-5 fixtures.

The market barrier noted by the lighting contractor was general lack of product knowledge among business owners. For the lighting contractor, the barrier was determining how to optimize efficiency and logistics delivering installations since many sites were not open year-round.

Company A’s executive noted that they had tried to install energy-efficient Coke machines and could not get employees to adopt to change. There appears to be an “office culture” which is not geared toward energy efficiency. Training is not taking place internally. Local managers are not

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demand response through dimming of the T-5 lights to a total potential reduction of 75% of the existing demand.

using the dimming feature. Company managers need to embrace the technology and ensure that staff receives training and are well aware of the dimming functions and UBAR reporting tools.

Market barriers are summarized as:

- Lack of product awareness specifically, and energy efficiency generally
- First cost
- Installation logistics

Participants' Experience with the Program and the Technology

Company A's executive manager was aware of the technology through experience with installations outside the state. Company B's Energy Manager was aware of T-5 lighting but not the dimming capability.

The majority of local store managers surveyed were not aware of T-5 dimmable lighting before they were contacted about the Program. Eighty-one percent (81%) reported that they were not previously aware of the dimmable T-5 technology.

The executive from Company A indicated that the company had experienced some problems with the Westinghouse T-5 lights with their earlier pilot locations in New Jersey and Ohio. The problems reported included lamps not fitting the ballasts correctly, and other issues. He had not heard of problems being reported in California. It appears there were no installation issues in this Program.

The executive indicated that he is an engineer and was involved in the company's decision to install the RetroLUX-D T-5s. He recommended that his Company switch to this kind of lamp because of the potential energy savings. However, he did indicate that he had some initial concerns about the complexity of the system. He reported that dimming features were being used 60% to 80% of the time. Yet he also reported that staff may not be using the dimming function and that lighting is being dimmed manually. (*"The automatic dimming function is not actively being used.")* This was confirmed in the evaluation team's site visits and the interviews with local managers. The Company A executive felt that, in the future, the company will move to a simpler efficient lamp, such as a T-8, without dimming. One reason to shift to simpler lighting has to do with staff turnover. Staff training initially took place when the T-5s were installed. However, internal staff training was not being done, and naturally occurring staff turnover caused the knowledge to operate the lighting at peak efficiency to be lost. He was not aware of plans in place to train new employees.

The Company B energy manager stated that the color rendition of the lighting was easier on the eyes and made workplace production better. Lighting levels were also lowered. This company's employees spend their days with computers and paperwork so the lighting did have a positive effect ("*better quality and better moral").* He said that they installed hundreds of lamps and no one has complained.

Twenty-one managers of local stores from both companies answered a telephone survey including questions about how they had initially learned about the program, their experiences with the technology, and related topics. Ten contacts from Company A and eleven respondents from Company B participated in the surveys.

The majority of survey respondents from both Company A (60%) and Company B (55%) indicated that they had heard about the Program from their corporate manager. Fourteen percent (14%) of the collective respondents indicated that the lighting contractor contacted them.

According to the telephone survey results, the participants were not taking full advantage of the lighting capabilities. Many respondents, 38% overall, indicated that they never used the dimming feature. Another 24% reported that the dimming was programmed into a set schedule and that they did not have any control over this function. Only 24% of the local managers used the dimming functions, and those used it once a day. Table 2–4 summarizes responses.

Table 2–4. Use of Stepped Dimming

	Company A N=10		Company B N=11		Overall N=21	
How often are dimming options used?	Frequency	Percent	Frequency	Percent	Frequency	Percent
Many times a day	0	0%	0	0%	0	0%
Once a day	3	30%	2	18%	5	24%
Rarely	1	10%	2	18%	3	14%
Never	4	40%	4	36%	8	38%
Program to set schedule	2	20%	3	27%	5	24%

Source: Participant survey (n=21)

Survey respondents were also asked if staff had raised any issues with the dimming of the lighting. The majority of respondents, 86% overall, indicated that they were not certain. Two single responses were provided. One staff person at Company B thought that the stores were too dark when the lights were dimmed. Another respondent at Company B stated that the lights could be dimmed more often. In other comments, respondents said that the light was not as bright, and that it was friendlier now that the lights were not too bright.

The majority of the respondents reported some problem or malfunction. The number of local store mangers reporting a malfunction was greater at Company A than it was at Company B. Table 2–5 summarizes responses related to equipment malfunction.

Table 2–5. Reported Equipment Failures or Malfunctions

	Company A N=10		Company B N=11		Overall N=21	
Have there been failures or malfunctions?	Frequency	Percent	Frequency	Percent	Frequency	Percent
Yes	8	80%	3	27%	11	52%
No	2	20%	8	73%	10	48%
Uncertain	0	0%	0	0%	0	0%

Source: Participant survey (n=21)

The reported malfunctions varied and there was no apparent single issue of concern. Local managers stated:

- *"The lights wouldn't come on or were not working."*
- *"It just sometimes went off and you'd have to reset it."*
- *"The lamps are burning out;, they're supposed to last four to five years."*
- *"Transmitters fell off but contractors fixed the problem."*

The local managers were also asked if training was provided, if it was useful, and if it met their needs. Overall, more than half the local managers said contractors did not provide training, with most of those people from Company B (Table 2–6). Company B's energy manager said he was waiting to train the managers until all the systems were installed, which would not occur until the next Program year.

Table 2–6. Dimming System Operations Training

	Company A N=10		Company B N=11		Overall N=21	
Was training about dimming options and system operations provided?	Frequency	Percent	Frequency	Percent	Frequency	Percent
Yes	7	70%	2	18%	9	43%
No	3	30%	9	82%	12	57%
Uncertain	0	0%	0	0%	0	0%

Source: participant surveys (n=21)

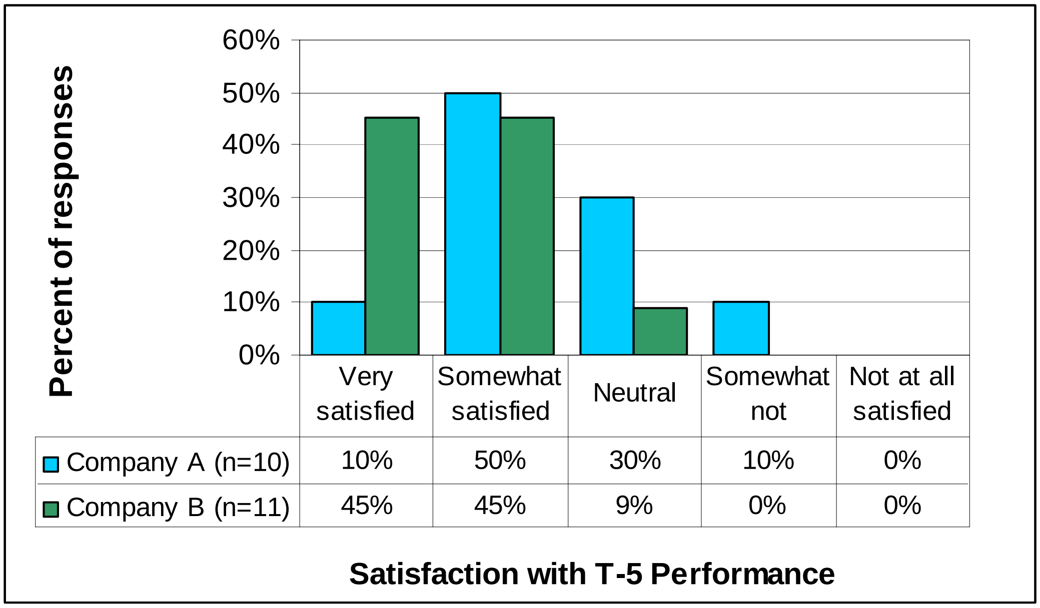
Of those who said the training was provided, 89% said the training met their needs. There is an apparent disconnect here since many said they were not using the dimming options. For example, 70% of Company A was adequately trained but only 30% used the dimming once a day (Table 2–4). In Company B, only two were trained, and two were using the dimming options.

While the equipment upgrade led to energy savings, the comments of the store managers indicated that Program participants did not take advantage of the full capabilities of the Westinghouse T-5 lamps and the EnergySolve UBAR system. There was no apparent difference in lighting performance between the two companies. Further training may be required on both aspects of the Program—the dimming technology as well as the UBAR program—to ensure that the local managers understand how to use the technology and incorporate it into their daily routines. Plans should be put in place to assist with the transfer of knowledge when a trained store manager is replaced.

Satisfaction and Suggestions

The majority of respondents, (76%, 16 of 21) reported they were "very satisfied" or "somewhat satisfied" with the performance of the lighting and dimming options. Survey responses of the local managers related to overall satisfaction with lighting performance are shown in Figure 2–4.

Figure 2–4. Overall Satisfaction with Lighting Performance



Source: Participant survey

Company A's executive manager was "somewhat satisfied" with the Program overall. He said that they would opt for a more simple technology in the future, such as T-8 lighting, which does not have the dimming options.

Company B's energy manager was "very satisfied" with the Program overall and felt there were *"a lot of possibilities to reap benefits of dimming the lighting by zone."* He also thought that theT-5 lighting had potential in large office complexes, schools and supermarkets. He suggested that where there is large square footage and the building is open from the *"sales floor to roof,"* skylights plus the T-5 would be an energy-efficient approach to lighting. This manager suggested that the website could use updating where data is accessed for each installation location. He would like to be able to set timing from the website *"which could solve the switch problem."* He also suggests rebates for occupancy sensors and tying the sensor into the system.

Free Riders

Decision-makers at participating companies answered a battery of questions designed to quantify free ridership. The central corporate level, and not individual stores, made the decision to install the Westinghouse RetroLUX-D T-5 lights. None of the local managers from Company A, and only one person from Company B, said they were directly involved in the decision to have the lighting installed.

The Company A executive manager stated some of their stores had participated in a T-5 lighting pilot with EnergySolve in other states prior to participating in IDEEA. EnergySolve included them as a "primary customer" when they initially proposed the Program to Edison. The executive stated his Company "*probably wouldn't have done it on its own."*

The Company B energy manager learned about the T-5 lighting and dimming system from EnergySolve at an Edison-sponsored lighting-efficiency workshop. He was not planning to install lighting prior to participating, and needed the incentives to go forward.

There were no free riders identified through the survey interviews, and the NTG ratio used in the analysis was 1.

Potential Spillover

Company A's executive manager had no plans to install lighting at any other stores, nor had he installed any other energy-efficient equipment in the stores, although he had encouraged the stores to use efficient equipment. He said he had not participated in prior Edison efficiency programs.

Company B's energy manager stated that he would install the lighting at other stores in the future, with incentives. He noted that they were planning to install lighting under another utility's program and they would not have done that without the experience with the Edison IDEEA Program. The respondent said his headquarters was monitoring the Edison area offices and may decide to install lighting in other locations outside of California. He also noted that the next project he was going to tackle was a pilot installation of Honeywell thermostats for the air conditioning systems. The AC pilot was not directly influenced by participating in the T-5 lighting Program. He stated that he is always looking for energy savings and for ways to stay on top. He had not participated in prior Edison efficiency programs.

The local store managers were asked if they had added any other energy-efficient equipment in their stores after hearing about the Program. None of the survey respondents indicated that they had.

Forty-three percent (43%) of the respondents indicated that they had installed T-5 dimmable lighting at other stores that they manage. Fifty-seven percent (57%) had not. At Company B stores, 78% indicated that they had plans to install T-5 lighting at other stores they manage in the next one to two years. These were the offices and locations committed but not yet serviced under the 2004-2005 Program, and do not represent spillover from this Program.

There does not appear to be any spillover from other Edison programs to the Demand Response Program. However, there is some spillover from Company B's participation in Demand Response to their participation in another utility's lighting program.

Lessons Learned by Program Staff, Future Plans

EnergySolve Program implementers interviewed emphatically believe that there is a market for this technology. EnergySolve estimated that the potential for the dimmable T-5s was very broad, with about 55% of the lighting around the country potentially upgradeable to the T-5s. They estimated 50% energy savings by changing out the T-12s to T-s. EnergySolve believes the Westinghouse RetroLUX dimmable T-5 technology provides a cost-effective demand response and energy efficiency technology. The UBAR system provides M&V measurement capability and can report customer savings.

Edison's Program Manager also felt there is potential for this technology. The ultimate Program goal was to use the incentive money to purchase kWh savings. The Program expended all incentives before the end of the Program and before all the lighting was installed in committed stores. Lighting committed and not installed was rolled into the next Program year. The Program fell short of its kWh savings goal largely because the operating hours fell short of expectations.

Program implementers suggested one difficulty broadening the Program is effectively identifying businesses with T-12 fixtures.

One potential programmatic and logistic issue EnergySolve identified was related to company size. That is, larger companies with many installations will likely have multiple base stations to control the installations over a designated geographic location. However, neither of the two current participants was large enough to tax the capability of the Westinghouse RetroLUX-D T-5 and UBAR system.

EnergySolve stated that retrofitting larger facilities is more cost-effective than retrofitting more but smaller facilities. One of the marketing issues is inertia, and getting customers to focus on energy use and lighting. In the future, they felt it would be worthwhile to educate and sell the technology to trade allies in order to market the system through additional marketing channels. They would also emphasize the UBAR tool and its M&V potential.

In terms of the actual installations, the 2006 Program learned how to increase performance from the 2004-2005 Program experience. This Program began by snapping the retrofit unit in place and retaining the ballast. The method disadvantaged savings because the ballast drew an additional six to eight watts of power. The installation procedure was changed to snip power to the old ballast and rewire a new ballast. This should be the only method allowed in the current program.

The seasonal operations of Company B affected everyone who wanted to gain access to the facilities. Edison conducted some on-site post installation inspections, with a goal of 20% on-site inspections. Coordination with the seasonal offices made it difficult to verify functionality although the equipment count was verified. One of the issues the lighting contractor encountered involved modifications to their work schedules when they discovered some seasonally occupied offices after arriving at the site.

Contractors first had to gain access to the office. Once accessed, the crew had to work in an occupied zone, around people and their desks. The contractors needed a customer-service orientation and patience.

After this Program experience, the contractor feels this is an excellent technology. With any new product, there are bugs or idiosyncrasies. There were some problems with failing transceivers and ballasts but Westinghouse replaced them under warranty. The manufacturer visited the facility, an corrected any problems.

Edison feels the innovative aspects of the Program were the wireless, dimmable capability, that is, the energy and demand savings marketed at the program level. Edison did not expect the demand capability to kick in during the 2004-2005 Program year, but they wanted the demand capability ready. The Edison manager worked with the demand response team to coordinate use of the technology installed through this Program. The demand response team has not made additional efforts to utilize the demand response capability of the installed T-5 lighting. In the 2006 program, the demand response potential is assessed during an audit and, where there is enough potential to meet Edison's demand reduction needs, auditors provide a lead to the Edison demand response team.

The utility incentives buy down the cost of the lamps and keep the price to the customer reasonable. Customer payment (defined in their service agreement with EnergySolve) is based on energy savings, which depends on the rate and operating hours at the facility. Fewer operating hours lower energy savings. The service agreement is designed so that the customer pays for their system through energy savings. A portion of the savings is applied to payment and the customer retains the rest of the energy savings; the agreement boils down to somewhere between a 50%-50% or a 60%-40% split, depending on the overall cost and projected energy savings at the facility. EnergySolve feels this is a good financial model. It removes the first cost barrier by taking initial outlay of cash (first cost) out of the equation. EnergySolve would use this model for future programs.

The two participating companies took different approaches to financing their installations. Company A decided not to use the service agreement model outlined above and to purchase the lamps outright. They do have a maintenance agreement with EnergySolve. Company B chose the service agreement approach and will own the Westinghouse RetroLUX-D T-5 system in about 15 years. For both companies, the incentives were important to their ability to participate.

Administratively the Program is no different from direct install programs where the customer is paid through a rebate, and the purchase is similar to customer co-pay. The Program delivery model was a good model for this market.

The Program financing follows an ESCO model where repayment is made through shared savings. EnergySolve provided the financing leased the equipment and the participating company paid EnergySolve through energy savings. The participating company owns the equipment at the end of the lease.

From an energy efficiency standpoint, the service agreement may attract larger customers, for example, the chain accounts. For a smaller customer it may not make sense to install the dimming capability; a conventional T-8 retrofit may be sufficient. However, one of the issues with the Program as implemented was that as a small program, only two customers used all the available incentive money. The Program needs to attract additional customers of sufficient size to take advantage of the financing model, the dimming capability, and be large enough to qualify for demand response programs. Mainstreaming the Program may be the solution to attracting a variety of customers and introducing the technology to a more diverse market.

The two participating companies also took different approaches to controlling their lighting levels and utilizing the UBAR system. At Company A, each store stood on its own and there was no corporate energy manager or "overseer" monitoring the stores via the Web interface. This manager also acknowledged that managers may not be using the dimming capability, that they were not training new hires in how to use the system, and that the technology may be too complex.

Company B’s energy manager was much more pro-active than Company A’s. This person had access to every site and was continuously monitoring light levels by zone and dimming remotely, and utilized the UBAR capabilities to increase savings. In this case, the individual store managers had less independent control over lighting in their stores. However, each local store manager could operate the dimming features at their store if they chose to do so.

The difference in approach appeared to be rooted in the level of interest and personal attitudes about taking advantage of the energy-saving technology. EnergySolve will need to educate all the local and division managers so that they can increase their energy savings profits by actively utilizing the system. One problem is turnover. Ongoing training is needed, conducted either internally or by contract with EnergySolve, so the knowledge is not lost when staff turnover.

One “change” in the Program from the original proposal occurred in the mix of fixture types anticipated and proposed. EnergySolve estimated the quantity of lamps, that is, the number of 8’ and 4’ lamps that would be retrofit. They found that the actual mix changed once they were in the field. This had no impact on lamp availability; manufacturers were able to meet the orders.

Operating hours may be an issue to address when computing energy savings goals in future programs. Implementers overstated the operating hours in the initial Program proposal, unaware that offices operated on seasonal schedules. Future programs need to incorporate screening questions based on operating hours.

The lighting contractor also pointed out that it is important that the on-site auditors who document existing conditions and specify equipment be knowledgeable about lighting retrofits. In the area of retrofit lighting, he notes that contractors must have broad-based retrofit experience and be extremely efficient in order to succeed. Retrofitters must be willing to work in the field, travel, work hard, appear clean-cut when working with the public, and get paid on a piecemeal basis. This contractor noted that in the energy-efficiency field, pay is typically low. For the efficiency industry to take hold, he feels it is important to pay the employee as much as possible.

3. Impact Evaluation

The impact evaluation objectives are to develop ex-post adjusted gross and net savings for the Program. The methodology and impact evaluation activities are discussed below. Both engineering analyses and a billing analysis were conducted.

Because not all buildings were included in the billing analysis, and the operating hours are unknown, factors at these buildings appear to have obscured the impact of the Program and the billing analysis has underestimated the Program's true impact. Since converting to more energy-efficient lighting—all other things being equal—would not result in an increase in energy consumption, there are clearly other factors influencing energy use at the assessed buildings. As a result, it was not possible to accurately determine the total savings attributable to the Program using a billing analysis without additional information that was not available.[227] For these reasons, the engineering analysis is used to estimate the Program's impact on energy savings.

Impact Evaluation Methodology

The general methodology employed to measure and verify energy savings attributed to the Program included the activities described below.

1. Complete measure installation verifications
    a. Develop a sample for field verification activities
    b. Conduct field verification activities including the installation of data-logging equipment
    c. Review any data on verification activities completed by Edison
    d. Develop adjusted measure installation rates based on field activities and data reviews

2. Complete an engineering analysis to develop ex-post realization rates
    a. Complete a review of evaluation Program data
    b. Analyze data provided through logging activities
    c. Complete analysis of customer energy bills
    d. Develop project and Program realization rates
    e. Determine operating hours and dimming schedule at participant sites

3. Develop adjusted gross and net Program ex-post savings

4. Provide conclusions and recommendations for the EnergySolve Demand Response Program and the overarching Edison IDEEA program

Each of these activities is discussed in detail in the following sections. Additional detailed information may be found in Volume 2, Appendices.

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[227] Although requested, the participating company's Energy Manager could not provide operating schedules for retrofit offices.

Measure Installation Verification

The objectives of the on-site verification activities were to complete visits to numerous sites and collect key energy Program performance metrics including:

11. Establishing the presence of Program measures by comparing the number of installations observed for a sample of sites with the number of installations recorded in the final flat file provided by the Program implementation contractor.
12. Providing input on the quality of installations observed.
13. Where observed equipment does not match Program reported installations, determine if retrofits were ever present, and/or the removal date and reason.
14. Recording key facility performance data, such as daily schedules, seasonal variations in schedules, occupancy, and control strategies (Program-specific).
15. Installing data logging equipment to verify self-reported run hour estimates and also measure power consumption and light levels provided by the Program retrofits.

The detailed measure installation verification instrument is provided in Volume 2, Appendices.

Installation Verification Sample

At the time the measure installation verification sample was drawn and fieldwork conducted, 34 Company A locations and 70 Company B locations participated in the Program.[228] Using a proportional sample approach where the sample is a large fraction of the population, it was determined that a sample of 23 sites would provide a confidence and relative precision of 90/15, respectively, as defined by the following equation:

$$\text{Sample size} = N * [P * (1-P) * Z^2] / [N * E^2 + P * (1-P) * Z^2] \qquad (1)$$

where

N = population size,

E = error,

Z = standard error, and

P = proportion of the population.

The verification approach required that the sample have three stratifications depending upon the type of activity at each site, as defined below.

In developing the sample, a number of steps were taken. First, each location was assigned a random number. The random numbers were then sorted in ascending order and the first eight Company A sites and the first 25 Company B sites were selected to receive verification visits.

[228] EnergySolve Edison flat file 3-21-06_Inv2.xls

Of the sites receiving verification visits, a random set of 12 Company B locations were selected to receive data loggers to record lighting run hours. Additionally, from the eight Company A locations receiving verification visits, two sites were selected to receive data loggers that record lighting run hours.[229]

The evaluation team also installed power loggers on select lighting circuits in order to confirm estimated kW and record the impacts of any dimming activities undertaken by site occupants. Of the sites receiving verification visits, a random selection of one Company A and three Company B locations were selected to receive power logging.[230] Table 3–1 provides a description of the distribution of planned site verification and data logging activities and the field activity achieved. Volume 2, Appendices, provides further sample details and highlights the verification activities that occurred at both Company A and Company B participant sites.

Table 3–1. Planned Site Data Collection and Sample Activities

Participant	Installed Sites at Time of Verification Field Activities	Planned Site Verification Sample	Planned Sites Receiving Lighting Level Logging	Planned Sites Receiving Power Logging
Company A	34	8	2	1
Company B	70	25	12	3
Total	104	33	14	4

Due to the fact that all Company A and Company B sites were homogenous, it was assumed that whole-facility influences (plug loads, power equipment) would also be consistent and impacts from the installed measures could be isolated with a census billing analysis. This involved an analysis of the whole facility utility meter data using techniques from simple comparison to regression analysis where applicable (IPMVP Option C). Evaluators also assumed that the partial field data collected through metering would correlate to changes in consumption recorded through billing data. However, where discrepancies occurred, a preference was given to metered data and engineering calculations (IPMVP Option A) as they were more accurate in attributing variations in energy consumption.[231] However, note that the billing analysis only showed 37% of the engineering analysis' savings, which was attributed to building alterations and/or other consumption factors that did not pertain to the retrofits.

Site Verification Activities

Field activities typically involved three components, listed below.

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[229] Loggers were distributed proportionate to sampling based on the distribution of savings. Uncertainty surrounding Company B's operating hours required sample revisions during field activities.

[230] The power logging was supported with light level logging and on-site verifications of operating hours. Findings revealed that most of Company A's sites operated under the same business schedule.

[231] Overview of M&V Options, *California Energy Efficiency Evaluation Protocols, 2005 ed.*

7. The evaluation team coordinated with the implementation contractor and primary customer contact to establish field activity dates and identify site level contacts.
8. While at the site, the evaluation team conducted a room-by-room, fixture-by-fixture audit noting fixture count, type, voltage, lamp wattage, conditions, etc. using the field instrument available in Volume 2, Appendices.
9. A detailed description was provided where data logging equipment had been installed. A data logger installation tracking sheet is provided in Table 3-2. A pick-up date was provided to each site and the evaluation team called each site in advance of returning to retrieve loggers.

Field verification activities took place between June 2nd and June 9th of 2006, with a total of 19 sites visited, or roughly 18% of all sites installed at the time of evaluation. While on site, data loggers were installed and spot measurements were taken at select sites to provide information on lighting run hours, lighting levels, and energy consumption. Where data loggers were installed, return visits occurred by mid August to recover the equipment, yielding an average logging period of 60 calendar days.[232] Table 3–2 provides a summary of the verifications activities undertaken by the evaluation team, including the types of activities completed at the various sites. Volume 2, Appendices, provides details on specific site activities.

Table 3–2. Summary of Verification Activities

Participant	Installed Sites at Time of Verification Field Activities	Planned Site Verification Sample	Achieved Site Verification Sample	Planned Sites Receiving Lighting Level Logging	Achieved Sites Receiving Lighting Level Logging	Planned Sites Receiving Power Logging	Achieved Sites Receiving Power Logging
Company A	34	8	7	2	1	1	1
Company B	70	25	12	12	5	3	3
Total	104	33	19	14	6	4	4

Deviation from Research Plan Verification Sample

The discrepancy that exists between the numbers of verifications stated in the research plan and achieved verifications is a result of the rotational operating hours of the Company B sites. During field activities, evaluators discovered that many sites were not open year-round, and thus the sample set was adjusted accordingly. On-site verifications were conducted at offices that were actually open and available for inspection.

[232] Each site typically had two to four lighting circuits retrofitted by the Program. Logging was generally done on circuits with the most lighting activity/dimming throughout the day. These circuits were determined through conversations with staff and/or by observation, determining which areas were most populated. Logging was generally done on 2-3, and sometimes all, lighting circuits. As such, the sampling error is perceived to be relatively small. The short term data was used to verify participant-claimed operating hours. The findings were applied to all stores based on a weighted average of operating hours for the resulting participant sites.

As discussed in the following sections, all Company B facilities operate under one of four different annual schedules. Of the 104 sites installed at the time of the evaluation field activity, only an estimated 18 sites were scheduled to be open.[233] However, after several attempts, it was only possible to gain access to the 12 sites that were referenced. Difficulty in accessing sites was also encountered when evaluation staff returned to select sites to retrieve data-logging equipment installed during the initial verification visit. As such, the actual field sample achieved exceeds the required sample of 15 necessary to provide a confidence and relative precision of 90/20, respectively, on a population of 104 installations per the sampling method previously described.[234] This same 90/20 confidence and precision statement applies to the total number of 181[235] installations completed by the end of the Program.

Installation Verification Results

As stated previously, the primary objective of the verification is to establish the presence of Program measures and installations recorded in the final flat file provided by the Program implementation contractor. To accomplish this objective a statistical analysis was employed in deriving the appropriate adjustment factor dependent upon the verification data collected during the site verifications. This analysis accounted for differences between the installations recorded in the Program reporting records, and verified installations. In addition, the evaluation team requested site-specific data from the implementation contractor where discrepancies existed between reported and verified installations. Several observations about the verification sample results follow.

- For the seven Company A sites visited, verified installations (determined by comparing observed installations to Program data reported for each site) ranged from 76% to 107%. The sample average was 95%.
- For the 12 Company B sites visited, verified installations ranged from 66% to 115%. The sample average was 97%.
- The final Program records submitted by the implementers indicated that there had been no installation at a site with installations verified by the evaluation team. After discussion with the evaluation team, the implementers completed a further review and updated their records to show that installations occurred at the site verified. This was likely a data entry issue.

The project and program-level verified installation rates are shown in Table 3–3.

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[233] Accepting sites that were not open year-round appears to hinge on a couple of issues. There were no criteria related to a minimum number of operating hours. The initial participant sites for the company with seasonal sites were open year-round. The corporate management requested additional sites participate; extending the program to these sites was a natural evolution and implementers chose not to exclude some offices.

[234] The sites operating hours were not completely representative of the 181 participating sites – as some sites were only open a portion of the year. However, ensuing discussions with their corporate office allowed us to calculate the weighted average operating schedule. Field findings further supported their claimed schedule.

[235] One hundred forty-seven Company B sites and 34 Company A sites.

Table 3–3. Installation Rates Determined from Evaluation Field Activities

Project	Reported Installation	Verified Installation	Installation Rate
Company A	666	632	94.9%
Company B	328	318	97.0%
Program Total	994	950	95.6%

As stated previously, a second objective of the verification activity is to provide input on the quality of installations completed through the Program. In general all facilities verified by the evaluation team appeared to be installed well and operating correctly.[236] Figure 3–1 provides a view of a typical Company B office, and shows the detailed fixture retrofit that occurred at nearly 100% of Company B fixtures.

Figure 3–1. Company B Installation Details

Several observations are worthy of note.

- In reviewing the operational performance and participant awareness of the dimming capabilities of the system, evaluators observed that none of the Company A facilities understood how to use the dimming capabilities. In addition, the operations staff at several Company A sites indicated that they were not aware of the dimming capabilities of the system.

[236] Dimming capability was verified by accessing the web based control interface and dimming various fixtures and circuits.

- Only one Company B site was aware of the dimming capabilities of the system, and this participant indicated that the dimming capability was used on all three dimming zones at that facility. Typically, dimming levels would be set and then not adjusted.

Edison randomly selected 10% of the sites to receive a visual verification of installation and operation. The evaluation team verified Edison sites totaling no more than 10% of the evaluation study sample, resulting in an expected overlap of approximately seven sites. The evaluation team requested records from Edison for all sites verified by Edison, however this data was not received, and subsequently no comparison was possible.

Engineering Analysis

An engineering analysis was conducted to develop adjusted realization rates for the Program. This included a detailed review of Program records and documents and data logging activities as described in the following sections.

Review and Evaluation of Program Data

The final Program records submitted by EnergySolve to Edison were analyzed for accuracy and consistency, and to ensure that the underlying assumptions were reasonable. The key documents analyzed included:

- The final Program 'flat file' submitted on June 30, 2006.[237] This file documents the activity at each site installed, including the type and number of fixtures installed and underlying energy savings assumptions, and the dates of the various installations. *This file provides Program gross energy savings values.*
- The final Program 'workbook' dated June 30, 2006.[238] This document provides a reporting format for the CPUC and represents a summary of the information contained in the Program flat file. It does not contain site-specific data. *This file provides Program net energy savings values*.

This review resulted in several observations.

1. The estimated 4,050 annual operating hours for lighting systems at Company A installations used in the flat file was identical to the operating hours identified through interviews with Company A staff and a review of posted store hours during the verification visits.

2. The estimated 2,424 annual operating hours for lighting systems at Company B installations used to provide ex-ante savings is likely overstated. Company B facilities generally fall into one of four annual operating hour schedules. Some facilities operate year-round while the majority of facilities operate only from September through April 15th. These facilities then typically close until the following fall. Based on discussions

[237] Edison Flat File 6-30-06_Inv4.xls

[238] EnergySolve Invoice 4 Workbook_6-30-06.xls

with Company B Management, Table 3–4 provides the operating schedule details on the four annual operating schedules, while Table 3–5 provides an estimate of the number of facilities that operate on each of the four schedules and the resulting weighted, average annual run hours for Company B facilities of 1,620. Evaluators recommend that the kWh impacts associated with Company B installations be amended to reflect this 33% reduction in run hours. In addition, when estimating peak kW savings associated with the Program, the fact that most Company B facilities are closed during the Edison summer peak period must be taken into account. Our analysis indicates that the peak savings attributable to Company B during winter peaking period is 256 kW while the peak savings attributable during the summer peaking period is 62 kW. This evaluation utilized the Energy Efficiency Policy Manual[239] peak demand period definition of noon to 7 p.m. Monday through Friday, June, July, August, and September.

3. Program records indicate that approximately 2,952 fixtures were replaced at the 34 Company A sites participating in the Program. Of these fixtures, approximately 31% were Westinghouse T-5 RetroLUX units, while the remainder were non-dimmable T-5 based fixtures designed to replace eight-foot T-12 strip-type fixtures. These records appear correct.

4. The Program records for Company B installations indicate that roughly 2,471 base case fixtures using four-lamp 40W T-12 fluorescent lamps were replaced with 2,721 fixtures using two T-5 based Westinghouse RetroLUX units. It was noted that the 2,721 fixtures referenced as baseline fixtures was based on an estimate made by the implementation contractor prior to installation and is not an actual inventory completed at the facilities prior to implementation. The contractor noted that the as-built measure count of 2,721 correctly reflects the number of original fixtures that existed prior to implementation. It was also discussed that the base case fixtures were not all 40 W lamps. Instead, the base case fixtures consisted of approximately 50% 40 W lamps and 50% 34 W ‘energy-saver’ lamps. While the evaluation team did not complete any pre-installation verifications of the base case assumptions, the assumed base wattages stated by the implementation contractor appear reasonable.

5. For the Company B retrofits the implementation contractor used 98.4 W per fixture as their estimated savings value. This estimate is based on the original Program plan that assumed that all baseline Company B fixtures used four 34 W lamps and consumed approximately 156 W per fixture. The retrofit fixtures were assumed to consume 72 W, yielding an estimated 84 W savings per fixture. An additional 14.4 W of savings was estimated as a result of a planned 20% dimming of all fixtures, yielding the total of 98.4 W in planned savings per fixture. After installation, the contractor estimated the base case fixture wattage at 168 W and the retrofit fixture consuming 60 W. This yielded a fixture level savings of 108 W. In addition, the implementation contractor assumed an additional six W of savings would be yielded through the use of a 10% dimming level, for a total post installation estimate of 114 watts per fixture. In interviews with end users at both Company A and Company B the evaluator concluded that none of the sites except one

[239] Version 2, August 2003.

used the dimming capability of the system. It is therefore unlikely that the additional 10% savings being contributed from the dimming is correct. The evaluation team concluded that the post-installation estimate of 108 W is reasonable; however, because no base case fixtures were observed, the evaluation recommends accepting the 98.4 W used in the final Program records. This value represents a good approximate of the average between the original and final non-dimmed savings of 84 and 104 W per fixture, respectively.

6. The workbook that the implementation contractor provided to Edison as the final workbook contained an error in the kWh savings being reported on 95% of Company B installations. The final workbook, dated June 30, 2006, indicated that 397 kWh were being saved (gross) per fixture. This is inconsistent with the final flat file submitted by the implementation contractor for the same installations. The final flat file indicates that a gross of 237 W are being saved per fixture, which is consistent with ex-ante Program assumptions. The implementation contractor indicated that the 397 kWh was a data entry error and that the workbook would be corrected and resubmitted using 237 kWh in gross ex-ante savings per fixture.

Table 3–4. Company B Operating Hour Profile

Operating Period Number	Period Start Date	Period End Date	Calendar Days	Number of Weekdays for Period	Hours / Weekday	Annual Weekday Period Hours	Number of Saturdays for Period	Hours / Saturday	Annual Saturday Period Hours	Number of Sundays for Period	Hours / Sunday	Annual Period Sunday Hours	Annual Hours
1	1-Jan	16-Apr	106	76	14	1,060	15	8	121	15	4	60	1,241
2	17-Apr	30-Jun	75	54	4	214	11	0	0	11	0	0	214
3	1-Jul	31-Aug	62	44	6	266	9	0	0	9	0	0	266
4	1-Sep	31-Dec	122	87	8	697	17	0	0	17	0	0	697
		Total	365	261		2,237			121			60	2,418

Table 3–5. Weighted Average of Company B Annual Lighting Operating Hours

Operating Period Number	Operating Period Annual Schedule	Estimated Number of Company B Installations for Each Operating Period	Percent of Company B Sites in Each Period	Annual Site Hours	Weighted Average Annual Operating Hours
1	January 1 thru April 16	63	43%	1,241	534
2	September 1 thru April 16	48	33%	1,507	496
3	July 1 thru April 16	18	12%	2,204	264
4	Year round	18	12%	2,721	327
Weighted Average Annual Operating Hours for All Sites					1,620

Site Data Logging Activities

Energy savings from the installed retrofits are based on two components:

1. The permanent kW and kWh reduction resulting from the retrofit
2. Savings resulting from the dimming capabilities of the retrofit

On/Off and Lighting Intensity loggers were installed to capture data needed to calculate ex-post savings values of the permanent kW and kWh reduction resulting from replacing a 34W or 40W T-12 lamp with a 28W T-5 lamp. Additionally, interval power consumption logging was conducted on approximately eight lighting circuits at four distinct sites to verify estimated kWh savings by verifying facility lighting run hours.[240] The loggers were in place for 45 to 60 calendar days. The sample of sites and lighting circuits used to verify lighting run hours was selected based on the following factors:

a. All of Company A sites shared a common layout and common operational characteristics. It was concluded that logging operating hours on all lighting circuits at two individual Company A sites would provide a sample that would be representative of the population of facilities participating in the Program. All Company A sites were retail outlets operating on a common schedule.

b. Company B sites share a common layout, fixture type, and common operational characteristics, such as run hours. Each site typically has two to four lighting circuits retrofitted by the Program. Since all of the Company B sites are nearly identical, it was concluded that logging operating hours on all lighting circuits at 12 individual Company B sites would provide a sample representative of the population of 90 facilities participating in the Program.

Savings could also be achieved through the dimming capabilities of the RetroLUX retrofit. The dimming activities were recorded through the use of light level loggers and logging power

[240] For supporting data, a subset of the 4 Channel loggers was placed on circuits that were not being logged by on/off or intensity loggers.

consumption at a sample of lighting fixtures. Logging activities were distributed to cover almost all building areas affected by lighting installations (e.g. front office, storage area, etc.). The lighting power loggers also helped establish the correlation between lighting intensity levels[241] and power reductions due to dimming actions.

Data loggers were installed at three Company A and six Company B sites to further confirm self-reported run hours. These loggers recorded when lights were turned on, and when they were turned off. Table 3–6 shows the results of on/off logging undertaken on 13 lighting circuits at the six different Company B facilities. The table shows the types of areas logged, the total number of hours the loggers were recording, the total number of hours the lights were reported to be on, and the percent of time the lights were on.[242] The total run time is 14.2%, with both office and storage areas showing about the same amount of run time. Note that this percentage of run time would represent approximately 1,243 hour annually; however, this would not be accurate because Company B facilities tend to have long run hours early in the year, and the logging activity occurred during the summer season, which traditionally has lower run hours. These data confirm the previous conclusion that Company B operating hours should be reduced from the Program-assumed 2,424 to the 1,620 annual hours recommended by the evaluator.

Table 3–6. Data Logging Output Providing an Estimate of the Percent of Time Company B Facility Lights Operate

Site (logger ID)	Location	Total hours logged	Total hours light operate	Percent of time lights operate[243]
Site 1 (816575)	Office	1,560	39	2.5%
Site 1 (833901)	Storage	1,536	4	0.2%
Site 1 (833947)	Office	1,560	474	30.4%
Site 2 (816637)	Office	1,512	63	4.2%
Site 3 (816647)	Storage	1,536	147	9.6%
Site 3 (833912)	Storage	1,536	153	9.9%
Site 4 (816577)	Storage	1,488	494	33.2%
Site 4 (816641)	Office	1,465	154	10.5%
Site 5 (816601)	Storage	1,104	121	11.0%
Site 5 (816619)	Office	2,352	300	12.8%
Site 6 (816633)	Storage	1,416	282	19.9%
Site 6 (833907)	Office	1,440	284	19.7%
Site 6 (833972)	Office	264	55	20.7%
Average % of time that lights are on				14.2%

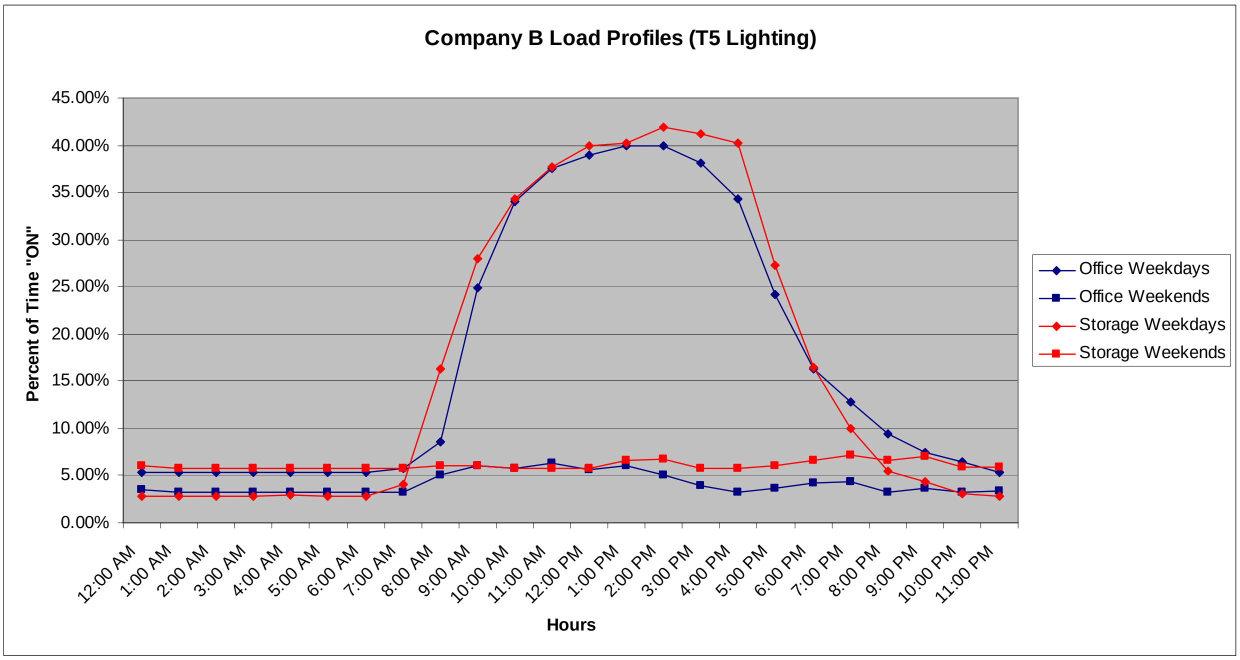
[241] Lumen output at the fixture was logged and lumens per sq. ft. for the circuit logged was calculated based on the configuration of fixtures on the circuit.

[242] In general, logged run hours compared well with the occupant reported hours. As noted, Company B facilities tend to have long run hours early in the year, and that a substantial number of sites were closed during site verification and logging activities. Operating hours on closed facilities were gathered through participant discussions.

[243] Variability in hours of operation is due to the diversity of area use types.

Figure 3–2 provides a load curve that was developed with lighting on-off data logger output. This curve indicates that no more than 40% of lights that were logged were operating coincidently during a typical weekday. This observation is true for both office and storage areas. During the weekend, no more than five to seven percent of lights are typically operating in either the office or storage areas. This curve is consistent with observations by the evaluation team that staff at many Company B facilities turn off lights in areas that are not occupied.

Figure 3–2. Company B Load Profile



As discussed earlier, data loggers were installed at three Company B sites and one Company A site to record changes in power consumption and lighting output levels that resulted from the use of the RetroLUX system dimming capabilities. Data loggers[244] were placed so that both power and light output could be recorded on the same circuit. Only one site that participated in the dimming activities (Site 2) actually used the dimming system during the evaluation data logging period. Figure 3–3 illustrates the change in energy (as measured by lighting circuit amperage) with changes in lighting output. For this specific case, a reduction of 0.41 amps resulted in a reduction of 290 intensity units.[245] A regression analysis was used to determine that intensity and energy draw were not linearly correlated—rather, a 12% decrease in amperage draw resulted in an approximate 45% decrease in intensity.[246] It should be noted that the amperage draw is equal to approximately 1, even when the intensity is 0, because of the error range of the CTs used for

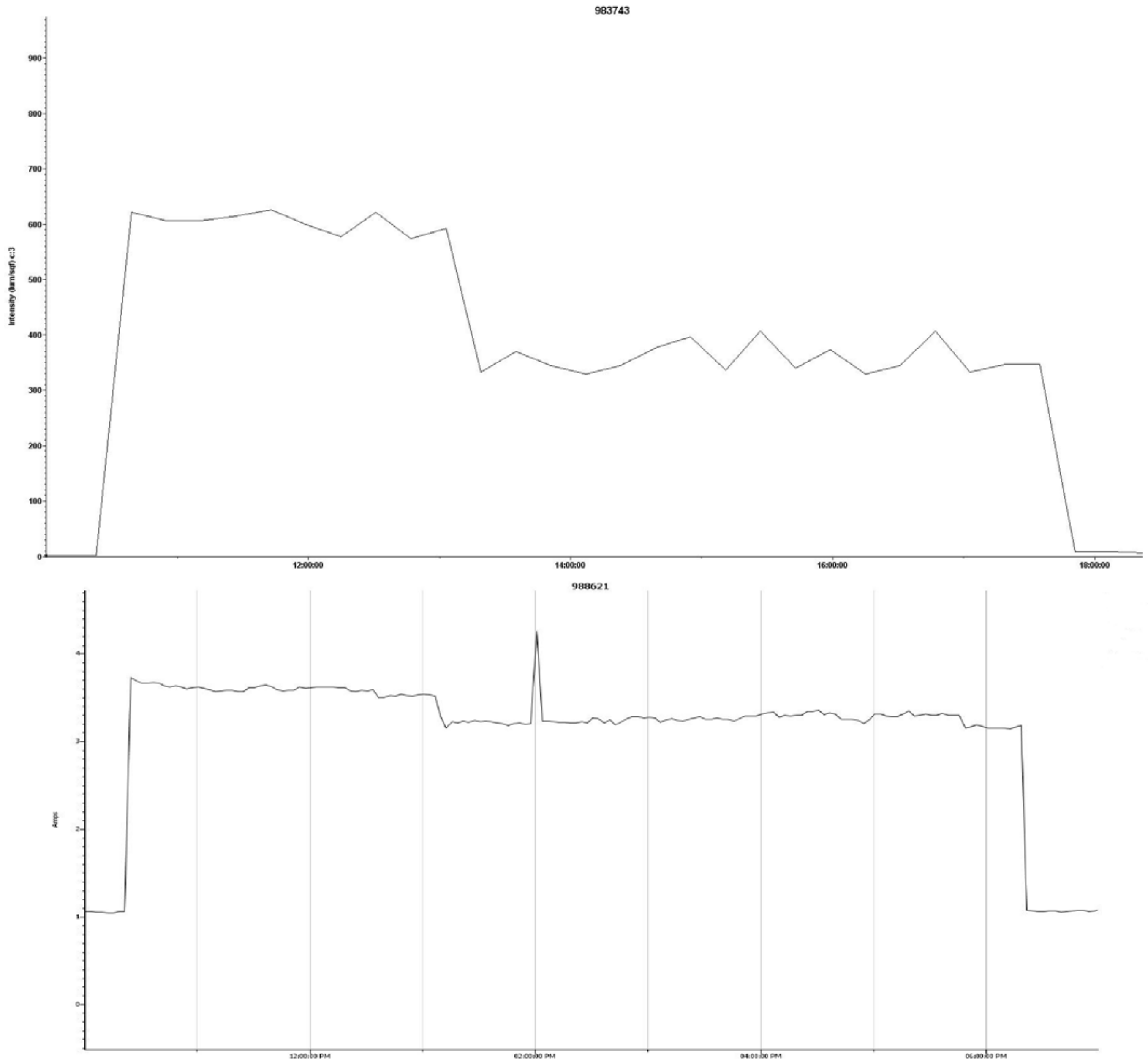
244 HOBO loggers and CTs

245 Lumens / sq. ft.

246 No manufacturer estimate of changes in intensity for this application was available for comparison

this analysis. However, this factor was accounted for in our analysis of the energy benefits attributable to customer-enacted dimming activities.

Figure 3–3. Dimming Activity at Site 2



Engineering Analysis Results

Based on the review of Program documents and site data logging activities, the following adjustments to Program realization rates are recommended.

1. The per-fixture power savings estimates (kW/fixture) provided in the implementation contractor flat files should be accepted for both the Company A and Company B installations. It should be noted, however, that the aggregate demand savings for Company B installation will be considerably lower during the summer peak period than during the winter due to lower occupancy rates.

2. The estimated run hours used to calculate the per-fixture energy savings estimates provided in the implementation contractor flat file should be accepted for all Company A sites. The estimated run hours used to calculate per-fixture energy savings estimates at Company B sites should be reduced from 2,424 to 1,627 hours per year. This revision will effectively reduce the annual energy savings estimates from 237 kWh per fixture to approximately 164 kWh per fixture.

Billing Analysis

The billing analysis included the data request, data cleaning and screening to optimize reliable results, and three separate fixed effects regression models. The regression models were conducted using a pre-post indicator, daily HDD, and daily CDD as independent variables to determine the impact of the Program upon daily energy consumption. Gross and net energy impacts were determined. Results were extrapolated to the Program level.

To conduct the billing analysis, Quantec first requested monthly energy consumption billing data from Edison dating back to June 2003 for each of the 141 and 134 Demand Response Program participants and nonparticipants, respectively. Nonparticipants were defined as customers who were slated to have measures installed but did not have them installed yet; that is, they were future participants. The future participants act as a comparison group for this analysis, in order to net out the Program effects. As noted elsewhere, the Program served two specific businesses. Since all audited Company A facilities participated in the Program, there was no future-participant sample available with which to determine the net impact of the Program at Company A sites. Therefore, only Company B included a nonparticipant comparison group.

To insure quality results, several filters were applied to the raw billing data prior to conducting the analysis. First, after matching each participant's pre- and post-installation periods (i.e., limiting the analysis to only the same months of the year in the pre- and post-periods), all participants without a minimum of six matched pre- or post-installation monthly meter readings were dropped from the analysis.[247] While an entire year of data is preferred in order to understand the full range of annual use, sufficient time had not passed since the average installation to impose such a stringent filter.

[247] The same months must be present in both the pre and post periods to be included in the analysis.

Second, while Program-installed lighting measures were obviously intended to reduce overall energy consumption it is also possible that other changes between the pre- and post-period, such as a change in business hours and overall operating hours, substantial remodeling, and the addition or removal of energy-intensive equipment, could impact energy consumption. To help prevent such changes from disguising the true impact of the Program, a ratio of change between the pre- and post-periods was calculated for each participant by dividing the observed average daily post-installation energy consumption by the average daily pre-installation energy consumption.

The resulting ratio indicated the magnitude of the difference in consumption between periods. For example, a ratio of 1.10 indicates a household consumed 10% more energy in the post-period than in the pre-period, while a ratio of 0.90 would indicate the opposite. While the ratio looked only at raw change (no weather-normalization), it provided a reasonable metric for identifying and subsequently removing participants and nonparticipants exhibiting "extreme" changes in their consumption unlikely to be related to the Program. For the purposes of this analysis, "extreme" change was defined as those participants in the top and bottom 1% of the ratio's distribution. The values at the 1% and 99% threshold were 0.30 and 1.52, respectively. All remaining values ranged from 0.70 to 1.34.

The data attrition associated with the two filters discussed above is presented in Table 3–7 for both participants and nonparticipants.

Table 3–7. Demand Response Billing Analysis Data Attrition

	Number of Unique Participants Removed		Percentage of Total Unique Participants Removed		Number of Unique Participants		Percentage of Total Unique Participants	
Metric	Part.	Non-Part.	Part.	Non-Part.	Part.	Non-Part.	Part.	Non-Part.
Total customers	- - -	- - -	- - -	- - -	141	134	100.0%	100.0%
Less than six matching months in pre- and post-period	57	43	40.4%	32.1%	84	91	59.6%	67.9%
Extreme pre-post consumption changes	0	10	0.0%	7.5%	84	81	59.6%	60.4%
Final sample	57	53	40.4%	39.6%	84	81	59.6%	60.4%

In addition to collecting and assessing participant billing data, weather data for the participating region was also gathered. Edison also provided the weather data utilized in this analysis, matching weather stations to zip codes. While Demand Response participants and nonparticipants lived in 133 unique different zip codes according to Edison records, all of the participating zip codes can be normalized using only 16 distinct weather stations.

Company A sites were open all year and no future participant group was available for analysis. Other than the original screening shown in Table 3–7, no further preparation was needed for Company A.

Once data from the participating and nonparticipating sites were organized and filtered, the remaining Company B sites were separated into three groups—those open year-round, those open only during the Operating Period 1 as shown in Table 3–5, and those open beyond Operating Period 1 but not year-round. It was not known that the participating and nonparticipating Company B sites were actually distributed into these specific groups, nor were the actual annual hours of operation for each site in the analysis known.[248] The three groups were chosen because of the seasonal nature of this company's operating hours. We used the following procedures to distribute the sites into these groups.

To determine which sites fell into each of the three groups, the average daily consumption in March 2005 (middle of Operating Period 1) was compared to the average daily consumption in August 2005 (outside of Operating Periods 1 through 3 shown in Table 3–5 but during the year-round operation). The ratio of the daily consumption offered insight into the seasonality of the site's operations. For example, if a site consumed an average of 100 kWh/day in March and 10 kWh/day in August, the site's seasonality ratio calculated to be 0.10. Because of the significant disparity in observed energy consumption between the two months, the site was believed to be closed outside of Operating Period 1. While it is relatively clear which sites are open only during Period 1 or year-round, it is relatively ambiguous for the large number of sites not exhibiting either a similar usage level or a dramatically lower one. Since trainings and other events are rotated through offices, determining the annual hours of operation—as well as the accurately capturing the savings generated by this group—is difficult. All results for the groups should be considered in such context.

Specific participating and nonparticipating Company B sites were allocated into the three scheduling groups based on the following observed seasonality ratios:

- *Primary Schedule (Operating Period 1)*: Seasonality Ratio <= 0.15
- *Intermediate Schedule (Operating Periods 2 and 3)*: 0.15 < Seasonality Ratio < 0.90
- *Year-Round (Operating Period 4):* Seasonality Ratio >= 0.90

After allocating all of the participating and nonparticipating Company B sites to groups according to their observed seasonality ratios, separate fixed effects regression models were conducted for each Company B schedule group. The same regression models were run for Company A participants, using a pre-post indicator, a participation dummy variable (Company B only), daily HDD, and daily CDD as independent variables to determine the impact of the Program upon daily energy consumption. The regression model utilized is below:

$$ADC = \alpha + \beta_1\, PrePost + \beta_2 AVGCDD + \beta_3 AVGHDD + \varepsilon$$

where

1. *ADC* is the average daily consumption during the pre (post) Program period;
2. *PrePost* is a dummy variable distinguishing between pre and post installation periods. Its coefficient captures the impact of participation;

[248] Company B could not provide data on operating hours by building. Occupancy varied with workload and rotating in-office staff training schedules.

3. $AVGCDD$ is average daily cooling degree days in the pre (post) period based on location; and
4. $AVGHDD$ is average daily heating degree days in the pre (post) period based on location; and
5. ε is the error term.

The results of the regression models, as well as the average annual pre-installation energy consumption and percentage of pre-installation consumption saved, are provided in Table 3–8 and Table 3–9. As noted previously, since there were no nonparticipating Company A sites, it was not possible to determine the net impact of the Program at these sites. However, the average gross impact of the Program was determined to be 6,704 kWh annually, or a savings of 8.7%.

Table 3–8. Gross Energy Impact—Company A

Participant Type	n	Average Annual Pre-Installation Consumption (kWh)	Average Annual Savings (kWh)	Percent of Pre-Installation Consumption Saved
Participant	34	77,294	6,704	8.7%
Gross	34	77,294	6,704	8.7%

As shown in Table 3–9 the net energy impact at participating Company B sites was determined to be 6427 kWh/year (or 10.7%) in facilities assumed to be open all year. At facilities assumed to be open during the primary operating period (Period 1), net savings were 2583 kWh (20%). At the facilities that appeared to be open somewhere between Period 1 (about four months) and all year, net savings were negative. That is, the nonparticipant (future participant group) reduced consumption more than the participant group.

Table 3–9. Net Energy Impact—Company B

Schedule Type	Participant Type	n	Average Annual Pre-Installation Consumption (kWh)	Average Annual Savings (kWh)	Percent of Pre-Installation Consumption Saved
Operating Period 1	Participant	21	3,026	12,773	23.7%
	Nonparticipant	40	443	13,103	3.4%
	Net	*61*	*2,583*		*20.3%*
Intermediate Schedule	Participant	23	2,043	22,081	9.3%
	Nonparticipant	33	3,166	17,662	17.9%
	Net	*56*	*(1,123)*		*-8.7%*
Year Round	Participant	5	10,170	53,262	19.1%
	Nonparticipant	6	3,743	44,789	8.4%
	Net	*11*	*6,427*		*10.7%*

Because not all buildings were included in the analysis, and the operating hours are unknown, factors at these buildings appear to have obscured the impact of the Program and the billing analysis has underestimated the Program's true impact. Since converting to more energy-efficient lighting—all other things being equal—would not result in an increase in energy consumption, there are clearly other factors affecting energy use at the assessed buildings.

Because of the factors discussed above, it was not possible to accurately determine the total savings attributable to the Program using a billing analysis without additional information that was not available. For these reasons, the engineering analysis will be used to estimate the Program's impact on energy savings.

Impact Evaluation Results

Engineering Estimates of Ex-post Gross Program Savings

Table 3–11 provides the ex-ante gross savings reported in the final flat file submitted by the implementation contractor, the verified gross savings values that are adjusted for the installation rates confirmed through field verification activities. In addition, the ex-post adjusted gross savings numbers that reflect both the recommended installation rates and changes in Program realization rates recommended from the engineering analysis.

In general, the Company A project performed as expected; however, the Company B project was adjusted to reflect the shortened run hour estimates, as well as the fact that the demand savings realized by this system during summer peak periods will be considerably less that winter savings due to facility operating schedules. Note also that the Company B ex-post gross savings values assume that no dimming activity is being undertaken, so no credit for savings resulting from dimming are included in this evaluation. The reported (ex-ante) Company B savings estimates assume a 20% dimming level at all installations (Table 3–11).

Table 4–11. Reported Ex-ante Gross Savings, Verified and Adjusted Ex-post Gross Savings

	Reported		Verified		Adjusted		
Project	Ex-ante Reported Gross Peak kW	Ex-ante Reported Gross Annual kWh	Verified Gross Peak kW	Verified Gross Annual kWh	Ex-post Adjusted Gross Winter Peak kW	Ex-post Adjusted Gross Summer Peak kW	Ex-post Adjusted Gross Adjusted Annual kWh
Company A	259	1,050,297	247	1,013,635	247	247	1,013,635
Company B	267	646,379	259	626,672	259	62	420,625
Program Total	526	1,696,676	505	1,640,307	505	309	1,434,260

Final Program Impacts

The Program impacts were estimated collectively for all lamps installed through the Demand Response Program. Table 3–12 presents the first year ex-ante gross and net energy savings goals and reported Program accomplishments.

Table 3–13 shows the first year ex-ante gross and net demand savings goals and reported Program accomplishments. The Program net ex-ante savings goals and reported accomplishments were estimated using a 0.80 NTG ratio. The Program reported achieving approximately 102 percent of their original kW and kWh goals.

However, it should be noted that there was a discrepancy between the savings stated in the final workbook and final reporting documents. The final flat file stated gross savings to be 1,696,676 kWh for the Program while the workbook stated gross savings of 2,135,914. In addition, there was a slight discrepancy (10 kW) between the two source's gross kW statements of savings.

Table 3–12. Comparison of Ex-ante Energy Savings Goals and Reported Accomplishments

	Ex-ante Program Gross Annual kWh Goals	Ex-ante Program Net Annual kWh Goals	Reported Ex-ante Gross Annual kWh Savings	Reported Ex-ante Net Annual Program kWh Accomplishments
Demand Response	2,091,485	1,673,188	2,135,913	1,708,731

Table 3–13. Comparison of Ex-ante Demand Savings Goals and Reported Accomplishments

	Ex-ante Program Gross Annual kW Goals	Ex-ante Program Net Annual kW Goals	Reported Ex-ante Gross Annual kW Savings	Reported Ex-ante Net Annual Program kW Accomplishments
Demand Response	516	413	526	421

The Program impacts are determined by two factors:

1. Program performance in terms of accomplishing Program participation goals.

2. Estimated ex-post savings impacts for the installed measures compared to the ex-ante measure savings assumptions.

The Program gross and net realization rates have been calculated as the combined effect of these two factors. The Program goals—overall and for its constituent measures—ex-post gross and net energy savings, and respective realization rates, are shown in Table 3–14. The Program evaluated ex-post gross energy savings are 1,434,260 kWh compared to the Program gross savings goal of 2,091,485 kWh. The Program evaluated ex-post net energy savings are 1,434,260 kWh compared to the Program goal of 1,673,188, yielding an 85 percent net energy savings realization rate. Note that the Net Realization Rate is greater than the Gross Realization Rate due to the evaluation assigned Net-to-Gross ratio of 1.0 vs. 0.8 from EEPM.

Table 3–14. Comparison of Program Goals and Ex-post Gross and Net Energy Savings

	Ex-ante Program Gross Annual kWh Goals	Ex-ante Annual Net Energy Savings Goals	Evaluated Gross Ex-post Program kWh Savings	Gross Energy Realization Rate	Evaluated Net Ex-post Program kWh Savings	Net Energy Realization Rate
Demand Response	2,091,485	1,673,188	1,434,260	68.6%	1,434,260	85.7%

The Program goals, ex-post gross and net demand savings, and respective realization rates are shown in Table 3–15. The Program evaluated ex-post gross demand savings are 505 kW and 309 kW for the winter and summer as compared to the Program goal for demand savings of 516 kW. The Program evaluated ex-post gross demand savings are 505 kW and 309 kW for the winter and summer as compared to the Program goal for demand savings of 505 kW.

Table 3–15. Comparison of Programs Goals and Ex-post Gross and Net Demand Savings

	Ex-ante Program Gross Annual kW Goals	Ex-ante Annual Net Demand Savings Goals	Evaluated Gross Ex-post Winter kW Savings	Evaluated Gross Ex-post Summer kW Savings	Evaluated Net Ex-post Summer kW Savings	Evaluated Net Ex-post Summer kW Savings
Demand Response	516	413	505	309	505	309

Realization rates compared to ex-ante evaluated results are shown in Table 3–16 and Table 3–17 below. The Program evaluated ex-post gross energy savings are 1,434,260 kWh compared to the Program reported ex-ante gross savings goal of 2,135,913 kWh, yielding a realization rate of 67 percent. The Program evaluated ex-post net energy savings are 1,434,260 kWh compared to the reported ex-ante net of 1,708,731 kWh, yielding an 84 percent net energy savings realization rate. The Program evaluated ex-post gross demand savings are 505 kW and 309 kW (for the winter and summer respectively), as compared to the reported ex-ante gross demand savings of 526 kW.

Table 3–16. Comparison of Reported Program Accomplishments and Ex-post Gross and Net Energy Savings

	Ex-ante Program Gross kWh Reported	Ex-ante Net Energy Savings Reported	Evaluated Ex-post Gross Program kWh Savings	Gross Energy Realization Rate	Evaluated Ex-post Net Program kWh Savings	Net Energy Realization Rate
Demand Response	2,135,913	1,708,731	1,434,260	67.2%	1,434,260	83.9%

Table 3–17. Comparison of Reported Programs Accomplishments and Ex-post Gross and Net Demand Savings

	Ex-ante Program Gross kW Reported	Ex-ante Net kW Savings Reported	Evaluated Gross Ex-post Winter kW Savings	Evaluated Gross Ex-post Summer kW Savings	Evaluated Net Ex-post Summer kW Savings	Evaluated Net Ex-post Summer kW Savings
Demand Response	526	421	505	309	505	309

Final Program savings, NTG ratios and realization rates are shown in Table 3–18 and Table 3–19. The individual components of the Program were assumed to have a net to gross ratio of 1.0 for evaluation purposes as compared to the Program planning assumption of .8.

Realization rates were calculated as the ratio of the evaluated net ex-post savings to the reported ex-ante gross savings. For the overall Program, the realization rate was 67.2 percent.

Table 3–18. Program Energy Savings

	Ex-ante Reported Gross kWh Savings	Ex-post Gross Program kWh Savings	NTG Ratio	Evaluated Ex-post Net kWh Savings	Realization Rate
Demand Response	2,135,913	1,434,260	1.0	1,434,260	67.2%

Table 3–19. Program Demand Savings

	Ex-ante Reported Gross kW Savings	Evaluated Gross Ex-post Winter kW Savings	Evaluated Gross Ex-post Summer kW Savings	NTG Ratio
Demand Response	526	505	309	1.0

Table 3–20 provides a summary of savings including ex-ante goals, ex-ante reported, and ex-post evaluated savings.

Table 3–20. Savings Summary

	Proposal				Reported				Evaluated		
	Ex-ante Gross	Net to Gross	Ex-ante Net		Ex-ante Gross	Net to Gross	Ex-ante Net		Ex-post Gross	Net to Gross	Ex-post Net
kWh	2,091,485	.80	1,673,188		2,135,913	.80	1,708,731		1,434,260	1.0	1,434,260
kW	516	.80	413		526	.80	421		309	1.0	309

Lifecycle Savings

Table 3–21 shows the Program's lifecycle savings. The Program lifecycle ex-post net energy and demand savings for this Program are shown in CPUC required format in Table 3–22 below.

Table 3–21. Program Ex-post Lifecycle Net Energy Savings

Ex-post EUL	Ex-post Lifecycle Net Energy Savings
16	22,948,160

The facilities at one company were operated on a seasonal schedule and the customers at both companies did not fully utilize the dimming capacity. Both of these factors reduced savings. Therefore, the Program lifecycle savings are affected by reductions in expected energy and demand savings. In addition, the Ex-post Evaluation Projected Peak MW Savings represent summer peak savings of 0.309 MW, which are considerably lower than winter peak savings of 0.505 MW because most Company B sites are not operating during the summer peak period, as noted previously in the report.

Table 3–22. Program Lifecycle Ex-post Energy and Demand Savings

Year	Calendar Year	Ex-ante Gross Program-Projected Program MWh Savings	Ex-post Net Evaluation Confirmed Program MWh Savings	Ex-ante Gross Program-Projected Peak Program MW Savings	Ex-post Evaluation Projected Peak MW Savings	Ex-ante Gross Program-Projected Program Therm Savings	Ex-post Net Evaluation Confirmed Program Therm Savings
1	2004						
2	2005	2,136	1,434	0.526	0.309	-	-
3	2006	2,136	1,434	0.526	0.309	-	-
4	2007	2,136	1,434	0.526	0.309	-	-
5	2008	2,136	1,434	0.526	0.309	-	-
6	2009	2,136	1,434	0.526	0.309	-	-
7	2010	2,136	1,434	0.526	0.309	-	-
8	2011	2,136	1,434	0.526	0.309	-	-
9	2012	2,136	1,434	0.526	0.309	-	-
10	2013	2,136	1,434	0.52	0.309	-	-
11	2014	2,136	1,434	0.526	0.309		
12	2015	2,136	1,434	0.526	0.309		
13	2016	2,136	1,434	0.526	0.309		
14	2017	2,136	1,434	0.526	0.309		
15	2018	2,136	1,434	0.526	0.309		
16	2019	2,136	1,434	0.526	0.309		
17	2020	2,136	1,434	0.526	0.309		
TOTAL	2004-2023	34,176	22,948				
Definition of peak MW as used in this evaluation: Average demand reduction during the summer months.							

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4. Conclusions and Recommendations

A number of conclusions can be drawn from both process and impact evaluations. The program did expend all incentives but did not meet its energy savings goals. Only two companies participated and one operated on a seasonal basis so that savings were less than expected by the sheer fact that operating hours were not as anticipated. The seasonal hours and closed offices made it difficult for both installers and site inspectors to conduct their business. Local managers did not utilize the full capacity of the T-5 dimming features and UBAR reporting system, which also led to fewer savings than expected. Edison did not utilize the demand response capability of the lighting system.

Conclusion 1. *The Program marketing was not implemented as designed.*

Because the second company that committed to the Program was large, all available incentives were dedicated early on. Therefore, the implementers did not put all facets of the proposed marketing plan into effect. This meant that the Program was not marketed to a broad segment of the small commercial population with T-12 lighting. However, the large company that did participate had multiple sites and it was a good test of the logistics of implementing the lighting in a large number of locations. In addition, the Energy Manager was very interested in utilizing the UBAR system, and the configuration of this company will make this a good test of the system's capability.

Conclusion 2. *The Program did not meet its energy savings goals.*

Program participation was limited to two companies because incentives were committed to these two companies early in the Program, and expended before the end of the Program year. One of the companies operated only on a seasonal basis. This Program was designed, and energy savings goals determined, assuming full time operating hours. The full extent of the impact of seasonal operating hours was not known to implementers at the onset of the Program and the seasonal operating hours impacted the implementer's ability to achieve energy savings. As a result their savings goals were not met.

At the same time, the incentives were fully committed, and the Program could not have been broadened without additional incentives and more time to market and complete additional installations. It is not practical to exclude interested companies from a program on the basis that their operating hours will deter the Program from reaching its energy savings goals.

Recommendation for Conclusions 1 and 2. *Increase the incentive pool, lengthen the Program timeframe and broaden marketing efforts. Target companies where hours of operation will not inhibit achievement of energy goals.*

The factors limiting Program marketing to a larger audience, and subsequently limiting the energy savings, were time and money. There was not enough incentive money in the pool to solicit additional participants to "make up" for the seasonal operations of the larger of the two participants. To meet energy savings goals, we recommend increasing the incentive funding and broadening the marketing plan to introduce the technology to a larger market, increasing the number of participants. We recommend opening additional marketing channels by introducing the technology and the Program to trade allies. For example, lighting contractors should be educated about the technology and the Program to market it to their customers.

Conclusion 3. *Local managers were not using the dimming features and UBAR reporting tools.*

Savings were not fully realized because the full capacity of the dimming capability was not used. Corporate managers had two philosophies and approaches to training and operating the systems. While most managers at Company A say they were trained, they also stated they did not use the dimming functions. The Company A executive manager left the dimming schedules up to the local managers and did not utilize the Web-based UBAR monitoring and reporting tool. Conversely, the majority of district managers in Company B said they were not trained. However, the Company B corporate energy manager was waiting until installations were complete before he trained all the district managers. Company B was monitoring the stores pro-actively and beginning to take advantage of dimming options, whereas Company A, though having trained their managers, took a laissez-faire approach to utilizing the dimming.

Recommendation 3. *Provide timely training and reinforce use of the technology.*

Provide training at the time of installation and ensure all local managers understand how to utilize the dimming feature to achieve additional energy and demand savings. Encourage participants to reinforce use of dimming features through internal training of new hires and through monitoring performance and energy use. Periodically contact participants to confirm participants' understanding of the dimming features and to reinforce utilization.

Conclusion 4. *Edison is not using the demand response option.*

While one of the innovations of the Program was the demand response capability that it offered Edison, that feature was not utilized. Edison did not plan to put it into place for this 2004-2005 IDEEA Program cycle.

Recommendation 4. *Implement and test the demand response option.*

We recommend that the IDEEA managers continue to work with Edison's demand response department to determine how the demand response capability can be fully utilized in this and other demand response programs. The demand response capability should be worked out so that it is testable at the time it is installed, so that it can be implemented to provide reliable and efficient operation of this resource.

Conclusion 5. *The Program delivery model was a good model for this market.*

Administratively, the Program is like a direct-install program where the customer is paid through a rebate. Implementers were paid an incentive per fixture that allowed them to buy down the purchase price of the fixtures, and finance the purchase. The lease and maintenance service agreement with participant customers is patterned after an ESCO arrangement where the customer pays for savings. Here, the customer pays a monthly maintenance and purchase fee based on a portion of the expected energy savings. There were only two participants, one choosing to purchase the lighting outright and the second opting for the service agreement. Flexibility in the structure of the payment was important. There were not enough participants to determine whether either financing option was more appropriate for this market.

Recommendation 5. *Continue offering direct installation of the measures and refine the financing options.*

Direct installation is an appropriate delivery method for measures in this Program. The financing mechanism should allow participants immediate access to energy savings. Continue to refine the service agreements and financing mechanism. Not all customers will be able to pay for the lighting up front.

Conclusion 6. *"Snip" is better than "snap" when it comes to savings.*

Edison, implementers, manufacturers and installers studied the energy penalty and logistics of "snapping" the T-5 lamps into a retrofit saddle and leaving the T-12 ballast in place to power the new lighting. Some problems related to power inconsistencies were experienced using this method. In the "snip" installation method, power to the old ballast was cut, thereby avoiding the six-to-eight-watt energy penalty presented by the "snap" installation method. Both the manufacturer and the lighting contractor were key to improving installation methods and logistics.

Recommendation 6. *Continue refining installation methods and logistics.*

Manufacturers and implementers continue to refine the technology to optimize performance and savings. The lighting contractor has gained valuable experience working with the technology and the logistics of delivering the measures. The contractor and/or implementer should train new contractors in order to share lessons learned and avoid having to reinvent the wheel.

Conclusion 7. *Baseline operating conditions were not well documented.*

Baseline conditions including number of lamps and fixture configurations, operating hours and store closures, were not well documented prior to the actual installations. In addition, employees at one of the companies normally turned lights off in unoccupied rooms. Because this activity and baseline conditions were not captured in the baseline documentation, it affected the energy savings and logistics, as well as lamp orders. Operating schedules also affected installation logistics, delivery schedules, and inspections.

Recommendation 7. *Collect accurate baseline data.*

Document baseline store closure dates and operating hours as well as occupants' conservation-related behaviors that affect measure performance or potential savings. Conduct a walk-through audit to record the baseline wattage, number of lamps, and fixture configurations. Accurately gauge the customer's normal activities and behaviors with regard to operating lights (e.g., turning them off in unused rooms), and whether the technology is a good fit with their culture (T-8 may be better suited to employees who take a hands-off approach to actively engaging in energy-efficiency practices, or for those who do not have the potential to contribute to the utility's demand response activities).

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10. Miniature Cold Cathode Lighting Program

1. Program Description

The Miniature Cold Cathode Lighting Program ("the Program") was a constituent program of Southern California Edison's ("Edison") 2004-2005 Innovative Designs for Energy Efficiency Activities (IDEEA) Program, and ran from June 2005 through June 2006. Energy Concepts & Controls (ECC) proposed delivering a program that would target businesses in Southern California with significant outdoor signage or indoor lighting requirements. Miniature cold cathode lamps were offered as a replacement for incandescent decorative lamps, particularly in applications where compact fluorescents had not proven to be a viable alternative replacement. Edison awarded ECC a $1 million contract to implement the project under the 2004-2005 Innovative Designs for Energy Efficiency Activities (IDEEA) program.

The Program was initiated by Energy Concepts and Controls (ECC) to "spark interest and motivate investment" in the emerging cold cathode technology within a market that uses a large number of incandescent lights for interior lighting or flashing outdoor reader boards in the Southern California Edison territory. Any interior lamp on a dimmer was a potential candidate for retrofit. This was a niche market, where the cold cathode technology was a good fit with businesses with large lighting needs. In the year prior to the IDEEA program, ECC had worked with Litetronics on other projects, largely in Las Vegas, where they gained some experience working with this market sector.

ECC targeted customers with large lighting loads (greater than 500 kWh) such as freeway signs, car dealerships, amusement parks, and casinos with large exterior signs. Retail and hospitality businesses with large indoor lighting needs, such as restaurants, hotels, and lamp retailers were also targeted.

In Program documents, ECC summarized the Program rationale:

- It promotes emerging technology that is economically viable
- It addresses market needs that are currently not served
- It is adaptive to applications that have not been served
- It has great potential for expansion with market opportunities for energy efficiency
- It has greater future potential for technology expansion

Miniature cold cathode fluorescent lamps (CCFL) lamps are screw-in type lamps, offered in UL-approved, three-, five- and eight-watt versions. Cold cathode lamps operate at 400^{o}F and use an iron thimble as a cathode. 'Standard' compact fluorescent lamps (hot cathode) push electric current through a thin tungsten wire filament to superheat it. The cold cathode lamps replace 25- to 60-watt decorative incandescent lamps. The eight-watt Litetronic International Micro-Brite™ cold cathode lamp, for example, claims color temperature and light output equivalent to a 60-watt standard incandescent bulb. At the onset of the program, it was estimated the replacements would average to a baseline conversion of 25 watts incandescent to five watts cold cathode. ECC estimates the cold cathode fluorescents operate with 65%-80% less energy than "standard" compact fluorescents .

Miniature cold cathode lamps were offered as a replacement for incandescent decorative lamps, particularly in applications where compact fluorescents had not proven to be a viable alternative replacement. According to program documents and interviews with a representative from Litetronics, one of two lamp suppliers for the program, the miniature cold cathode technology offers 25,000 hours of lamp life, two and one-half (2 ½) times longer than standard CFLs. ECC notes that the technology is more resilient to vibration than its incandescent predecessors, is dimmable without any special dimming ballast, and can withstand continuous on-off cycles, or flashing. Cold cathode have a cycling life of an estimated 500 million on-off cycles, where standard CFLs have an estimated life of 10,000-12,000 on-off cycles. Dimming and flashing does not reduce lamp life. Cold cathode lights do not get hot, another advantage for interior applications. In these respects, the lamps were energy-efficient alternatives where standard CFLs could not be installed. They were also an alternative to LED lamps in terms of price, aesthetics, longevity and lumens depreciation.

The Edison Program Manager noted that this was an innovative program serving a niche market that was not aware of energy-efficient alternatives. Exterior signs offered good savings potential, where lamps could be changed out one-for-one and there was little notice that something different was in place.

The Program concept was to introduce the technology and offer incentives for the installation of approximately 100,000 miniature cold cathode lamps delivering an estimated 1,280 kW of demand savings and approximately 2,048,000 kWh of savings. These goals were subsequently revised to 1,072 kW, and 4,824,070 kWh.

After program activities concluded, ECC reported their activities had resulted in 619 kW and 5,035,994 kWh (as reported in the final program E3 worksheet). The reported kW savings were 58% of the goal, and the energy savings were 104% of the goal.

Table 1–1 shows the original and final program goals and achievements for energy and demand.

Table 1–1. Proposed and Reported Savings Summary

		Proposal				Reported				Evaluated	
	Ex-ante Gross	Net to Gross	Ex-ante Net		Ex-ante Gross	Net to Gross	Ex-ante Net		Ex-post Gross	Net to Gross	Ex-post Net
kWh	6,030,088	.80	4,824,070		6,294,993	.80	5,035,994		5,553,865	.90	4,998,479
kW	1,340	.80	1,072		774	.80	619		874	.90	787

Quantec, LLC and Summit Blue Consulting conducted a comprehensive process and impact evaluation of the Program. The process evaluation involved interviews with Program staff, implementers, Program participants, nonparticipants and dropouts. The impact analysis included a detailed engineering analysis, with reviews and recalculation of engineering algorithms, detailed reviews of Program records and verification site visits for 15 exterior signs, and an M&V component. These approaches generally conformed to the Basic rigor level for process and impact evaluation as defined by the 2006 California Evaluation Protocols, although technically, these protocols do not apply to evaluations of 2004-2005 programs. A confirmatory billing analysis was also done. However, issues with signage schedule and content changes, and difficulties in identifying specific meters for signs in large facilities, made the results problematic. While the billing analysis was unable to accurately determine the energy impact of the Program, the results of select sites lend legitimacy to the savings estimates projected by the Program and confirmed by the engineering analysis. Results of the billing analysis are presented in Volume 2, Appendices.

The next section describes the program structure and reported achievements. Section 2 presents the process evaluation component of the evaluation. The process evaluation includes a discussion of the program logic, design and implementation, contractor and participant decision making and satisfaction. Section 3 reports the primary impact evaluation results from the engineering assessment of the program. Finally, Section 4 presents the major conclusions and recommendations. Volume 2, Appendices, describes the billing analysis that was used as another point of triangulation for the engineering analysis.

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2. Process Evaluation

Process Evaluation Methodology

This section describes the Miniature Cold Cathode Lighting program and the comprehensive evaluation that was conducted to assess Program processes. The purpose of the process evaluation was to document the Program design and its development, including any differences between the proposed Program design and the Program that was implemented. The background and rationale for the Program were examined, and a Program logic model was developed. Interviews with Program staff and producers were conducted to gather information on market assumptions and barriers to project implementation, as well as implementation issues such as marketing and recruitment efforts, project identification and selection, and free ridership and spillover

Program Logic Model

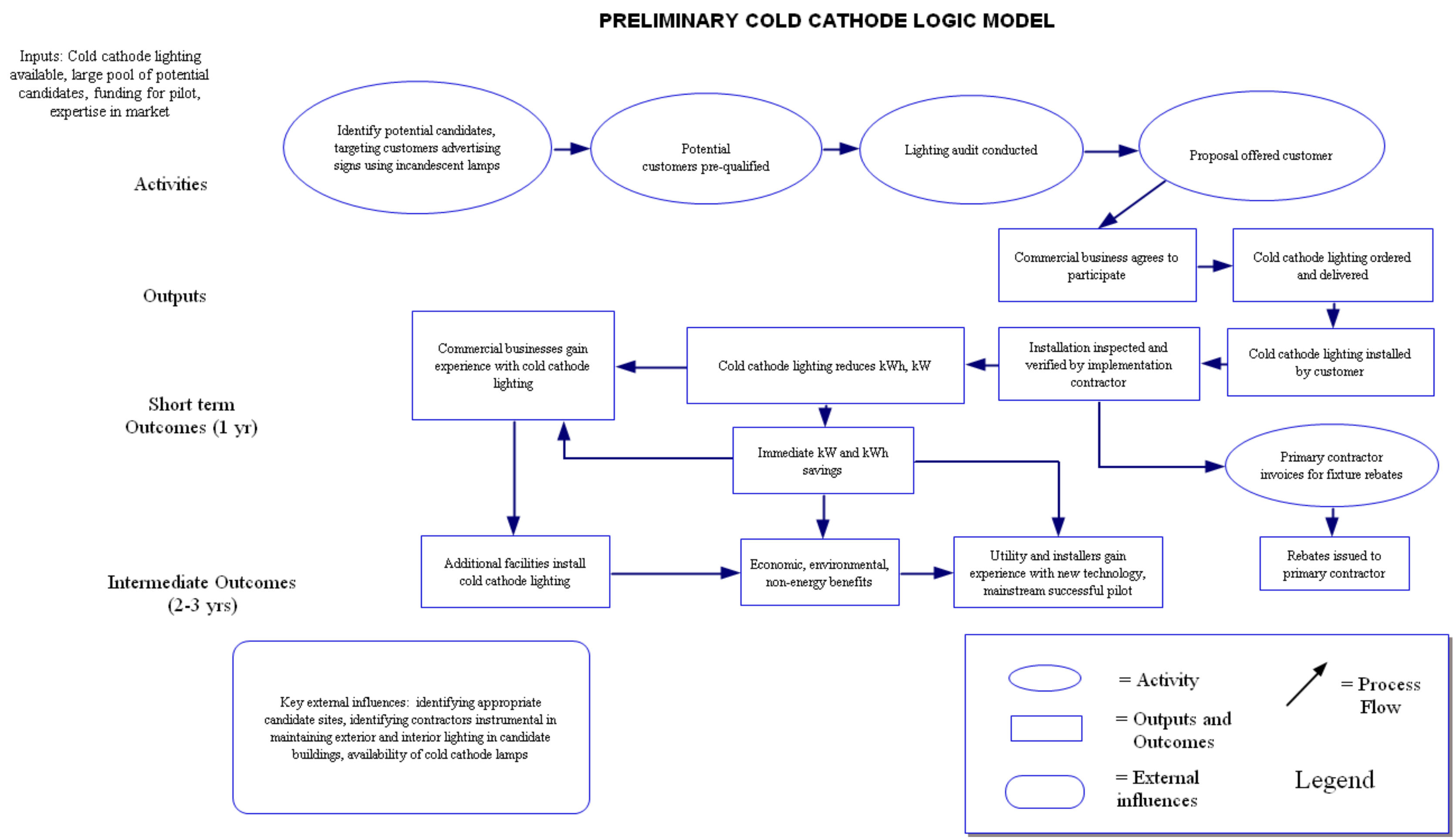
The logic model (Figure 2–1) graphically displays the process by which the Program activities led to specific outputs and outcomes. The context for the Program includes the inputs and the Program's external environment that influenced Program design. The external factors include the availability of the lamps, the size of the prospective target market, identifying participants, funding levels for the incentives that would promote participation, availability of lamps, and acceptance of the technology by market actors.

Program activities began with the implementer marketing the Program to potential participants. Outputs included obtaining agreements to participate, ordering and installing the lamps.

Program outcomes included immediate energy savings and load reduction, capturing potential lost energy-efficiency opportunities, and heightening awareness of and experience with this technology. Additional businesses chose to participate after observing other cold cathode signs. However, it can also be said that businesses chose not to participate after viewing other installations.

Key differences between the as-designed and as-implemented models are in the incentive structure and marketing approach. Both the incentive structure and the methods used to market the program were modified from the original proposal after some experience was gained in the field.

Figure 2–1. Preliminary Cold Cathode Logic Model



Process Evaluation Sample Design

Research questions were developed from the logic model as part of the work plan and then used to develop interview guides. The questions explored the decision-making process used by participating companies to determine whether to participate, and also explored the participants' experiences with the technology since the installation. Program dropouts were interviewed to learn whether they had interior or exterior sign applications, if they were aware of the technology, why they did not participate, and if they had participated in other Edison programs.

As reported by Energy Concepts and Controls, twenty businesses participated in the Program. The researchable issues addressed in the process evaluation included the Program's origin and original goals, and differences between the Program as designed and as implemented. Delivery and implementation issues such as experience with the installed lamps, participant satisfaction, and issues of free ridership and spillover were also addressed. Finally, lessons learned, and reasons for nonparticipation in the Program were addressed.

The process evaluation is based upon a review of Program documents and interviews. The evaluation sample plan called for interviews with four Edison and ECC staff, 20 participants, 67 nonparticipants, and two trade allies (lighting maintenance contractors).

Interviews and surveys were conducted with the Edison Program Manager, two staff at ECC most involved in implementation, 12 of the 20 participating businesses (participants), 20 contacts from ten businesses that originally chose to participate but later dropped out of the Program or decided not to participate (dropouts), 26 nonparticipating businesses, two lighting maintenance contractors that supported participating businesses, and one cold cathode manufacturer/supplier. The participants had all utilized Edison incentives to purchase cold cathode lamps through the program.

Table 2–1. Sample Plan

Task	Goal	Achieved
Staff/implementer interviews	4	3
Participant interviews	20	12
Drop-out and partial participant interviews		20 from 10 businesses
Nonparticipant interviews	67	26
Participant trade ally interviews	2	3
Total interviews	93	64

The correct phone number for one of the 20 participants could not be located, leaving 19 to interview. After repeated calls and attempts to schedule, six were never available to interview. One refused to be interviewed. A total of 12 participants completed the interview survey.

Table 2–2. Cold Cathode Participant Attrition Table

	Frequency	Percent
Population	20	
Wrong number/non-working number	1	
Eligible sample	19	
Completed surveys	12	63%
Not available	6	32%
Refused	1	5%

Half of the dropouts interviewed (10 of 20) were store managers at different locations of one large lighting retailer which originally chose to participate and then dropped out. While their individual responses are recorded, the decisions to participate and later to drop out were made by corporate staff, who were also interviewed. However, the corporate decision to drop out resulted from complaints by the local store managers. The other ten dropouts interviewed included corporate managers of two restaurant chains, and managers of car dealerships and a shopping mall. Of the remaining five businesses that dropped out, four were never available for interview, and one refused to be interviewed.

Table 2–3. Cold Cathode Dropout Attrition Table

	Frequency	Percent
Eligible sample	25	
Completed surveys	20	80%
Not available	4	16%
Refused	1	4%

Edison provided Energy Concepts and Controls with a spreadsheet including contact information for 3390 potential participants. The same spreadsheet was provided to Quantec. From this list, ECC identified a subset of 664 potential participants they contacted about the Program. Of those 664, 292 were identified as nonparticipants with phone numbers. Quantec outsourced this survey, and the survey firm contacted a random sample of these businesses. This group of nonparticipants was very difficult to reach. Multiple contact names were provided for many accounts. All were tried in order to find the person who remembered the contact from ECC. For the most part, these businesses included car dealerships, restaurants, hotels, and a few adventure parks. The final random sample of respondents included 19 with a large volume of low-wattage interior lighting and three with exterior signage with flashing lamps. Six had neither, and four had both interior and exterior lighting that were potential applications for the cold cathode lamps. Two were participants, and they were removed from the nonparticipant sample.

Table 2–4. Cold Cathode Nonparticipant Attrition Table

	Count	Percent
Sample provided by Edison	3390	
Contacted by ECC	664	
Potential participants with phone numbers	292	
Ineligible/unused sample	167	
Not qualified	56	
Wrong number/non-working number/computer/fax/duplicates	107	
Language barrier	2	
Program participants	2	
Eligible sample	125	
Completed surveys	26	21%
Refused	20	16%
Unable to reach after six attempts	72	58%
Terminated call during survey	7	6%

The interviews took place during August through October, 2006. Before interviewing participants, interviewers confirmed that the respondent was involved in the company's decision to participate. All respondents were involved in the decision-making process for the project, or were aware enough of the project details to provide meaningful information.

Process Evaluation Results

In this section, the program is described as experienced by individuals who designed and implemented the program, by the sample of businesses that participated in the program, by the sample that dropped out, and by the sample who chose not to participate.

Program Design

In the original Program design, the hospitality sector was the focus of marketing efforts. Restaurant chains and retail lighting chain outlets were approached. Hotels and malls were dropped (there was little interest). In the end, there appeared to be more interest by the businesses with outdoor signs. ECC also began working with sign maintenance contractors, finding that many businesses deferred decision making to them, or relied upon their opinions. The maintenance contractors also knew the specifics of the business' lighting needs and could deal with technical issues.

The original incentive structure called for the customer to pay for the lamps, and then receive a rebate check from Edison. ECC found that oftentimes large customers were apprehensive about investing in new technology, particularly when they relied upon a rebate check to recoup some of their investment. ECC changed the original incentive structure to one designed to overcome this barrier. Edison approved an agreement whereby the cost of the lamps was covered by the incentives, and so the customer did not have to pay for these costs up front, only needing to cover the installation costs. In essence, participants assigned the rebate to ECC, who used it to purchase the lamps (averaging $7.70 each), which were shipped directly to the customers. The cold cathode manufacturer interviewed concurred that without the incentives, the sale of these lamps would have faced a cost barrier. He reported that in most retrofit situations, customers pay $7 to $15 per lamp, and relamp 10,000 to 20,000 lamps at a time. This is cost-prohibitive without utility incentives or rebates.

At the onset of the Program ECC worked with only one supplier, Litetronics. A second manufacturer, TCP, entered the marketplace in December 2005, introducing competition which helped to drive down the price of the lamps. With a significant variance in price, the original manufacturer lowered their price as well. According to program implementers, this activity lowered the price by about 30% overall, which enabled the incentives to cover more of the lamp and installation costs. Litetronics reported that they have since held their prices at the same levels, as quality issues with the TCP product later emerged.

This Program's activities, along with similar activity with other utility rebate programs, led to more work in the development side of the technology. At first, five watts was the maximum wattage available, but eight-watt lamps soon appeared. (Five-watt lamps replace 20-25 watt incandescents and eight-watt lamps are designed to replace 60-watt incandescents.) Spurred by end user's need for brighter lamps to extend the range of application, even higher wattage lamps are under development and are predicted to enter the market late 2007. Challenges to higher-wattage lamps include issues with coil size and heat. The higher-watt lamps are geared to replace 100-watt incandescents.

Litetronics reported significant growth in product use, particularly in the Las Vegas area, and estimates that the Edison program and other utility programs have significantly helped distribution of the idea and technology. Litetronics estimates that 75% of their cold cathode sales is to the utility-incentivized market and 25% of sales are to businesses buying smaller units of lamps, without overlap between groups. Note that these lamps are sold through distribution channels and are not available in "big-box" stores.

The original Program design offered a limited number of cold cathode lamps. Additional lamps were added to the portfolio of offerings after finding that different combinations of lamps, different wattages, and other lighting solutions were needed by prospective participants.

Market Assumptions

Outreach for the Program relied primarily on the ECC representatives. Edison provided ECC with a list of potential participants, selected by market sector. ECC mailed information to selected groups, particularly where major accounts were identified. Customers who called Edison were referred to ECC for follow-up.

ECC and Litetronics had worked with the hotel industry in Las Vegas, and it was originally thought that this would be a good target market, but it turned out that hotels in large part were not interested. ECC was, however, successful in carrying over some of their experience working with amusement parks and casinos in Las Vegas to the marketing under the Program.

With little interest generated from ECC's first targeted mailing, ECC shifted their marketing approach and essentially conducted "drive-by" marketing, driving down the freeway in metro areas with concentrated sign usage, in order to identify potential participants. Installing the technology in high visibility locations also had the potential to increase the spread of the technology.

The ECC representatives and contractors who initially contacted participants and dropouts explained the technology, addressed specific concerns related to the technology, and conducted a site audit providing initial energy savings and cost estimates.

Marketing and Participation Decisions

Participants and dropouts reported they learned about the Program primarily by mail, fax, phone, through their corporate office, or through direct contact with a Program installation contractor, though they rarely remembered who the contact person represented (Table 2–5). Both participants and dropouts often mentioned being contacted more than once, through a variety of methods. Participant and dropout respondents were either involved in the company's decision to participate, or were aware of why the company originally chose to participate.

Table 2–5. How Respondents Heard about the Program

Source	Participants (n=12)	Dropouts (n=20)	Nonparticipants (n=26)	Total
Phone call	6	6	4	14
Company corporate office		11	2	13
Someone came to office	4		3	7
Third party contractor		2	4	6
Mail	4		1	5
ECC		1	1	2
Edison representative or presentation	1	2	1	4
Email	2			2
Hadn't heard before			2	2
Fax	1			1
Sign maintenance company			1	1
Colleague			1	1
Don't know	1	2	6	9

Source: Survey of participants (n=12) and dropouts (n-20) nonparticipants (n=26)

As shown in Table 2–6, all twelve participants, 18 of 20 dropouts, and 15 of 26 nonparticipants interviewed remembered being told that specific benefits of the technology were saving energy and money (43 total). Fourteen of these respondents also said that the lamps would be free of charge and were being paid for by Southern California Edison. One mentioned the free audit provided as part of the Program. Other benefits mentioned were the fact that this was an experiment being conducted by Southern California Edison (and that their trust-level was high as a result), that the lower wattage bulbs would keep their interior shopping areas cooler, and that the lamps had a longer useful life. Note however, that ten of the twenty dropouts were from a large lighting retail chain, where the corporate office made the decision to participate. The corporate office told the local managers about some of the benefits.

Table 2–6. Benefits Remembered by Respondents

	Participants (n=12)	Dropouts (n=20)	Nonparticipants (n=26)	Total
Saving money and energy	12	17	15	43
Free bulbs	4	5	5	14
Program was an Edison experiment		1	1	2
Lower energy bulbs keep the store cooler		1		1
Longer life bulbs lower maintenance costs		1	4	2
Corporate decision		1		1
Possible rebate			1	1
No benefits			1	1
Don't know / don't remember			13	13

Source: Survey of participants (n=12), dropouts (n-20), and nonparticipants (n=26). Multiple responses accepted

Participants reported that saving energy and money were the primary considerations in their decision to participate. Four respondents mentioned that the look of the bulbs in their outdoor signs was very important, and that they felt that the new lamps were equivalent or superior to incandescents. Two mentioned they had looked at the light quality of other installations before deciding to participate. Two participants stated the fact that Southern California Edison was paying for most, if not all, of the project cost was very significant, and one participant mentioned the free audit as being a nice feature of the initial project scoping.

Participants and nonparticipants were asked how important Edison sponsorship was to their decision-making. The majority of respondents said that sponsorship was very important. Comments included *“we wouldn’t have done it without them”* and *“we had other programs and trusted their judgment.”* Several commented that Edison’s sponsorship was important because of the lamp cost and incentives offered (Table 2–7). For nonparticipants, Edison sponsorship was important, but there were other factors driving the decision to participate.

Table 2–7. Importance of Edison Sponsorship to Decision-making

	Participants (n=12)	Nonparticipants (n=26)
Not at all important		3
Somewhat unimportant		2
Not important and not unimportant		1
Somewhat important		5
Very important	12	15

Source: Survey of participants (n=12) and nonparticipants (n=26)

When asked if they would install the lamps without incentives, most participants (10 of 12) stated that they would not have installed the cold cathode lamps without the incentives. In addition, three added that they participated because the bulbs were free. For these participants, we can infer the incentives were very important to their decision to participate. Only one participant expressed uncertainty about whether they would have installed the technology without incentives.

Dropout Decision making

Dropouts stated that the incentives weren't very important since they were either included in the price from the contractor or that their corporate office (lighting retailers) had made the decision, and they were not aware of any incentives (Table 2–8). Many of the independent businesses that dealt with contractors directly, however, felt the incentive was "very important" or "somewhat important." For those making a financial decision to participate, the incentive was a very important factor in the decision to participate.

Table 2–8. Importance of Incentives to Decision-making

	Dropouts (n=20)	Nonparticipants (n=26)	Total
Not at all important	8	3	11
Somewhat unimportant	1	2	3
Not important and not unimportant	2	1	3
Somewhat important	2	5	7
Very important	5	15	20

Source: Survey of dropouts (n-20) and nonparticipants (n=26)

Dropouts were also asked if the extended lamp life influenced their original decision to participate. On a three-point scale, nine reported "no influence," seven were "neutral," and two reported "a lot of influence."

Dropouts were asked to describe the key reasons why they decided to drop out of the Program. The primary reasons mentioned (13 of 20 dropouts) were dissatisfaction with the lamp color temperature, and lumens output. These represented large potential clients with interior applications including four large national chains.

Half (10 of 20) of the dropouts interviewed were from one chain of lighting retail stores which installed the TCP-manufactured cold cathode lamps in their interior lighting fixture displays. The lighting retailers agreed that the color of the bulbs was inferior to incandescents or other low energy bulbs. One store manager stated, *"We did install the bulbs in our stores but the color was horrible and people would not buy the lamps that the cold cathode were installed in."* Another store manager commented on the color by saying that *"the bulbs made everything in the store look green."* The lighting stores were originally told by their corporate office to participate, but after their experience with the installed lamps they were allowed to de-install and return the bulbs after providing this feedback.

Lamp color was also the reason the corporate office of a restaurant chain decided not to install the lamps inside their public seating areas. The respondent stated, *"Restaurants rely on good ambiance and presentation of the food. The new bulbs gave everything a green or purple hue which we could not accept."*

The Litetronics representative interviewed explained that it is not the Color Rendering Index (CRI) but the Kelvin color temperature that people were reacting to. In the early program, only lamps with Kelvin temperatures typically used for exterior applications were available, that is, the more white or green color. Responding to the industry requests for other options, Litetronics has since developed two other Kelvin temperature ranges that produce the warmer red colors for interior applications.

Follow-through is an issue Edison and Program implementers should address. One dropout stated that he could never get an actual total project price quote and thought the vendor applied for incentives prior to their final decision. Another dropout stated that he had decided to go forward with the project but that the contractor never got back with a price quote after the initial contact. He also stated that he still has money in the budget to participate, if the Program is still being offered. One other dropout stated that the initial contact represented himself as being from Edison, but upon arrival the respondent learned, to his discomfort, that they were a third party, and not Edison.

As noted, the primary issues for dropouts that were retailers or restaurant chains with interior applications were related to aesthetics. Other reasons participants dropped out of the Program or decided not to participate included:

- Not having enough funding to pay for their portion of the project
- The business had decided to install a new type of sign instead
- The sign was going to be removed
- The sign was too old to work with the new technology
- There was no follow-through by implementers

Nonparticipant Decision-making

Nonparticipants were asked if they were aware of cold cathode lamps before being contacted about the Program and why they decided not to participate in the Program. Ten respondents stated they were aware of cold cathode lamps and 15 were not aware of this type of lamp before being contacted. Respondents reported variously that they did not participate because the investment was too great (four respondents), because they didn't think it applied to them (three respondents), because there was not need for it (one respondent), and because the light was not bright enough (one respondent). Another reported that they had a five-year contract with another lighting manufacturer and if they broke the contract they would lose money. One said they agreed to participate, were sent a fax and asked to sign it, in order to indicate that the lamps had been installed; however, they never received any lamps, and did not actually participate. Surprisingly, 13 others stated that they were participating when they weren't. ECC confirmed that they were not participants, either in the 2004-05 program, or later. (Edison, however, determined that three were participants in the Express Efficiency program which offers incentives for CFLs.)[249] Clearly, even though respondents were given a description of the Program at the onset of the interview, they were unable to distinguish between Edison programs.

Program Delivery and Implementation

ECC outreach and sales contractors audited interested participants' facilities to gauge the size and cost of the project. When participants were asked how they determined which signs or locations would receive the new technology, the majority (seven of twelve) stated they replaced all lamps that were good applications for the cold cathode technology. Other responses noted, variously that: the contractor specified which locations would be best for the bulbs, the lamps with the most usage were replaced, only the lamps in the main sign were replaced, corporate made the decision for replacement, and lighting with a lower heat output was desired for indoor displays. Most participants (11 of 12) installed the lamps in exterior signs, with several noting that they had only one sign.

While incentives lowered the cost of the lamps to the participants, the level of participant investment varied with approximately half (six of twelve) stating that they did not have to pay anything, and the other half (five of twelve) indicating that they did pay a portion of either the lamp or installation cost. One respondent was uncertain. Four provided information on their out of pocket contribution, largely installation costs: $600, $2,000, $8,000 and $10,000. Investments ranged widely due to the number of bulbs installed for the different projects and the associated installation costs. A majority (eight of twelve) of the participants stated a third party contractor installed the lamps. Two others installed the lamps themselves and two had their maintenance contractors install them.

Participants were asked how the lamp installation fit with their planned lamp replacement and maintenance schedules (Table 2–9). Seven of the twelve participants stated that the installations fit very well with their planned schedules, while three reported slight inconveniences resulting from delays in the delivery of lamps, and contractor scheduling issues. The maintenance manager for one golf course said,

> *"I had to shut down a part of the golf course twice to finish the project for our large sign, but this did not cause a major inconvenience to our customers."*

Two participants stated that they had major issues with the downtime caused by the project, stating in one case that the lamps did not work for one of their two locations, resulting in additional labor that will be incurred in the future to remove the bulbs when the weather changes. This participant stated,

> *"The lamps are very temperature-sensitive and are not bright enough at colder temperatures, which the contractor did not tell us when he installed them in the summer.*

[249] During the program period, Edison did not incent the cold cathode lamps through the Express Efficiency Program, but did incent standard CFLs and other lighting. Edison offered incentives for cold cathode CFLs through the Express Efficiency Program after the 2004-2005 IDEEA Program period.

We will not be able to use these in the winter and will have to remove them at our own cost and time."

Another participant stated that the project incentive deadlines required them to put the new lamps in ahead of their normal maintenance schedule. They were then impacted again when they experienced the weather-sensitivity issue and had to remove the bulbs.

Table 2–9. Installation Fit with Planned Lamp Replacement and Maintenance

Experience	Count
Fit well with normal operation and maintenance	7
Bulb delays and contractor scheduling had minor effects on scheduling	3
Major issues with bulb performance caused additional unplanned maintenance	2
Total	12

Source: Survey of participants (n=12)

Participants and sign maintenance contractors were asked if any issues requiring corrective action came up during or since the installation of the lamps. Five of the twelve participants indicated that no issues arose either during or since the installation. Six of the twelve stated that there were issues which required corrective action by their staff or outside contractors. The remaining participant stated that they were not sure if any issues had come up because their maintenance contractor managed the entire project.

Each participant described a unique problem. One participant restated the issue with temperature sensitivity and the resulting reduction in lumens in colder temperatures. He removed the lamps for one of his two installations at his own cost.

Another participant stated that some of his lamps did not seat properly and were at angles less than perpendicular to the sign surface. When this occurred there was a perceived reduction in lumens. He removed and reinstalled the lamps to correct the problem.

A third participant experienced what is believed to be a voltage threshold problem causing an incompatibility of the cold cathode lamps with his older sign. The older sign was not designed to power low-wattage lamps. This sign could not accommodate the new lamps on both sides of the sign and continue to operate properly. The contractor tried several different corrective actions, including turning the lamp's brightness down, but could not find a solution that allowed both sides of the sign to be lit at the same time. Because the participant chose not to upgrade the sign electronics, incandescents were reinstalled on one side of the sign, reducing energy savings by half. The participant stated he was still very happy with the lamps, even though only half the sign could be upgraded.

One participant reported a very positive "issue" when he received a call from his accounts-payable department.

"My controller called to see what the problem was in our facility that had resulted in such a drop in the utility bill."

One sign maintenance contractor stated that the lamp "flicker" issue could never be fully resolved and that the bulb color was definitely different from the white light produced by standard incandescents. She also stated that the lamp lumens were less than the incandescents they replaced. Nevertheless, her customer had not made complaints about these issues.

The second sign maintenance contractor was sure the client did not participate in the Program, stating the initial investment cost had not been budgeted, and that the maintenance contractor had advised against going forward with the project. He thought he could purchase the lamps for far less money through his wholesalers, and bulbs were never purchased through this project. However, when interviewed, the client expressed high satisfaction with the new technology and resulting energy savings. Site visits by the team conducting the impact evaluation verified that this business did, in fact, participate.

Market Barriers

Several market barriers were identified by the implementers, participants, nonparticipants and dropouts. Implementers felt there was some apprehension on the part of potential participants because the technology was so new. Other barriers included the low lamp wattage, color temperature and aesthetics, internal procurement timing, and cost differentials. One also reported issues with performance during cold temperatures and stated they would remove the lights in cold weather and reinstall them in warmer weather.

After initial discussions, one restaurant chain chose not to participant because the lamps were not bright enough. Had they been 13-watt lamps, ECC feels the large chain would have stayed with the Program, and in fact the Program would have been oversubscribed. This representative stated in their interview that they dropped out because of color temperature and unacceptable aesthetics. A restaurant chain (that dropped out) installed about half the number first anticipated because wattage was too low. The low-wattage lamps limit the type and number of applications.

Prolonged procurement time, i.e., the corporate decision-making process, left one large restaurant chain unable to commit to participate within the Program's time frame.

Price differential was another market barrier identified by Program implementers. The cost of the cold cathode lamps can be 30%-40% higher than standard incandescents. At the onset of the Program, lamps cost about $7.70 each. Incentives provided through Edison funding roughly covered the cost of the lamps. As the Program progressed, the cost came down and incentives were able to subsidize some of the installation costs.

Having gained experience with the new technology, participants were asked if they felt there were any barriers to the widespread adoption of the cold cathode lamp technology. Five of the satisfied participants could not think of any barriers, three participants stated the higher cost of cold cathode lamps over incandescents would be a barrier, and one participant stated more market awareness and education would be needed before the new lamps could capture a large portion of the potential market.

One participant felt there were several potential barriers, including the fact that the durability of this new technology is currently unknown and that his maintenance contractor had increased the cost of his contract as a hedge against the possible failure rate. He also stated that the cold cathode signs could be identified because there was a difference in color and fade out that occurred when looking from certain angles.

Other barriers mentioned included the concern that different sign types (e.g., color-faced) would not work as well with the new lamps, the installation orientation issues experienced by one sign participant (bulbs did not seat perpendicular to sign face), and the feeling by some that the lumens were less than the replaced incandescent bulbs.

ECC and the Edison Program Manager acknowledged the cold cathode lamps compete with LED retrofits. LEDs have an advantage, having had prior incentives and more name recognition. LEDs that do not screw in, however, require a whole new sign, and it is less costly to retrofit with cold cathode lamps than to install a new sign. Screw-in LEDs are reportedly more expensive (at $20+ each) than cold cathode lamps, and the technology may not be "proven" in the exterior flashing sign applications. ECC reports that LEDs produce fewer lumens per watt, so on a flat panel board, the LEDs deliver brightness but not savings, compared to the cold cathode lamps. *"It's all about marketing,"* they said.

ECC also noted that another barrier with older signs was the older hardware used to control the flashing (triacs).[250] the older signs are not designed to work with low-wattage lamps, and require rewiring to accommodate the cold cathode lamps. This was a "moderate job" on some of the signs (although one was a $4,000 rewiring job). Only one participant decided not to rewire and their sign was retrofit only on one side.

In summary, market barriers included:

- First cost
- Procurement time
- Limitations in wattage
- Lumens output and temperature dependence
- Color temperature
- Unknown durability and maintenance requirements
- Age of signs and ability to accommodate cold cathode lamps
- Competition from LEDs

Participants' Experience with the Program and Technology

Participants were asked whether any sign maintenance had been required, or if any of the lamps had been removed, since installation (Table 2–10). Most (nine of twelve) participants responded that they had performed sign maintenance since installation, with six reporting change-outs for

[250] A TRIAC, or TRIode for Alternating Current is a bidirectional electronic switch which can conduct current in either direction when it is turned on.

lamp burn-out or failure, citing lamp failure as the cause. One participant restated the lamp seating issue as the reason for maintenance and lamp replacement, while another participant restated the voltage threshold issue between the two sides of his sign as the reason for both maintenance and replacement of the lamps. None of the participants experiencing lamp failures had inventoried the number of failures.

Two of the participants stated that they were not sure if there had been any sign maintenance, as their maintenance contractors took care of all issues, although one said it did seem like fewer lamps were being changed out during maintenance. Two participants stated no maintenance or lamp replacements had been required since the installation.

Table 2–10. Maintenance and Replacement

	Count
Lamp burnout failure & replacement	6
Lamp reseated	1
Lamps removed & replaced with incandescents	1
Routine maintenance	1
Unsure - handled by maintenance contractor	2
No maintenance or replacement	1

Source: Survey of participants (n=12)

Participants were asked about their future plans for lamp failure. Most (ten of twelve) stated that their maintenance contractors would be responsible for replacing failed lamps. One participant stated he did his own maintenance and had an inventory of spare lamps, and one participant stated that he was unsure of what the company's plans were for lamp failure.

Participants were asked if they had changed any sign operating procedures with the installation of the cold cathode lamps. Three sites reported changes. One site rarely used the dimmer installed on one of their signs, needing higher output from the new bulbs to achieve the same effect as the incandescents they replaced. A second site was taking advantage of the energy savings by extending their hours of operation while still using less energy than before participation. A third reported operational changes, including equipment shutdown and turning on lights later in the day.

Participants were asked if they had taken any actions that would impact energy use since the cold cathode lamps were installed. Most (ten of twelve) participants had not made other changes since the new technology was installed. One participant said that at the same time he had also installed computerized HVAC controls, demand response measures, changed out exterior lighting for lower wattage bulbs, and would soon install photocell detectors for some of the lighting. Another participant had also replaced much of his interior lighting with energy-efficiency technology (Table 2–11).

Table 2–11. Changes in Operating Procedures or Equipment

	Yes	No
Change in operating procedures or behaviors	3	9
Change in additional equipment that would reduce consumption	2	10
Non-energy benefits realized	4	8

Source: Survey of participants (n=12)

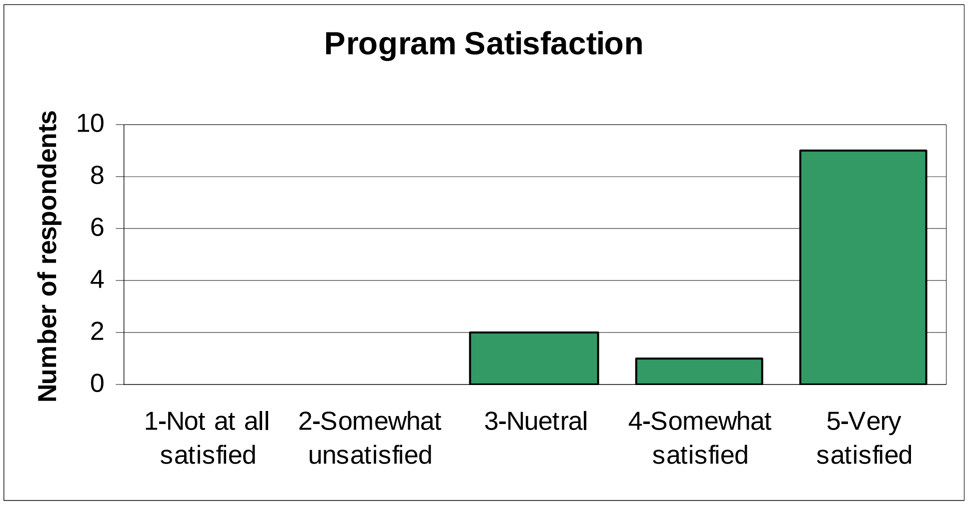
Participants were asked if any non-energy benefits had been realized since the new lamps were installed. Four participants reported non-energy benefits (Table 2–11). One respondent said the new lamps had “freshened” up the look of their old signs and one stated that his customers were actually mentioning how much better the sign looked with the new lamps. One participant said that the savings had made him more receptive to other energy-efficiency measures, and one participant felt that the new lamps brightened up his retail floor area and created a better shopping environment for customers.

When questioned about whether they had actually seen energy savings on their utility bills, over half (seven of twelve) stated that they had. One participant stated, *“The savings were huge; in our first month the power bill was $3,000 less.”* One participant stated that he has a very large electric bill that consolidates the consumption across multiple locations and that he had not expected the savings to be visible on his bill. One stated that any drop that may have shown on his bills initially had been negated by the higher utility prices. One stated that he does not see the power bills and another stated that they had not had time to analyze the billing since the new technology was installed. Another participant stated he had made several other changes during the same period and that it would, therefore, be impossible for him to separate out the cold cathode technology energy savings.

Participants and sign maintenance contractors were asked to rate their satisfaction with the Program using a five-point scale, where 1 was “not at all satisfied,” and 5 was “very satisfied.” Most participants stated they were either “very satisfied” (nine of twelve) or “somewhat satisfied” (one of twelve) with the new lamp performance, and one participant stated that they were neutral. The participant who de-installed the lamps in one sign was the only participant who stated he was “not at all satisfied” with the performance of the new technology. (Figure 2–2).

One sign maintenance contractor stated she was “somewhat dissatisfied” because of lamp flicker issues, color temperature, and lumens. The second maintenance contractor could not comment because he did not think his client had actually participated in the Program.

Figure 2–2. Program Satisfaction



Source: Survey of participants (n=12)

Program participants were asked which characteristics of their businesses they felt made them good candidates for cold cathode lamps. The most frequent response (eight of twelve) was that exterior signs that operated 24/7 or for very long periods each day were the best candidates for the technology, and that they (the respondents) had those kinds of constant usages. Two of these respondents also mentioned that their signs were very big in size, consuming large amounts of energy.

Qualities of the cold cathode technology that the business owners liked included:

- No retrofitting other than control adjustments was needed before signs could accept the new lamps.
- Lower heat output of the new technology reduced the cooling load in retail floor space in interior applications.
- In exterior sign applications, the performance of the bulbs was equivalent to incandescents, giving similar visibility.

Program participants were asked if they had any suggestions for Program changes (e.g., selection of products, marketing, Program delivery). Five individuals had the following suggestions:

- Give potential participants a list of current installations they can look at prior to making a commitment to install the new technology.
- Establish a better contractor quality assurance process to avoid Program misrepresentations or poor workmanship.
- Conduct additional testing of the new lamps in older signs. Respondents felt older signs may need to be disqualified from upgrades.
- Increase the Program budget to allow more participation.

- Southern California Edison should conduct direct marketing and outreach to provide higher visibility and credibility to the Program.
- Increase the visibility of Program representatives and contact potential participants several times. Retailers are very busy and often need contact several times before they decide the benefits are worth the business interruptions.

Free Riders

To assess free riders in this Program, participants were asked if they were aware of the technology and if they would have installed the lighting without the Program incentives. One-quarter of the respondents (26%) stated they were aware of the technology before being contacted. Two of the twelve participants, four of the twenty dropouts, as well as 10 of the nonparticipants reported they were already aware of the technology.

Participants, dropouts, and maintenance contractors were asked if any had installed the technology prior to the Program. One participant said they had, stating that the lamps were the same efficiency level as those offered by the Program, but they could not recall the quantity of lamps installed. None of the dropouts or maintenance contractors had installed the technology prior to the Program.

Respondents were asked if they had considered installing the cold cathode lighting before the Program, without incentives, and asked when the lighting would have been installed (Table 2–12). None of the dropouts (n=20 respondents from 10 businesses) and two of the participants (n=12) had considered the technology prior to the Program. Two participants reported they would have installed the lamps within the next year. The business that had installed cold cathode prior to the Program also said that they had funding in the budget but that the additional lamps were not ordered. One other participant stated that before the Program they were quoted $80,000 for the lamp upgrade and did not install the lamps due to the high cost. One other respondent stated that they would have installed the lamps in three to five years.

None of the dropouts or maintenance contractors stated that they had plans to install the cold cathode lamps.

Table 2–12. Awareness and Installation of Cold Cathode Technology

	Participant n=12	Drop- out n=20	Nonparticipants n=26
Were aware of cold cathode lamps before being contacted	2	4	10
Considered installing before Program without incentives	2	0	
Installed before Program	1	0	

Source: Survey of participants (n=12), dropouts (n=20), nonparticipants (n=26)

Table 2–13 below shows the free ridership weighting applied to participant responses. One participant was a definite free rider, one participant was assigned a 50% weight and a third was assigned a 25% weight. The free rider factor was calculated by summing the percentage weights and dividing by the number of respondents, resulting a 10% free rider factor. The net-to-gross ratio was calculated as .90.

Table 2–13. Free Rider Calculation

Free Ridership Score	N	Already Ordered or Installed	Would have Installed w/o Program	Same Efficiency	Would have Installed All of the Measures	Planning to Install Soon	Already in Budget
100%	1	Yes-1	Yes	- - -	- - -	- - -	- - -
0%	9	No	No	- - -	- - -	- - -	- - -
0%		No	Yes	No	- - -	- - -	- - -
50%		No	Yes	Yes	Yes	Yes	Yes,
25%		No	Yes	Yes	Yes	No	Yes
25%	1	No	Yes-1	Yes	Yes	Yes within 1 year	No
0%		No	Yes	Yes	Yes	Yes	No
0%	1	No	Yes-1	Yes	Yes	within 3-5 years	No
25%		No	Yes	Yes	No	Yes	Yes
12.50%		No	Yes	Yes	No	No	Yes
12.50%		No	Yes	Yes	No	Yes	No
0%		No	Yes	Yes	No	No	No

Potential Spillover

To get a sense of whether there was any spillover from the Program, participants and dropouts were asked questions about future plans to install the cold cathode lamps in other applications or locations, either at their own expense or with incentives (Table 2–14).

Most (ten of twelve) participants stated they did not have plans to install the new technology in other locations, primarily because most of the participating businesses only had one location. One participant stated they planned to install the cold cathode lamps at other locations this year, the second could not specify.

A majority of the participants stated they would consider installing the cold cathode lamps in the future, with eleven of the twelve participants indicating they would install the lamps with incentives and eight of the participants stating they would install the lamps at their own expense. Multiple answers were allowed, and six of these respondents stated they would install the lamps at their own expense and with incentives. Two of the participants stated they would not use this technology in the future. One of these was because the lamps were not working well, while the other was because they had no other application for the lamps.

Eight dropouts reported they would not install the technology in the future, five reported they would consider installing the lamps with incentives, four reported they would install the lamps without incentives. (Three of these respondents answered that they would install the lamps at their own expense or with incentives.) Four stated that they were undecided about whether they might install this type of lamp in the future.

Overall, 31% would not install the lamps in the future, either because there was no place to install additional lamps, or because the experience was unsatisfactory. However, 47% said they would install the cold cathode lamps, with 41% of respondents requiring incentives to install them.

Table 2–14. Reported Spillover

	Participant n=12	Drop- out n=20	Total n=32	Percent
Would not install in the future	2	8	10	31%
Yes, only at own expense		2	2	6%
Yes, only with incentives	3	1	4	13%
Yes, at own expense and with incentives	6	3	9	28%
Uncertain	0	4	4	13%

Source: Survey of participants (n=12) and dropouts (n-20), multiple responses allowed

Dropouts were also asked if they would install *other* types of energy-efficient lighting in the future. Half stated that they would consider installing energy-efficient lighting in the future either if the utility helped pay for the cost of the lamps (10 of 20), or at their own expense (14 of 20). Many, however, qualified these statements by indicating that the color and lumens would have to meet their needs. This was clearly articulated by one of the lighting retailers who said, *"We would install any lamp with acceptable lumen and color, and with a "traditional" look so that customers will buy them."*

Those indicating they would install energy-efficient lighting in the future were asked what type of lighting might be considered. While not all dropouts responded with specifics, some mentioned fluorescents (CFLs, T8 and T5), low-wattage bulbs and dimming controls. Others focused on the look and lumens of the bulb with one retailer indicating, *"We like to offer whatever is available on the market to our customers."* One respondent stated they just implement whatever their corporate office indicates should be stocked.

Four dropouts, however, stated they would not consider any energy-efficient lighting in the future because of their experience with this technology. These respondents had a mix of interior and exterior applications for the cold cathode lamps.

Often, introduction to energy efficiency through programs such as this raises the awareness of market actors, resulting in pursuit of additional methods to save energy in their businesses or for their clients. Participants and maintenance contractors were asked if, since participating in the Program, they had installed any additional energy-efficiency measures without incentives from the utility or other energy-efficiency organizations (Table 2–15).

Four of the twelve participants stated they had installed additional energy-efficiency measures including a new HVAC system, LED signage, and fluorescent lights inside and outside their buildings. The remaining eight participants had not installed additional energy-efficiency measures since the cold cathode lighting was installed. All four who installed additional energy-efficiency measures, said that the cold cathode program was "very influential" in their decision to add other measures.

Both of the sign maintenance contractors interviewed said they had not been asked to install any other lighting efficiency measures for their clients.

Dropouts that left the program after receipt of the lamps were also asked if they had installed other energy efficiency measures since participating. Four of the 20 dropouts said they had installed fluorescent lighting inside their businesses and one installed a new high-efficiency HVAC system.

Overall, eight, or 24 percent, of the respondents had installed other energy-efficient equipment since hearing about the Program.

Table 2–15. Installation of Other Energy-efficient Equipment

	Yes	No
Participant	4	8
Drop- out	4	16
Sign maintenance contractors	0	2
Total	8	26
Percent	24%	76%

Source: Survey of participants (n=12), dropouts (n=20), sign maintenance contractors (n=2)

All survey respondents, including participants, dropouts, nonparticipants and sign maintenance contractors, were asked whether they had previously participated in other Southern California Edison energy-efficiency programs (Table 2–16). None of the maintenance contractors had participated in prior programs. Four of the twelve participants, six of the twenty dropouts, and 11 of 26 nonparticipants said they had participated in previous programs. These programs included demand response, lighting discounts, HVAC, lighting controls, Savings by Design, a cogeneration project, air conditioning, LED exit signs, thermostats, and solar panels. Three of the participants participated in multiple programs. One nonparticipant said they had seven contracts with Edison.

Table 2–16. Participation in Other Edison Programs

Participation in other Edison Programs							
	Participant n=12	Drop-out n=20	Non participants n=26	Maintenance contractor n=2	Total	Percent
No	7	11	14	2	34	55%
Yes	4	6	11	0	23	37%
Uncertain	1	2	1	0	4	6%
Total	12	19	26	2	61	98%

Source: Survey of participants (n=12), dropouts (n=20), nonparticipants (n=26), sign maintenance contractors (n=2)

Lessons Learned by Program Staff, Future Plans

The incentive structure for the Program changed early in the Program to better meet the needs of participants. One of ECC's challenges was attracting participants with a rebate structure, because the lamp replacement cost was high. Sign-ups remained difficult until the incentive structure changed to assign rebates to the implementers. This shifted the burden of first cost away from participants. Most of the commitments came near the end of the Program. ECC feels changing the incentive structure from a rebate to a discount program was the *"most significant positive improvement"* they made to the Program.

With the entry of a second supplier, and with demand from participants, the Program did grow large enough to reduce the cost of the lamps. However, the incentive amount for the lamps was not changed. Going forward, Edison feels the incentive for the lamps could be reduced since the cost of the lamps has seen a reduction.

Both Edison and ECC remarked on the long lead time needed by businesses to make large procurement decisions. The cost of the lamps may lead to procurement in budget cycles that are beyond the timeframe of the Program. In addition to the decision process, lamps took three to eight weeks to deliver since there was not a large stock being ordered, and the lamps were imported from China. Part of the lead time problem was attributable to sourcing. There was only one supplier until near the end of the Program. There was also much manual labor involved with the process. Overall, the long lead time, from attracting a participant, through decision-making and delivery of the lamps, was a problem throughout this Program. It is one reason that at least one large participant dropped from the Program.

ECC, Edison, and Litetronics acknowledge that the eight-watt maximum limits the market to specialized applications. The low wattage offered challenges to meeting customer expectations. Introduction of more light through higher wattage will increase opportunities.

In addition, the competition from LED lighting options was discussed with ECC and Edison. ECC aggressively marketed the cold cathode as a retrofit product and alternative to LEDs, and incentives may have "turned the tide" for cold cathodes. ECC noted that one RV dealer they approached had just committed to LEDs and was not told about the cold cathode retrofit option by their salesperson. Another participant was persuaded to use the cold cathode product instead of an LED product.

As noted elsewhere, the outdated signs using triacs, the electronic hardware that controls flashing, were a problem for the low wattage lamps. The triacs don't "see" the load and don't send the electronic pulse that causes the lamp to flash. These signs can sometimes be rewired.

The energy savings targets would have been exceeded except for the rejection of the lamps by a large lighting retailer chain and large restaurant chain. Both chains rejected the lamp's color temperature. In addition, the restaurant chain had procurement and timing constraints that could not be met within the Program's timeline. Lamps for the restaurant chain were not ordered. In the case of the lighting chain however, nearly 20,000 lamps were delivered to nine stores, installed, de-installed, then shipped to a central warehouse for pickup. Negotiations proceeded for two months before the company dropped out completely. The two retractions alone represented 37,168 lamps or nearly 30% of what could have been installed. The primary issue appeared to be color temperature or color quality that was not "up to par" or equal to the merchandizing effort. In some applications, the color appeared warmer than in other applications. The color of the lamps that were delivered may have been inferior for that batch, or the quality of the manufacturer's product may have been inferior. In the end, it was too close to the end of the project to bring in an acceptable replacement product.

Edison, ECC, and Litetronics all feel that cold cathode lamps must be incentivized to work their way into the market. This is supported by survey respondents. Lamps are expensive and the rebate significantly reduces the cost to consumers. Litetronics noted that even where there is no specific utility rebate program (in other territories) they can often work with the utility to develop the rebate procedure for interested consumers.

The Program was actually expanded near the end of 2005 with increased interest and sign-ups near the end of the Program. The Program had expected to exceed its target for number of lamps sold, kWh and kW. However, with the ultimate pullout of the large chains, the Program fell short of its sales goals including number of lamps and kW goals.

Overall, ECC feels that the freeway signs and amusement parks are good applications for cold cathode lamps in outdoor signs. They also found that the lamps do not yet have the brightness, color, and aesthetic qualities desired in the retail and restaurant markets with interior applications. However, ECC notes that the manufacturers did gain experience and information to improve their products for this sector of the industry. In addition, ECC notes that the price drop with competitors entering the marketplace is another indicator of Program and product success, and that the product will have a long term impact on the marketplace as a whole.

Edison feels this is a good market that needs to be addressed. The cold cathode technology has been included in Edison's Express Efficiency Lighting program for small to medium businesses. The two- to eight-watt lamps qualify for a $2/lamp rebate.

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3. Impact Evaluation

Impact Evaluation Methodology

The methodology employed to accurately measure and verify energy savings attributed to the lighting retrofits installed under the Miniature Cold Cathode Lighting program included field verification activities and the utilization of the data obtained to develop adjusted gross savings estimates.

A billing analysis was completed, but results proved too uncertain to use in the impact evaluation. Results of the billing analysis are presented in Volume 2, Appendices. There are several possible reasons for the discrepancy between the engineering savings estimates and the savings determined through the billing analysis. First, it was unknown whether the meters being used were dedicated meters or meters for the entire site. While four meters that were clearly not dedicated exclusively to the retrofitted sign were removed from the final analysis, it is possible that non-Program end uses were being captured on the other meters and distorting the results.[251] Second, since some of the meter data initially provided exhibited pre-installation energy consumption lower than the total expected Program savings, it is possible that other meters for the site (perhaps that monitored the sign or that also captured sign energy usage) were not included in the analysis. While the billing analysis showed savings at all participating sites, given the data quality issues, it is uncertain how accurate the results of the effort are. Although other factors and end uses potentially on the meter may be distorting—by either overstating or understating—the true impact of the Program, it is clear that two-thirds of the participating sites experienced a decrease in their energy consumption of more than 20%. While the billing analysis was unable to accurately determine the energy impact of the Program, the results of select sites lends legitimacy to the savings estimates projected by the Program and confirmed by the following engineering analysis.

The steps involved in the engineering estimation of savings included three major activities:

1. Completing measure installation verifications:
    a. Developing a sample for field verification activities
    b. Conducting field verification activities and observations
    c. Reviewing any data on verification activities completed by Edison
    d. Developing adjusted measures installation factors based on field activities and data reviews

2. Completing an engineering analysis to develop ex-post realization rates:
    e. Completing a review and evaluating Program data
    f. Analyzing data provided through field verification activities
    g. Completing analysis of customer energy bills[252]

[251] The distortion included changes in operating schedules and new equipment.

[252] Meter numbers were recorded during the M&V onsite survey whenever possible, however, some meters were physically inaccessible during the evaluation process. Future programs should require recording meter numbers.

h. Developing project and Program realization rates
i. Determining operating hours of participant sites

3. Developing adjusted gross and net Program ex-post savings.

Measure Installation Verification

The objectives of the verification activities were to complete visits to numerous sites that installed the cold cathode hardware and collect key energy Program performance metrics including:

1. Establishing the presence of Program measures by comparing the number of installations observed for a sample of sites with the number of installations recorded in the final flat file provided by Energy Controls and Concepts.[253]

2. Providing input on the quality of installations observed.

3. Where observed equipment did not match Program reported installations, determine if the retrofits were ever present, and/or the removal date and reason.

4. Recording key performance data such as daily schedules and seasonal operational variations.

The detailed measure installation field verification instrument is provided in Volume 2, Appendices.

A total of 30 exterior signs were installed through the Program at the time of the field verification work.[254] The Program originally intended to also install cold cathode lamps on interior signs and lamps that were used for interior area lighting or decoration. However, the implementation contractor was unable to solidify contracts in the retail lighting sector and the restaurant chain sector. Part of this problem was attributed to what was perceived as a color rendering quality issue with the lamps. Ultimately, no cold cathode lamps were installed in interior signs under the Program.

Using a proportional sample approach where the sample is a large fraction of the population, it was determined that a sample of 15 sites with exterior sign installations would provide a confidence and relative precision of 90/15, respectively, as defined by the following equation:

$$\text{Sample size} = N * [P * (1-P) * Z^2] / [N * E^2 + P * (1-P) * Z^2] \quad (1)$$

where

N = population size,

[253] 0008-Miniature-flat file for may06.xls

[254] The program ultimately completed installation on 34 signs, with four signs completed after field verification activities were initiated

E = error,

Z = standard error, and

P = proportion of the population.

Exterior signs consisted of larger advertising signs, such as those seen at automobile dealerships, and also smaller accent or decorative signs, such as those seen at amusement park rides. After determining the sample size of 15, the sample was further stratified in order to accurately represent the Program.[255] The verification approach required that the sample have two stratifications based on the size of the sign and resulting contribution to Program impacts. The 30 installed exterior signs were first sorted by contribution to Program savings and then separated into two strata—signs that contributed the mean amount of savings or greater, per sign, and signs that contributed less than the mean, per sign. The specific sample design methodology for these two strata includes:

- ***Sample of signs contributing the median per sign savings or greater.*** A total of 16 signs contributed more than the mean savings, per sign, and 12 signs were selected at random from this group.
- ***Sample of signs contributing less than the median per sign savings.*** A total of 14 signs contributed less than the mean savings, per sign, and three signs were selected at random from this group.

This method provided a verification sample that focused on individual signs that contributed towards a higher percentage of Program savings, and yielded a sample that accounted for over 95% of total exterior sign savings. Volume 2, Appendices, provides the sample of participant sites planned for verification activities.

The sample of signs receiving verification activities was random, and therefore represented little bias. The billing analysis occurred on external signs with dedicated meters, or signs on meters with loads that could be characterized without additional metering. The distribution of signs with dedicated meters and signs without dedicated meters was random, so there was no assumed bias in this aspect of the analysis as well.

Verification efforts did not correlate directly with any of the IPMVP Options. However, the activities most closely resembled an amalgamate of Option A and Option C[256] in that they stipulated partial measurement of the energy of use of the system(s) along with the measurement of energy use at dedicated meters. Where discrepancies occurred, preference was shown in the following order:

a) Savings calculations derived from dedicated meters

[255] The verification approach required that the sample have two stratifications based on the size of the sign and resulting contribution to Program impacts.

[256] *International Performance Measurement & Verification Protocol, vol. III.* Accessible from *http://www.evo-world.org/index.php?option=com_content&task=view&id=61&Itemid=80*

b) Engineering calculations resulting from field observations

Savings derived from non-dedicated meters were compared with engineering calculations to assure validity. Ultimately, however, the field observations were deemed more accurate in attributing energy savings to the Program.

Site Verification Activities

Field activities typically involved the following components:

1. The evaluation team coordinated with the implementation contractor and primary customer contact to establish field activity dates and identify site-level contacts.

2. The customer contact at each site was provided with a letter of introduction on Edison letterhead that provided a description of the activities to be undertaken at their site.

3. The evaluation team visually inspected each sign to confirm operation, and also to count the retrofit lamps installed on each sign.

4. The evaluation team attempted to identify lamp wattage; however almost all lamps installed in exterior freeway signs could not be accessed due to height restrictions, even with a ladder. Note that these signs are typically mounted at a height that makes them visible from the roadway. As such, most signs are installed at heights greater than 30 ft. with no means of access to inspect the individual lamps installed. As such, the evaluator was not able to inspect individual lamps and compare installed lamp wattage with lamp data recorded in Program records. In some cases, lamp wattage verification occurred primarily by reviewing replacement lamp stock, if available.[257]

5. n order to confirm flash rates on exterior signs, each exterior sign was observed for a representative amount of time. During this time, a digital photograph was taken each time a sign changed message, or at some consistent time interval, to gain a sense of the average number of lamps illuminated. The photographs were analyzed in order to estimate the percentage of lamps operating for each message displayed and the resulting kW and kWh. These values were compared to flash rate assumptions made in the Program design.

6. In order to support billing analysis, evaluators confirmed meter numbers for exterior signs with dedicated meters, or where non-dedicated meters could be associated with a sign, assuming the percentage of load attributable to the sign was meaningful.

7. The estimated average load from the flash rate analysis, discussed above, was be compared with the billing analysis on related signs in order to further validate Program assumptions.

[257] Invoices were requested from the implementation contractor in an effort to confirm wattage, but were not provided.

8. The results of these field activities were used to calculate installation rates and develop adjusted gross Program savings.

A total of 17 sites were visited, and15 signs were verified in accordance with the aforementioned sampling methodology. The evaluation team encountered difficulty verifying sign installations at Site 11 due to the volume of lighting fixtures installed at the park. In some cases, the implementation contractor was unable to provide identifications on specific lighting retrofits. As such, Site 11 was not verified, and several alternative signs were selected in order to reach the sample objectives. Volume 2, Appendices, provides a summary of the sites that received visits and verification activities. Table 3–1 provides a summary of field verification activities proposed in the final research plan, as well as of verification activities completed by the evaluation team.

Table 3–1. Proposed and Completed Verification Activities

Activity	Final Research Plan Verification Activity	Verification Activity Completed
Site visits	No less than 25% of exterior signs will receive verification activities. An inspection of approximately 15 exterior signs at 15 unique sites. No indoor signs have been installed or are likely to be installed through the Program.	44% of installed exterior signs received verification activities. 13 exterior signs at 13 unique sites received verification visits. No indoor signs were installed through the Program.
End-use metering	None	Photo analysis of flash rates

Upon conducting the site verification field work, it was discovered that some of the signs were not operating during the period that they were visited. As such, multiple trips were made to try and observe these cold cathode signs when they were active. However, there were two signs that were unable to be verified despite the numerous efforts that were made to correlate verification activities with the signs' operating schedules.

Complications such as these resulted in deviations from the original sample set of sites to be verified. However, 50% of the signs installed at the time of verification were visited and, ultimately, the verification sample accounted for 44% of all signs installed by the completion of the Program.

As stated previously, the primary objective of the verification activities is to establish the presence of Program measures and installations recorded in the final flat file provided by the Program implementation contractor. As such, the evaluation team labored towards ensuring the representative nature of the flat file through both verification activities and interviews with site representatives.

By the end of the Program, a total of 34 exterior signs had been retrofitted with cold cathode lamps. Of these participants, only two sites (Site 10 and Site 14) required further investigation due to conflicting information and measure absence, as discussed below.

1. The sign at Site 14 was not physically verified by the evaluation team. However, ensuing interviews with both the site manager and sign manager led to conflicting information as to whether or not the cold cathode lamps were actually installed. Further analysis allowed

evaluators to conclude that the site did, indeed, participate in the Program.

2. The sign at Site 10 had a sign that had been inactive for multiple months prior to being verified. Follow-up interviews with site representatives did not shed any light on whether or not they had participated in the Program. Ultimately, it was concluded that the site did participate in the Program.

Interviews with site representatives revealed that all but one site participated in the installation of cold cathode lamps. Because the uncertain participation of Site 10 represents less than 3% of the total number of installations under the Program, it was deemed that the installation rates recorded by the Program were representative, and the Program installation rate was concluded to be 100% of reported values.

All signs verified by the evaluation team appeared to be installed well and operating correctly. The lamp installation rate was observed to be 100%. However, as with any large light fixture display, there were certain lamps that had failed and needed to be replaced.

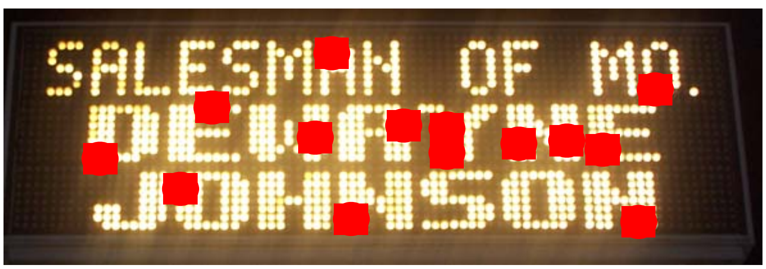
The evaluation team also conducted a lamp failure rate analysis on each sign in the sample.[258] The estimated lamp failure rate was calculated through the following equation.

Estimated lamp failure rate = (2)

(Number of Failed Lamps) / (Number of Energized Lamps on Message Grid)

The analysis was conducted by selecting messages for each sign that have a high number of active lamps, and identifying lamps that have clearly failed based on the context of the message being displayed. Figure 3–1 provides an example of observed cold cathode lamp failures at Site 17. This message employs 730 lamps. The lamps circled in red show where 14 lamps have failed, resulting in a failure rate of 1.9%. Table 3–2 provides the observed percentage of lamp failures at each site

Figure 3–1. Cold Cathode Lamp Failures



[258] The cold cathode lamps installed have a manufacturer's rated expected life of 20,000 operating hours.

Table 3–2. Percentage of Lamp Failures

Strata	Customer Site	Failure Rate
1	Site 1	0.00%
1	Site 2	1.50%
1	Site 3	0.80%
1	Site 4	2.00%
1	Site 5	1.40%
1	Site 6	0.90%
1	Site 7	2.50%
1	Site 8	0.80%
1	Site 9	1.60%
1	Site 12	0.70%
Alt	Site 15	0.50%
Alt	Site 16	0.70%
Alt	Site 17	1.90%
Average		1.18%

Representatives from Southern California Edison provided records on 20 sites verified in the course of their internal Program management. These inspections typically included verification of the lamp count, operating hours, and notes regarding measure and base lamps. Of these sites, 7 failed and 13 passed the inspection, allowing invoices to be processed and paid. Of the 13 sites that passed, 9 were also verified by the evaluation team. Table 3–3 provides a summary of the comparison between these two efforts. In general, both reports were very similar for all sites, with the 99.8% agreement on lamp counts, and the evaluation team's estimated operating hours at 103% of the Edison estimate. The evaluation team estimated the flash factor at all sites where installations were verified; one flash factor estimate was provided by Edison. Flash factor impacts the potential energy savings.

Table 3–3. Summary of the Southern California Edison and Evaluation Contractor Field Verification Activities

Customer Code	Edison Verified Flash Factor	Evaluation Verified Flash Factor	Edison Verified Lamps	Evaluation Verified Lamps	Edison Verified Annual Operating Hours	Evaluation Verified Annual Operating Hours
Site 1	na	0.3	5,120	5,120	5,840	6,935
Site 4	na	0.39	5,120	5,120	na	6,570
Site 5	na	0.37	3,840	3,840	7,288	6,570
Site 8	na	0.33	3,840	3,840	4,015	3,650
Site 9	na	0.36	3,792	3,840	8,760	7,280
Site 12	na	0.34	3,840	3,840	6,205	6,570
Site 15	na	0.35	5,120	5,120	na	6,205
Site 17	na	0.32	3,840	3,840	6,205	6,205
Site 21	0.375	0.36	1,920	1,920	8,760	8,760

The following summarizes the measure installation verification results and recommendations

a) Verification activities and staff observation indicated that the lamp installation rate was 100%.

b) After conducting a lamp failure rate analysis, the average failure rate (per sign) was calculated to be 1.7%.

c) In addition to the site verification activities, interviews with participating site representatives were administered in order to verify and adjust run-hour estimates for the Program. Table 3–4 provides both the recorded and verified run hours at sites that were able to be contacted and interviewed. The hours verified through the interviews showed an average sign operating time of 6,367 hours annually, while the average operating hours stated by the implementation contractor from this same sample was 6,665 hours annually.

Table 3–4. Verified Operating Hours

Strata	Customer Name	Recorded Operating Hours	Verified Operating Hours
1	Site 1	6,935	6,935
1	Site 2	7,280	7,280
1	Site 3	6,570	6,570
1	Site 4	6,916	6,570
1	Site 5	7,280	6,570
1	Site 6	7,280	7,280
1	Site 7	4,380	3,650
1	Site 8	4,120	3,650
1	Site 9	7,280	7,280
1	Site 12	6,552	6,570
Alt	Site 14	8,760	8,760
Alt	Site 15	7,280	6,205
Alt	Site 16	7,280	6,570
Alt	Site 17	5,408	6,205
Average		6,665	6,435

Impact Evaluation Results

An engineering analysis was conducted to develop adjusted realization rates for the Program. This included a detailed review of Program records and documents and an analysis of data on sign operation recorded during field visits to confirm Program assumptions about sign flash rate.

The final Program records submitted by Energy Controls and Concept to Edison were analyzed for accuracy and consistency, and to ensure that the underlying assumptions were reasonable. The key documents analyzed included:

a) The final Program flat file. This file documents activity at each participant site, including the type and number of lamps installed, the underlying energy savings assumptions, and the dates of the various installations. *This file provides Program reported gross energy savings values.*

b) The file provided by the implementation contractor, which provides a more accurate statement of base and measure lamps installed. This file provides more detail on the type of retrofit undertaken at each site, and provides the demand impacts ultimately used in the Program flat file. No data was supplied by the implementation contractor on pre-retrofit lamp burnout rates.

c) The final program workbook. This document provides a reporting format for the CPUC and represents a summary of the information contained in the Program flat file. It does not contain site-specific data. *This file provides Program goals and reported net energy savings values.*

Several observations resulted from this review:

1. The method used by the implementation contractor to estimate ex-ante gross savings was awkward because the Program reporting format required by Edison required that demand and energy savings calculation be obscured.

2. Many base lamp values in the flat file did not match the actual base lamps reported by the implementation contractor in separate files. For example, the flat file lists 28-watt lamps as the base lamp at Site 10; however, a second report from the implementation contractor indicated that the base lamp replaced was a 45-watt unit. As a second example, the flat file lists 28-watt lamps as the base lamp at Site 17; however, a 25-watt base lamp was confirmed in a second report. This reporting discrepancy occurred in more that 50% of project reports, making verification difficult. Ultimately, the final flat file provided by the implementation contractor clarified lamp wattage discrepancies, and those values were used in the final impact analysis.

3. Savings values presented in the flat file are not consistent with calculations presented in additional implementer reports. For example, the flat file for one site, Site 4, reports a demand reduction per lamp of 10.8 watts. This sign replaced a 50-watt incandescent lamp with a 5 W cold cathode lamp yielding a 45 W delta. The contractor reports a flash factor of 30% on this sign, which implies an average demand savings of 13.5 watts per lamp. This discrepancy may be the result of difficulties encountered from the reporting format requirements previously discussed; however, the evaluation team concluded that this resulted in errors in reported ex-ante gross savings.

In order to accurately establish the demand and energy savings for the Program, it was necessary to analyze how the signs operated. This process involved studying the types of messages being displayed, estimating the ‘flash rate’ (the number of lamps active during each discrete message), and calculating the maximum and average demand that resulted as a sign scrolled though various messages. This analysis, along with the annual operating hour data obtained from the sign operators, allowed the evaluation team to accurately calculate demand impacts and expected annual energy savings for each sign. The results of this analysis were then extrapolated to the population of participating signs to establish Program ex-post savings values.

In determining the flash rates for each sign reviewed, it was necessary to understand the sign operations in terms of the types of messages being displayed and the frequency and duration of messages, and record this data for analysis. All of the signs in the evaluation sample displayed multiple messages, and each message had a varying number of lamps operating. In order to capture a representative number of messages, each sign in the sample was photographed at four-to-five-second intervals for a period of one minute. This provided roughly 12 photographs per sign (including cycling), and generally included the full range of messages outputted. This process allowed the evaluation team to calculate the number of lamps active for each message (or the message flash rate) and determine the demand (kW) resulting from each message.

Two methods were used to analyze the photographs taken during field visits, and to develop flash rates estimates for each sign. The first method involved a visual inspection of each photograph and estimating the number of lamps active for each message. The second method employed professional particulate-counting software[259] to estimate the number of active lamps.

Figure 3–2 provides an example of the first method, visual inspection and counting, and shows a photograph of a sign located at Site 17. This sign employed a matrix of 30 light panels distributed over three rows and ten columns. Each light panel contained 64 lamps. The analysis of this message included calculating the number of lights energized in each panel, including the impact of inoperable lamps that should have been active for the message. Figure 3–3 provides the full range of messages observed throughout a one-minute period.

Figure 3–2. Typical Outdoor Reader Sign Message

[259] Gatan Digital MicroGraph Software

Figure 3–3. Sequence of Outdoor Reader Sign Messages over a One-minute Period

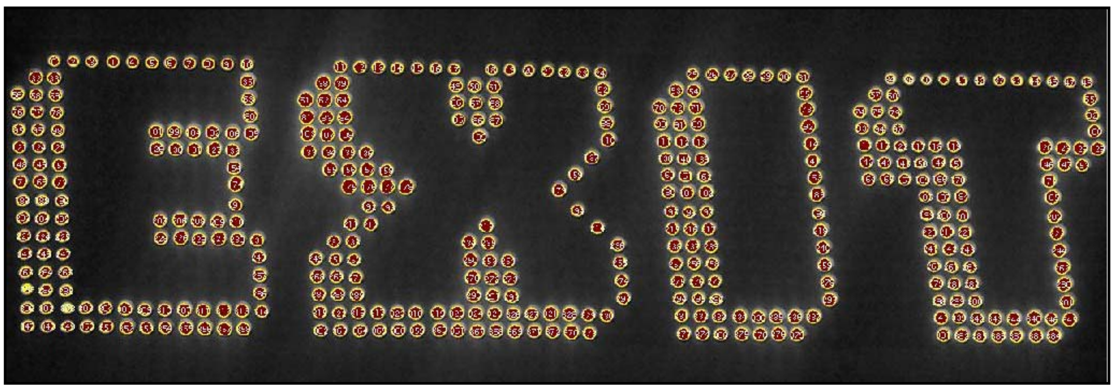
Table 3–5 provides a summary of the flash rate calculations for each of the 12 photographs at Site 17, including the estimated demand resulting from the use of cold cathode lamps, the estimated demand based on the original lamps, and the resulting difference in demand (demand savings) for each message. The message displayed in photograph 7 in Figure 3–3 resulted in the highest flash rate of 54%, while the message in photograph 9 yielded the lowest flash rate of 7%. The average flash rate was 32%. The maximum demand for the retrofit sign of 8.4 kW was generated by frame 7, while the average demand was 4.7 kW. It should be noted that this analysis is for the message displayed on both sides of the sign.

Table 3–5. Flash Rate Analysis Based on Visual Inspection of Photographs for One Sign at One Site

Frame	1	2	3	4	5	6	7	8	9	10	11	12	Max	Avg.
Flash Rate	37%	34%	27%	10%	40%	42%	54%	41%	7%	27%	12%	33%	54%	32%
Cold Cathode kW	5.7	5.2	4.2	1.5	6.2	6.6	8.4	6.4	1.1	4.2	1.9	5.2	8.4	4.7
Base Lamp kW	35.6	32.6	26.0	9.5	38.5	41.0	52.1	39.6	6.6	26.0	11.6	32.1	52.1	29.3
Delta Kw	29.9	27.4	21.8	8.0	32.3	34.4	43.8	33.2	5.6	21.8	9.8	26.9	43.8	24.6

In order to accurately calculate the number of lamps operating in each message displayed by the sign, professional particulate-counting software[260] was used to enumerate the number of active lamps. In certain cases, however, the pictures taken were not in focus and had to be assessed through more rudimentary means—namely, by counting the number of active lamps manually. Although the latter methodology may have taken more time, the results proved to be just as accurate as the results achieved by the software. Figure 3–4 highlights the software's process of identifying both active and inactive lamps.

Figure 3–4. Particulate-Counting Software Output



The software approach involved converting the picture files into an integer data format, calibrating the controls to specify what light intensity constituted a lamp, and allowing the program time to compute how many distinct light bulbs were in the picture. Due to the fact that the calibration process was rather subjective, multiple trials were often needed to accurately enumerate the number of bulbs in a given photograph.

No additional end-use data-logging or submetering activities were undertaken for this project. The results for the flash rate calculations for several signs are presented in Volume 2, Appendices.

Based on the aforementioned methodologies and review of key Program documents, the following adjustments to Program realization rates are recommended.

[260] Gatan Digital MicroGraph Software

Because of the difficulties in confirming the implementer's calculations discussed previously, the evaluation contractor developed an alternate methodology for estimating ex-post demand and energy savings based on the following equations:

$$\textit{Ex-post Annual Peak Demand (kW) savings} = \quad (3)$$

$$\textit{(Average Flash Rate)*(Number of Lamps on the Sign)*(Measure kW Savings)}$$

$$\textit{Ex-post Annual Energy (kWh) savings} = \quad (4)$$

$$\textit{(Average Flash Rate)*(Number of Lamps on the Sign)*(Measure kW Savings)*(Annual Op. Hours)}$$

Table 3–7 provides a comparison of the information contained within the final flat file (provided by Energy Controls and Concepts) to the evaluation team's verification findings using this methodology discussed above. It should be noted that the "Recorded Unit Savings (kW)" differ from the "Verified Unit Savings (kW)" due to the fact that the flat file inherently accounts for the flash factor in their demand savings estimates.[261] However, the evaluation team's approach differed in that the flash-factor analysis was conducted independently of the unit savings calculations.

As an example of how the evaluation methodology impacted calculations on a specific site, Table 3–6 provides a summary of the Program recorded and ex-post savings for sign located at Site 17. The difference in demand savings represents the difference in the flash rate assumptions used in Program reporting and the flash rate established in this evaluation. The implementer's reported flash factor was 52% versus a value of 32% calculated by the evaluator from the method discussed above. The difference in energy savings is attributable to the differences in assumed and verified annual operating hours. The Program recorded savings are based on 5,408 hours per year, while verification activities showed the sign to operate 6,205 hours per year. The annual kWh savings discrepancies noted in Table 3-6 result from the fact that the Program assigned a deemed savings of 64.64 kWh / lamp-year, for this retrofit, versus the evaluation analysis calculation of 39.12 kWh / lamp-year using the method discussed above. The deemed savings value would require a flash factor of 52%, which is considerably higher than the 32% field observed flash factor.[262]

Furthermore, when calculating the annual energy savings, it was noted that the percentage of time that the sign was blank—usually intermittently between different message displays—could be significant. For example, at this specific site, records indicated that the sign was blank approximately 18% of the time. This factor was apparent on all signs reviewed and could detract from the annual operating hours, however we did not make this a formal component of our study as the limited evaluation budget did not support obtaining the necessary sign operating and

[261] Table 3-7 applies the verified flash factor to the verified kW.

[262] Based on the savings algorithm, (3) and (4) above, a percentage difference between assumed and verified flash factor/baseline wattage will increase or decrease savings by that same percentage. The distribution of savings attributed to those two parameters varied by sign and application. (Table 3-7)

programming data necessary to confirm this value. As such we consider this a subjective number that did not factor into our evaluation.

Table 3–6. Program Reports and Ex-post Savings Analysis for Sign at Site 17

Metric	Program Recorded	Ex-post	Delta	Delta %
Maximum kW saved	NA	43.8	NA	NA
Average kW saved	28.4	24.6	-3.8	-13.48%
Annual kWh saved	248,218	152,475	-95,724	-38.56%

Table 3–7. Summary of Field Sample Verification Values and Recorded (Ex-ante) and Ex-post Gross Savings Estimates

Customer	Recorded Lamp Count	Verified Lamp Count	Recorded Unit Savings (kW)	Ex-post Unit Savings (kW)	Verified Average Flash Rate	Recorded Site Savings (kW)	Ex-post Savings (kW)	Recorded Savings (kWh)	Ex-post Savings (kWh)
Site 1	5,120	5,120	0.0074	0.025	0.3	37.9	38.4	330,957	266,304
Site 2	2,560	2,560	0.0108	0.023	0.37	27.6	21.8	242,278	158,599
Site 3	5,120	5,120	0.0074	0.025	0.4	37.9	51.2	330,957	336,384
Site 4	5,120	5,120	0.0108	0.045	0.39	55.3	89.9	484,557	590,354
Site 5	3,840	3,840	0.0108	0.023	0.37	41.5	32.7	363,418	214,697
Site 6	3,840	3,840	0.0108	0.025	0.41	41.5	39.4	363,418	286,541
Site 7	3,840	3,840	0.0037	0.025	0.4	14.2	38.4	124,109	140,160
Site 8	3,840	3,840	0.0037	0.025	0.33	14.2	31.7	124,109	115,632
Site 9	3,840	3,840	0.0108	0.023	0.36	41.5	31.8	363,418	231,469
Site 12	3,840	3,840	0.0074	0.025	0.34	28.4	32.6	248,218	214,445
Site 15	5,120	5,120	0.0108	0.025	0.35	55.3	44.8	484,557	277,984
Site 16	6,144	6,144	0.0108	0.045	0.38	66.4	105.1	581,468	690,260
Site 17	3,840	3,840	0.0074	0.02	0.32	28.4	24.6	248,218	152,494
						490.0	582.2	4,289,679	3,675,323

This engineering analysis was replicated for all signs verified, and subsequently extrapolated to the population of 34 signs retrofitted through the Program, including a recalculation of the demand and energy savings calculations using the methodology discussed above. It should be noted that the 13 signs evaluated and presented in Table 3-7 included 56,064 of the 87,171 lamps installed through the Program, or more than 64% of total retrofit lamps. Volume 2, Appendices, provides details on the evaluation sample and population ex-post (adjusted) gross demand and energy savings.[263]

[263] The billing analysis results compared favorably with engineering estimates at a select few sites. However, a majority did not correlate with on-site findings. The field verified engineering analysis was ultimately adopted because of the inability to distinguish between dedicated and non-dedicated meters for specific signs.

Final Program Impacts

Table 3–8 provides the ex-ante gross savings reported in the final flat file submitted by the implementation contractor, the verified gross savings values that are adjusted for the installation rates confirmed through field verification activities, and the ex-post adjusted gross savings numbers that reflect both the recommended installation rates and changes in Program realization rates recommended from the engineering analysis.

In general, the evaluation team concluded that demand savings were likely understated by the implementation contractor due to difficulties in translating Program accomplishments into a format that complied with Program reporting requirements. Specific reporting formats for the program workbooks made it difficult to accurately quantify savings on a per-site basis. Moreover, calculations from the flat file were not easily replicable in the workbook formats, limiting the transparency of savings estimates. Program reported demand savings also reflect discrepancies within implementation contractor documents that state alternative base lamp wattage values. Conversely, the calculated average flash factor of 36.1% was slightly lower than the average value of 39.3% used by the implementation contractor, resulting in lower ex-post energy savings values.

Table 3–8. Reported Ex-ante Gross Savings and Verified and Adjusted Ex-post Gross Savings

Project	Ex-ante		Ex-post		
	Ex-ante Reported Gross Peak kW	Ex-ante Reported Gross Annual kWh	Ex-post Adjusted Gross Winter Peak kW	Ex-post Adjusted Gross Summer Peak kW	Ex-post Adjusted Gross Adjusted Annual kWh
Program Total	773.8	6,294,992	874.1	874.1	5,597,141

The Program impacts were estimated collectively for all lamps installed through the Program. Table 3–9 presents the first year ex-ante gross and net energy savings goals and reported Program accomplishments.

Table 3–10 shows the first year ex-ante gross and net demand savings goals and reported Program accomplishments. The Program net ex-ante net savings goals were estimated and reported accomplishments were estimated using a 0.80 NTG ratio. The Program reported achieving approximately 104% of ex-ante kWh goals, and 58% of ex-ante kW goals.

Table 3–9. Comparison of Ex-ante Energy Savings Goals and Reported Accomplishments

	Ex-ante Program Gross Annual kWh Goals	Ex-ante Program Net Annual kWh Goals	Reported Ex-ante Gross Annual kWh Savings	Reported Ex-ante Net Annual Program kWh Accomplishments
Cold Cathode	6,030,088	4,824,070	6,294,993	5,035,994

Table 3–10. Comparison of Ex-ante Demand Savings Goals and Reported Accomplishments

	Ex-ante Program Gross Annual kW Goals	Ex-ante Program Net Annual kW Goals	Reported Ex-ante Gross Annual kW Savings	Reported Ex-ante Net Annual Program kW Accomplishments
Cold Cathode	1340	1072	774	619

The Program impacts are determined by two factors: (1) Program performance in terms of accomplishing Program participation goals, and (2) estimated ex-post savings impacts for the installed measures compared to the ex-ante measure savings assumptions. The Program gross and net realization rates have been calculated as the combined effect of these two factors. The Program goals, overall and for its constituent measures, ex-post gross and net energy savings, and respective realization rates are shown in Table 3–11. The Program evaluated ex-post gross energy savings are 5,553,865 kWh compared to the Program gross savings goal of 6,030,088 kWh. The Program evaluated ex-post net energy savings are 4,998,479 kWh compared to the Program goal of 4,824,070, yielding a 103% net energy savings realization rate.

Table 3–11. Comparison of Programs Goals and Ex-post Gross and Net Energy Savings

	Ex-ante Program Gross Annual kWh Goals	Ex-ante Annual Net Energy Savings Goals	Evaluated Gross Ex-post Program kWh Savings	Gross Energy Realization Rate	Evaluated Net Ex-post Program kWh Savings	Net Energy Realization Rate
Cold Cathode	6,030,088	4,824,070	5,553,865	92%	4,998,479	104%

The Program goals, ex-post gross and net demand savings, and respective realization rates are shown in Table 3–12. The Program evaluated ex-post gross demand savings are 874.1 kW as compared to the Program goal for demand savings of 1,340 kW, yielding a 65% gross demand savings realization rate. The Program evaluated ex-post net demand savings are 787 kW compared to the Program net demand savings goal of 1,072 kW, yielding a 73% net realization rate.

Table 3–12. Comparison of Programs Goals and Ex-post Gross and Net Demand Savings

	Ex-ante Program Gross Annual kW Goals	Ex-ante Annual Net Demand Savings Goals	Evaluated Gross Ex-post Program kW Savings	Ex-post Gross Demand Realization Rate	Evaluated Net Ex-post Program kW Savings	Net Demand Realization Rate
Cold Cathode	1340	1072	874	65%	787	73%

Realization rates compared to ex-ante evaluated results are shown in Table 3–13 and Table 3–14 below. The Program evaluated ex-post gross energy savings are 5,553,865 kWh compared to the Program reported ex-ante gross savings goal of 6,294,993 kWh, yielding a realization rate of 88%. The Program evaluated ex-post net energy savings are 4,998,479 kWh compared to the reported ex-ante net of 5,035,994 kWh, yielding a 99% net energy savings realization rate. The Program evaluated ex-post gross demand savings are 874 kW compared to the reported ex-ante gross demand savings of 774 kW, yielding a 113% reported gross demand savings realization rate. The Program evaluated ex-post net demand savings are 787 kW compared to the reported ex-ante net demand savings of 619 kW, yielding a 127% net realization rate.

Table 3–13. Comparison of Reported Program Accomplishments and Ex-post Gross and Net Energy Savings

	Ex-ante Program Gross kWh Reported	Ex-ante Net Energy Savings Reported	Evaluated Ex-post Gross Program kWh Savings	Gross Energy Realization Rate	Evaluated Ex-post Net Program kWh Savings	Net Energy Realization Rate
Cold Cathode	6,294,993	5,035,994	5,553,865	88%	4,998,479	99%

Table 3–14. Comparison of Reported Program Accomplishments and Ex-post Gross and Net Demand Savings

	Ex-ante Program Gross kW Reported	Ex-ante Net kW Savings Reported	Evaluated Ex-post Gross Program kW Savings	Gross Energy Realization Rate	Evaluated Ex-post Net Program kW Savings	Net Demand Realization Rate
Cold Cathode	774	619	874	113%	787	102%

Final Program savings, NTG ratios and realization rates are shown in Table 3–15 and Table 3–16. The self reported Net to Gross ratio of .90, established in the process evaluation, was used for evaluation purposes; the implementer's final workbook assumption was .8.

Realization rates were calculated as the ratio of the evaluated net ex-post savings to the reported ex-ante gross savings. For the overall Program, the realization rate was 79% for energy and 102% for demand.

Table 3–15. Program Energy Savings

	Ex-ante Reported Gross kWh Savings	Ex-post Gross Program kWh Savings	NTG Ratio	Evaluated Ex-post Net kWh Savings	Realization Rate
Cold Cathode	6,294,993	5,553,865	0.90	4,998,479	79%

Table 3–16. Program Demand Savings

	Ex-ante Reported Gross kW Savings	Ex-post Gross Program kW Savings	NTG Ratio	Evaluated Ex-post Net kW Savings	Realization Rate
Cold Cathode	774	874	0.90	787	102%

Lifecycle Savings

Cold cathode lamps typically have a rated life of 25,000 hours. Based on 6,367 expected average annual run hours on signs retrofitted through the Program, it is expected that the useful life of the lamps installed is approximately four years. Table 3–17 presents the Program ex-post lifecycle net energy and demand savings for cold cathode lamps installed through this Program, and does not account for the impact of replace-on-failure activity that occurs after the lamps installed by the Program reach the end of their useful lives. Table 3–18 shows the lifecycle savings in CPUC reporting format.

Table 3–17. Program Ex-post Lifecycle Net Energy and Demand Savings for Cold Cathode Lamps

Ex-post EUL	Ex-post Lifecycle Net Energy Savings
4	19,993,915

Table 3–18. Lifecycle Savings

	Year	Calendar Year	Ex-ante Gross Program-Projected Program MWh Savings	Ex-post Net Evaluation Confirmed Program MWh Savings	Ex-ante Gross Program-Projected Peak Program MW Savings	Ex-post Evaluation Projected Peak MW Savings	Ex-ante Gross Program-Projected Program Therm Savings	Ex-post Net Evaluation Confirmed Program Therm Savings
	1	2004						
	2	2005	6,295	4,998	0.774	0.787		
	3	2006	6,295	4,998	0.774	0.787		
	4	2007	6,295	4,998	0.774	0.787		
	5	2008	6,295	4,998	0.774	0.787		
	6	2009	6,295		0.774			
	7	2010	6,295		0.774			
	8	2011	6,295		0.774			
	9	2012	6,295		0.774			
	10	2013						
	11	2014						
	12	2015						
	13	2016						
	14	2017						
	15	2018						
	16	2019						
	17	2020						
	18	2021						
	19	2022						
	20	2023						
	TOTAL	2004-2023	50,360	19,994				

Definition of peak MW as used in this evaluation: Average demand reduction during the summer months.

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4. Conclusions and Recommendations

The following conclusions and recommendations are based on findings from the process and impact evaluations.

Conclusion 1. *Customers' perceptions of lumens output and color temperature varied widely, as did their acceptance of the technology.*

There is a wide range of opinion on the acceptability of the lumens output, temperature dependence of lumen output, and color temperature of the new technology. While a majority of the participants who stayed with the program are happy with the results, several large commercial chains dropped out as a result of the color or lumens produced by the lamps. Conversely, other large retailers felt the new lamps produced a better shopping environment for their clients, and satisfied sign owners felt the new lamps had "freshened up" their old signs. Color temperature and the perception of ideal light output will always be somewhat subjective; however, this was a consistent thread in the feedback from unsatisfied participants and dropouts.

Discussions with one manufacturer indicated that they are aware of the color temperature problem and have addressed this issue. The industry overall—and not just this program—has pushed manufacturers to develop other "warm" temperature lights. Since the Program inception, Litetronics, for example, has developed and marketed two additional lamps with warm color temperatures. In addition, the manufacturer reported they are working on higher-wattage lamps to address the interest in brighter lights. A review of lighting manufacturer websites show a growing range of cold cathode products for indoor and outdoor applications.

Recommendation 1. *Provide demonstration sites or displays.*

Demonstration sites or displays that allow potential participants to view the different color temperatures of the cold cathode lamps, both day and night, would be helpful to customers during the decision-making process. Addressing the concerns and experiences of dropouts will be important to repair the perception that these lights produce color unsatisfactory to their application.

Conclusion 2. *Various issues caused customer disruptions and dissatisfaction with the technology.*

Beyond the issues with color temperature and lumens, other problems caused multiple disruptions to businesses, and additional labor and expense to correct. Several sign owners, because of their experiences with the program, stated that they would not use the technology again. Technical limitations reported by respondents that need further investigation include:

- Low watt limitations of older signs that require rewiring before retrofit
- "Fade out" concerns when viewing the sign at different angles
- Lamp "flickering"
- "Temperature sensitivity" that led to removal of lamps during winter months
- Lamp "seating" that required removal and reinstallation of lamps

Recommendation 2. *Provide additional customer education and training.*

Educate contractors about the technical limitations of the technology, providing them with information and training to discuss the issues with clients, and be willing to work with clients if problems arise. Customers should be fully informed about issues that may occur, such as the voltage threshold limitations, and "down" time that may be required during installation.

Conclusion 3. *Quality assurance, accurate information and follow-up needs improvement.*

Several participants and dropouts expressed concern and frustration over dealings with the lamp contractors, feeling that they had oversold the technology and misrepresented their relationship to Southern California Edison. Others noted that they were willing to participate, but there was no follow-through by contractors. A good quality-assurance process can facilitate immediate feedback and corrective action with customers who feel contractors have been less than forthright with them about the program, technology, or incentives.

Recommendation 3. *Add a quality-assurance process.*

Institute a regulated quality-assurance process monitored by Southern California Edison to ensure customers get immediate attention when problems arise, and to monitor contractor performance.

Conclusion 4. *Manufacturers are developing additional product to meet customers' needs.*

This program and other utility-sponsored cold cathode rebate programs clearly fed into the development of the technology and moved the product toward wider public acceptance. Manufacturers are addressing industry's need for higher wattage, a wider color selection, and more quickly available product. Edison has moved to mainstream rebates for the lamps by including rebates for two- to eight-watt cold cathode lamps in their energy-efficiency lighting program.

Recommendation 4. *Monitor product developments and offer rebates for new products.*

Monitor changes in the product, and as new products become available, include rebates for additional cold cathode products. Educate consumers about the advantages of cold cathode lamps. Market the cold cathode products in a manner that differentiates them from more commonly available CFL and LED products. For example, cold cathode lighting products can be installed in applications not only where CFLs are typically installed, but they can also be used in applications where CFLs cannot. In addition, cold cathode products can be installed where more expensive LEDs are often installed. Cold cathode lamps are an energy-efficient alternative to CFLs and LEDs.

Conclusion 5. *Recordkeeping for signage location was unavailable.*

Treated signs were identified on-site for the impact analysis, usually with the help of customer identification. However, at least one sign at one very large site could not be located because nobody on-site was familiar with the location, and the program records recorded only the site address, and not the location of the treated sign.

Recommendation 5. *Provide more detailed installation information on the location of the retrofit installations.*

Location-specific information for treated systems should be included in program tracking, even if it is only included in a “comment” field. If the treated system has a customer-initiated unique identifier (e.g., “Sign # 24”), that identifier should be included in the tracking database.

Conclusion 6. *Meter data that could enable accurate billing analysis was not available.*

Recommendation 6. *Provide accurate meter information that can be tracked to a customer service account number.*

While the majority of signs had meter cabinets nearby, all were locked, and so the evaluator could not confirm that billing analysis was being conducted on the correct service account. The implementation contractor should be responsible for providing accurate meter information that can be tracked to a customer service account number.

Conclusion 7. *There is potential for takeback.*

The potential for takeback, or reduced energy savings due to changes in participant operating behavior, is a risk. Because the participating signs were used primarily for advertising, the reduced energy costs may encourage operators to run the signs for longer periods of time. While no participant indicated that this was the case, one out of seven total participants interviewed indicated that they were considering extending their sign operating hours, in part due to reduced energy costs. This may become a more prevalent practice when operators conclude that their retrofit sign energy consumption has been reduced by 50% to 70% of base-case consumption.

Recommendation 7. *Assess the extent of tackback with random billing analyses and surveys.*

An ongoing, random billing analysis may indicate whether takeback is occurring, and whether deemed savings for cold cathode lamps in outdoor advising applications should be adjusted.

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11. Mobile Home Evaporative Cooler Program

1. Program Description

In response to Edison's requests for innovative energy efficiency proposals, in October 2004 Cal-UCONS and American Synergy Companies (ASC) proposed delivering a Program to the hard-to-reach mobile home sector focused on improving the efficiency of existing evaporative (swamp) coolers. The Mobile Home Evaporative Cooler Program sought to improve the efficiency of existing mobile homes with both evaporative cooling and compressor air conditioning through providing evaporative cooler (EC) tune-ups. The tune-ups were expected to result in better functioning evaporative coolers. Since ECs are far less expensive to run than compressor air conditioners, the Program designers hypothesized that well functioning ECs would displace air conditioner use, resulting in energy savings and peak demand reductions. The Program also offered compact fluorescent lamps (interior and exterior) and programmable thermostats to mobile home residents.

According to contacts at both implementation organizations, UCONS and American Synergy Companies relied on their extensive experience in the mobile home sector to develop the Program plan and outreach strategies.

The Program sought to evaluate the potential for evaporative cooler tune-up as an innovative strategy for encouraging mobile home residents to rely more on their evaporative coolers, as opposed to window or central air conditioning units. Target areas were identified through climate zone analysis focused on the climate zones with the combination of heat and low humidity likely to make evaporative coolers an attractive option. Another innovative component, the EC fan depowerment,[264] was also included. This measure represented an approach that was new to Edison. Since the results of the fan depowerment strategy were unknown, Edison limited installation to 100 units, until results could be verified.

The Program proposal also described involving park managers and mobile home owners in the development of new programs, and evaluating whether new marketing and partnership arrangements with mobile home park management firms result in a more comprehensive set of measures and financial participation from a hard-to-reach sector.[265]

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[264] Evaporative cooler fan depowerment involves adjusting the pulley and belt on the EC fan motor to reduce the power of the fan. UCONS proposed testing the measure in this program noting in their proposal that a fan can be de-powered substantially with only a small decrease in fan flow.

[265] UCONS, LLC. A Proposal for Evaporative Cooling Repair, Upgrades and Innovations for Qualifying EDISON mobile home customers. Prepared for Southern California Edison Company, October 2004. pg.4.

In the original Program proposal document, Cal-UCONS and ASC proposed contacting approximately 30,000 mobile home residents via direct mail and canvassing activities directed at targeted mobile home parks, garnering 4,000 appointments for measure installation, resulting in 3,500 projects completed and invoiced. The Program scope was revised downward in December 2004 to 20,000 contacts, 3,000 appointments for installation, and 2,500 projects completed and invoiced.

According to the final report, 12,874 individuals were contacted about the Program, 4,247 individuals were contacted via neighborhood meetings. The final report also states that 3,402 individuals were served by the Program, and that 2,178 evaporative coolers were tuned-up or repaired. Table 1–1 shows the Program's goals for the number of installations for each proposed measure, and the number of measures installed during the Program.

Table 1–1: Measure Unit Goals

Measure	Unit Goal[266]	Achieved[267]
Evaporator Cooling Tune-up	2,500	2,178
Evaporative Cooler Fan De-Powerment	100	738
Programmable Thermostat	250	0
Energy Star CFLs – exterior	2,500	1,065
Energy Star CFLs – interior	5,000	6,148
Common Area Energy Star CFLs - exterior	2,000	1,043
Common Area Energy Star CFLs – interior	1,000	542

As is apparent in the table above, the Program experienced a somewhat major change in course following the measurement and evaluation activities completed mid-Program. The Program implementers sought to establish accurate savings estimates for the evaporative cooler tune-up measure, but could not document energy savings resulting from the tune-ups alone. The Program changed in response to a mid-Program evaluation that showed disappointing energy and demand savings resulting from the EC tune up measure but promising results from the test of fan depowerment. In light of this information, the last third of the Program implementation period reflected a shift away from EC tune-ups entirely, focusing instead on fan depowerment.

The measure mix installed ended up being somewhat different from the mix proposed in the initial proposal. One Program contact expressed surprise that the final measure mix did not necessarily match the broad range of measures originally proposed, as they had clearly believed that the original design made sense. According to the Final Report, the Program met or exceeded its unit goals only in EC fan depowerment and interior CFL installations.

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[266] As listed in Southern California Edison Company. Change Order dated 6/25/05 documenting the expectations for materials and installation costs.

[267] UCONS 2004-2005 Evaporative Cooler Program Final Program Report, June 2006

The Evaporative Cooler Program received only a process evaluation as part of the evaluation of 2004-2005 IDEEA programs. An impact evaluation had already been completed by Alternative Energy Systems Consulting (AESC) in association with Stellar Processes and was in the process of being finalized at the time of this process evaluation. This assessment also attempted to answer several basic process evaluation questions. AESC completed a draft Energy Savings Assessment in November 2005 that reviewed preliminary energy savings from evaporative cooler tune-ups, fan de-powering, and installation of compact fluorescent lamps. The impact evaluation included engineering estimates and billing analysis.

This draft impact assessment was reviewed in February, 2006 by a team at Quantec who urged that several deficiencies be corrected. AESC agreed to reanalyze several components and to further interview a sample of participants—including those already contacted as part of the billing analysis.

These evaluation approaches generally conformed to the basic rigor level for process and impact evaluation defined by the 2006 California Evaluation Protocols. To verify measure performance, this study employed utility bill data analysis (Option C) for the evaporative cooler tune-ups and compact fluorescent lamps installations, and onsite data analysis (Option A) for the fan depowerment.

This report is organized into five sections. The next section (Section 2) presents the process evaluation, including the Program logic model, results of interviews with Program staff and participants, and free rider estimates. Section 3 describes the final Program impacts. The impact evaluation is a stand alone document, conducted under separate contract prior to the IDEEA process evaluation. That evaluation is included as Volume 2, Appendices. Section 4 presents the major conclusions and recommendations.

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2. Process Evaluation

Process Evaluation Methodology

The Evaporative Cooler Program received only a process evaluation as part of the evaluation of IDEEA Programs. An impact evaluation had already been completed and was in the process of being finalized at the time of this process investigation. In finalizing the impact evaluation, the impact evaluators planned to interview a sample of Program participants (from non-master-metered parks).[268] Several process questions for participants were added to the survey relating to the frequency with which they used their air conditioning versus their evaporative coolers in 2005 and 2006.

The purpose of this process evaluation effort was to document project design, administration, and progress towards goals; to assess customer satisfaction; and to document barriers to participation and describe current practices among participating parks.

Program Logic Model

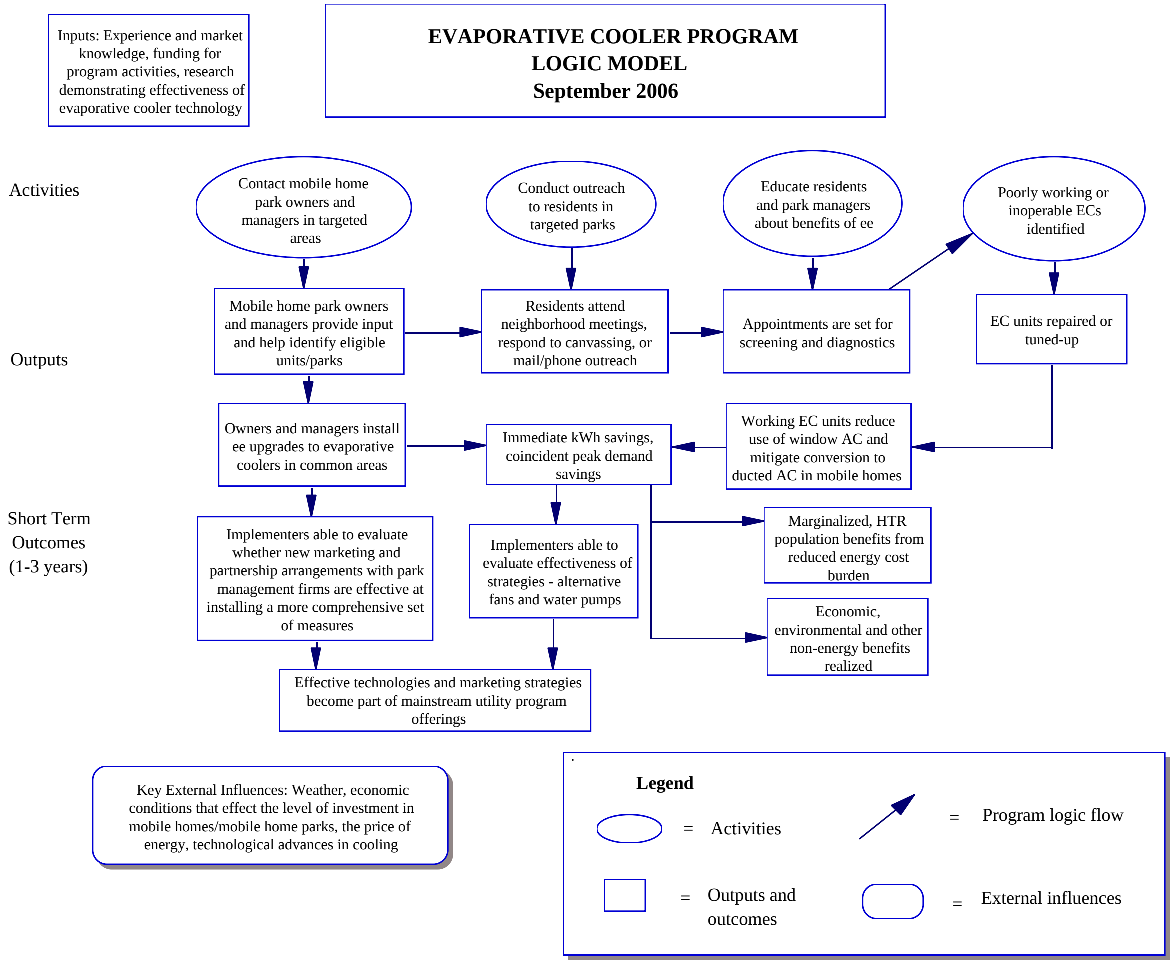
The Program logic model diagram is shown in Figure 2-1. Key Program assumptions as described in proposal included:

- There is a large population of mobile home residents with poorly working or inoperable evaporative cooling. Implementers reported identifying 19,000 mobile homes with inoperable or inefficient evaporative coolers in the previous seven years of implementing programs in Edison service territory.
- Current mobile home owners are not (typically) availing themselves of evaporative cooling incentives offered for the single family sector.
- Use of window AC units can be reduced by providing EC tune-up services to those with inoperable or poorly functioning evaporative cooling systems.

Following on these Program assumptions, the Program logic model diagram in Figure 2–1 shows the key features of the Program as understood by the evaluation team and indicates the logical linkages between activities, outputs, and outcomes.

[268] Impact evaluators completed 67 surveys with participants.

Figure 2–1. Logic Model



The Program has four primary activities: three associated with outreach and one focused on identifying units appropriate for evaporative coolers (EC) tune up or repairs. Program representatives would contact mobile home park owners and managers in targeted areas, conduct outreach to residents in targeted parks, and inform residents and park managers about the benefits of energy efficiency. Using these strategies, the Program would identify poorly working or inoperable evaporative coolers.

These activities are expected to result in mobile home owners/managers providing input and identifying eligible units or parks, residents responding to outreach activities, and appointments being set for screening and diagnostics. These outputs should result in EC units being repaired, tuned up, or otherwise restored to efficient working order—causing residents to choose their EC over their window air conditioner (AC), and/or delay their conversion to ducted AC. Additionally, it is expected that owners and managers install energy efficiency upgrades to EC units and lighting in common areas.

Short and intermediate term outcomes include immediate kWh savings and coincident peak demand savings, economic benefits to a marginalized, hard-to-reach population in the form of reduced energy cost burden, and economic, environmental and other non-energy benefits realized. These outcomes are expected to allow implementers to evaluate the effectiveness of new strategies, including fan depowerment and marketing partnership arrangements with park management firms, giving Edison staff experience with these new approaches.

Process Evaluation Sample Design

The Program proposal documents and the Program workbook listed the key staff at UCONS and ASC involved in some aspect of Program implementation. Research questions were developed as part of the work plan and then used to develop interview guides. Questions addressed their role in the Program; experiences with administration, marketing, and outreach; delivery and implementation issues; perceptions about market or customer response, and overall lessons learned in designing and implementing this IDEEA project. Interviews took place in September and October of 2006.

The Program reached approximately 142 mobile home parks in Edison service territory with 2,033 unique individual participants. Of these, more than half (1,138) lived in one of approximately 58 master metered parks, the remaining 84 were not master metered. Under separate contract with Edison, AESC was conducting a satisfaction process evaluation survey with 67 people. AESC was provided some additional process questions to be included in that survey. The questions for Program participants focused on issues that had emerged in the interim impact evaluation: how frequently participants obtained maintenance services for their ECs and estimates of frequency of using ECs and ACs in 2005 and 2006.

The sampling plan did not include interviews with participating and nonparticipating customers. Participating customers were being surveyed by the implementation contractor's evaluation team (AESC) as noted above. In addition, customers contacted the Program directly after hearing about it through community meetings and/or flyers, making it difficult to identify those who simply did not respond. Therefore, there were no plans to interview nonparticipating customers.

The evaluation plan anticipated contacting a sample of mobile home park contacts (owners, managers or association presidents as appropriate) to ask them about the process of participating in the Program, their experience with Program representatives, and with the Program-installed measures. Interview guides for mobile home park owners and managers were developed and the process team sought to interview the primary contact at participating mobile homes, assuming that from the park managers of the 140+ parks an adequate sample could be obtained that included people who recalled the Program and had some opinion about targeting evaporative coolers, about the Program, and about energy efficiency. However, after interviewing the staff involved in Program management, outreach and implementation, it was discovered that no list existed with names and contact information for the participating and nonparticipating park managers. Therefore, interviews with park managers were not conducted.

Six Program contacts were interviewed: one primarily focused on Program design; two involved in Program administration at ASC, including the Program manager; and three involved in outreach and implementation at ASC (two of these three were not formal interviews, rather short conversations focused on the few aspects these contacts were most familiar with).

Table 2–1 shows the sample plan and number of interviews completed. As noted above, implementers did not keep contact lists of participating and nonparticipating mobile home park managers and no interviews could be conducted.

Table 2–1. Survey Sample Goals and Achievements

Task	Goal	Achieved
Program/implementer staff	6	6
Participating mobile home park owners/managers	25	0
Nonparticipating mobile home park owners/managers	10	0
Total	41	6

Process Evaluation Results

In this section, the Program is described as experienced by individuals who designed and implemented the Program, by the sample of businesses that participated in the Program, the sample that dropped out, and the sample that chose not to participate.

Program Design

According to contacts at Cal-UCONS and ASC, the design for the Mobile Home Evaporative Cooler Program emerged several years before the Program was selected in 2005. The Program was proposed in response to the first IDEEA RFP in 2003, but was not selected. Cal-UCONS proposed the same design in 2004 and was pleased when the Program was selected. Program contacts involved with the design effort report basing the design on previous experiences with advanced mobile home programs in Eugene, Oregon and the data that inform the Regional Technical Forum (an advisory committee established by the Northwest Power and Conservation Council in 1999 to develop standards to verify and evaluate conservation savings).

Both Cal-UCONS and ASC contacts reported their firms had been delivering energy efficiency programs to mobile home parks for many years. Through this experience, the implementers became aware of the prevalence of swamp coolers on rooftops that were working poorly, or were inoperable. The observations about poorly working or inoperable evaporative coolers, combined with technical papers indicating that swamp coolers were more effective at reducing peak load in dry climate zones, indicated that increasing reliance on evaporative cooling represented a good strategy for displacing AC load during periods of peak demand—particularly in the hot, dry climates of California's inland desert.

ASC had more direct experience in Edison territory, so they were assigned most of the implementation tasks, including outreach and marketing, screening and measure delivery, quality assurance, and customer service. Contacts from the two organizations, Cal-UCONS and ASC, estimated different portions of the mobile homes that were expected to have evaporative coolers. One contact estimated that they had been to 20-30% of the parks in PG&E and Edison territory and that 20% of the homes had evaporative coolers. Another estimated that 75% of the homes in the targeted parks had both AC and EC units.

Market Assumptions, Marketing, and Decision-Making

According to the original Program proposal, customer recruitment and eligibility would be determined through three steps: (1) meeting with mobile home park managers in order to conduct a needs assessment [regarding the number of homes that had been treated, with which measures, the number of homes in the park treated, and number of homes that qualify for repair or service]; (2) if determined by the outreach associates that the residents would benefit, activities designed to inform neighbors would commence [flyers, notification and neighborhood meetings]; and (3) interested residents would be scheduled [through direct contact or calling the hotline].

Program outreach contacts described relying upon their existing relationships with mobile home parks managers and residents to market the Program opportunity. Contacts universally mentioned the strong relationships ASC had with mobile home parks in the geographic areas targeted by the Program. ASC sought to leverage those relationships. ASC had outreach staff who worked directly with the mobile home parks to communicate the various programs ASC was implementing at any given time.

One staff member, who was not directly involved in implementation of the Evaporative Cooler Program, reported identifying parks likely to be receptive to the ASC Program: *"They contacted the parks I sent them to—prior good relationships make them more* *likely to answer the telephone and be responsive."* Other ASC contacts confirmed the strategy of contacting park leadership at parks where they had the strongest relationships: *"usually you'll have an owner, manager, or association president—sometimes the association president is the better contact."* The most common strategies for recruiting participants included neighborhood meetings (to inform residents about the Program and sign them up to participate), information fairs, and word of mouth contact (including chats with neighbors and inclusion in a monthly resident bulletin or newsletter).

The lead technician was very involved in outreach and identifying parks. He worked full-time on the Program when it was in the field, and reported spending a portion of his days leading meetings and classes that would result in residents signing up to participate.

> *"I'd talk to the manager about the class, if they agreed; they'd promote it by putting it in their bulletin or otherwise notifying people. I'd also knock on doors, with my truck on the street."*

In canvassing a park, the technician would have had to check in with the park manager, who typically wanted to know why he was there and believe the ASC representative was not a salesman before allowing him into the park. Contacts reported:

> *"I'd have to get manager approval, but they knew me, trusted the company, and knew it was free."*

> *"We didn't have to do a ton of marketing—word of mouth was very strong. Neighbors would stop and see the work happening. They already knew us in many cases; there was a relationship of trust. Some of the parks we had worked in previously."*

Program contacts were accustomed to working with parks and noted the importance of building trust with park contacts. Outreach efforts had to be perceived as non-threatening since many parks work to keep solicitors and troublemakers out of parks. Attending the community meeting was frequently required to assuage concerns and introduce the Program. *"This is Synergy's strength; they know these guys."*

One contact noted that direct mail did not generally work well, and that getting park manager permission, or even having them accompany Program representatives in canvassing was the best strategy for outreach. ASC contacts described neighborhood meetings and word-of-mouth as most effective strategies, but also noted that mailings within a park or coordination with a park manger for inclusion in a monthly resident newsletter were also options.

When asked about parks most likely to be receptive to the Program, contacts described focusing on inland area most likely to be located in targeted climate zones where hotter, dryer weather make evaporative cooling an attractive option. Additionally, contacts believed that average park income can affect interest in the Program; evaporative cooling tends to be more common in older parks with lower-income residents. Occasionally, Program staff report encountering parks in which roof evaporative cooling units were not allowed.

Program Delivery and Implementation

Program contacts described experiencing an acceptable volume of calls on the Program's hot line. Call volumes varied depending on the level of outreach. After each neighborhood meeting, the call volume would increase. Program contacts estimated that approximately 80% of participants made contact with the Program via the hot line. Those who called were screened and eligible customers were then scheduled to receive evaporative cooler tune ups or fan depowerment.

After a customer contacted the Program, an appointment with a technician was scheduled to assess their evaporative cooler and provide the Program-sponsored measures.

Program contacts reported that the most common way that residents would become aware of the Program opportunity was through meetings with the manager, or association meetings.

According to the lead technician, ASC would also send out letters to the mobile home parks, broadly announcing the Program and encouraging eligible customers to contact the Program, however, the targeted population tended to be older, retired residents, who were unlikely to respond to a flyer. For this reason the meetings were the most effective strategy, followed by door-to-door contact.

> *"We'd encourage those that had received the service to talk to their neighbors, and ask for referrals—if possible, we would have them call their friends and neighbors then and there, especially if we didn't have any appointments—we'd say 'call them right now and we'll drive over there.'"*

Technicians were trained on all aspects of evaporative cooler tune-up, and were instructed to look for signs of ill repair. The EC tune-up measure involved diagnostic, test, tune-up, and repairs of evaporative cooler units. The diagnostic and test activities involved checking the overall evaporative cooler (including the housing, sealing, and water regulation flotation device), as well as checking the water pump, the fan assembly and fan motor, the fan belt, the EC controls, the EC pad, the EC vent and checking for any obstructions. Cooler repair and tune-up activities involved cleaning out and servicing the unit, repairing and/or replacing inoperable parts, replacing pads, cleaning out or replacing water pump filter, adjusting or replacing the fan belt, lubricating any moving parts and sealing any leaks.

As part of their training, the lead technician would also make sure that the other technicians understood the importance of looking professional, how to phrase their reason for being there, and how to create trust. *"They'd slam the door if they thought we were trying to sell them something,"* he said.

Market Barriers

The presence of evaporative coolers in mobile home parks varies by the park and by the area. Hotter, inland areas were more likely to have EC units, as were older parks. One Program contact estimated that he had expected to find 70-80% of homes in the targeted parks would have both an AC unit and an EC unit. Another Program contact estimated that only 20% of the cooling needs in a typical park were met by evaporative cooling. *"We estimate only 20%, but some parks don't have any, and, a lot of them don't work."*

All Program contacts noted that EC units require maintenance, that is, filters need to be cleaned frequently, filter pads must be changed, and if not properly maintained they are prone to emit bad smells. At the end of the cooling season, EC units should be winterized and they must be prepared for summer each spring. However, given the high cost of electricity in California, a more efficient EC unit can compete with AC units requiring more power to run.

The Program involved installation of measures and provision of services at no charge to customers, however several barriers to participation remained. One Program contact noted that residents remained suspicious of free programs, wondering why something would be given away. According to him, working through a park manager is one way to overcome this suspicion. Another contact reported that few barriers to installation remained after residents learned of the opportunity: they all expected professional service and responsive installers. Still another noted that there were few concerns once residents understood that the services were free, and that working with the managers and relying on word of mouth were the best strategies for communicating the validity of the Program.

Contacts reported learning little new information about the decision making process among mobile home owners. As expected, park residents wanted to save energy and money. Park managers were protective of the residents, but if they become convinced of a Program's value they will help identify interested residents. Contacts could identify no major differences in the way that the Program was received at master metered parks versus individually metered parks.

Participants' Experience with the Program and the Technology

In the initial Program proposal, Cal-UCONS and ASC noted that *"homeowners readily understand that using evaporative cooling will have immediate savings on the energy bill."*[269] Residents are aware of the electricity bill consequences associated with using air

[269] Cal-UCONS, Inc. A Proposal for Evaporative Cooling Repair, Upgrades and Innovations for Qualifying EDISON Mobile Home Customers. October 25, 2004. pg 5.

conditioning instead of evaporative coolers, but in extreme heat evaporative coolers can not compete with air conditioning in their ability to cool a dwelling.[270]

As described above, ASC asked 67 surveyed participants about the portions of their cooling needs met by evaporative cooling versus air conditioning in 2005 and 2006. Responses show that participants relied on their compressor air conditioning units for a greater portion of their cooling load in 2006 than they did in 2005, regardless of the tune up they received for their EC unit. (Tables 3–2 and 3–3). These responses likely indicate the effect of weather and comfort desires on the choice to use compressor air conditioning.

Table 2–2: Customer reported use of EC

Portion of time cooling home with EC	In 2005		In 2006	
	Count	Percent	Count	Percent
81-100%	24	44%	16	30%
61-80%	5	9%	6	11%
41-60%	10	19%	9	17%
21-40% of cooling	5	9%	7	13%
0-20% of cooling	8	15%	15	28%
Don’t know/No answer	2	4%	1	2%

Source: Survey of participants (n=54)

Table 2–3: Customer reported use of AC

Portion of time cooling home with AC	In 2005		In 2006	
	Count	Percent	Count	Percent
81-100%	10	19%	21	39%
61-80%	4	7%	5	9%
41-60%	11	20%	9	17%
21-40% of cooling	7	13%	8	15%
0-20% of cooling	19	35%	10	19%
Don’t know/No answer	3	6%	1	2%

Source: Survey of participants (n=54)

Participants were asked in which of the last four years (2002-2005) they had their EC serviced. A plurality (20 of 54, or 37%) reported having their EC serviced each year. Thirty-two percent (17 of 54) reported having their EC serviced only in 2005, the year of the Program. The remainder reported their unit had not been serviced (9, or 16%), had been serviced only in 2004 (5, or 9%), or reported multiple years (3, or 5%). Since many participants had arranged for EC service in the three years prior to 2005 (28, or 52%), these results disconfirm the assumption that residents were not maintaining their EC

[270] AESC’s Draft Impact Evaluation notes that consumers appeared to understand the benefits of evaporative coolers and seek to keep their evaporative coolers functioning. Consumer surveys indicated that most participants were using their evaporative coolers and expected to continue to use them.

units, and indeed were using their EC for some portion of their cooling needs prior to Program treatment.

Free Riders

For all measures, the impact evaluators, AESC, used a net-to-gross ratio of 0.89.[271] The initial NTG proposed by Program implementers was also 0.89.

Lessons Learned by Program Staff, Future Plans

Contacts reported learning that the energy savings resulting from the EC tune-up measure were very hard to discern, however, the fan depowerment measure showed promise in field tests and should be considered in the future. The fan depowerment, referred to by several contacts as the most innovative component of the Program, involved adjusting the pulley size to create more efficient fan operations. Exploring the results of this measure was part of the project design. A field test was created and 100 sites tested prior to installation at more sites. The results were promising and indicated that fan belt tension adjustments could have an unexpectedly large effect on the fan power, and that the reduction of fan power resulted in measurable energy savings. Following these results, the Program stopped promoting evaporative cooler tune-ups and began promoting fan depowerment. Several Program contacts felt the fan depowerment measure could be successfully transferred to other locations or programs.

One contact noted becoming even more aware of the need to consider the evaluation requirements in the Program design. Avoiding master metered parks would have helped the impact evaluation activities, and the Program could have set up the data files to support the evaluation from the beginning. Conversely, data collection could have been planned from the outset to include the special considerations of collecting data from participants at master metered parks.

Program contacts appreciated the support of Edison staff, and noted in the final report the value of adding a “silver sticker” to indicate the units treated by the Program for Edison verification inspectors. This suggestion came from Edison program staff, and was considered a positive improvement. The suggestion emerged because it was not always easy for Edison inspectors to be sure that the EC unit they were inspecting had actually been treated by the Program. (Approximately 10% of jobs were randomly inspected.)

Program contacts unanimously felt that the project was executed well and felt that customers were well served by the Program.

The overall effectiveness of EC units to adequately cool the air depends on how hot the weather is, and how humid. A more humid summer in 2005 versus 2004 created disappointing year-to-year energy use comparisons for treated homes. Similarly, a hotter

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[271] Volume 2, Appendices. Impact Evaluation of UCONS Hard-To-Reach Mobile Home Evaporative Cooler Program

summer in 2006 versus 2005 also affected the self-reported use of evaporative cooling, causing residents to rely more on the more expensive, but more powerful, compressed cooling in their air conditioners on very hot days. In light of the disappointing savings from the tune-up measure, one Program contact involved in Program design reported he would include EC tune ups as one of several tools in weatherization effort, keeping the ability to implement it when relevant, but not building a program around it.

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3. Impact Evaluation

Impact Evaluation Methodology

An impact evaluation had already been completed and was in the process of being finalized at the time of the IDEEA Program's process evaluation. Alternative Energy Systems Consulting (AESC) completed a draft Energy Savings Assessment in November 2005 that reviewed preliminary energy savings from evaporative cooler tune-ups, fan de-powering, and installation of compact fluorescent lamps. This assessment also attempted to answer several basic process evaluation questions. The impact evaluation report was submitted by Cal-UCONs and is included in this report in its entirety as Volume 2, Appendices. Program impacts extracted from the impact evaluation are presented below.

Final Program Impacts

The Program impacts were estimated collectively for all measures installed through the Mobile Home Evaporative Cooler Program. Data for these tables were extracted from the AESC impact evaluation and from the Program Implementer's E3 notebook. Note that the projected ex-ante gross and net energy savings goals reported here conform to the Implementer's E3 workbook. An error was found in AESC Table 1.1, Common Area Energy Star CFL - Exterior, which led to understated ex-ante proposed goals in that table in the impact evaluation. AESC used 328 gross kWh savings per unit instead of 354 kWh, per the E3 workbook.

Table 3–1 presents the first year ex-ante gross and net energy savings goals and reported Program accomplishments, with ex-ante savings extracted from the implementer's E3 workbook.

Table 3–1. Comparison of Ex-ante Energy Savings Goals and Reported Accomplishments

	Ex-ante Program Gross Annual kWh Goals	Ex-ante Program Net Annual kWh Goals	Reported Ex-ante Gross Annual kWh Savings	Reported Ex-ante Net Annual Program kWh Accomplishments
Evaporative Cooler	4,821,700[8]	4,291,313	3,949,781	3,515,305

Source: E3 Workbook

Table 3–2 shows the first year ex-ante gross and net demand savings goals and reported Program accomplishments. The Program net ex-ante net savings goals were estimated and the implementer's reported accomplishments were estimated using a 0.89 NTG ratio. The implementer's final workbook specifies net annual Program energy savings to be 3,515,305 kWh.

Table 3–2. Comparison of Ex-ante Demand Savings Goals and Reported Accomplishments

	Ex-ante Program Gross Annual kW Goals	Ex-ante Program Net Annual kW Goals	Reported Ex-ante Gross Annual kW Savings	Reported Ex-ante Net Annual Program kW Accomplishments
Evaporative Cooler	3082.5	2743.4	2778.76	2,473.6

Source: E3 Workbook

The Program goals, overall and for its constituent measures, ex-post gross and net energy savings, and respective realization rates are shown in Table 3–3. The Program evaluated ex-post gross energy savings are 709,782 kWh compared to the Program gross savings goal of 4,821,700 kWh. The Program evaluated ex-post net energy savings, using NTG ratio of .89, are 631,706 kWh compared to the Program goal of 4,821,700, yielding a 13 percent net energy savings realization rate.

Table 3–3. Comparison of Programs Goals and Ex-post Gross and Net Energy Savings

	Ex-ante Program Gross Annual kWh Goals	Ex-ante Annual Net Energy Savings Goals	Evaluated Gross Ex-post Program kWh Savings	Gross Energy Realization Rate	Evaluated Net Ex-post Program kWh Savings	Net Energy Realization Rate
Evaporative Cooler	4,821,700[8]	4,291,313	709,782	15%	631,706	13%

Source: E3 Workbook, Appendix A. Impact Evaluation Tables E.1, 3.1

The Program goals, ex-post gross and net demand savings, and respective realization rates are shown in Table 3–4. The Program evaluated ex-post gross demand savings are 16.3 kW, compared to the Program goal for demand savings of 3082.5 kW.

Table 3–4. Comparison of Programs Goals and Ex-post Gross and Net Demand Savings

	Ex-ante Program Gross Annual kW Goals	Ex-ante Annual Net Demand Savings Goals	Evaluated Gross Ex-post Program kW Savings	Gross Demand Realization Rate	Evaluated Net Ex-post Program kW Savings	Net Demand Realization Rate
Evaporative Cooler	3082.5	2743.4	16.3	.53%	14.5	.47%

Source: E3 Workbook, Appendix A. Impact Evaluation Tables E.2, 1.1, 2.1, 3.1

Realization rates compared to ex-ante evaluated results are shown in Table 3–5 and Table 3–6 below. The Program evaluated ex-post gross energy savings are 709,782 kWh compared to the Program reported ex-ante gross savings of 3,949,781 kWh, yielding a realization rate of 1.8 percent. The Program evaluated ex-post net energy savings are 631,706 kWh compared to the reported ex-ante net of 3,515,305 kWh, yielding a 1.6 percent net energy savings realization rate. The Program evaluated ex-post gross demand savings are 16.3 kW compared to the reported ex-ante gross demand savings of 2778.76 kW.

Table 3–5. Comparison of Reported Program Accomplishments and Ex-post Gross and Net Energy Savings

	Ex-ante Program Gross kWh Reported	Ex-ante Net Energy Savings Reported	Evaluated Gross Ex-post Program kWh Savings	Gross Energy Realization Rate	Evaluated Net Ex-post Program kWh Savings	Net Energy Realization Rate
Evaporative Cooler	3,949,781[8]	3,515,305	709,782	1.8%	631,706	1.6%

Source: E3 Workbook, Appendix A. Impact Evaluation Tables E.1, 3.1

Table 3–6. Comparison of Reported Programs Accomplishments and Ex-post Gross and Net Demand Savings

	Ex-ante Program Gross kW Reported Savings	Ex-ante Net kW Savings Reported Savings	Evaluated Gross Ex-post Program kW Savings	Gross Demand Realization Rate	Evaluated Net Ex-post Program kW Savings	Net Demand Realization Rate
Evaporative Cooler	2778.76	2,473.6	16.3	.59%	14.5	.52%

Source: E3 Workbook, Appendix A. Impact Evaluation Tables E.2, 1.1, 2.1, 3.1

Final Program savings, NTG ratios and realization rates are shown in Table 3–7 and Table 3–8. The individual components of the Program were assumed to have a net to gross ratio of 0.89 for evaluation purposes.

Realization rates were calculated as the ratio of the evaluated net ex-post savings to the reported ex-ante gross savings.

Table 3–7. Program Energy Savings

	Ex-ante Reported Gross kWh Savings	Ex-post Gross Program kWh Savings	NTG Ratio	Evaluated Ex-post Net kWh Savings	Realization Rate
Evaporative Cooler	3,949,781[8]	709,782	.89	631,706	1.6%

Source: E3 Workbook, Appendix A. Impact Evaluation Tables E.1, 3.1

Table 3–8. Program Demand Savings

	Ex-ante Reported Gross kW Savings	Ex-post Gross Program kW Summer Savings	NTG Ratio	Evaluated Ex-post Net kW Savings	Realization Rate
Evaporative Cooler	2778.76	16.3	.89	14.5	.52%

Source: E3 Workbook, Appendix A. Impact Evaluation Tables E.2, 1.1, 2.1, 3.1

A summary of the Program savings is shown in Table 3–9. The Program ex-post net energy savings were 631,706 kWh compared to an ex-ante net Program savings goal of 4,291,313 kWh. The Program ex-post net demand savings were 14.5 kW compared to an ex-ante net Program savings goal of 2,743 kW. The NTG assumed by both the implementers and impact evaluation team was 0.89.

Table 3–9. Savings Summary

	Proposal				Reported				Evaluated		
	Ex-ante Gross	Net to Gross	Ex-ante Net		Ex-ante Gross	Net to Gross	Ex-ante Net		Ex-post Gross	Net to Gross	Ex-post Net
kWh	4,821,700[272]	.89	4,291,313[8]		3,949,781[8]	.89	3,515,305[8]		709,782	.89	631,706
kW	3082.5	.89	2743.4		2778.76	.89	2,473.6		16.3	.89	14.5

Source: E3 Workbook, Appendix A. Impact Evaluation Tables

Lifecycle Savings

Table 3–10 shows the measure life and expected energy and demand savings per measure as reported by Program implementers. Table 3–10 also includes the evaluator's EUL for measures installed through the Program.

Table 3–10. Measure Life and Gross Savings per Unit

MEASURE / ACTIVITY NAME	GROSS COINCIDENT PEAK DEMAND REDUCTION PER UNIT (kW)	GROSS ANNUAL ENERGY SAVINGS PER UNIT (kWh)	Implementer's EUL	Evaluator's EUL
Evaporator Cooling Tune-up	1.0500	930.00	10	4
Evaporative Cooler Fan De-Powerment	0.3000	550.00	15	4
Evaporative Cooler PV Installation	0.2000	950.00	15	
Programmable Thermostat	0.1500	256.00	15	
Energy Star CFLs	0.0200	328.00	7	8
Energy Star CFLs	0.0200	99.00	7	8
Energy Star Hardwire Fixtures CFLs	0.0200	328.00	16	
Energy Star Hardwire Fixtures CFLs	0.0200	99.00	16	
Common Area Energy Star CFLs	0.0800	354.00	7	8
Common Area Energy Star CFLs	0.0800	354.70	7	8
Common Area ES Hardwire CFLs	0.0800	354.00	16	
Common Area ES Hardwire CFLs	0.0800	354.70	16	

Source: Implementer's (American Synergy Corporation) E3 workbook: *0006-Evaropativ-uconssceevapcoolermar06workbook revised.xls*
Source Evaluator's EUL: Appendix A. Impact Evaluation of UCONS Hard-To-Reach Mobile Home Evaporative Cooler Program

[272] Note that the projected ex-ante gross reported here conforms to the Implementer's E3 workbook. An error was found in AESC Table 1.1, Common Area Energy Star CFL - Exterior, which led to understated ex-ante proposed goals in that table. AESC used 328 gross kWh savings per unit instead of 354 kWh, per the E3 Workbook.

The Program lifecycle ex-ante gross and ex-post net energy and demand savings for this Program are shown in CPUC required format in Table 3–11 below. The ex-ante reported gross energy and demand savings were calculated using the implementer's reported EUL for each measure. The ex-post evaluated net energy and demand savings were calculated using the impact evaluation team's EUL for each measure as reported in the E3 workbook. See Volume 2, Appendices, for the impact evaluation prepared by Alternative Energy Systems Consulting.

Table 3–11. Program Lifecycle Ex-Post Energy and Demand Savings

Year	Calendar Year	Ex-ante Gross Program-Projected Program MWh Savings	Ex-Post Net Evaluation Confirmed Program MWh Savings	Ex-Ante Gross Program-Projected Peak Program MW Savings	Ex-Post Evaluation Projected Peak MW Savings	Ex-Ante Gross Program-Projected Program Therm Savings	Ex-Post Net Evaluation Confirmed Program Therm Savings
1	2004						
2	2005	3950	710	2.78	0.02		
3	2006	3950	710	2.78	0.02		
4	2007	3950	710	2.78	0.02		
5	2008	3950	710	2.78	0.02		
6	2009	3950	374	2.78	0.02		
7	2010	3950	374	2.78	0.02		
8	2011	3950	374	2.78	0.02		
9	2012	2430	374	2.78	0.02		
10	2013	2430		2.51			
11	2014	2430		2.51			
12	2015	405		2.51			
13	2016	405		0.22			
14	2017	405		0.22			
15	2018	405		0.22			
16	2019	405		0.22			
17	2020						
TOTAL	2004-2023	36,963	4,334				

Definition of peak MW as used in this evaluation: Average demand reduction during the summer months.

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4. Conclusions and Recommendations

The process evaluation and the impact evaluation offered the following conclusions and recommendations for future programs or studies.

Conclusion 1. *Program marketing works best on a personalized, park-by-park, basis.*

Program marketing effectively reached a hard-to-reach residential sector by relying in part on strong relationships between mobile home park managers and Program representatives. Program contacts noted the importance of building trust with park contacts. Outreach efforts had to be perceived as non-threatening since many parks work to keep solicitors and troublemakers out of parks. Attending the community meeting was frequently required to assuage concerns and introduce the Program.

Recommendation 1*. Plan marketing efforts and training to focus on one-on-one outreach.*

Common strategies for recruiting participants included neighborhood meetings, information fairs, and word of mouth contact through canvassing the mobile home park. Program delivery often worked through a park manager to overcome suspicions that technicians were solicitors. As part of their training, technician were taught to understood the importance of looking professional, how to phrase their reason for being there, and how to build trust.

Conclusion 2. *Lack of contact information hampered the process evaluation.*

Implementers did not keep contact lists for participating and nonparticipating mobile home park owners or managers. These people could not be contacted to get a better sense for how the outreach activities described in the proposal were carried out, what, if any, remaining concerns they had, and how their residents tended to respond to programs like this one.

Recommendation 2*. Collect and maintain baseline contact information.*

Lack of contact information led to the omission of potentially valuable information that could inform future programs. Including the park owners and managers in the interviews broadens the perspectives and insights about the Program. In addition, it becomes a Program management tool to track which parks and managers had already been contacted and their response.

Conclusion 3. *The Program may not have reached the targeted population specified in the Program design.*

The Program targeted mobile home customers who had discontinued or reduced the use of there evaporative coolers as a result of maintenance or performance issues. It appears that customers were already aware of the energy and bill savings that accrue to them when they use their evaporative cooler in place of their compressor air conditioning, thus they do maintain their systems. Fifty-two percent of the participants surveyed reported servicing their evaporative coolers annually. Also, not all evaporative coolers appeared to be in the state of severe disrepair.

Recommendation 3. *Screen and select potential participants who meet specifications of the targeted market.*

Be more selective when identifying potential consumers or mobile home parks for Program participation. Adding the evaporative cooler tune-up and fan depowerment measures to a standard mobile home Program will allow the implementer to customize the Program offering to meet the needs of individual mobile home parks. Also, screen out participants who might not use their evaporative coolers because of medical reasons or are seasonal residents who relocate in the summer.

Conclusion 4. *The Program design did not plan for data collection at master metered parks, unnecessarily limiting the analyses.*

Participants included in the billing analysis, site inspections and customer surveys were limited to individually metered mobile home parks. The Program participants in master metered parks may represent a subpopulation for which the Program design assumptions may be more accurate.

Recommendation 4. *Develop and implement a complete data collection plan to include information for all participants.*

From the beginning of the Program, coordinate with the managers of master metered mobile home parks to collection billing usage. Including master meter participants will result in a more representative billing analysis.

Conclusion 5. *The Program was built around a measure that did not result in discernable energy savings; mid-Program M&V steered the Program in another direction.*

The evaporative cooler tune-up measure was selected so that poorly functioning or non-functioning evaporative coolers could be brought back into use through servicing. A mid-Program M&V effort revealed that this approach did not result in discernable energy savings. In response to disappointing results, the Program switched to a more promising measure, that is, evaporative cooler fan depowerment.

Recommendation 5. *Conduct early M&V on new measures to determine if mid-course corrections may be needed.*

This Program benefited from the mid-Program M&V and from the ability to be flexible and develop other Program measures.

Conclusion 6. *Projected ex-ante savings for all measures were greater than field observations and reports in the literature.*

Impact evaluators found that the ex-ante evaporative cooler kilowatt-hour savings, ex-ante fan depowerment estimates, and compact fluorescent lamp (CFL) ex-ante measure savings were significantly higher than those found in literature reviews and field observations.

Recommendation 6. *Assume ex-ante deemed savings that are supported by the most recent evaluation studies or the 2005 DEER Database.*

In the case of weather sensitive measures such as evaporative cooler tune-up, implemented savings should be specified by square footage, climate zone, and building age. Comprehensive baseline information should also be collected to accurately specify savings.

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12. New Technology for Multifamily HVAC Controls Program

1. Program Description

The New Technology for Multifamily HVAC Controls Program (“the Program”) was designed by Resource Management Corporation (RMC) in response to Southern California Edison’s (“Edison”) request for innovative energy-efficiency proposals under the 2004-2005 Innovative Designs for Energy Efficiency Activities (IDEEA) program. Edison awarded RMC a contract for $548,800 to implement the Program. The Program featured installation of Energy Eye™, an energy management system designed to independently control HVAC systems. The technology was first introduced into the hotel/motel industry, and the application in apartment complexes was unique.

The Program was designed to reduce HVAC energy consumption in multifamily housing in inland communities through this new, wireless, occupancy-sensing technology. By using multiple occupancy sensors throughout an apartment that communicate with a central “brain,” air conditioners and electric heat pumps can be turned off, or the thermostat allowed to float to a higher set point, reducing operation during periods when an apartment is unoccupied, which frequently occurs during peak demand periods. This technology can be deployed to control thermostatically-controlled as well as individual through-the–wall units. The energy savings provided by this technology occurs without occupant involvement and will accommodate daily changes in residents’ schedules. As a direct installation program, this technology is offered at no cost to the property owner or tenant. The project proposed to install this new HVAC control technology into 1,000 units, with an anticipated savings of 1.92 MWh (net) for the entire project.

Occupants of multifamily housing face a dilemma in terms of saving energy in their homes. They are typically only committed to their particular housing unit for the term of their lease. On average this is less than one year, and frequently only six months or less. Thus, they may not be motivated to invest in energy efficiency when the return on their investment is longer than their lease. Additionally, multifamily housing occupants frequently have fewer financial resources than residential homeowners. However, this also means that a reduction in energy expenses may be very meaningful to the apartment dwellers. This may be especially true in the hot inland areas of San Bernardino and Riverside counties where air conditioning loads are great. On the other hand, multifamily property owners are often not motivated to invest in energy-efficiency measures on a retrofit basis, as their ability to recoup the expense is problematic.

Benefits to both the property owners and residents included:

- No charge to either the owners or residents for all equipment and installation
- Minimal disruption for installation

Benefits to the residents included:

- Anticipated reduction in electric utility expenses by decreasing HVAC energy use by up to 40%

Benefits to the owners included:

- Increased property attractiveness through reduced electric utility expenses
- Ease of Program participation
- Likely increased life of HVAC equipment due to decrease in operational intensity

The equipment installed through the Program was manufactured by Energy Eye™, a privately held corporation founded in 2001. The key system components are wireless passive infrared "people detectors," wireless micro door sensors, and an HVAC "brain" receiver/controller. This system is designed (via the door sensor) to shut off HVAC systems when outside doors are left open more than ten minutes.

The wireless sensors require a battery for operation. The system can intelligently detect a low battery and will go into a "safe" default mode, relinquishing all control to the occupant so that there will never be a lapse in HVAC operability. The manufacturer states that it should only be necessary to change the battery every two to five years with normal usage.

Implementers anticipated net savings of 1.92 MWh per year from the 1000 installations. RMC, the Program implementers, reported that no in-field data was available to estimate savings, and so used the E-Quest energy simulation software to estimate potential savings, modeling several apartment types in the targeted geographic locations. Based on E-Quest modeling, it was anticipated that the average net savings per unit would be at least 1,920 kWh (2,400 kWh x .80 NTG). The Program projected that the technology would reduce consumption from 1,600 kWh to 4,500 kWh per year per multifamily unit through reduced air conditioning loads.

The evaluation of this Program included both a process and an impact evaluation. The process evaluation included interviews with the Edison Program manager, with Program implementation staff, managers of the multifamily apartment complexes that participated in the Program, and with a sample of the tenants in whose apartments the sensor control was installed. The impact evaluation included site visits, an engineering analysis and a billing analysis for participating apartment complexes. It also included reviews and recalculation of engineering algorithms, and detailed reviews of Program records. Although this was a 2004-2005 program, the evaluation conforms to the 2006 Protocols at the Basic level (IPMVP Option A).

This chapter is organized into five sections. The next section (Section 2) presents the process evaluation, including the Program logic model, results of interviews with Program staff and participants, and free rider estimates. Section 3 describes the impact evaluation and the engineering and site visit results, and calculates realization rates, ex-post gross and net savings, and lifecycle savings. The final section (Section 4) presents the major conclusions and recommendations.

2. Process Evaluation

Process Evaluation Methodology

The purpose of the process evaluation was to document project progress, assumptions, and barriers to wider implementation, to assess customer satisfaction, and to document barriers to participation and describe current practices among nonparticipants. A Program logic model guided the research.

Program Logic Model

The Program logic model diagram is shown in Figure 2–1. The logic model shows the key features of the Program as understood by the evaluation team, indicating the logical linkages between activities, outputs, and outcomes. The primary activities involved marketing the Program to the multifamily apartment market, and direct canvassing to identify potential participants. Once potential candidates were identified, eligibility was confirmed with property managers.

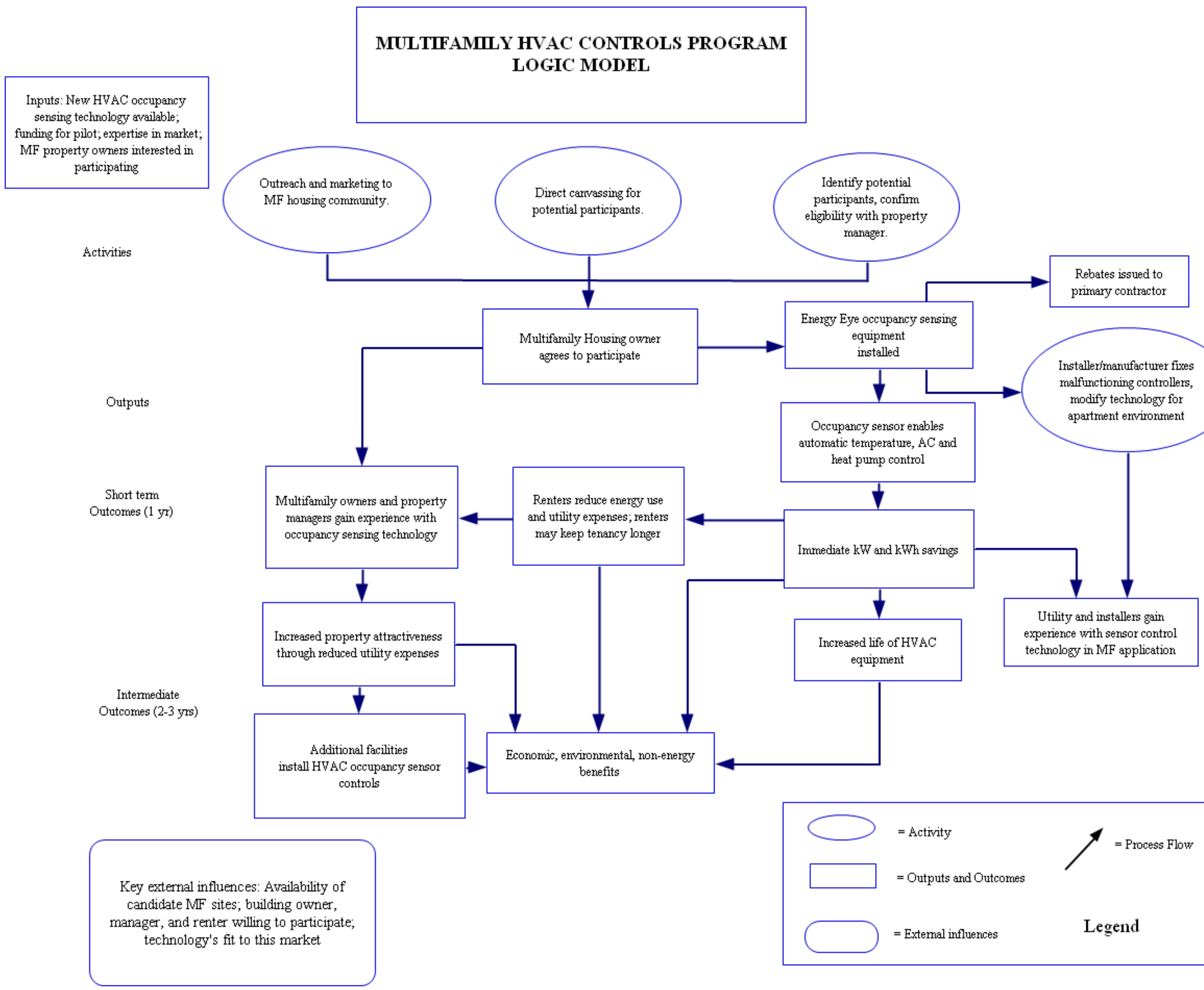
The initial activities resulted in participation agreements with the owners and property managers. The Energy Eye™ installation was scheduled and completed. The technology reduced air conditioning in unoccupied rooms throughout the day. The installations also resulted in manufacturer's follow-up activities to repair the systems.

Short and intermediate term outcomes included immediate kW and kWh savings. Renters reduced energy use. The multifamily property owners, managers, and tenants gained experience with the technology. Experience with a new market approach and technology was gained by the manufacturers and installers as well as by the implementers and Edison.

Longer-term potential outcomes could include additional installations of the technology at other apartment complexes, enhanced desirability of apartments which reduce energy use, and reduction in tenant turnover related to energy costs.

The Program was implemented as designed. Additional funding was provided so that the sensors could be installed in an additional 400 units.

Figure 2–1. Final Logic Model



Process Evaluation Sample Design

The process evaluation was based upon a review of Program documents and interviews. Interviews were conducted with the Edison Program Manager, the RMC project manager, and the Energy Eye™ sensor manufacturer. This evaluation was also informed by interviews with 14 property managers at participating apartment complexes and by surveys with 55 tenants (Table 2–1).

To determine whether this technology had been installed in other multifamily applications, we contacted several market actors. Eleven associations listed on the CA Apartment Associations website were contacted as well as four businesses listed on the CA Apartment Associations "energy resource management" website. Four product manufacturers were contacted, including Honeywell, Onity, InnErgy, and Energy Eye™, the product being installed. NYSERDA R&D and Residential Programs, and the Association for Energy Affordability, that work with multifamily buildings, were also contacted. None knew of multifamily applications of wireless infrared occupancy sensor technology controlling HVAC systems. Because there were no other identified multifamily applications of this technology, nonparticipant interviews were not necessary. The free rider estimate was set to zero and the NTG ratio was 1.

Table 2–1. Survey Sample Goal and Achievement

Task	Goal	Achieved
Program/implementer staff	3	2
Participating owners/managers	14 (census)	14 (census)
Energy Eye™ manufacturer	1	1
Participating tenants	65 (90%±10%)	55
Total	83	72

Almost all of the units in the 14 participating apartments (96%) had the hardware installed. The remaining 4% of nonparticipants within participant buildings were typically units where the building manager decided not to install the technology, identifying these as "problem" units. Since nonparticipants were not involved in the decision to install the technology in their unit, they were not interviewed.

The Program implementers provided contact lists for the property managers. Managers at all properties were interviewed, although there had been turnover in managers at some properties since the sensors were installed.

The impact evaluation team conducted site visits at 84 apartments. During the site visit, the evaluators explained to the tenant that we would like to conduct a phone survey, and requested permission to contact them. Evaluators were able to obtain contact information for 68 of the 84 tenants. The property managers were not willing to provide the names and contact information for the remaining tenants where the evaluation team inspected the sensor technology and the tenant was not home.

A contact list for households within the participating property's zip codes was purchased from Affordable Samples. Zip codes for all 1400 participants were provided for data extraction. The purchased list included contact information for only 209 dwelling units. This list was limited because it typically takes one year of residency for a name to appear on marketing lists. In the housing segment of interest, there is a high turnover rate and many residents were not in the apartment long enough to appear on the list.

A total of 277 tenant contact names and numbers were collected. Duplicates across the two lists (evaluator's list and Affordable Samples' list) removed 23. Because of the large Hispanic population within the various apartment complexes, the survey was translated into Spanish and administered in either Spanish or English, as appropriate. The eligible survey sample included 176 contacts with good phone numbers. Five attempts were made to contact the tenant. Of the eligible sample, half were not available, the phone was busy, or there was no answer during each of the contact attempts. Refusals accounted for 15% of the eligible sample and 31% of the eligible sample completed the survey (Table 2–2).

Table 2–2. Sample Disposition

	Frequency	Percentage
Contact list compiled through evaluation team's site visits (68) and zip code purchase (209)	277	
Duplicate	23	
Wrong number/non-working number	31	
Disconnect	42	
Language barrier/business /computer-fax	5	
Eligible sample	176	
Completed surveys	55	31%
Incompletes	7	4%
Refusals	26	15%
Not available/no answer/busy	88	50%

Research questions were developed as part of the work plan and then used to develop interview guides. Interview questions explored the decision-making process used by managers of participating apartment complexes to determine whether to participate, and also explored the managers' and tenants' experiences with the technology since the installation. Respondents were fielded questions about initial Program marketing/outreach, the potential for spillover, and perceived barriers to adoption.

The interviews took place between August and September 2006. Tenant interviews began with a confirmation of the tenant's move-in date to determine if they were living in the apartment when the sensor was installed. Interviews were conducted by phone.

Process Evaluation Results

In this section, the Program is described as experienced by individuals who designed and implemented the Program, by the sensor technology hardware manufacturer, by the sample of tenants who participated in the Program, and by the property managers.

Program Design

The energy savings provided by this technology were intended to occur without occupant involvement and to accommodate daily schedule changes. As a direct installation program, the Program addressed the split-incentive aspects of multifamily housing where the building owner does not pay the apartment energy bill, and the tenant does not own the property.

The Program targeted inland desert environments in Edison's service territory. RMC selected 14 different apartment complexes to participate in the Program. The original Program was designed to treat 1000 units. At Edison's request, an additional 400 units were added near the end of the Program, increasing the original unit goals by 40%. The direct install Program paid Energy Eye™ manufacturers/installers a fixed financial incentive for each dwelling with completed installations.

The original Program was designed around the premise that most tenants would be away from their residence during the day. The occupancy sensor controls would allow the air-conditioning to be turned off during the day when an apartment was unoccupied. This time frequently corresponded to summer peak demand periods. However, even with questions asked to screen potential participants for complexes where residents were away during the day, implementers found that some of the residents were home during the day and the air conditioning continued to operate during the day.

The Program was implemented as designed, installing the HVAC control technology in moderate to low income multifamily apartments with one and two bedrooms. Installations were limited to the maximum of 125 units in one complex (with one exception, as agreed to by Edison), and installations were completed at a variety of apartment complexes.

Market Assumptions

The target market for this Program was primarily moderate-income customer housing units (multifamily rentals) in hard-to-reach communities (outside the L.A. and San Diego basins) in San Bernadino and Riverside County, at properties with air conditioners over five years old. Additional criteria included:

- A minimum of eight units
- Buildings with less than three floors
- Facilities with a thermostat-stat controlled split system or PTAC
- The HVAC system could not be a rooftop unit with through-ceiling duct and five-wire control

Early in the Program RMC placed announcements in multifamily property management trade publications. The Program was also introduced at a meeting of the Apartment Association of the Greater Inland Empire. Most of the marketing took place in the field, however. RMC conducted direct canvassing of potential properties. In addition to the criteria above, RMC looked for full-time residential units where the residents left the home during the day. Retirement and senior complexes were not a good fit because tenants were home all day. RMC set an arbitrary limit of

125 installations per property to meet Edison's interest in spreading the installations over different properties. That led to exclusion of the larger apartment complexes. Most participating complexes were low and moderate income complexes.

When RMC identified a likely candidate, they talked with the property manager and provided Program information. RMC asked managers if their residents had lifestyles that would cause them to be gone during the day, since that was the preferred tenant profile.

At some establishments the property manager was unwilling to forward information to the property owners and the discussion stopped with the first contact. At other properties, the local manager was involved in the decision making and/or was interested enough to pass along Program information to owners. RMC offered brochures that explained the Program and also provided information for tenants that explained benefits about how the system worked. This document was to be included in the property manager's "Notice of Entry" form if the property chose to participate. The potential sites were pre-inspected for suitability but not formally surveyed or audited.

Marketing and Participation Decisions

While RMC, the implementation contractor, had some experience with Energy Eye™ in hotels, the technology had not been used in multifamily apartments. RMC searched for locations and building types that might save energy. They also looked at competitor's energy management systems but found they were much more expensive and that cost was an issue.

RMC experienced some initial difficulties finding appropriate residential apartment properties to install the sensor. Their final report states that after some consideration, *"it became more clear that the greatest potential savings were in units with central HVAC systems in properties with residents somewhat higher in income and therefore less sensitive to their electric bills."*[273]

RMC notes that as the Program was originally designed, the intent was to spread the installation of 1000 Energy Eye™ systems across a number of different properties, and set an arbitrary limit of 125 units per property. For that reason, the larger properties were excluded from the Program. However, RMC later surmised that the larger properties were also higher-rent apartments, and could be larger in size, using more energy to heat and cool. In addition, residents could be less sensitive to energy price, use more energy, and therefore, could stand to gain more from installation of the Energy Eye™ system.

One larger property was allowed to participate that would fit the "higher rent" characteristics. This property was actually treated in two waves. First (in April 2005), just the two-bedroom units were treated, in an attempt to remain true to the 125-unit limit. However, seven months later, the one-bedroom units were permitted to participate (November 2005).

Half of the interviewed property managers recalled being contacted about the Program. In some cases, the property managers originally involved with Program implementation were replaced by

[273] RMC, Final Multifamily Report to Southern California Edison, January 2006, page 3.

new staff. Five property managers reported learning about the Program from the previous property manager. Other property managers cited learning about the Program from RMC (4), Edison (1), and other properties they manage (1). Three were uncertain about their information source (Table 2–3).

Program information was offered to the property managers verbally, either in person (10) or over the phone (6). Others received Program information via a flyer (1), email (1), or they didn't recall (2)(Table 2–4).

Table 2–3. How Respondents Heard About the Program

	Property Managers (N=14)	Tenants (N=55)	Total (N=69)	Percentage of Respondents
Edison	1		1	1%
RMC	4	6	10	14%
Previous property manager	5		5	36% (percentage of property managers)
Landlord		9	9	16% (percentage of tenants)
Other	1		1	1%
Don't know	3	23	26	38%
Sensor was already installed when tenant moved in		11	11	20% (percentage of tenants)

Source: Survey of tenants (n=55), property managers (n=14). Multiple responses allowed.

Over half the tenants, (69%, or 38 of 55) were living in their apartments when the sensor was installed. When asked about who contacted them and explained what the control sensors were for, most (23 of 38) cited that they couldn't remember, nine cited the landlord, and six the installer (Table 2–4). Sensor information was provided to tenants in various formats, including by mail, in person, and over the phone. Ten respondents couldn't recall the communication format.

Table 2–4. How Program Information Was Delivered

	Property Managers (N=14)	Tenants (N=55)	Total (N=69)	Percentage of Respondents
Mail		13	13	19%
Email	1		1	1%
Phone	6	1	7	10%
In person	10	10	20	29%
Tenant	1		1	1%
Flyer	1		1	1%
Installers	1		1	1%
Other		4	4	6%
Don't know	2	10	12	17%

Source: Survey of tenants (n=38), property managers (n=14). Multiple responses allowed.

Providing Program information in intangible, verbal formats, in conjunction with high property manager staff turnaround and tenant turnover, significantly increases the likelihood of losing valuable Program details over time.

More than half of the property managers (9 of 14) were not involved in Program participation decision-making. Of these 9, four specifically stated that the prior property manager was the decision-maker.

Of the five property managers who were involved in the decision-making, involvement included making the decision to participate, making arrangements for the installations, and discussing with the owners and/or managing communications with the property owners. These five all stated they participated because it was a good way to save energy and money and they wanted their tenants to reduce their energy bills.

The five property managers who were involved in the decision were asked if Edison's sponsorship of the Program was important to their participation decision. Edison's sponsorship was "very important" to three property managers and "somewhat important" to two. Comments included:

> *"If it's good for Edison, it's good for us."*
>
> *"It helps—you want to trust Edison."*
>
> *"We trust Edison."*
>
> *"It gave us confidence that the Program was going to be successful."*
>
> *"It makes us think the Program is legit."*

Most (11 of 14) property managers were not aware of the control sensor technology prior to this program. For the three who were, they cited learning about them through tenants who saw similar sensors in motels, Las Vegas apartments, and other complexes within the same management company. Because sensor controls had not been installed in multifamily apartments prior to this Program, the evaluation team is assuming the respondent meant Las Vegas hotels or motels and not "apartments."

All 14 property managers interviewed recalled the energy-efficiency benefits of the sensor control, stating that the controls would help tenants save energy and/or money.

Tenants were asked about the benefits of the sensor controls, and opinions were nearly equally divided. The 38 tenants living in the apartment when the sensor was installed responded to the question. Energy efficiency was a benefit cited by 19 respondents, and 17 felt that there weren't any benefits to the sensor. One respondent noted that no one had discussed the sensor with him, and one said the sensor *"did not do what it was supposed to do."*

Tenants were asked whether or not apartment renting decisions were influenced by energy bills. Most (36, or 65%), said energy bills were not a factor in rental decisions, with 16 (29%) saying they were, and three saying they were uncertain. Tenants who said energy bills were a factor were asked in what way the energy bills influenced their decision about which apartment to rent. Some of the comments were:

> *"I'd rather get an apartment on the bottom floor so it won't get too hot, and face the windows a certain way. The building can't be too old."*

> *"I get a discount with a program I receive for people that have low income."*

> *"I just go by which one the sun hits the most, depending on where the apartment is situated."*

> *"Moving to less areas where you can reduce energy and conserve."*

> *"Depending on how much space I will be providing energy for, I look for a smaller place so I don't have to buy much energy."*

Program Delivery and Implementation

RMC coordinated and scheduled installations with property managers and Energy Eye™ technicians. Installations were completed by two-person teams. The technicians typically completed installations for each property in about two days. Coordinating with property managers' and tenants' schedules was the most difficult part of the installations. Implementers noted that contractors commented on the difference between a visual review of the properties from the outside, and conditions of the apartments and HVAC systems once they were inside. Some of the apartment complexes were not as well maintained as the outside appearances suggested. Poor condition of the HVAC may have been a factor in technology compatibility. In future Programs, inspections of the HVAC and a sampling of the apartments might lead to different choices in participants.

Nine property managers reported that control sensors were installed in all apartment buildings. Control sensors were not installed in every apartment at the other five complexes for several reasons, including:

- 18 four-bedroom and 16 three-bedroom apartment units did not qualify
- Tenants elected not to have control sensors installed
- Tenants were absent during the installation (no permission to access apartment)

Most, 13 of the 14 property managers, reported that they understood how the control sensors worked. The manager who did not understand how the controls worked also said that none of his staff knew how the controls worked either.

Most, 12 of 14, property managers reported they regularly scheduled HVAC maintenance. The property managers were asked who would be responsible for maintaining the Program's sensors. A little over half of property manager respondents, 8 of 14, stated that a maintenance contractor was responsible for maintaining the Program's control sensors. Two stated that on-site management was responsible, and four were unsure.

The occupancy and door sensors require camera batteries which cost about $40/unit about every six months.[274] The property managers were asked if battery maintenance was part of their maintenance responsibility. Only two of the managers agreed that it was, eight said that they were uncertain, and the remainder did not answer the question. Nine (64%) noted that the sensors and batteries were serviced or tested at least once every six months. Four were uncertain about service and testing frequency and one stated that it was done “as needed.” Property managers were asked if they tracked how many or which batteries were replaced. Nine responded that they didn’t track the batteries; one stated they did, and four were uncertain.

This discussion shows that it is not clear to all the property managers just who is responsible for maintenance of the Energy Eye™ sensors and the upkeep of the batteries. Only one tracks the batteries that are replaced. Batteries are expensive and neither the tenant nor the property managers are expecting to pay the cost for them.

Tenants who responded to the full survey were asked if they were comfortable with the control sensor that was installed in their apartment. The majority of tenants, 39 (71%), said they were comfortable with the sensors, 8 (15%) said they were not comfortable with the sensors, and 8 didn’t have an opinion. The eight respondents who said they were not comfortable with the sensors preferred to control their AC themselves. They offered the following reasons for their discomfort.

> *“I get too hot and the heat goes to my head.”*
>
> *“I use the timer to make the AC turn on earlier so it’s cool when I get home. I don’t like not having control.”*
>
> *“It gets so hot in my apartment that the system has a hard time to cool once the temperature reaches 80^{o}.”*
>
> *“If I had a choice I wouldn’t install it in my own home.”*
>
> *“It’s just something we’re not interested in. We monitor our AC pretty well.”*
>
> *“I don’t want a machine to know when I am at home. I’m paranoid. I don’t think anybody has the right to turn it on and off. I can do it myself.”*
>
> *“I like to be in control of it all times. I am pretty thrifty and conscious of saving energy.”*
>
> *“I don’t like to come home to a warm house.”*

The tenants were also asked if they had any concerns about the sensors. (Tenant concerns about the control sensors are shown in Table 2–5.) Concerns included having no control in the decision

[274] The billing analysis shows that savings across various apartment complexes averaged $10/year. Battery cost outweighs savings, and, tenants are unlikely to purchase expensive batteries, regardless of savings.

to install the sensor (30 or 55%), effectiveness of control sensor (6 or 11%), security concerns (1 or 2%), and no concerns (16, or 29%).

Some of the comments about their concerns included:

> *"Apparently it is really hard on the thermostat system. That's what the technician said."*

> *"At night when everybody is sleeping and nobody is moving, the air conditioning doesn't go on."*

> *"I still have a piece of it. I asked them to take it out."*

Table 2–5. Tenant Concerns about Sensors

Tenant Concerns	Frequency	Percentage of Responses
No control in decision to install sensor	30	55%
No concerns	16	29%
Concerns about operational effectiveness	6	11%
Security concerns	1	2%
Other	1	2%
Didn't install one	1	2%
Total	55	100%

Tenants were asked if they were manually controlling the air conditioner or if they let the sensor control the air conditioning system. The results were nearly equally divided between manually controlling the air conditioning (28, or 51%) and allowing the sensor to control the air conditioning (24, or 44%). Three respondents were uncertain.

When tenants were asked why they manually operated their air conditioner, answers included:

> *"I just turn it off when I don't need it."*

> *"I don't like the sensors controlling it."*

> *"I am here all day and leave the air conditioning on all day."*

> *"I have to set it to whatever I want, or it won't come on."*

> *"I set the switch on automatic when I felt like it needed to be more cool."*

> *"I am a capable human so I can choose it to be on."*

> *"I turn it off and turn it on because I don't use the sensor; I don't know how."*

Most (71%) of the tenants stated that they had not changed the times or temperatures for cooling the apartment since the sensors were installed.[275] Fifteen stated they had changed the times or temperatures of the controllers; however, the changes were largely weather-dependent and were not influenced by the sensors themselves.

Market Barriers

The Energy Eye™ manufacturer felt that the primary barrier to widespread implementation is first cost, education and marketing, and ongoing maintenance. First cost can be overcome with volume sales, that is, *"when the energy management system can be offered along with thermostat models at Home Depot (for example), the volume will reduce the price."* Property managers and owners need to be educated about the sensor's ability to save energy and money.

The main barrier, however, is identifying who will be responsible for maintaining the equipment. Once identified, that person or persons would need training to handle issues beyond changing the batteries. These sensors are not a do-it-yourself item. In the hotel industry where this technology had its roots and had been proven effective, there is a clear chain of command. However, with the apartment complexes, some building managers don't know what the equipment is or how it works, most likely because of high turnover rates among management and the consequent lack of commitment to the systems or the lack of a plan to transfer information.

Property managers were asked if they thought there were barriers to widespread installation of the HVAC control sensors. The barriers that they described are summarized in Table 2–6.

Table 2–6. Barriers to Market Penetration

Barrier	Frequency	Percentage of Property Managers
Cost	1	7%
Time	1	7%
Education/marketing	2	14%
Sensor not appropriate for market	1	7%
Malfunctions/ improper functioning	6	43%
Don't know/none	6	43%

If property managers are to lend support to the energy management systems, the systems will need to function properly. In addition to their comments about barriers, this sentiment is also supported in the section below that discusses participants' experiences.

Tenants' comments speak to market barriers from the perspective of the tenant. Their concerns included lack of control over the decision to install the sensors in their apartment, lack of control

[275] The system's "brain" is a 24VDC receiver/controller/thermostat; this is not a programmable thermostat.

over the HVAC system, system malfunctions, and lack of understanding about the technology itself.

Participants' Experience with the Program and the Technology

Property managers were asked about the issues emerging with the sensor controls, including issues they had experienced and issues brought to their attention by tenants. Eleven property managers (79%) stated that the sensors were ineffective at controlling temperature. Ten property managers noted that tenants have commented or complained about the HVAC control sensors. Issues included:

- Difficulty keeping the apartment at a comfortable temperature (six comments)
- Air conditioning shuts off at night and the apartment gets hot (six comments)
- Air conditioner doesn't turn on and off as described (three comments)

Additional comments included complaints about malfunctioning control sensors:

- The green light is on in most units (but people dislike the control settings)[276]
- The light is blinking in 90% of the units with control sensors
- The sensor on windows isn't compatible with window blinds, and malfunctions (doesn't turn off air conditioning when people leave)[277]

The impact evaluation discusses the blinking lights. Blinking green lights mean the battery is low and needs to be changed. Apparently, the managers did not know what the blinking lights means and did not change the batteries.

Other comments included:

> *"The sensor is turned off when people sleep, and the air conditioning turns off, and people awake in the middle of the night to 100-degree temperatures. This defeats the purpose of the sensors."*
>
> *"Batteries are dead in many units . . . batteries cost $40/unit, which is pretty outrageous. I doubt the energy savings in properly functioning units would even cover the cost of replacing these."*
>
> *"They are ruining our air conditioning units."*

All fourteen property managers surveyed agreed that turnover among renters has not decreased since the installation of the control sensors. When asked if rent rates have changed since the control sensors were installed, nine said "yes they had" and five said "no they had not." Eight

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[276] The solid light indicates the Energy Eye™ System is operating correctly, battery levels are acceptable and all components are in place.

[277] The window sensor operates as other occupancy control sensors.

stated that there was a rent increase but that the change was not related to sensor installation. Concerns that the energy management system would reduce consumption, make the property more marketable, and result in increased rents, were unfounded.

Property managers were asked to rate their satisfaction with the performance of the control sensors, satisfaction with the installation company, and overall satisfaction with the Edison Program. Of these three, property managers were most satisfied with the installers.

Half of the property managers stated that they were "somewhat not satisfied" or "not at all satisfied" with the performance of the control sensors. These responses are shown in Table 2–7. Two respondents (or 14%) stated that they were "very satisfied."

Table 2–7. Property Manager Satisfaction with Sensor Control Performance

	Frequency	Percentage of Respondents
Very satisfied	2	14%
Somewhat satisfied	1	7%
Neutral	3	21%
Somewhat not satisfied	5	36%
Not at all satisfied	2	14%
Uncertain	1	7%

Source: Property manager surveys (n=14)

In terms of satisfaction with the company installing the sensors, a little over half (eight) of the property managers responded that they were "somewhat" or "very satisfied." Table 2–8 shows the distribution of survey responses with respect to the company installing the sensors.

Table 2–8. Property Manager Satisfaction with Company Installing the Sensors

	Frequency	Percentage of Respondents
Very satisfied	7	50%
Somewhat satisfied	1	7%
Neutral	2	14%
Somewhat not satisfied	2	14%
Uncertain	2	14%

Source: Property manger surveys (n=14)

Property managers were also asked to report their satisfaction with the Edison Program overall. Most responded that they were "neutral" or "somewhat not satisfied." These responses are shown in Table 2–9.

Table 2–9. Property Manager Satisfaction with Edison Program Overall

	Frequency	Percentage of Respondents
Very satisfied	1	7%
Somewhat satisfied	2	14%
Neutral	6	43%
Somewhat not satisfied	4	29%
Not at all satisfied	1	7%

Source: Property manger surveys (n=14)

Property managers offered comments and suggestions for Program changes, including:

> *"Better follow-up with Program participants . . . the availability of the replacements is very scant. It took the company three weeks to return my call regarding an estimate for replacing one part."*

> *"I don't like to have to coordinate inspection of the units— it takes too much time and energy on our behalf."*

> *"I don't think it was rolled out properly. There was no education to tenants or disclosure of how/when to maintain these sensors . . . or the cost of maintaining the batteries."*

> *"Test the technology thoroughly prior to deploying malfunctioning equipment."*

> *"Update and fix the technology."*

Clearly, the property managers were not satisfied with the performance of the technology. The reasons for the property managers' dissatisfaction are found in the larger discussion. They offered an abundance of comments based on their experience and reports from their tenants that indicated tenant education fell short and the actual technology did not perform as expected. It is also evident that they feel the technology was not ready to be rolled out as a Program. There are serious issues with knowledge transfer when there is turnover in property management and staff.

Some of the tenants whose Energy Eye™ system was inspected onsite by the evaluation team commented on their experience during the inspection. No survey was conducted, but their unsolicited comments are worth noting. Of those who did make comments (52 tenants) 56% said they did not know how the system worked and 21% said it was explained to them. Six (12%) said the sensors or Energy Eye™ were removed because the system was not working, and seven (13%) said that they were not using the sensors. Two said they didn't know it was there, two thought it was a camera, and two thought it was an alarm system. Not everyone who made comments mentioned energy savings. However, 38% (20 of 52 tenants making general comments) said the Energy Eye™ did not save energy or money and 21% (11 of 52) said they had noticed some change in their energy bills.

In the telephone survey with 55 tenants, tenants were asked if they were satisfied with the functioning of the occupancy sensors and if they were satisfied with the level of comfort in their homes.

Eighteen tenants (33%) said that they were "very satisfied," while 20 tenants (36%) indicated that they were "somewhat satisfied" with the sensor control functioning. Table 2–10 shows the responses received.

Table 2–10. Tenant Satisfaction with Sensor Control Functioning

	Response	Percentage
Very satisfied	18	33%
Somewhat satisfied	20	36%
Neither satisfied nor dissatisfied	3	6%
Somewhat not satisfied	5	9%
Very dissatisfied	9	16%

Source: Tenant surveys (n=55)

Tenants who said they were "neither satisfied nor dissatisfied," "somewhat not satisfied," or "very dissatisfied" with the functioning of controls were asked why they were dissatisfied. Responses were categorized into four groups:

- Issues with retaining control of the system (five comments)
- Energy bills had not decreased (four comments)
- Sensors were not working, they didn't use them, or they no longer had them installed (four comments)
- *"Just don't know"* why they are dissatisfied (four comments)
- Comfort-related issues (two comments)

Most tenants described their satisfaction with the level of comfort in their home as "very satisfied" (28, or 50%) or "somewhat satisfied" (21, or 38%). The other respondents were either "somewhat satisfied," "very dissatisfied" or "neither satisfied nor dissatisfied." These responses are shown in Table 2–11.

Table 2–11. Tenant Satisfaction with Level of Comfort in Home

	Response	Percentage
Very satisfied	28	50%
Somewhat satisfied	21	38%
Neither satisfied nor dissatisfied	2	4%
Somewhat not satisfied	2	4%
Very dissatisfied	2	4%

Source: Tenant surveys (n=55)

All but two respondents who were "very" or "somewhat satisfied" with the functioning of the sensors were also "very" or "somewhat satisfied" with the level of comfort in their home.

These satisfaction ratings are not in keeping with all the other complaints about the system that tenants made to the evaluators and to their landlords and property managers. Crosstabulations show that even though tenants had concerns because they had no control over the decision to install the technology, they were still satisfied with the controls' performance. Crosstabulations also show that of the 28 tenants who manually operate the controls, nine were "very satisfied" and eight were "somewhat satisfied" with the functioning of the sensors. It appears that tenants who manually control the system are satisfied with their own operation, or, they relinquish control to Energy Eye™ more often than they thought. It also appears that tenants don't know how the system operates, confirming other statements to that effect.

Free Riders

Several market actors were contacted to determine whether this technology had been installed in other multifamily applications. Eleven associations listed on the CA Apartment Associations website were contacted, as well as four businesses listed on the CA Apartment Associations "energy resource management" website. Four product manufacturers were contacted, including Honeywell, Onity, InnErgy, and Energy Eye™, the product being installed. NYSERDA R&D and Residential Programs, and the Association for Energy Affordability, who work with multifamily buildings, were also contacted. None knew of multifamily applications of wireless infrared occupancy sensor technology controlling HVAC systems. No other applications of this technology were identified in multifamily apartment complexes. There were no free riders and the NTG ratio equals 1.

Potential Spillover

When asked if they would install this type of HVAC control sensor in the future, twelve property managers cited that they would not install it at their own expense *nor* with incentives, one said he would install the technology with incentives, and one said he was unsure. None of the fourteen property managers had any current plans to install HVAC sensors at other buildings they managed.

When asked if they had installed energy-efficiency equipment in addition to the control sensors, eleven property managers had not. Of the three who had, the equipment included energy-efficient refrigerators, upgraded replacement air conditioning units, and energy-efficient replacement stoves. Two out of the three respondents stated that the Program was influential in the decision to add additional energy-efficiency equipment installation. There is little spillover from this Program to other Edison efficiency programs; two of 14 (14%) were influenced by this Program.

Nine of 14 property managers had not participated in another Edison energy-efficiency program. Four cited previous participation, and one was unsure. Prior programs they had participated in included energy-efficiency refrigerators, exterior lighting, LIEE, HVAC, duct sealing, thermostats, and weatherization. It does not appear that there was much spillover from prior Edison programs to this one. None mentioned that their prior participation directly influenced their decision to participate in this Program.

Lessons Learned by Program Staff, Future Plans

RMC reported that finding the actual properties likely to save energy was much more challenging than originally anticipated, given the Program's limitation on property size. The effort literally took a great deal of driving and looking at candidate properties. The original intent was to limit the number of units installed at one property (125 units maximum) so that more properties could participate. However, after observing many properties in the field, RMC felt that the greater savings potential would be found in larger properties that were excluded. Factors that may have increased the likelihood of energy savings there were that the units would have been larger and had higher rents, that residents would likely have had higher incomes and would have been less sensitive to electric bills, that they would have had fewer people per bedroom, and that they would have used more energy. Because of the nature of the Program, this hypothesis was not fully tested. Only one property participated that had more than 125 units treated. This property had one- and two-bedroom units treated in two waves.

While RMC screened the properties on the initial visit, it was not always easy to tell which properties were the best candidates for the Program. Some structures looked good but installers discovered they had the wrong population, that is, tenants were home all day. Other properties looked like they had amenities that would indicate well maintained properties but once in the buildings, installers found the units were poorly maintained.

There were a number of issues with the technology itself, including battery failures at inconsistent intervals and in random apartments, and inability to turn the air conditioning back on once it was turned off.[278] After some time and effort, the Energy Eye™ manufacturer was finally able to diagnose the problem, and determined it was related to the nature of the wiring in the building, as discussed in more detail below. They did fix the problem and added devices to later installations until the controller was modified altogether. RMC was pleased with the manufacturer’s attitude and felt they bent over backwards to fix the system.

RMC found that the installers themselves, employees of Energy Eye™, were courteous and supportive, and worked well with apartment tenants. Installations were typically completed by a two-person team. RMC coordinated the installations with the property managers and the installers. Managers were asked to plan ahead with their tenants to ensure that the installers had access to property. For the most part, the managers were organized, but there was at least one unit at each property where access could not be gained. Installers talked to any interested tenant while the units were being installed. However, most tenants were not at home.

Managers provided tenants with a one-page flyer, in English and Spanish, which explained how the system worked. Most of the calls RMC received from tenants were along the lines of “what is this,” rather than complaints.

RMC selected properties and apartments to provide Edison the mix of building and apartment complexes and conditions they were looking for. Both one- and two-bedroom units were selected for participation. Three- and four-bedroom units were not selected as originally planned. The larger complexes might have offered greater savings. However, RMC feels the Program was true to its experimental nature and intent. Edison and RMC discovered the limitations of the technology, and Energy Eye™ overcame those limitations.

[278] The system requires operating batteries. Once the battery fails, the system as a whole fails.

Administratively, RMC felt the flat file and workbook were not difficult to complete. Participant's Edison account numbers were difficult to collect.

Energy Eye™ had not been installed in a multifamily housing environment before this Program. As noted elsewhere, the technology had its roots in the hotel/motel industry. The manufacturer notes that the Program was large enough so that they learned the "ins and outs" for application in this market segment. The biggest issue in this Program and the item that distinguishes this application from the hotel/motel applications is maintenance and communication with the user. In the hotel industry there is a clear chain of command and responsibility for maintenance is clearly defined. This Program was approached at the management level with the understanding that the management would be responsible for maintaining the system. However, this Program really should have been approached as if each tenant were a customer, so that they would understand the system. The overall "time crunch" of the Program exacerbated problems with communications about the functioning and maintenance of the technology. Not enough time was spent with each tenant to explain how the sensors worked. In hindsight, each tenant should have received a maintenance manual, not just the property manager. The property managers did not pass along enough information to users, perhaps because they did not receive enough information themselves.

The Energy Eye™ manufacturer found that it was nearly impossible to rely on the property management to maintain the system. He learned that some managers reported they did not know how to contact them, even though the managers had received materials and the manufacturer's contact information could be found on the internet. Energy Eye™ developed a maintenance manual and mailed a copy to all the participating properties at their own expense. The manufacturer recommends regular contact with the users, that is, the tenants, and not just the property managers, I order to ensure that the system is maintained. The manufacturer also recommends a mandatory training course with the property HVAC maintenance crew to review the general service procedures that on-site staff can conduct.

In addition, in a future program such as this, the manufacturer suggested that he would set up a regional network and hire full-time staff to work with the tenants and to develop personal relationships with each building maintenance crew so that they understand what the sensors are, what they do, and how they work. While the approach may include more legwork and more effort, it would provide a solid foundation, and reduce the number of dismantled or malfunctioning units.

Initially, the Energy Eye™ controllers were designed for installation with a secondary relay power source that provided a constant voltage to the controller. The HVAC interface in hotels and apartment complexes were not the same, however, and the technology needed some adaptation to the apartment applications. To reduce installation time and keep installations within the timeframe of the Program, the relay controls were abandoned and the controller was connected directly to the thermostat. However, this yielded inconsistent results from one building to another because the voltage inputs were different from building to building and site to site.[279] The voltage variations caused temperature buildup inside the unit and caused incorrect

[279] Input voltage variations were likely due to different current draws and transformer capacity.

temperature readings. The controller units needed to be recalibrated. During the Program, the manufacturer developed a fix using an external regulator. Late in the Program the switching power supply circuit was incorporated into the controller itself. As a result of the controller modifications, later Program installations should have been more reliable and have fewer problems than the early installations.

RMC and Energy Eye™ both discussed the electrical condition noted above that led to failure of the central processing unit in at least one of the properties. The manufacturer went to great expense diagnosing the problem and developing a solution. In the end, the problem led to development of a new controller model that accepts a wider range of input voltages as noted above. However, the renter in the apartment where the problem surfaced decided to have the system removed, even after the controller issue was identified and repaired.

The Energy Eye™ manufacturer also discussed the problem with inconsistent battery quality. The battery voltages were unevenly matched and had uneven discharge rates. For example, he noted that one battery may discharge to 1.6V and the second battery in the same sensor discharge to 2.1V. Uneven discharge rates would cause the sensor to enter “low battery mode” or “standby” mode until the batteries were changed. As soon as one battery goes below the operating threshold, the system shuts down. Toward the end of the Program, the manufacturer changed battery suppliers and brands to upgrade the quality. In addition, they now test all batteries using a pulse discharge tester before batteries are installed in the sensor. In future programs, the manufacturer recommends that battery replacement be included as part of the Program. Reasons for including batteries as part of the Program include cost, and maintenance assurance. Batteries cost the manufacturer about $1 each; the manufacturer did not know that the cost to the tenant was as high as $15 per battery. Batteries delivered by the manufacturer at the time that they should be replaced assures that the batteries are “fresh.” Under any new program the manufacturer recommends replacement every nine months for a period of three years, which should be beyond the initial payback period.[280]

The manufacturer feels that incentives are needed for this technology to be installed in multifamily buildings on a larger scale, and that the incentives should go to the property owners. He suggests that at least 80% of the property needs to opt-in before installations can occur. He also notes that a free sensor might not retain enough attention from the tenant to keep it operational. He suggests perhaps some token payment, charged in monthly amounts through the customer’s bill.

The manufacturers made a number of adaptations to their equipment for this Program. While it involved a great deal of time and expense, ultimately it was a “good thing” that led to the adaptation of the sensors not just to apartments but to small office parks. In addition, the manufacturers learned what it takes to install and maintain the technology in a multifamily environment.

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[280] Based on average participant savings of $10/year (kWh savings determined through billing analysis * .072 cents SCE residential rate), and proposed next-generation system cost of $350, the energy savings would pay for the system in 35 months.

Manufacturers were paid a fixed price per installed unit within an apartment, regardless of the number of sensors installed in the apartment. Some units had more room and door sensors than others, depending on the number of bedrooms. The Program covered the full cost of the installation so that there was no cost to the tenants or property managers. While the Program met its enrollment goals, the savings were not in tune with expectations.

Scheduling was the biggest issue during the installation and inspection phases. The implementers, tenants, property managers, and installers all had to coordinate schedules. The second largest issue with the Program was the technology itself. The sensors looked like cameras to some tenants and there were misconceptions about what they were even though product brochures were provided to the tenants.

Coordinating inspections with property managers presented scheduling issues since there were a number of parties involved. Edison's inspections were visual site inspections to verify measure installation. They did not complete more technical inspections that tested the unit.

The Edison Program Manager feels a program that offers a more comprehensive approach to providing services would take advantage of the contractor who is already on site. For example, a lighting assessment of the unit, and/or an energy audit could be conducted.

Edison received minimal comments from tenants and property managers that were relayed to RMC. Edison's experience with RMC was positive, and they said they were very easy to work with. RMC kept Edison up to date with any issues or concerns, and were available for questions, and approachable.

RMC had difficulty collecting the tenant's utility account numbers. Edison understood RMC's difficulty in collecting account numbers from customers and relaxed the requirement.[281] The Program Manager researched and input a number of account numbers into the flat file spreadsheet. In the future, there needs to be an easier and more accurate way to collect and input account numbers. In the end, the customer must feel comfortable providing their account number, but they must also provide the account number in exchange for participation.

To their credit, RMC selected a number of different building types and apartments so that data could be analyzed to profile the type of unit that was successful in providing savings with this technology. However, the account numbers were not complete, and Edison had an extremely difficult time extracting data for participants in this project. They were unable to match by name and address. A process must be put into place to accurately collect and record customer account numbers and/or meter numbers, names, and addresses so that data extractions from the Edison mainframe becomes an easy and straightforward task. Without accurate and complete billing histories, consumption analyses using billing histories cannot be conducted.

[281] Evaluators collected the meter numbers on-site, and matched meter numbers to buildings. Meter numbers were provided to Edison to extract customer billing histories for the billing analysis, however, account numbers could not always be matched to meter numbers and buildings. Future programs should document meter numbers matched to buildings and apartments.

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3. Impact Evaluation

Impact Evaluation Methodology

The objectives of the evaluation of the IDEEA New Technology for Multifamily HVAC Controls Program, implemented by RMC, are to develop ex-post adjusted gross and net savings for the Program.

Impact Evaluation Methodology Overview

The methodologies employed to accurately measure and calculate energy savings attributed to the Energy Eye™ control system installed under the MF HVAC Program included field verification activities and the utilization of the data obtained to develop adjusted gross savings estimates. The steps involved in this process included:

1. Complete measure installation verifications.
   b. Develop a sample for field verification activities.
   c. Conduct field verification activities and observations which include an analysis of battery estimated useful lifetime (EUL) and sensor operating range.
   d. Review any data on verification activities completed by Edison.
   e. Develop adjusted measures installation factors based on field activities and data reviews.

2. Complete an engineering analysis to develop ex-post realization rate.
   f. Complete a review of, and evaluate, Program data.
   g. Analyze data provided through field verification activities.
   h. Complete analysis of customer energy bills.
   i. Develop project and Program realization rates.
   j. Determine operating schedules of participant sites.

3. Develop adjusted gross and net Program ex-post savings.

4. Provide conclusions and recommendations for the MF HVAC Program and the overarching Southern California Edison (Edison) Innovative Design for Energy Efficiency Activities (IDEEA) Program.

Each of these activities is discussed in detail in the subsequent sections.

Measure Installation Verification

The objectives of the on-site verification activities were to complete visits to a sample of residential complexes which installed the energy-efficient retrofits and to collect key energy Program performance metrics, including the following:

1. Establish the presence of Program measures by comparing the number of installations observed for a sample of sites with the number of installations recorded in the final flat file provided by the Program implementation contractor.

2. Provide 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 were ever present, and/or the removal date and reason.
4. Record key performance data, such as daily HVAC settings, seasonal variations in settings, and Program-specific control strategies.
5. Utilize a voltmeter to verify component battery levels and analyze the subsequent effective operating range of the equipment installed in order to gauge persistence potential.

The detailed measure installation verification instrument is provided in Volume 2, Appendices.

Installation Verification Sample

At the time the evaluation field work was conducted, a total of 1400 apartment units at 14 distinct residential complexes had the Energy Eye™ system installed. The evaluation team utilized a proportionate sample approach with a 90% confidence level and 10% error in developing a viable sample verification set. It was anticipated that 68 apartments distributed throughout six of the participant apartment complexes would receive verification activities. The 6 sites selected provided a representative cross section of the geographic and demographic characteristics of the population of 14 sites participating in the program. The evaluation team also ensured their no more than 10% of their onsite inspections overlapped with Edison's verification sample. Additionally, the six apartment complexes to be verified were selected from the eight sites where the Energy Eye™ had been in operation for at least one year prior to the verification inspections. This design yielded the most optimal conditions to verify equipment installation and operation, and also to clarify key research issues, including these noted below:

- ***Persistence of savings.*** Field activities and the use of a voltmeter determined if the batteries were maintaining the manufacturer's claimed expected useful life (two to five years, depending on the device and usage area), and whether owners were participating in, and acting on, the battery replacement plan.
- ***Installation quality.*** In addition to confirming the number and type of measure installations in participant homes, verification activities provided the opportunity to analyze measure installation quality and conditions.
- ***Impact of demographics***. Demographic changes such as tenant turnover and lifestyle changes have effects on the energy savings attributable to the Program.

Table 3–1 provides a detailed description of the distribution of planned site verifications.

Table 3–1. Planned Site Data Collection and Sample Activities

Site	Approximate Install Date	Number of Apartment Units at Complex	Number of Apartment Units Reported Retrofit
Site 1	4/1/2005	60	57
Site 2	4/20/2005	290	236
Site 3	5/17/2005	25	24
Site 4	6/22/2005	44	35
Site 5	7/27/2005	38	31
Site 6	8/8/2005	140	121
Total		597	504

Verification efforts did not correlate directly with any of the IPMVP Options.[282] Whole building billing analysis was conducted (by grouping individual apartments into buildings), consistent with Option C. However, the activities most closely resembled Option Bin that they stipulated the measurement of energy use at dedicated meters, along with an analysis of the retrofit equipment at the component level. Where discrepancies occurred, preference was shown in the following order:

1. Engineering calculations resulting from field observations

2. Savings calculations derived from dedicated meters

The field observations were deemed more accurate in attributing energy savings to the Program primarily because there could be unknown factors influencing energy consumption at the meter. Engineering adjustments made to specific measure savings were subsequently extrapolated to the population of installed measures for the specific program.

Site Verification Activities

Field activities typically involved three components.

1. The evaluators coordinated with the implementation contractor and primary property manager to establish field activity dates and identify site level contacts. A copy of the property manager contact letter can be found in Volume 2, Appendices.

2. While on site, the evaluation team conducted a room-by-room audit noting retrofit count, type, voltage level, operating range level, installation conditions, etc., using the field instrument provided in Volume 2, Appendices.

3. In order to support billing analyses, the evaluation team confirmed meter numbers of all residential units at each residential apartment complex where site verification activities were conducted.

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[282] *International Performance Measurement & Verification Protocol, vol. III.*

Field verification activities took place between August 14th and August 18th, 2006, with a total of 71 units visited at six participant sites. Table 3–2 provides a summary of the verification activities undertaken by the evaluation team, including the types of activities completed at the sites. Volume 2, Appendices, provides field verification activity details.

Table 3–2. Summary of Verification Activities

Site	Number of Units at Complex	Number of Units Reported Retrofit	Expected Verifications	Achieved Verifications
Site 1	60	57	10	10
Site 2	290	236	18	22
Site 3	25	24	10	10
Site 4	44	35	10	9
Site 5	38	31	10	10
Site 6	140	121	10	10
Total	597	504	68	71

In general, the completed verification activities correlated directly with the anticipated verification activities. However, at Site 4, one of the expected participant tenants retracted their offer to participate in the verification activities when the evaluation team arrived, reducing the number of achieved verifications at that site by one. The evaluation team compensated for this discrepancy, and any other potential deviations, by conducting four extra verifications at Site 2.

Installation Verification Results

As stated above, the primary objective of the verification activities was to establish the presence of Program measures and installations recorded in the final flat file provided by the Program implementation contractor. The evaluation team verified the entries in the flat file with onsite observations and interviews with residential participants.

Table 3–3 provides the project and Program level verified installation rates for the sample of sites evaluated. The column titled “Program Recorded Apartment Installations” consists of apartments listed in the Program records having the Energy Eye™ system installed, while the “Verified Apartment Installations” column indicates the number of systems installed. Only one location, Site 2, showed a discrepancy in the number of apartments reported with installations and the number of apartments with verified installations, including systems installed and subsequently removed. The column “Apartments with Removed Retrofits” indicates the number of apartments at each site that had systems removed, which accounted for approximately 29% of apartments verified, while the last two columns of the table provide details on which systems components had been removed. These verified installation rates were subsequently compared to Edison verification values to ensure consistency and to identify and address any discrepancies. The Edison inspections confirmed only the presence and operation of all systems at the sites they verified, but did not record configuration details.

Table 3–3. Installation Observations

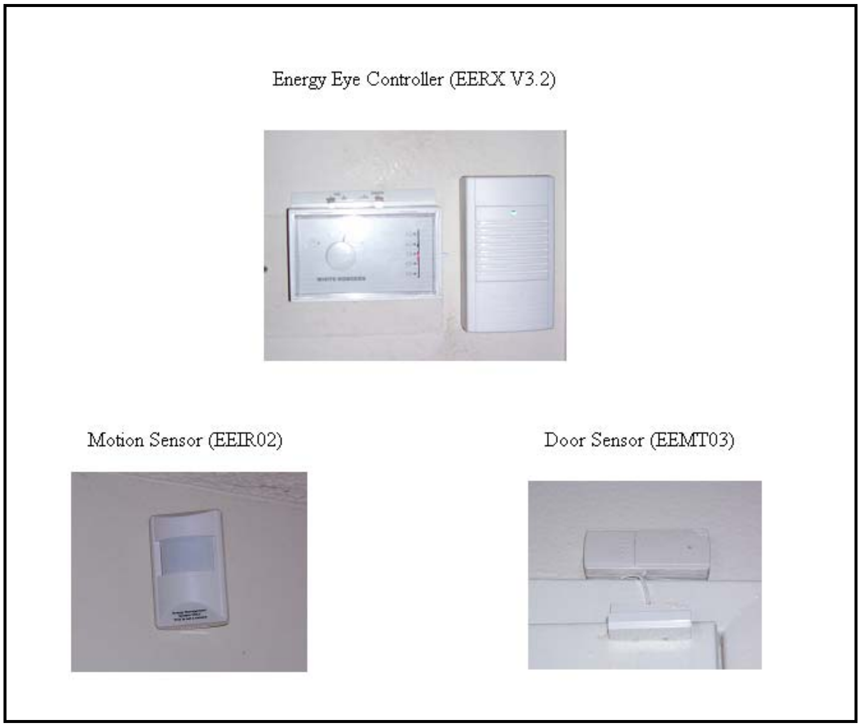
Site	Program Recorded Apartment Installations	Verified Apartment Installations	Apartments with Removed Installations	Number of Motion Sensors Removed	Number of Door Sensors Removed
Site 1	10	10	0	0	0
Site 2	17	17	9	21	19
Site 3	10	10	0	0	0
Site 4	9	9	5	6	7
Site 5	10	10	4	10	6
Site 6	10	10	1	4	2
Total	66	66	19	41	34

A secondary objective of the verification activities was to provide input on the quality of installations completed through the Program. In general, all retrofits verified by the evaluation team appeared to be well installed and operating correctly. However, there were instances where batteries and/or entire Energy Eye™ components were removed. This was attributed to tenant lifestyle and did not influence calculated installation rates. Removal of components, however, directly impacted the persistence of energy savings. Several observations are worthy of note.

- Conversations with Program participants revealed that a majority did not know how the system operated. Furthermore, there were more than a few cases where tenants would inform the evaluation team that they thought the motion sensors were cameras and had covered them with a piece of cloth.
- Following detailed interviews with tenants, approximately 45% of the removed unit count was attributed directly to participant dissatisfaction.
- Some units only removed batteries from one or two of the Energy Eye™ system components. Further conversations with the tenants did not reveal any information as to why some motions sensors were left untouched, but a logical explanation seems to be that the batteries were removed for use with other appliances.
- The removal rate was extrapolated and calculated to be 14.4% at the Program level. These removals were due to both tenant-initiated activities and property management modifications.

Figure 3–1 details the Energy Eye™ components and installation orientation at a participant site.

Figure 3–1. Energy Eye™ System Components



Between April 2005 and February 2006, an Edison inspector visited 158 randomly selected apartments, confirming installations and system operation. The Edison inspection included a visual inspection of 10% of the installed units and included the following components:

- Presence of control device
- Presence of door sensor(s)
- Presence of occupancy sensor(s)
- An active “green” light on the control device

All systems reviewed were confirmed and operational at the time of the Edison inspections. The six apartment complexes reviewed by the evaluation team were also visited by Edison. Table 3–4 provides the location, installation dates, and inspection dates for this sample. Edison inspections typically occurred within one month of installation and approximately one year prior to the evaluation team visits. This indicates that the systems were installed correctly and were operational as stated by the implementation contractor, but that they degraded significantly within one year.

Table 3–4. Edison and Evaluation Inspection Dates

Site	Approximate Install Date	Edison Inspection Date	Evaluation Team Visits
Site 1	4/1/2005	5/18/2005	8/14/2006
Site 2	4/20/2005 - 11/15/2005	5/24/2005	8/14/2006
Site 3	5/17/2005	6/29/2005	8/15/2006
Site 4	6/22/2005	7/26/2005	8/15/2006
Site 5	7/27/2005	8/26/2005	8/16/2006
Site 6	8/8/2005	8/30/2005	8/16/2006

Engineering Analysis

An engineering analysis was conducted to develop adjusted realization rates for the Program. This included a detailed review of Program records, documents, and Energy Eye™ measurement activities as described in the following sections.

Review and Evaluation of Program Data

The final Program records submitted by the implementer to Edison were analyzed for accuracy and consistency, and to ensure that the underlying assumptions were reasonable. The key documents analyzed included the following.

- The final Program 'flat file' submitted January, 2006.[283] This file documented the activity at each site where the Energy Eye™ system was installed, including the type and number of retrofits installed, the underlying energy savings assumptions, and the installation dates. This file provided Program gross energy savings values.
- The final Program "workbook" dated January, 2006.[284] This document provided a reporting format for the CPUC and represented a summary of the information contained in the Program flat file. It did not contain site-specific information and assumed a .80 net-to-gross ratio and a 15 year effective useful life. This file provided Program net energy savings values.
- The final Program Narrative dated January, 2006.[285] This document provided an overview of Program expenditures and recorded energy savings for Program benchmark energy savings values.
- The Program synopsis titled *Multifamily HVAC Controls Program Technical Proposal Synopsis*. This file presented the Program logic and implementation plan, including energy and demand savings estimates.

[283] 0011-New Techno-flatfile-rmc-january2006.update.with.apt.final.072006.csv

[284] 0011-New Techno-ideea2005-rmc-january2006.xls

[285] 0011-RMC_IDEEA Report Narrative-Final2006.doc

Several observations resulted from this review.

1. The implementation contractor attributed .125 kW and 2,400 kWh gross savings value to each Energy Eye™ system installed, regardless of the number of motion and door sensors installed, and the relative size of each apartment. Table 3–5 shows that a range of baseline AC systems was encountered, including a variety of configurations and vintages, and ranging in size from 1 to 3.2 tons. The evaluation contractor could not identify a base AC system size or efficiency in the Program planning documents.

Table 3–5. Baseline AC systems

Site	Site HVAC
Site 1	Sample new AC: Goodman CPLE24-1A. (Mfr's site says SEER 10, 22,800 BTUH.)
Site 2	Mostly originals of unknown brand; approximately 2.5 tons.
Site 3	Mostly original Payne units. Few replacements. York, 2 to 2 1/2 tons.
Site 4	Amana, relatively new. RLA=9.1 Amp=12.
Site 5	Split system heat pumps, approximately 1.5 tons.
Site 6	Split system heat pumps.
Site 7	Equipment varies. Generally 2.6 tons. (16.1 amps, 230 volts, 11.9 RLA)
Site 8	Mostly Lennox. Varies: 1, 1.5, and 2 tons.
Site 9	Split system heat pumps. Most likely 2-2.5 tons.
Site 10	Split system heat pumps. Approximately 2 tons.
Site 11	**GAS HEAT** Split systems. Equipment varies. Some are 3.2 ton.
Site 12	Split system heat pumps. Generally 2 tons.
Site 13	Self-contained through-the-wall 2-ton units.
Site 14	Mostly original Janitrols, approximately 2 tons.

2. The final Program workbook assumes the estimated useful life (EUL) of the Energy Eye™ system is 15 years. However, field observations have shown that without replacing the batteries (prevalent in a majority of sites verified), the EUL is reduced to less than two years.[286] A field supported engineering analysis of battery EUL is discussed below.
3. The final flat file and workbook assume a 100% persistence rate. However, field verification activities demonstrated that many tenants removed entire Energy Eye™ systems and/or components. This factor detracted from the overall persistence savings attributable to the Program.

Review of Program Energy Savings Assumptions

The Program used an E-Quest model to estimate savings. The results of the E-Quest computer-based energy simulation models suggest that the average savings per apartment in the desert communities would be 3,159 kWh and .125 kW. The implementation contractor made several

[286] Battery life analysis reveals a mean time to failure of 88.4 days – a significantly reduced EUL for the series based system.

adjustments to provide a more conservative view of savings and reduced annual savings to 2,400 kWh as follows.

- The modeling did not include any savings from apartments using electric energy for heating purposes, though our sample indicated that no participants have electric space heating.
- The average apartment was assumed to be only 640 square feet, though the actual size averaged over 700 square feet.
- The average savings per unit were reduced from 3,159 kWh to 2,400 kWh.[287]

The Program energy savings assumptions provided to the evaluation contractor included simple engineering models, though the EQuest modeling was not provided.[288] It is likely that original assumptions about apartment occupancy rates are in error. The demographics at the majority of sites indicated that these apartments are occupied for extended periods of time, including midday during weekdays. This was noted during site visits that typically occurred from morning until evening on weekdays. The evaluation team could not find documentation of expected occupancy levels, a key assumption for a control system that depends on vacancy to provide savings.[289]

In addition, the evaluation team concluded that the battery life degraded much faster than the two to five year life expectancy claimed by the implementation contractor and equipment vendor. This projection was based on hotel/motel installations, and it is likely that battery life was significantly shorter in this application because the higher occupancy rates in these apartments required the controller to work much harder than in hotel applications. An interview conducted with the participant during site visits confirmed that occupancy rates and usage patterns at the apartments varied considerably from the manufacturers assumed application in hospitality facilities. Savings from similar technology applied to hotels indicate that a 45% occupancy rate yields a 20% reduction in energy usage.

Based on these observations and the discrepancies between the model assumptions and actual installation parameters, the evaluation team concluded that the savings resulting from the simulation analysis were inaccurate for reporting purposes.

Site Measurement Activities

The equipment installed through the Program was manufactured by Energy Eye™, a privately held corporation founded in 2001. The key systems components included:

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[287] RMC, *Multifamily HVAC Controls Program Technical Proposal*, page 12. Implementer's stated: "To further reduce the possibility of over-stating savings, we reduced the average savings by 14%, down to 2,400 kWh." The evaluation contractor confirmed 2400 kWh savings were applied in the program workbooks.

[288] Ibid, page 11. Implementer's stated: "Since no in-field data was available to estimate savings, we used the E-Quest energy simulation software to model several apartment types situated in the targeted geographic locations."

[289] The Technical Proposal did not list occupancy assumptions used in E-Quest simulations, but noted occupancy habits (in part) could lead to variation in savings.

- A wireless, passive infrared “people detector” requiring two CR123A batteries per sensor rated at 3V
- A wireless micro door sensor requiring one CR2450 battery rated at 3V
- An HVAC “brain” receiver/controller

A rigorous methodology was employed at each participant site in order to validate the claimed EUL and confirm system operability. The process included two primary measurement activities.

- Test the battery strength with a voltmeter.
- Test sensor signal strength through observations of system operation, and by physically removing/testing individual sensor effective radii. This ensured that the sensors could properly transmit to the controller and that nothing was interfering with the radio transmission (e.g., metal frames or a magnetic field).

The steps required to accurately gauge these two measure parameters involved the following.

1. A voltmeter was used to read the voltage levels on the batteries installed in both the door sensors and the motion sensors at participant sites.
2. When testing the door sensors, the sensor was activated to see if it sent the appropriate radio transmission signal to the controller. The controller would thereby indicate successful reception and “decode” the signal by illuminating the yellow signal decode LED. The yellow LED illuminated each time a signal was sent (e.g., when a door was opened or closed).
3. When testing the motion sensors (EEIR02), it was necessary to stand completely still for at least 10 to 15 seconds. This ensured that the battery preservation feature was reset and would transmit a signal upon the next movement detection. After the allotted time had passed, a member of the evaluation team would move, thereby activating the sensor to transmit an occupancy signal to the controller, which was also indicated by an illuminated, yellow LED.
4. If any LEDs did not illuminate, careful notes were taken to that effect.

The results were recorded using the field instrument in Volume 2, Appendices.

Battery Measurement and Results

The system operation is highly dependant on the function of the wireless sensors. The wireless sensors require batteries for operation, and, operation of the wireless sensors is highly sensitive to battery capacity. The infrared sensor uses two common CR123A lithium camera-type batteries and the door sensor requires one common lithium CR2450 coin cell battery. The manufacturer advises hotel properties to change their sensor batteries according to the same schedule they would need to change the electronic lock batteries, but provided no guidance on multifamily facility usage.

The manufacturer stated that the system could intelligently detect a low battery and go into a 'safe' default mode relinquishing all control to the occupant so that there would never be a lapse in HVAC operability. However, according to the installation Manual,[290] it should only be necessary to change the battery every two to five years with normal operating usage in the hospitality market segment.

The following observations about the batteries are based on site visits and tests.

1. If one battery drops below 2.3V, a blinking LED indicates a low battery condition.
2. If one battery is below 2.2V the system will not operate, and control is relinquished to the original thermostat.
3. A great disparity in the quality of batteries was found by the Energy Eye™ company.
4. If the motion sensor batteries fail, the door sensor will not operate.

Because most installations occurred in low-income housing, battery replacement is likely a significant issue. Based on a review of five retail outlets, CR123A battery prices ranged from $1.99 to $11.99, with an average price of $6.89 per battery, indicating an average cost of $13.78 to change both batteries in each occupancy sensor. Our sample of 55 apartments indicated that 2.3 occupancy sensors were installed in the average apartment, requiring 4.5 batteries with an average replacement cost of $31.49 per apartment.

A similar survey of CR2450 batteries indicates a price range of $2.99 to $9.95 with an average battery price of $5.98. Our sample indicated that the average apartment has 1.26 door sensors requiring 1.26 total batteries with an average replacement cost of $7.55 per apartment.

The total average battery replacement cost is $39.04 per apartment, which is somewhat unreasonable for the participating market.

Controller Measurement and Results

The illumination of the LEDs within the Energy Eye™ controller was noted as well. Each LED corresponded to a specific component. Figure 3–2 illustrates the components of the Energy Eye™ controller (EERX) and Table 3–6 provides a description of the signal decode LEDs.

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[290] Energy Eye™ System—Advance Wireless RF HVAC Control and Energy Management System (EMS) Installation & Operations Manual.

Figure 3–2. Energy Eye™ Controller

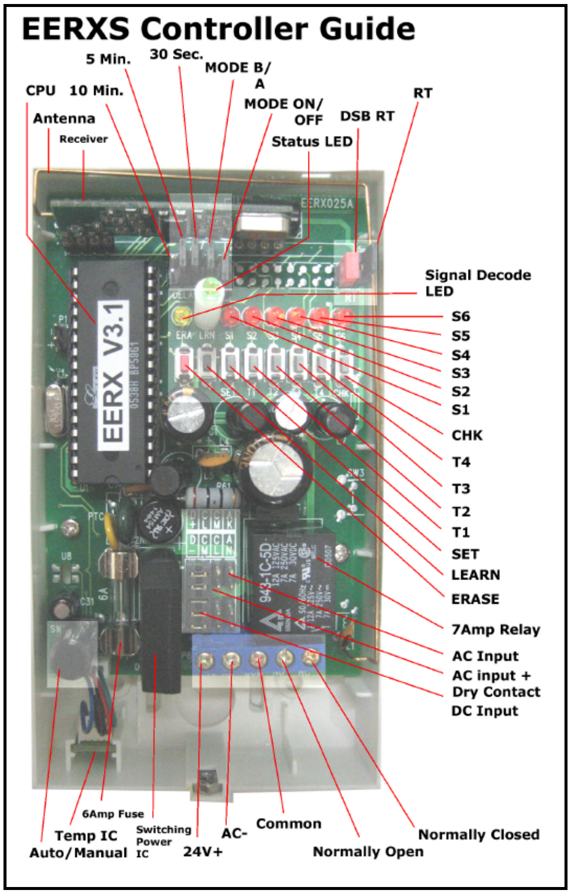


Table 3–6. Signal Decode LED

S1 – Main entry or front door
S2 – Secondary entry door, back door or beach access point
S3 - Sliding glass, lanai, or window sensor (instant HVAC turn-off when opened)
S4 – Main room motion sensor
S5 - Second room motion sensor
S6 – Third room motion sensor

The collected data were used to analyze and extrapolate battery levels at the Project and Program levels. In addition, the battery level measurements served to indicate whether or not the Energy Eye™ system was inoperative due to a lack of power or a transmission error since the controller did not explicitly detail the cause of failure. Table 3–7 details the Energy Eye™ system definitions for displayed LED signals.

Table 3–7. LED Signal Definitions

LED Action	Status	Explanation
Solid	Normal Operation / Auto Mode	The Energy Eye™ System is operating correctly, battery levels are acceptable and all components are in place.
Blinking 1	Low Battery / Component Non-Communication	Corresponding red LED will blink, with the green LED indicating which component is missing, experiencing interference (non-communication) or has a low battery. Low Battery status will be indicated slightly prior to total power loss in order to change batteries without interrupting operation.
Blinking 2	Controller Failure	Green LED will blink without Red LED component indication. One of the critical components (temperature thermistor or receiver cache) has failed or has been damaged by static electricity.
Off	Bypass Operation / Manual Mode	The controller is set to Manual Mode and is not controlling the room temperatures during any occupancy state. If Red LEDs are also off this may indicate a loss of power.

An analysis of the Energy Eye™ controller LED illuminations was conducted to correlate battery voltage readings with controller-identified failures. Table 3–8 illustrates the evaluation team's findings. S1 through S6 correspond to the signal decode LED in Table 3–6.[291]

Table 3–8. LED Distribution

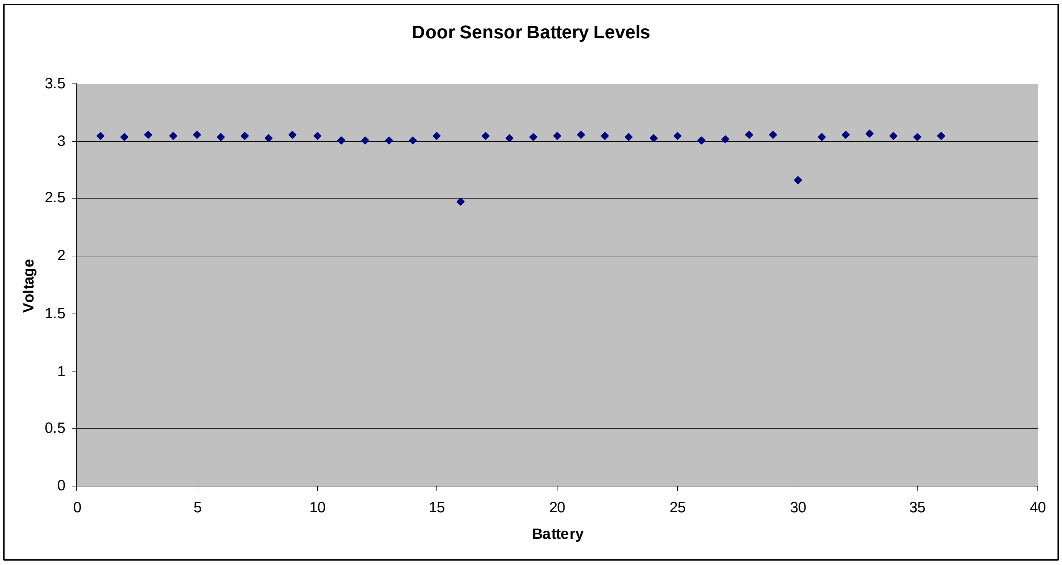
	Status LED	S1	S2	S3	S4	S5	S6
Solid	6%	86%	88%	92%	6%	23%	41%
Blinking	94%	14%	13%	8%	94%	77%	59%

The LED illumination analysis results correlate fairly well with the battery readings in that a majority of the door sensors were operating correctly, while a disproportionate number of motion sensors were failing due to low battery levels. The blinking LEDs are indicative of the problems with the sensors.

Figure 3–3 and Figure 3–4 provide a detailed analysis of the Energy Eye™ component battery levels by verified sites. This information was later analyzed in conjunction with installation dates to calculate an estimated battery life degradation factor. Figure 3–3 and Figure 3–4 only account for batteries taken from sites that had a thermostat controller installed and operating.

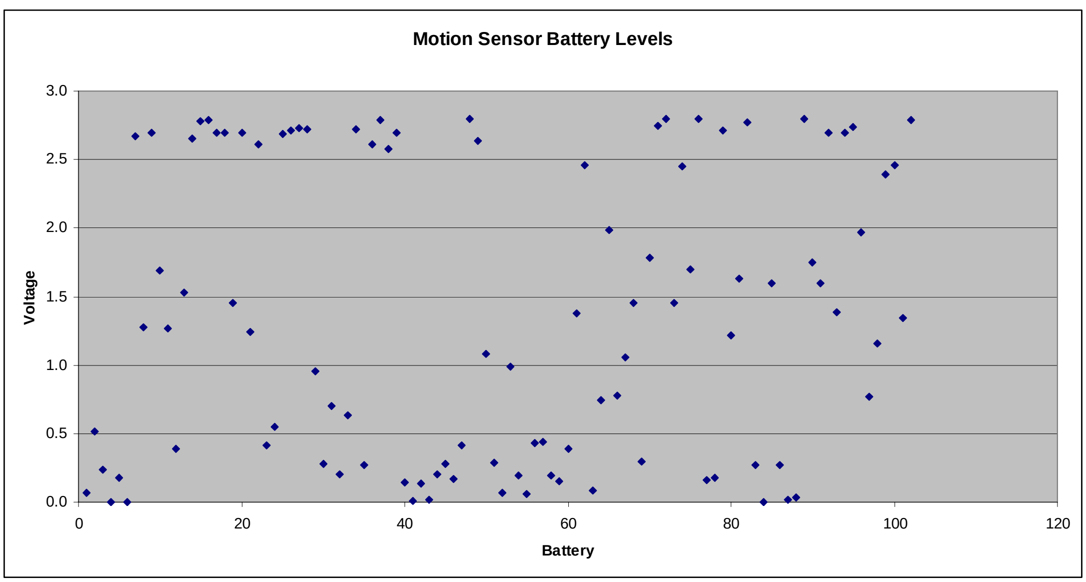
[291] A solid LED represents a working system. A blinking LED represents a low battery/component non-communication and/or controller failure. The blinking LEDs notify participants of which component needs attention. Table 3-8 details the aggregated findings at all verified sites. In all verified sites, 6% of the systems were solid, while 94% were blinking. Furthermore, S1 was solid 86% of the time, meaning that the main entry door sensor was operating as intended. However, S4 (main room motion sensor) was blinking 94% of the time. This is to be expected since this sensor is utilized more often than the main door and is prone to battery failure.

Figure 3–3. Door Sensor Voltage Readings



The average door sensor battery reading was calculated to be 3.02V. It is believed that there is very little variability in the readings due to the fact that the door sensor is utilized only a fraction of the amount that motion sensors are utilized, resulting in increased battery life.

Figure 3–4. Motion Sensor Voltage Readings



The average motion sensor battery reading was calculated to be 1.36V. The wide fluctuation in readings is believed to be caused by three main factors:

– Different installation dates

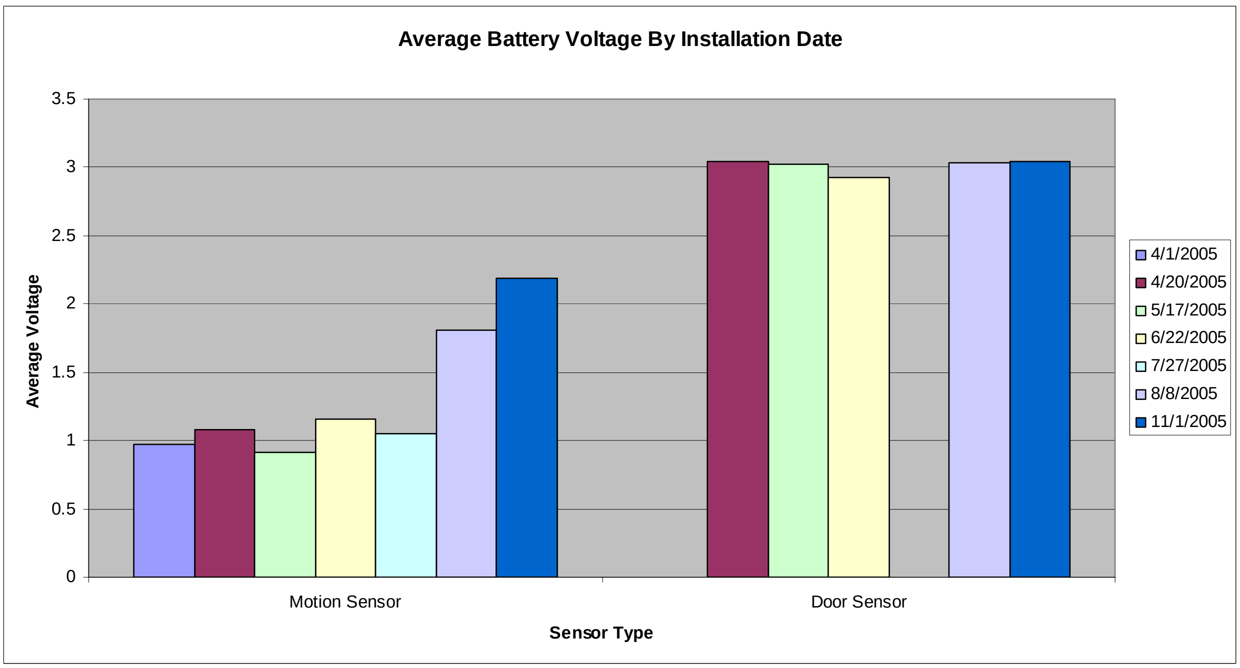
– Different utilization rates (different tenant demographics and lifestyle)

– Non-uniform battery replacement

A total of nine apartments had the Energy Eye™ controller installed but shut off, and two apartments had the Energy Eye™ components installed, but the thermostat controller was removed.

The battery voltage levels were tracked with respect to Energy Eye™ system installation dates in order to determine, if possible, a relationship between the batteries expected life and the systems' operating history. The results of this analysis are depicted in Figure 3–5.

Figure 3–5. Voltage Levels Respective of Installation Dates



It should be noted that Site 2 installed measures on two different dates, which is why the graph identifies seven installation dates for the six sites verified. A regression analysis was utilized to estimate the battery degradation factor for both the motion and door sensors. The motion sensor batteries were calculated to degrade at a rate of .19V per month.[292] This degradation presents a risk to the persistence savings of the Program without a regimented battery replacement program. The door sensor voltage readings were fairly uniform (due to lower utilization rates), and it was assumed that their degradation was negligible with respect to Program performance goals.

[292] At this rate, it would take 88.4 days for the voltage to drop to the point where the sensor shuts down. See MTTF failure below. Field/Engineering analysis revealed that the batteries could operate the sensors above as long as the voltage reading was greater than 2.2V.

The lower-than-expected EUL is due mainly to the fact that the system is comprised of multiple batteries, each of which is responsible for system functionality. If one battery fails, the entire system shuts down. Therefore, there is almost an inverse relationship between expected system lifetime and the number of batteries that the system depends on. An analysis of system mean time to failure (MTTF) was conducted based on the average number of system components observed at the sites. This analysis provided general insight into measure effective life. However, a number of engineering assumptions were made and are noted below.

1. The average number of motion sensors observed per site was calculated to be 2.3.

2. The average number of door sensor observed per site was calculated to be 1.26.

3. The average lifetime of a motion sensor was assumed to be approximately eight months (5,760 hours), based on the battery voltage analysis conducted on site.

4. The average lifetime of a motion sensor was assumed to be two years (17,520 hours), due to lower utilization rates.

Under these assumptions, the average failure rate of the motion sensors is 2.3/5760. Similarly, the average failure rate of the door sensors is 1.26/17,520.[293] The failure rate of a system is defined to be the aggregate of the failure rates of its components.

Failure Rate $_{\text{System}}$ = (2.3/5760) + (1.26/17,520) = .000047.

Consequently, the average $\text{MTTF}_{\text{System}}$ is the inverse of the failure rate: 2122 hours, or 88.4 days.

Engineering Analysis Results

Based on the review of Program documents and site measurement activities, the following adjustments to Program realization rates are recommended.

1. The estimated useful life of the Energy Eye™ system without a battery replacement program is much shorter than the manufacturer forecast of two to five years. In addition, the installation manual states that the batteries should be replaced if they drop below 2.5V; however, field observations revealed that the system components still operated effectively until voltage levels dropped below 2.2V.
2. Table 3–9 shows system failures due to battery failures based on a sample of 128 occupancy sensor batteries at 55 apartments at six different sites. (Batteries in systems that were disconnected were not accounted for in this analysis.) Battery depletion resulted in a high percentage of failures at all sites, from a high of 100% failure at Site 1 to a low observed failure rate of 80% at Site 2. Our sample indicates that 66.4% of all batteries tested were below the 2.3V required to operate the system, resulting in a failure rate of the system of 89.1%.

[293] 5,760 and 17,520 are the expected lives of individual measure components.

Table 3–9. Battery Failures

Site	Batteries Passing	Batteries Failing	Percentage of Batteries Below Threshold Voltage	Number of Systems Passing	Number of Systems Failing	Percentage of Apartment Systems Failing
Site 1	2	6	75.0%	0	4	100.0%
Site 2	14	19	57.6%	3	12	80.0%
Site 3	5	29	85.3%	0	10	100.0%
Site 4	7	12	63.2%	1	8	88.9%
Site 5	7	9	56.3%	1	7	87.5%
Site 6	8	10	55.6%	1	8	88.9%
Total	43	85	66.4%	6	49	89.1%

3. After analyzing the Program installation records, coupled with RMC verifications and the evaluation team's observations, the evaluation team concludes that the installation rate is 100%, that is, 100% of the installations have occurred.
4. Many of the participants were dissatisfied with the performance of the Energy Eye™ system and removed the system and/or distinct components. The frequency of disabling the system varied greatly between apartment complexes, with 55.6% of systems removed or disabled at Site 4, and no systems removed at Site 1.
5. In estimating ex-ante lifecycle savings, a 15-year measure life was used for the Energy Eye™ system. However, the three components of the system have different measure lives. The Energy Eye™ controller operates in ways similar to a programmable thermostat, which has a measure life of 11 years according to the DEER database of measure lives. This controller, however, must operate together with an occupancy and door sensors. A failure of either component will make the system inoperable. The occupancy sensor has a measure life of eight years, which hinders overall system functionality. Therefore, the evaluator assigned an eight-year measure life to the system based on the system components. No EUL was found for the door sensor. An eight-year economic useful life is used in Table 3–25.

The evaluation team concluded that a billing analysis would provide the most accurate estimate of energy savings attributed to the Energy Eye™ system for the following reasons:

1. Program assumptions were deemed to be unrepresentative of actual installation parameters. For example, the system was designed for the hospitality market segment and provided no guidance in modifying measure expectations/needs for the multifamily environment. The engineering analysis depends, to some extent, on the validity of these assumptions and may not have been able to accurately account for the number and magnitude of errors in Program assumptions. It is likely that the billing analysis more accurately accounts for the higher occupancy rates at multifamily sites than the Program assumptions used in the engineering analysis, which were based largely on estimates for the hospitality market.

2. As shown in the analysis, a majority of systems were identified to have failed prior to the verification visit by evaluation staff. Even after conducting a regression analysis on battery voltage as a function of time, it is difficult to accurately identify exactly when the

systems failed. It is likely that the billing analysis more accurately reflects the early system failure rates.

Billing Analysis

The billing analysis included the data request, data cleaning and screening to optimize reliable results, and three separate fixed-effects regression models. The regression models were conducted using a pre-post indicator, daily HDD, and daily CDD as independent variables to determine the impact of the Program upon daily energy consumption. Gross and net energy impacts were determined. Results were extrapolated to the Program level.

To conduct the billing analysis, monthly energy consumption histories were requested from Edison for all Program participants listed in the flat file. Some of these participants had Edison account numbers, some had meter numbers and some had no Edison account number or meter number. Edison made several attempts to extract data based on available account numbers and participant names and addresses. This is a population with high turnover, which made it difficult to match names and addresses between the flat file and Edison's customer information system. Because of this, and incomplete data, extracting billing data was extremely tedious, complex, and not very productive. In addition, the plan was to conduct the billing analysis on a building-level basis rather than on an apartment-level basis. The implementer's flat files did not provide enough information to determine which apartments were housed within each building.

In an effort to resolve the problem surrounding data extraction and identifying which apartments were in each building, efforts were coordinated with the evaluation team conducting onsite verification. A random sample had been selected for onsite verification from sites with the Energy Eye™ in operation for at least one year. All inspected and verified apartment units had dedicated meters. During the onsite verifications, meter numbers were collected manually for all apartments at the apartment complex. Data was also collected to indicate which apartments were housed in each building. Subsequently, a revised data request was submitted to Edison which included meter numbers collected at the site.

Data was requested for 601 meter numbers for six properties included in the site visits. The meter numbers included units that did and did not have the Energy Eye™ sensors installed. There were 505 meter numbers belonging to units with sensors installed. Edison's extraction resulted in 578 matches between the extracted billing data and the contractor's files with installation dates. Of these, 492 units had sensors installed and the remaining units did not have sensors installed. The billing data included consumption histories ranging from June 2003 through September 2006. Table 3–10 shows the data attrition for the requested billing data.

The methodology for analyzing energy savings in a multifamily dwelling requires the building to be analyzed as a whole due to the interaction between apartment units; they do not behave the same single family homes. Analyzing billing data at the building level assumes that the sensors were installed within a few days of each other and that the installation month could be dropped from the analysis. That is, the installation month would not be considered either pre or post.

Special consideration was needed for one participating property. At this site there are both one- and two-bedroom units in each building. The sensors were installed in two waves: two-bedroom units were completed in April 2005, and one-bedroom units were completed in November 2005. Because installations took place in the same building in both April and November, an "installation month" could not be excluded from the pre- and post-periods, and, the building could not be analyzed as a whole. Therefore, the one-bedroom units and two-bedroom units were separated into their own corresponding "building" and were analyzed separately.

For each participating site, the zip code was matched to the appropriate Edison weather station. Three Edison weather stations were mapped to the zip codes. One zip code did not have a station mapped to it, so the nearest station was manually assigned. For each station, the average daily temperature from the weather data provided was used to create base 65 cooling degree days (CDDs) and heating degree days (HDDs). The HDDs and CDDs were matched to each of the billing data periods.

The unit-level billing data and weather CDDs and HDDs were allocated to a calendar month. This was done because there were irregularities in meter read dates between the units within the same building. As noted previously, the month of installation was removed to ensure a clean pre- and post-period.

Five data quality screens were applied as shown in Table 3–10. The first screen removed any month with less than 1 kWh per day. A monthly reading this low would indicate that the unit is vacant. This step did not remove any sites, just single months within the unit's history. The second screen removed sites with less than two summer months. Since we were interested in the cooling component of usage in particular, it was important to have cooling season data. The third screen removed sites with less than five months of pre- or post-data. The first three screens dropped our participant sample significantly, from 492 to 261.

Table 3–10. Final Participant Attrition

Screen	Metric	Number of Unique Participants Removed	Percentage of Total Unique Participants Removed	Number of Unique Participants	Percentage of Total Unique Participants
	Total number of units with sensors installed and meter numbers collected	- - -	- - -	505	100.00%
Pre-screen	Unable to accurately match billing and measure data	13	4.58%	492	97.43%
Screen 2	Less than two summer months in pre or post period	209	73.59%	283	56.04%
Screen 3	Less than five months in pre or post period	22	7.75%	261	51.68%
Screen 4	Models with unintuitive parameters	10	3.52%	251	49.70%
Screen 5	Extreme pre-post consumption changes	30	10.56%	221	43.76%
	Final sample	284		221	43.76%

In this billing analysis it was important to isolate each unit's HVAC usage component. If the heating slope (β_2) was positive the apartment appeared to heat with electricity. Although analyzing cooling usage is the primary focus of this Program, we separated the heating component of usage whenever possible. In this modeling approach, two models were run for both the pre-period and post-period.

For each unit *i* and calendar month *t*, and cooling and heating base 65,

$$ADC_{it} = \alpha_i + \beta_1 AVGCDD_{it} + \beta_2 AVGHDD_{it} + \varepsilon_i \qquad (1)$$

where

- α_i is the intercept for each participant. This represents the base load usage in the pre- or post-period;
- β_1 is the cooling slope in the pre- or post-period;
- β_2 is the heating slope in the pre- or post-period;
- ADC_{it} is the average daily consumption during the pre (post) Program period;
- $AVGCDD_{it}$, is the average daily cooling degree days (base 65) pre (post) period based on site location;
- $AVGHDD_{it,}$ is the average daily heating degree days (base 65) pre (post) period based on site location; and
- ε_{it} is the error term.

From the model above, the weather normalized annual consumption (NAC) for the pre or post period is computed as follows:

$$NAC_i = \alpha_i * 365 + \beta_1 LRCDD_i + \beta_2 LRHDD_i + \varepsilon_{it} \quad (2)$$

where, for each customer *i,*

- NAC_i is the pre(post) period normalized annual consumption;
- α_i * 365 is the annual model base load (non-weather related usage) for each unit ;
- β_1 is the cooling slope in the pre- or post-period from the model;
- β_2 is the heating slope in the pre- or post-period from the model;
- $LRCDD_i$, is the annual long run (normal) cooling degree days (base 65) for site *i*, based on location;
- $LRHDD_i$, is the annual long run (normal) heating degree days (base 65) for site *i*, based on location;
- $\beta_1 LRCDD_i$, is the annual pre or post cooling usage component for (base 65) for site *i*, based on location;
- $\beta_2 LRHDD_i$, is the annual pre or post heating usage component for (base 65) for site *i,* based on location; and
- ε_{it} is the error term.

The model outputs were examined, and those with unintuitive model parameters (i.e., negative base load, cooling load, or heating load) were removed (Screen 4, Table 3–10). Once these "bad" models were removed, the best model at a given unit was chosen as the model with the highest r-square. Also, any participants that had a change in cooling usage of more than 80% from pre- to post-periods were dropped. Such a drastic change would indicate that the units were vacant, that occupants changed from pre- to post-period, or that there were other anomalies in the unit-level billing data which could not be attributable to the Program (Screen 5, Table 3–10). Together, these final screens reduced the total number of participants included in the billing analysis to 221. It should be noted that through the screening process entire buildings were dropped.

The Program-level results are summarized in Table 3–11. For the 221 participants analyzed in this Program, across all properties, the average savings per unit was 131 kWh. This is considerably lower than the ex-ante savings estimate, or 2,400 kWh per unit, and also considerably lower than the 1200 kWh that the engineering analysis offers. The Program-level realization rate was 5%. The average pre-period cooling usage per unit was 2,736 kWh—which was 42% of pre-period consumption.

Table 3–11. Usage and Savings Per Unit at Program Level

	Treated Units	Pre-period Normalized Total Usage	Pre-period Cooling Usage	Cooling Savings	Estimated Savings	Realization Rate	Savings as % of Cooling Usage	Cooling Usage as % of Total Usage
Program	438	6,589	2,736	131	2,400	5%	5%	42%

Savings were calculated at the unit level and weighted up to the building level. Savings were then calculated for the complex and at the Program level. Weights were developed at the unit level based on the number of units in each building that were treated and the number of units in the building that were included in the analysis. This allowed a correction for the treated units that had been screened out of the analysis. For example, if the building contained three treated units and only one unit remained after screening, the remaining unit had a weight of three. The weights summed to the number of treated units in a building. Cooling savings were computed by weighting the savings of each unit remaining in the billing analysis up to the total number of treated units in a building.

As is evident from Table 3–12, savings observed in the analysis ranged dramatically by site, but in all cases savings were much lower than the expected engineering savings. The highest realization rate at the site level was 19%. For the remaining sites, the savings were minimal, and usage for one site was actually increasing. It should be noted that savings at Site 1 were the highest, where no Energy Eye™ systems were removed. Site 4, where 56% of the systems or components were removed, had one of the three lowest rates of energy savings.

Table 3–12. Usage and Savings per Unit at Property Level

Site	Treated Units	Pre-period Normalized Total Usage	Pre-period Normalized Cooling Usage	Cooling Savings	Estimated Savings	Realization Rate	Savings as % of Cooling Usage	Cooling Usage as % of Total Usage
Site 1	46	5,618	2,197	445	2,400	19%	20%	39%
Site 2	200	6,912	1,569	167	2,400	7%	11%	23%
Site 3	23	7,030	2,864	12	2,400	1%	0%	41%
Site 4	28	4,825	3,154	53	2,400	2%	2%	65%
Site 5	29	5,850	2,723	199	2,400	8%	7%	47%
Site 6	112	6,954	4,912	-38	2,400	-2%	-1%	71%
Total	438							

One site installed the energy management system in two-bedroom apartments in April and returned to install the system in one-bedroom apartments in November. The results of an analysis on this site do not support the hypothesis that larger units might save more energy, but the results may be clouded for several reasons. The two-bedroom units were installed early in the Program when the issues with controllers and batteries (described in the impact evaluation) were still being reviewed. The manufacturer didn't have a clear date for resolution of the issues but felt the last 30% to 35% of the installations would have had the modified controller and the upgraded batteries. If that is the case, then the one-bedroom units, realizing greater savings than the two-bedroom units, may be benefiting from the controller and battery modifications, as shown in Table 3–13.

Table 3–13. Comparison of Various Installation Configurations Completed at Separate Times

Site	Size Installed	Treated Units	Pre-period Normalized Cooling usage	Pre-period Cooling usage	Cooling Savings	Estimated Savings	Realization Rate	Savings as % of Cooling Usage	Cooling Usage as % of Total Usage
Site 2	2BR -April	133	7870	1586	37	2400	0.02	0.02	0.2
Site 2	1BR-Nov	67	5010	1536	426	2400	0.18	0.28	0.31

Implementers anticipated the ex-ante savings would average more than 2,400 kWh annually. The billing analysis found that for some sites, the ex-ante projected 2,400 kWh savings was more than the entire cooling usage of the participant in the pre-period.

In summary, the billing analysis showed almost negligible savings overall, with a 5% realization rate.

Program implementers acknowledged that savings would vary by the size of the apartment, the geographic location (climate and CDD), and occupancy patterns. Future energy-efficiency programs using this type of measure, should adjust energy savings estimates to reflect these factors.

Impact Evaluation Results

Engineering Estimates of Ex-post Program Gross Savings

Table 3–14 provides an overview of Program reported and achieved savings. The discrepancy between reported and evaluated energy savings is attributed mainly to inaccurate Program assumptions and lower-than-expected system lifecycles, as well as first year savings. The reported ex-ante gross peak demand savings are 175 kW as compared to the evaluated ex-post gross summer peak demand savings of 9.6 kW. The reported ex-ante gross annual kWh energy savings is 3,360,000 kWh as compared to the evaluated ex-post gross annual energy savings of 183,400.

Table 3–14. Reported Ex-ante Gross Savings and Verified / Adjusted Ex-post Gross Savings[294]

Project	Reported		Verified	
	Reported Ex-ante Gross Peak kW	Reported Ex-ante Gross Annual kWh	Verified Gross Peak kW	Verified Gross Annual kWh
Program Total	175	3,360,000	9.6	183,400

Final Program Impacts

Table 3–15 presents the first year ex-ante gross and net energy savings goals and reported Program accomplishments. Table 3–16 shows the first year ex-ante gross and net demand savings goals and reported Program accomplishments.

The Program net ex-ante net savings goals and reported accomplishments were estimated using a 0.80 NTG ratio. The Program reported achieving 100 percent of their original kW and kWh goals as shown in Table 3–15 and Table 3–16.

Table 3–15. Comparison of Ex-ante Energy Savings Goals and Reported Accomplishments

	Ex-ante Program Gross Annual kWh Goals	Ex-ante Program Net Annual kWh Goals	Reported Ex-ante Gross Annual kWh Savings	Reported Ex-ante Net Annual Program kWh Accomplishments
MF HVAC	3,360,000	2,688,000	3,360,000	2,688,000

Table 3–16. Comparison of Ex-ante Demand Savings Goals and Reported Accomplishments

	Ex-ante Program Gross Annual kW Goals	Ex-ante Program Net Annual kW Goals	Reported Ex-ante Gross Annual kW Savings	Reported Ex-ante Net Annual Program kW Accomplishments
MF HVAC	175	140	175	140

The Program impacts are determined by two factors:

1. Program performance in terms of accomplishing Program participation goals
2. Estimated ex-post savings impacts for the installed measures compared to the ex-ante measure savings assumptions

[294] Verified and adjusted savings are combined since they were identical. The savings values were derived from on-site verification of operating hours, device failure rates, etc.

The Program gross and net realization rates have been calculated as the combined effect of these two factors. The Program evaluated ex-post gross energy savings are 183,400 kWh compared to the Program gross savings goal of 3,360,000 kWh. The Program evaluated ex-post net energy savings are 183,400 kWh compared to the Program goal of 2,688,000 kWh, yielding a 6.8 percent net energy savings realization rate. The Program goals, overall and for its constituent measures, ex-post gross and net energy savings, and respective realization rates are shown in Table 3–17.

Table 3–17. Comparison of Programs Goals and Ex-post Gross and Net Energy Savings

	Ex-ante Program Gross Annual kWh Goals	Ex-ante Annual Net Energy Savings Goals	Evaluated Gross Ex-post Program kWh Savings	Gross Energy Realization Rate	Evaluated Net Ex-post Program kWh Savings	Net Energy Realization Rate
MF HVAC	3,360,000	2,688,000	183,400	5.5%	183,400	6.8%

The Program demand savings goals, ex-post gross and net demand savings, and respective realization rates are shown in Table 3–18. The Program evaluated ex-post gross demand savings are 9.6 kW as compared to the Program goal for demand savings of 175 kW, yielding a 5.5 percent gross demand savings realization rate. The Program evaluated ex-post net demand savings are 9.6 kW compared to the Program net demand savings goal of 140 kW, yielding a 6.8 percent net demand savings realization rate, as shown in Table 3–18.

Table 3–18. Comparison of Programs Goals and Ex-post Gross and Net Demand Savings

	Ex-ante Program Gross Annual kW Goals	Ex-ante Annual Net Demand Savings Goals	Evaluated Gross Ex-post Program kW Savings	Ex-post Gross Demand Realization Rate	Evaluated Net Ex-post Program kW Savings	Net Demand Realization Rate
MF HVAC	175	140	9.6	5.5%	9.6	6.8%

Realization rates compared to ex-ante evaluated results are shown in Table 3–19 and Table 3–20 below. The Program evaluated ex-post gross energy savings are 183,400 kWh compared to the Program reported ex-ante gross savings goal of 3,360,000 kWh, yielding a realization rate of 5.5 percent. The Program evaluated ex-post net energy savings are 183,400 kWh compared to the reported ex-ante net of 2,688,000 kWh, yielding a 6.8 percent net energy savings realization rate (Table 3–19).

Table 3–19. Comparison of Reported Program Accomplishments and Ex-post Gross and Net Energy Savings

	Reported Ex-ante Program Gross kWh	Reported Ex-ante Net Energy Savings	Evaluated Ex-post Gross Program kWh Savings	Gross Energy Realization Rate	Evaluated Ex-post Net Program kWh Savings	Net Energy Realization Rate
MF HVAC	3,360,000	2,688,000	183,400	5.5%	183,400	6.8%

The Program evaluated ex-post gross demand savings are 9.6 kW compared to the reported ex-ante gross demand savings of 175 kW, yielding a 5.5 percent reported gross demand savings realization rate. The Program evaluated ex-post net demand savings are 9.6 kW compared to the reported ex-ante net demand savings of 140 kW, yielding a 6.8 percent net realization rate (Table 3–20).

Table 3–20. Comparison of Reported Programs Accomplishments and Ex-post Gross and Net Demand Savings

	Reported Ex-ante Program Gross kW	Reported Ex-ante Net kW Savings	Evaluated Ex-post Gross Program kW Savings	Gross Energy Realization Rate	Evaluated Ex-post Net Program kW Savings	Net Demand Realization Rate
MF HVAC	175	140	9.6	5.5%	9.6	6.8%

Final Program savings, NTG ratios and realization rates are shown in Table 3–21 and Table 3–22. The individual components of the Program were assumed to have a net-to-gross ratio of 1.0 for evaluation purposes. The Program implementer's final workbook assumed .80 NTG ratio.

Realization rates were calculated as the ratio of the evaluated net ex-post savings to the reported ex-ante gross savings. For the overall Program, the realization rate was 5.5 percent for energy and demand savings.

Table 3–21. Program Energy Savings

	Ex-ante Reported Gross kWh Savings	Ex-post Gross Program kWh Savings	Evaluated NTG Ratio	Evaluated Ex-post Net kWh Savings	Realization Rate
MF HVAC	3,360,000	183,400	1	183,400	5.5%

Table 3–22. Program Demand Savings

	Ex-ante Reported Gross kW Savings	Ex-post Gross Program kW Savings	Evaluated NTG Ratio	Evaluated Ex-post Net kW Savings	Realization Rate
MF HVAC	175	9.6	1	9.6	5.5%

Table 3–23 provides a summary of savings including ex-ante goals, ex-ante reported, and ex-post evaluated savings attributed to the MF HVAC Program.

Table 3–23. Savings Summary

	Proposal				Reported				Evaluated		
	Ex-ante Gross	Net to Gross	Ex-ante Net		Ex-ante Gross	Net to Gross	Ex-ante Net		Ex-post Gross	Net to Gross	Ex-post Net
kWh	3,360,000	.8	2,688,000		3,360,000	.8	2,688,000		183,400	1	183,400
kW	175	.8	140		175	.8	140		9.6	1	9.6

Lifecycle Savings

Table 3–24 and 4-25 illustrate the Program's ex-ante and ex-post expected net lifecycle savings based on the assumed lifecycle of the system's motion sensor component. Note that the ex-post EUL assumes that sensors operate for 8 years with proper battery maintenance. Ex-post savings reflect the fact that the majority of sensors fail early due to improper battery maintenance, and these sensors are not maintained beyond the initial failure.

Table 3–24. Program Ex-ante Lifecycle Net Energy Savings

Ex-ante EUL	Ex-ante Lifecycle Net Energy Savings
16	53,390

Table 3–25Program Ex-post Lifecycle Net Energy Savings

Ex-post EUL	Ex-post Lifecycle Net Energy Savings
8	1,550

The Program lifecycle ex-post net energy and demand savings for this program are shown in CPUC required format in Table 3–26 below.

Table 3–26. Program Lifecycle Ex-post Energy and Demand Savings

Year	Calendar Year	Ex-ante Gross Program-Projected Program MWh Savings	Ex-post Net Evaluation Confirmed Program MWh Savings	Ex-ante Gross Program-Projected Peak Program MW Savings	Ex-post Evaluation Projected Peak MW Savings	Ex-ante Gross Program-Projected Program Therm Savings	Ex-post Net Evaluation Confirmed Program Therm Savings
1	2004						
2	2005	1,512	82.35	0.079	0.0043	-	-
3	2006	3,360	183.4	0.175	0.0096	-	-
4	2007	3,360	183.4	0.175	0.0096	-	-
5	2008	3,360	183.4	0.175	0.0096	-	-
6	2009	3,360	183.4	0.175	0.0096	-	-
7	2010	3,360	183.4	0.175	0.0096	-	-
8	2011	3,360	183.4	0.175	0.0096	-	-
9	2012	3,360	183.4	0.175	0.0096	-	-
10	2013	3,360	183.4	0.175	0.0096	-	-
11	2014	3,360	0	0.175	0		
12	2015	3,360	0	0.175	0		
13	2016	3,360	0	0.175	0		
14	2017	3,360	0	0.175	0		
15	2018	3,360	0	0.175	0		
16	2019	3,360	0	0.175	0		
17	2020	3,360	0	0.175	0		
18	2021	1478.4	0	0.077	0		
TOTAL	2004-2023	53,390	1,550				

Definition of peak MW as used in this evaluation: Average demand reduction during the summer months.

4. Conclusions and Recommendations

A number of conclusions can be drawn from both process and impact evaluations. The Program offered Edison an opportunity to test a new market and a new delivery method for energy management systems typically deployed in hotels and motels. The Program was implemented as designed and did expend all direct incentives. More energy management systems were installed than originally planned (at Edison's request). While implementers reported that they met 100% of their energy and demand savings goals, the impact evaluation found that the Program did not meet its goals. The property managers and tenants at the 14 participating sites did not, on the whole, understand what the system was or how it worked, nor was there a clear maintenance policy or practice in place. In addition, there were a number of technological adjustments that were needed. Many systems and/or components were removed. However, the manufacturers went to great lengths to address the system malfunctions and by the end of the Program had addressed two primary issues, i.e., the batteries and the controllers.

Conclusion 1. *Apartment complexes may be the wrong application for this technology.*

The system was designed for hotels, and did not work well in the multifamily apartment complexes at the onset of the Program. There were several issues that made this application different from hotel/motel applications. Manufacturers found that adjustments were needed for the technology to work in this environment because the HVAC setups were different from those usually found in hotels and motels. Occupancy patterns of the tenants are quite different from guests in motels, and many tenants were at home during the day, reducing savings potential. In addition, the economic interests between participants in the hospitality and multifamily markets are quite different and may limit the relative benefits of the system in the multifamily market. In the market targeted by the Program, residents were typically low income and may therefore take a more active role in manually adjusting their AC systems to keep their bills low, eliminating much of an automated control system's savings potential. Room occupants in the hospitality market likely take a less active role because they do not pay the energy bills, and so an automated system may help compensate for this. At night, the sensors did not register movement and the AC turned off, making the rooms too hot. Scheduling installations and inspections was difficult. Turnover among property managers and tenants was very high, and information easily lost. A maintenance policy and practice including battery upkeep was needed but was not clearly defined and maintenance costs, particularly battery costs, were prohibitive for both property managers and tenants. However, with this Program experience in the field, the manufacturer reported a number of lessons learned, and modifications were made to the controllers and batteries.

Recommendation 1. *Reevaluate deployment of the technology in apartment complexes.*

The manufacturer reported that they addressed a number of the technological issues and had modified the system for deployment in the apartment market segment. These improvements along with maintenance policies should be evaluated if the technology is introduced further into this market segment. Deploying the technology in apartments should be carefully reevaluated and considered only when the tenant's, the property manager's and the owner's concerns can be fully and successfully addressed. Moreover, maintenance responsibilities must be clarified and explicitly addressed prior to implementation.

Conclusion 2. *Baseline conditions and the operating environment impact the technology's success.*

The impact evaluation, both the engineering and billing analyses, identified low savings from this technology. Information gathered during on-site verifications and during interviews suggest two primary reasons for low savings. The first is that the baseline practices may already be effective at saving energy; that is, the tenants were monitoring and controlling their AC use and were conscientious about turning it off. Half the population maintained manual control of their HVAC. In addition, a number of tenants were also home during the day which reduced the potential for savings. Second, there were problems with the technology and its application in the apartment environment, including problems with the controllers and batteries, which followed the Program through at least three-quarters of its life. Both of these issues reduced the potential savings from the control technology.

Recommendation 2. *Assess baseline conditions and technology modifications.*

Establish and document baseline practices for potential participants. Screen the apartment complex to determine whether tenants meet the preferred profile. Retest the technology with the reported improvements made to the controller and batteries.

Conclusion 3. *Low-income tenants may be the wrong demographic for this technology.*

Many of the participants surveyed said they preferred to control their own HVAC system. This particular demographic may have less disposable income, use less energy, and be careful with the AC operations. Nearly half overrode the system and controlled the HVAC manually. As the implementers noted, the larger, "higher-end" apartment complexes may be a better market segment with larger potential for savings. In addition, as noted above, many tenants were home during the day, which also reduced potential savings. The Program was specifically targeting complexes where the tenants worked during the day. It is difficult to screen entire complexes to determine that tenants meet the desired demographics.

Recommendation 3. *Test the technology within the larger apartment complexes.*

Should this technology be deployed in this market, better screening tools are needed to determine whether or not most people are home during the day. Tenants in larger complexes may have more disposable income, be less sensitive to price, and work outside the home a large part of the day, all of which better fits the profile for application of this technology.

Conclusion 4. *Vital information about the control sensor, operation, and its benefits was easily lost over time.*

Program information was usually presented in an intangible, verbal format, supplemented by one brochure for tenants in English and Spanish as well as a maintenance document for the property managers. Interviews with all Program actors established that communications were lacking. Due to the high turnover of property managers, the short duration of installer presence, and tenant turnover in apartments, vital information about the control sensor program and its benefits was easily lost over time. One manager and a number of tenants did not know what the sensors were. Some tenants thought the sensors were cameras or an alarm system. About half the tenants cited energy and cost savings as a Program benefit and the other half did not believe the sensor had any benefits.

Recommendation 4. *Provide tenants and property managers with additional information about the system, including operations and maintenance.*

The technology needs buy-in from both the tenants and property managers to reach its technical potential. This will only happen when tenants and managers understand what the energy management system is and how the technology works. Ongoing information sharing is needed: additional printed brochures may be useful, or existing brochures may be modified so that they better explain how the sensors work, and better describe the benefits of the sensors and the Program. Different brochures should address the concerns of the respective targeted audiences, i.e., property managers and tenants.

New tenants of apartment with sensor controls should receive a brochure and demonstration of the technology upon moving into their apartment. Existing tenants could receive an updated brochure as a reminder about what the sensor does and how it works. Additionally, Edison and the property managers should consider including a small sticker mounted next to the sensors that provides a basic explanation of its function, maintenance procedures, and contact information for questions and repair. "Information nights" could be offered several times a year, open to all tenants who want more information about the technology.

Documents for property managers should reside in the apartment complex office and serve as an ongoing reference for staff. Information and maintenance information should be included in management procedures manuals. Maintenance procedures for battery replacement should be in place.

Conclusion 5. *Property managers seemed unclear about who is responsible for battery maintenance.*

Battery replacement and cost were issues. The batteries in the occupancy sensor degraded faster in the apartment environment than in the hotel environment which led to a much shorter useful life than anticipated. Batteries discharged at different rates and systems required battery replacement when only one fell below the operating threshold. In the hotel industry, the chain of command for maintenance of systems such as these is clearly defined. This is not the case for this Program's property managers. Even though over half the property managers claimed that batteries were tested every six months, the maintenance procedures and responsibility for battery replacement remained unclear. Property managers noted that the high cost of batteries (estimated at $40 per apartment every six months) could outweigh the potential energy and cost savings for tenants. The property managers were not prepared to purchase replacement batteries, and replacement could be cost prohibitive for participant tenants. Onsite inspections by evaluators found that 66 percent of all batteries tested were below the 2.3V required to operate the system. The manufacturer was made aware of battery problems and reported that he contracted with new battery suppliers, as well as implemented a battery test program prior to battery deployment. The manufacturer reported that to address the disparity in battery discharge rates, their test program ensured voltage was matched in paired batteries installed in the same sensor.

Recommendation 5. *Implement or coordinate scheduled battery maintenance, and track battery replacement.*

Replace batteries every six to nine months. As part of any new program, fresh batteries should be sent to the property managers at the time the batteries should be replaced, and tenants should be alerted to replace the batteries. Batteries should be included as part of the overall cost in any future program. For this Program, where replacement batteries were not included in the installation package, property managers and tenants should be sent a reminder postcard every six or nine months describing what needs to be done, what batteries to buy and some options about where to buy them. In addition, maintenance staff should be fully trained in the sensor operations, understand what the blinking LED mean, know when to change batteries and when to contact the manufacturer about malfunctioning systems. Periodic training is likely to be required because of high turnover in this market segment.

Conclusion 6. *Tenant discomfort and need for control limits the effectiveness of the technology.*

About half of the participant tenants interviewed stated they manually controlled their HVAC, overriding the sensor, for reasons of comfort and control. Tenants reported their apartment was too hot when they came home, or the system did not turn on when they were sleeping because the occupancy sensor was not activated.

Recommendation 6. *Further developments of the sensor technology are needed.*

Sensors need to release control of the HVAC during the night when tenants are sleeping so that the AC remains operable. Sensors need to have the flexibility to be set to fit the tenant's lifestyle. The system should accommodate both automatic and manual control.

Conclusion 7. *Tenants' primary concern was the original decision-making.*

Over half the tenants said they had concerns because they were not involved in the decision to install the energy management system. Many did not want to relinquish HVAC control to the system and one said they didn't want the sensors to know when they were not at home.

Recommendation 7. *Inform tenants early in the process.*

Tenants should be informed early in the process so that they buy into installation of the sensors and take ownership in their success.

Conclusion 8. *Property managers had a variety of concerns about the system.*

Overall, property managers said they were "not satisfied" or "neutral" about the sensor controls, specifically, and the Program overall. Improper sensor functioning was the largest reason for dissatisfaction. Thirty five percent (35%) of the property managers stated that the sensors do not work. Some property managers expressed concern about the sensors damaging their air conditioning units, and most of the property managers noted that tenants have expressed concern about the sensor units. Property managers have also expressed frustration surrounding the process to obtain replacement units and contact company staff. Other major areas of concern included Program rollout and communication, battery maintenance, cost savings, and sensor functioning. In order for this Program to succeed and expand in the market, it will be necessary to address these issues.

Recommendation 8. *Address any concerns that remain, and design communications into any new program.*

Manufacturers reported that they modified the controllers and addressed the battery issues. They also sent an operations manual to all participating property managers. Final Program follow-up coordinated between the manufacturer and Edison should be made by contacting each manager individually to address lingering concerns. Future programs of this nature should build in staff time to keep dialogue and communications open between the manufacturer, the property managers, maintenance crews, and tenants.

Conclusion 9. *Measure life is likely about half the original estimate.*

In estimating ex-ante lifecycle savings, implementers estimated a 15-year measure life for the Energy Eye™ system. However, the three components of the system have different measure lives. The Energy Eye™ controller operates in ways similar to a programmable thermostat, which has a measure life of 11 years according to the DEER database of measure lives. The controller operates together with occupancy and door sensors and failure of either component renders the system inoperable. The occupancy sensor has a measure life of eight years, which is the weakest link in the entire system that must operate together. Therefore, the evaluator assigned an eight year measure life to the system based on the controller.

Recommendation 9. *Consider all system components when determining the system's measure life.*

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13. Refrigerated Warehouse Program

1. Program Description

Onsite Energy proposed the Refrigerated Warehouse Program ("the Program") in response to Southern California Edison's ("Edison") requests for innovative energy-efficiency proposals. Southern California Edison awarded Onsite an $800,000 contract to implement the Program under the 2004-2005 Innovative Designs for Energy Efficiency Activities (IDEEA) program. Onsite Energy Corporation (Onsite) is an energy service company (ESCO) headquartered in Carlsbad California. Onsite Energy implemented the Program and hired subcontractor kW Engineering to complete the initial engineering review and installation verification.

Program documents report that California's refrigerated warehouse market consists of approximately 246 facilities making up over 470,000,000 cubic feet of space. Based on benchmarking of energy used per cubic foot, this results in overall energy consumption of 1,800,000,000 kWh and 360 MW at a cost of approximately $200 million annually. The Edison service territory consists of approximately 25% of this market.[295]

The Program was designed with the goal of reducing energy usage by over three million kWh in Southern California Edison territory. The Program was based upon a simple concept—market financial incentives to a relatively small target audience capable of realizing significant energy savings. The innovative feature of the Program was the niche-market approach it took—that is, targeting a very specific group of end-users that were relatively large energy consumers. The anticipated energy savings for this market ranged from 187,000 kWh to over two million kWh per facility.

The Program offered a comprehensive menu of refrigeration and lighting technologies, including efficiency and demand-reduction measures. In all, five different efficiency measures were offered through the Program. This "complete menu" approach was one innovative aspect of the Program and resulted in customized energy-efficiency measure installations. The Program offered financial incentives for the installation of mechanical and lighting measures to improve the energy efficiency of commercial refrigerated warehouses. Participating companies received $0.16 (sixteen cents) per kilowatt hour saved by the installed measures.

Onsite Energy proposed that the Program would address the following barriers:

- Lack of information on the benefits and magnitude of energy-efficiency improvements
- Perceived complexity of projects
- Lack of capital
- Mismatch between utility incentive structure and business decision criteria

[295] Onsite Energy, Technical Proposal, Feb. 2005, page 8.

The Program's process flow required an independent investment grade audit of the facility and engineering review and as well as customer acceptance prior to installation of measures. The Program was designed so that upon customer acceptance and authorization to proceed, the contractor would either implement a turnkey project for customers or work directly with them as they implemented projects internally. The project would be monitored and savings verified using approved measurement and verification (M&V) protocols. Although the final Program savings were highly dependent on the measures chosen and the engineering reviews, the Program as designed anticipated savings in excess of three million kWh.

The efficiency measures offered as part of the Program included:[296]

- ***Energy-efficient freezer and cooler doors to reduce refrigeration system loads***. Fast-acting cooler and freezer doors should result in energy savings by reducing the time that open doors allow treated air to leave the refrigerator or freezer. Energy is saved by reducing heat and moisture gain in the cooler. Safety is improved with reduced ice build-up on the floors and product. Onsite proposed to gather baseline information to estimate energy savings by measuring door opening sizes, temperature differentials across the door, measuring existing strip curtains (that hang inside the door), and conducting an analysis of open and close cycles per shift.
- ***Lighting retrofits involving new T-5 fluorescent fixtures that can operate at very low temperatures, and associated lighting controls.*** This measure replaces metal halide and high pressure sodium fixtures in cold storage applications. The sealed T-5 fixtures were designed to operate in temperatures at 0 degrees Fahrenheit. Lighting is dimmable and controlled by occupancy sensors. Heat produced in the sealed fixtures keep the lamps warm enough to fire and reach full output. These T-5 fixtures cost more than the standard T-5 fixtures and would exceed a two year payback without incentives.
- ***Automatic non-condensable purgers.*** The function of a purger in any refrigeration system is to remove air from the system. An automatic system with non-condensable functionality improves the overall efficiency of the refrigeration unit by removing air that can contribute to increases in temperature. Unlike its manual counterpart, an automatic system can make system adjustments without operator intervention. It also removes the purging process from maintenance staff task lists. Onsite proposed to measure energy savings resulting from the auto-purgers by measuring the condenser discharge pressure and temperature at discrete times and detecting the amount of non-condensables in the system.
- ***Integrated refrigeration controls to optimize refrigeration system operations.*** The integrated computer control systems allow existing refrigeration systems to operate in a more responsive manner to changing conditions throughout a warehouse, including daily and seasonal temperature effects. This measure focuses on electrical loads that can "slow down" or go off line during summer peak demand periods such as refrigeration, cold room fans, battery chargers, HVAC systems and secondary processes. The proposed system is designed to control and optimally sequence the refrigeration compressors to ensure only the minimal required compressors are online to minimize compressor power.

[296] Onsite Energy, Technical Proposal, Feb. 2005, pp 17-18.

This measure optimizes the peak electrical energy consumption to lower the total cost of energy.[297]

- ***Variable frequency drives on process pumps and fans.*** The refrigerated warehouse industry has a large number of fans and pumps that operate under variable load conditions. Significant savings can result from retrofit with VFDs. This is a proven technology and incentives offered through this Program should encourage implementation of the measure.

From the larger list of refrigerated warehouses in Edison's territory, implementers identified an initial potential participant pool of 26 facilities, all large energy users. Edison's Program manager noted that this niche market does not usually participate in the Standard Performance Contract (SPC) offered by Edison.

Quantec, LLC and Summit Blue Consulting completed a comprehensive process and impact evaluation of this Program. The process evaluation involved interviews with Program staff, implementers, Program participants and nonparticipants. The impact analysis was a detailed engineering analysis, including reviews, recalculation of engineering algorithms, detailed reviews of Program records, and verification site visits with an M&V component. These approaches generally conformed to the basic rigor level for process and impact evaluation as defined by the 2006 California Evaluation Protocols, though technically, these protocols do not apply to evaluations of 2004-2005 programs.

The next section (Section 2) presents the process evaluation component of the evaluation. It describes the Program structure and reported achievements, and includes a discussion of the Program logic, design and implementation, contractor and participant decision-making, and satisfaction. Section 3 reports the primary impact evaluation results from the engineering assessment of the Program as well as a billing analysis that was used as another point of triangulation for the engineering analysis. Finally, Section 4 presents the major conclusions and recommendations.

[297] The sequencing strategy monitors refrigerated zones to see if zonal temperatures are met. The controls allocate optimal compressor combination to meet the refrigerated load. At one site this was installed with a new condenser to enable the facility to float to discharge pressure. At this particular site, the condenser was installed with incentives through Edison's Standard Performance Contract. Onsite Energy Corporation, Energy Savings Analysis for Southern California Edison, Nov. 2006.

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2. Process Evaluation

Process Evaluation Methodology

This section describes the Refrigerated Warehouse Program and the comprehensive evaluation that was conducted to assess Program processes and impacts. The purpose of the process evaluation was to document the Program design and its development, including any differences between the proposed Program design and the Program that was implemented. The background and rationale for the Program were examined, and a Program logic model was developed. Interviews with Program staff and producers were implemented to gather information on market assumptions and barriers to project implementation, as well as implementation issues such as marketing and recruitment efforts, project identification and selection, and free ridership and spillover.

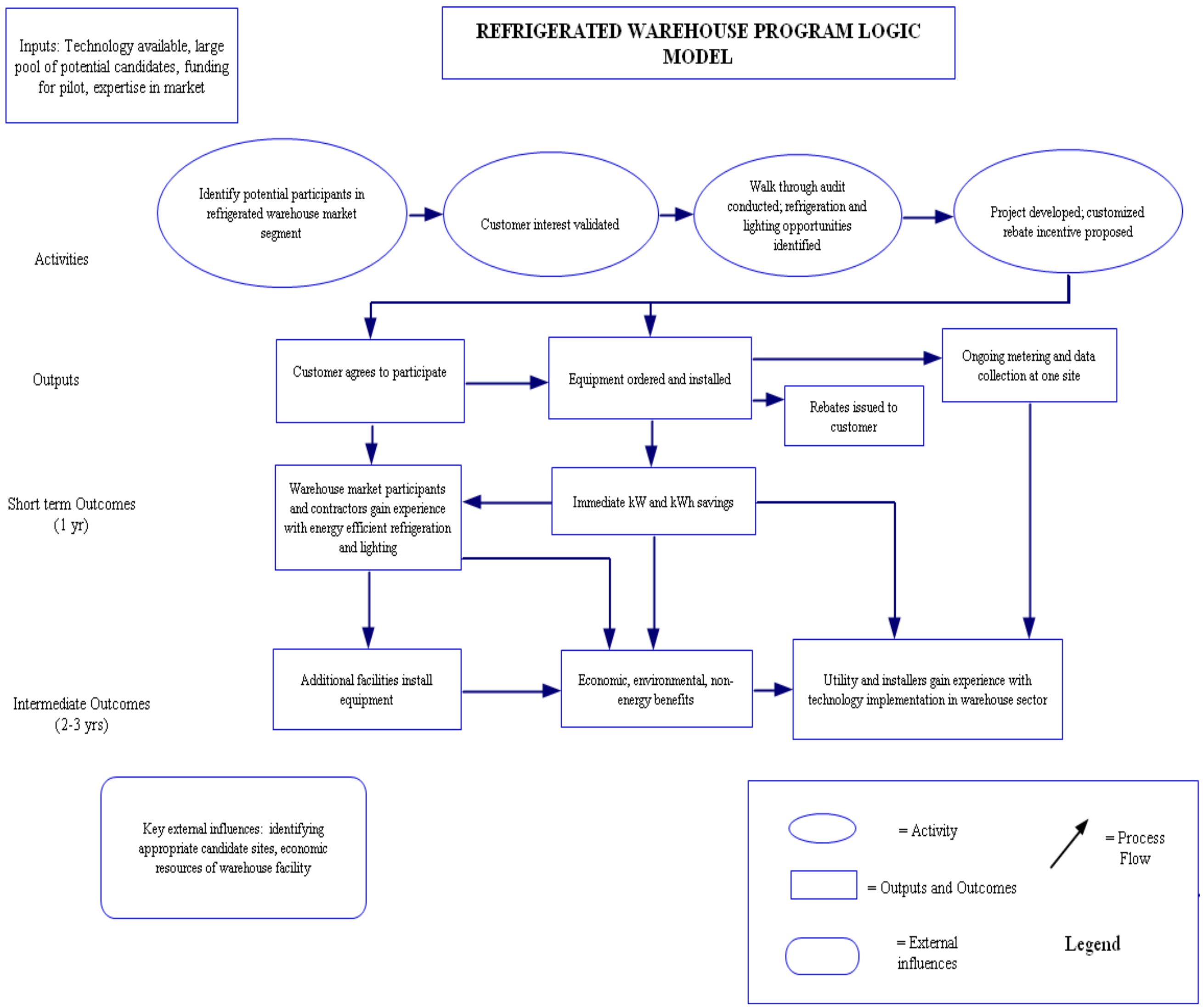
Program Logic Model

The Program logic model diagram is shown in Figure 2–1. The logic model shows the key features of the Program as understood by the evaluation team, indicating the logical linkages between activities, outputs, and outcomes. The primary activities involved identifying the potential participants, verifying their interest, conducting the walk-through audit, and developing the measure proposal with customized rebate.

The activities were expected to result in the following outputs: customer agreements, equipment installations, metering and post-installation data collection. Short and intermediate term outcomes included kW and kWh savings. Experience with a new market approach and technologies would be gained by the implementers, installers, company managers and Edison. Other outcomes included environmental and economic benefits.

The Program was implemented as designed and according to the logic model. The short-term outcomes that were anticipated within one year have been realized, i.e., warehouse participants and contractors have gained experienced with the efficiency measures, and savings were realized.

Figure 2–1. Final Logic Model



Process Evaluation Sample Design

The Program was implemented by Onsite Energy Corporation. Four companies with refrigerated warehouses participated in the Program. Data collected for the process evaluation included interviews with the Edison Program Manager, one person at Onsite Energy most involved in Program design and implementation, and contacts at all four of the participating warehouses. Two nonparticipants were also interviewed.

Onsite and Edison initially identified 26 facilities in the Edison service territory as potential candidates for this Program. Implementers proposed to include ten of these sites in the project. Six sites initially committed to install measures. However, installation occurred at just four of the sites. All four sites installed lighting retrofits. Two sites also installed mechanical controls. The proposed interview sample with all six anticipated participants was revised to include the census of participants. Interviews with participants were conducted on-site at the same time impact evaluation site visits were completed. Table 2–1 shows the attrition from potential participants to sites installing measures.

Table 2–1. Participant Pool Attrition

Participant Pool and Completed Installations	
Identified potential participants	26
Initial participation target	10
Committed sites	6
Sites installing measures	4

Contact data were requested for the warehouses that were on the initial list of 26 potential participants. Interviews with a sample of 10 nonparticipants were planned. However, contact data was only provided for three nonparticipants who were initially interested in the Program but later dropped out. Interviews were attempted with all three whose contact information was made available. Two surveys were completed; one nonparticipant refused to be interviewed.

Completed interviews are listed in Table 2–2 below. A total of nine interviews were conducted. Two were conducted with one participant company because different managers were involved with different aspects of the Program.

Table 2–2. Survey Sample Goals and Achievements

Task	Goal	Achieved
Staff/Implementer Interviews	4	2
Participant Interviews (warehouse owners/managers)	6 (census) 3 committed with measures installed; 3 committed without measures installed	5 (census) (including 2 from one company)
Nonparticipant Interviews (warehouse owners/managers)	10 (including drop-outs)	2
Total Interviews	20	9

Research questions were developed as part of the work plan and then used to develop interview guides. The questions explored the decision-making process used by participating warehouse managers. The process evaluation focused on the marketing approach used, selection of the final participants, the customer decision-making process, and the barriers addressed.

The interviews took place in October and November 2006. Before interviewing participants, interviewers confirmed that the respondent was involved in the decision to participate in the Program and/or were directly involved and knowledgeable about the Program.

Process Evaluation Results

In this section, the Program is described as experienced by individuals who designed and implemented the Program, by the sample of businesses that participated in the Program, and the sample who chose not to participate.

Program Design

The Program was largely implemented as designed and met or exceeded its energy and demand savings goals, and that there is substantial potential for a continuing Program in this sector. Both lighting and mechanical measures were installed as planned; however, fewer warehouses participated and fewer mechanical measures were installed than anticipated. This is the only "deviation" from the Program proposed. While fewer mechanical efficiency measures were installed than expected, the energy savings goals were met. However, the incentive structure may need to be redesigned to accommodate the ROI requirements for individual firms.

Marketing Assumptions

Onsite Energy identified potential participants through existing business contacts as well as through the International Association of Refrigerated Warehouses (IARW). Targeted mailings were sent to member facilities. In addition, others were targeted through the Public Refrigerated Warehouses which included a number of customer-owned sites. Marketing included direct mailing, industry trade shows, and direct contact. Marketing was designed to introduce the Program, discuss the Program's and the implementer's relationship to Edison, and review the available incentives. Onsite included information and discussed ways to overcome cost barriers.

Potential sites were first identified in late 2005, and investment grade audits were completed in March 2006. Installation of the recommended technologies occurred between March and June of 2006, and all field verification was scheduled for completion before the end of June 2006. Six sites initially were slated to participate in the Program. Four sites moved forward with the Program and completed measure installations.

The final list of measures installed at the four participating sites included the following, as shown in Table 3-1.

- Custom Freezer Lighting Fixture Retrofit (all four sites)
- Refrigeration Controls (one site)

- High Capacity Condenser (one site)
- High Efficiency Compressor (one site)

One site combined the IDEEA program incentives with incentives from Edison's Standard Performance Contract to install recommended measures.

Marketing and Participation Decisions

Program implementers noted that it could take many months before a facility was fully ready to participate. That is, first the site had to be identified and the participant had to commit to install measures; then the site needed to be audited, and the final proposal for measure installation agreed upon at the corporate level. In addition, the size of the projects dictated that some sites issue an RFP to select installation contractors. In their search for good candidate participants, implementers assessed characteristics of potential sites, including their energy expenditures, the number of facilities, and the facility's size.

Interviews were conducted with managers at each of the four participating warehouses. Each was asked how they had learned about the Program. Two indicated that they had attended a presentation, one at a regional trade-show, the other at his own facility. One learned about the Program from Edison. The fourth participant could not comment, as he had joined his company following the decision to participate.

Three of four participants said Edison's sponsorship was "very important" to their decision to participate. Only one said that Edison's sponsorship was "neither important nor unimportant" because they were not the decision-maker.

All four participating companies indicated that the availability of financial incentives to support the installation of the energy measures was a "very important" factor contributing to their decision to participate. One respondent also indicated that their company had established a goal of reducing energy consumption by 20%. He viewed the measures installed through the Refrigeration Warehouse Program as a positive step toward meeting that goal:

> *"The rebate was critical to our participation in the Program. The hurdle rate for return on investments at our company is 15%, and the incentives were key in our being able to achieve this target."*

> *"Our company has an initiative to reduce energy consumption by 20% through any means available. This includes natural gas, steam and electricity. This looked like a good technology for us and the incentives were an important contributor to the financial performance of the Program and hence our participation."*[298]

[298] Note that the manager interviewed stated that since this was a pilot and new technology, they would not have taken the risk and installed the lighting measure without the incentives. This measure replaced metal halide lighting installed just three years prior. While the company actively looks for means to reduce consumption, this was not a freerider.

The requirements posed by different companies for rate of return on their investments also influenced whether or not a company participated. For one participant, that threshold was 15% ROI. His company was able to meet that requirement with the assistance of incentives. One of the two nonparticipants interviewed, on the other hand, reported that their ROI needed to be two years or less. He felt that he could not meet that requirement even with incentives.

One of the two nonparticipants interviewed was very direct in his comments regarding Edison. When asked if Edison's sponsorship had an influence on his company's participation decision, he responded that it "*certainly had.*" He provided two examples of past rebate programs where he felt that his company had not received expected rebates. In one instance, his company installed variable-speed fan motors and thought that they would receive a rebate after installation. He later learned that a larger proportion of his facility had to be equipped with this measure in order to qualify. In another earlier project, T-8 lighting was installed which did not receive the expected rebate. Regardless of how well he did or did not understand the program requirements when he signed on, he reported *"being left with a bad taste in my mouth."* This respondent chose not to participate because in part, based on his past experience, *"it's not worth the hassle to get the rebates."*

The second nonparticipant interviewed stated that it took *"about six months to get comfortable with the idea and needed six months to convince the owners they would see positive return on investment and make money back."* In addition he stated it took about a year to initiate installation of measures and three or four phases to install them. He thought they would participate in the 2007 Program.

Overall, the participants needed the incentives before they could install measures. Timing, the "hassle-factor," and lack of incentives were primary reasons that companies chose not to participate.

Program Delivery and Implementation

None of the participating warehouses had planned equipment installations that coincided with the schedule mandated by the Program. One of the warehouse managers stated that his company had previously been replacing the older equipment as it failed. One respondent reported that "*this was more of a test case to see if this works.*" This company operated three additional facilities in the same area, but only the warehouse participating in the Program had been retrofitted.

None of the respondents experienced any problems with the audit or installation of equipment. Two reported that three or four ballasts had burned out shortly after installation; one was apparently more inconvenienced than the other, and cited some minor safety considerations as a result of the loss of light. Another replied that they had to make some minor adjustments to some of the occupancy sensors.

One nonparticipant interviewed reported that T-5s were not effective in areas with high ceilings, that is, ceilings above 30 feet. His company decided to install T-8 lights and take advantage of incentives under Edison's Standard Performance Contract Program, rather than take part in the IDEEA Program.

One respondent stated that his company had made some minor changes in operating standards related to occupancy sensors associated with lighting controls. Because each of the replacement lamps had an occupancy sensor, care had to be taken so that entire areas were not left in darkness at the same time.

One participant had problems with mechanical controls and a sequencer. The installation was complete in April 2006 but all issues were not resolved until October 2006. Mechanical controls were fully functional in November 2006.

Market Barriers

Each of the four participants and one nonparticipant cited cost as the implementation barrier. The participants agreed that the cost differential between the technologies incentivized and promoted in the Refrigerated Warehouse Program and their conventional counterparts was significant. *"It's mostly an issue of cost,"* one replied. Another noted lighting had not been installed before because of *"high first cost—we needed the utility incentive in order to complete this project."* Respondents noted that because cost is a barrier, the financial incentive was critical to their participation in the Program. One responded that "*we always look for rebates"* when installing new equipment.

Participation may also depend upon timing related to capital investments at a given site. According to one respondent, it *"could depend on if they are in the market for the technology in the first place."*

Four of the six respondents (three participants and one nonparticipant) felt that there was a real lack of awareness regarding the benefits of the technologies and/or availability of incentives. A fourth respondent disagreed. He stated that he thought most owners of refrigerated warehouses were aware of available technologies *"from the RETA promotions."*[299] However, he further stated that demonstrations were very important:

> *"Education & marketing. Many owners, including us, don't believe that these things work until they actually see them. I think that the best thing to do would be to install demonstration lights, so customers can see the difference in light levels and this would probably cause them to be more interested in actually installing the new lights."*

Another important issue and barrier is the lead time required for some corporations to complete the process to explore a new technology, then identify and allocate funding. In order to be effective, utility incentives need to be available at the time when long-term capital planning is taking place. Another concern was the amount of downtime when measures were installed.

The Program implementers felt that, in general, companies don't have an understanding of the cost of energy related to the cost of production. For example, Onsite's manager visited with

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[299] Refrigerated Engineers & Technicians Association (RETA) serving the professional development of industrial refrigeration operators and technicians. <http://www.reta.com>

CEOs from several competitive companies and asked what they spent on energy and how energy costs impacted their profits. These particular businesses did not have an understanding of the relationship between energy costs and production or production costs. To that end, educating businesses about energy efficiency is very important to the Program implementers.

The Onsite manager also noted that relative to other customers, the refrigerated warehouses oftentimes had more stringent payback criteria on their investments, and incentives were important. He felt that raising the incentive levels could encourage more participation. Even with the $.16/kWh saved incentive, some chose not to participate because they could not get the project into the budget process. Other barriers to implementation that were mentioned included the fact that some businesses were just not interested in doing efficiency projects, and one business did not participate because it was being sold.

In summary, the primary market barriers were:

- Knowledge and awareness of the technology
- First cost
- Timing projects with budget cycles
- Internal financing
- Potential down-time during installation

Participants' Experience with the Program and the Technology

Participants were asked if the lighting and mechanical measures installed met their performance expectations. On the whole, participants were very pleased with the Program and measure performance. One participant said that three fixtures had occupancy sensors that failed in the first month of operation which were immediately replaced by the installation contractor. However, this participant was still very happy with the performance of the lighting and mechanical systems. Participants made the following comments:

> *"The lighting system has performed above and beyond our expectations. We couldn't believe the increase in light levels. When compared to the old lights it was like day and night."*

> *"It went perfectly. They came in and did the work in the off hours so there was no disruption to the operation. We didn't experience any startup problems beyond a few ballasts and having to adjust some of the occupancy sensors."*

> *"It has exceeded our expectations. It has almost doubled the light levels. And that's my guess based on looking at it. We did not measure the light levels. We are very satisfied with the dimming system."*

> *"I don't think that there was any plan to replace the old equipment. I think this was more of a test case to see if this works. We have three facilities in this area and this is the only one that has been retrofitted."*

"The lighting has been great and the sensor controls are very convenient."

"We have more capacity to expand now that we installed the mechanical equipment."

New lighting should reduce heat output and could result in reduced lighting-refrigeration interaction effects. Participants were asked if the level of heat generated by the new lighting system was less than the heat generated by the old lights. Participants reported that there was a great deal of heat reduction after replacing the old HID lights.

"This is very huge gain for us. We raised suction pressure by about 4 pounds. In other words were able to take the cooler temperature from 43° to 33° with no change in energy consumption. That's a big gain."

"You could not touch them [HID] after they had been operating for a few minutes. They would get so hot they would melt the gloves that we were wearing. Because the new lights were installed in the cold areas above 32° the impact to the refrigeration system is not as great as it would've been had these lights been installed in the freezer area . . . We are currently looking into installing the same types of lights in the freezer area, and we will be able to track the benefits to the refrigeration system, if those lights are installed."

Participants were asked if they thought the refrigerated warehouse market was a viable market niche for the technology installed. Participants were unanimous in their opinion that this was a good market for the efficiency measures. Answers included:

"Absolutely."

"I think this is a great market for this technology. In addition to the energy savings from replacing the lighting you also have big reductions on heat load in the facility and that translates into savings on the mechanical system."

"Yes I do think that refrigerator warehouses are a viable market for the lighting technology. But the technology that is installed in freezer areas will need to be demonstrated that it works in areas below 32°."

"I think so. We've installed the same technology in the deep freeze that stores ice cream at -20°. It seems to work fine. In that area we set up the fixtures so that the lights on some fixtures turn off completely when no one is in the room. We don't seem to have any trouble with the occupancy sensors or the lights working in this temperature."

"Yes, especially the lighting retrofits. The benefits and convenience of sensor controlled lights are tremendous."

Non-energy benefits mentioned by participants included increased lighting levels on the production floor. Implementers added that the reduction of greenhouse gases and carbon emissions through reductions in kWh were non-energy societal benefits.

According to the implementers, one of the participant warehouses encountered some difficulties with the commissioning of the refrigeration controls. They also had difficulties documenting the final kWh saved. One of the issues involved the software associated with the installed compressor. All issues have been resolved.

The primary shortcoming in the Program appeared to be the small number of participants—a total of four warehouses participated in the Program. In designing the Program, Onsite had anticipated that approximately ten sites would complete energy-efficiency installations. It is significant that fewer than half of the potential sites participated in the Program. Participation largely hinged on the cost of the proposed energy measures. As observed by the nonparticipant interviewed, even with the financial incentives, the costs to install the measurers remained prohibitively expensive.

Satisfaction and Suggestions

Regardless of the small sample size, Program satisfaction among participants was strong. Three of the four participating refrigeration warehouse operators indicated that they were "very satisfied" overall with the Program. The fourth responded that he was "somewhat satisfied" with the Program overall, but this was because he did not know much about the Program; decisions to participate occurred before he joined the company and got involved with the project.

Participants were asked if they had recommendations to improve the Program. Two of the four warehouse companies recommended that incentives be provided for lighting that operates at very cold levels, that is, in the freezer areas as well as refrigeration areas.

Further follow-up to verify energy savings would also be valuable not only for the warehouses involved, but as positive case examples and as demonstrations for other companies. One of the participant companies indicated that demonstration projects are critical and that corporate decision makers need this kind of documentation in order to convince their company to invest in energy-efficient technology.

Free Riders

To assess free riders in this Program and to quantify the NTG ratio, participants were asked if they were aware of the technology and if they had considered installing any of the measures before the Program. They were also asked whether they would have installed lighting or mechanical measures without the incentive, when they would have installed them, and whether they would have been of the same efficiency level.

None of the respondents had previously installed the same type of technology without an incentive. One company had converted to metal halide lighting about three years ago. With the Refrigerated Warehouse Program they were able to upgrade again to the T-5 industrial fluorescent fixtures.

> *"It is unlikely that we would've installed without proof that the technology worked, which Onsite provided, and some sort of incentive because this is a pilot installation and we probably wouldn't have taken the risk on our own."*

One company noted that it was their policy to *"always require a utility incentive for energy efficiency projects."* Without the Program at that time however, installation of lighting was more than five years out; they did not have the money in their capital plan. When the Program came along, they fast-tracked the lighting improvements to meet Program timelines.

One respondent indicated that they had installed the same type of mechanical control technology previously without an incentive. It was his belief, however, that the equipment was not at the same level of energy efficiency.

Because none of the participants had current plans and funding available to install the lighting and efficiency measures outside of the Program, there was no free ridership in this program, and a net-to-gross ratio of 1 is assumed.

Potential Spillover

Participants were asked if they had participated in any Edison programs in the past. Two participants said they had, including a bilevel lighting system, VFDs on their evaporator fans in 2000, and Savings by Design when they build new facilities. One nonparticipant said they participate in the "Optional Binding Mandatory Curtailment" Program.

One respondent indicated that they had installed similar lighting at another facility where incentives had been available in the past. They were installing lighting at the current facility as a result of the Refrigerated Warehouse incentives.

Two respondents for the same company stated they would install similar lighting in one to two years.

> *"We plan to do only the dock areas and other areas that are above 32°. When we prove the technology for the freezer areas below 32° we will probably install the same lighting technology in those areas*." They are "*building a new facility in the Valley and will use this technology there. We will probably use the Savings by Design Program to assist us with that design. We work with Savings by Design to make sure that it is as energy-efficient as possible."*

Another warehouse manager stated they would likely install lighting in one to two years. He stated that other managers are looking at the lighting they installed.

> *"…[This company] has 30 plants and 10 distribution centers in California that are considering this technology. I know of six plants that are planning to convert like we have done. This site was pretty much a test case for the technology and I think that the remaining plants will convert very quickly."*

All participants said that, in the future, they would install efficiency measures with incentives.

> *"I don't know that we would do this without incentives. I just submitted my capital plan for 2007 and have two cents per cubic foot for all the projects that I need to do. That's not a lot of money and I need to do a lot of improvements for that so I*

think that incentives are probably necessary to make this work. If we do the other two facilities we will probably need incentives."

Lessons Learned by Program Staff, Future Plans

The Refrigerated Warehouse Program was implemented primarily as designed. However, the final ratio of lighting to mechanical measures installed favored lighting to a larger degree than initially envisioned. Onsite noted, as Edison did, that fewer mechanical efficiency measures were installed than anticipated. There were two companies that also had mechanical measures proposed but did not install them. One of the participating companies had lighting controls installed under the Refrigerated Warehouse Program but the incentives ran out and they had to move the condenser project over to Edison's SPC Program where the incentives were far less.

The short time frame of the Program and the low level of incentives both impacted participation. Relatively early on in the Program it appeared that incentive funding would run low or run out. Edison felt it was possible to increase incentives and Onsite continued to contact potential participants. However, it took a long time to get the project going and secure commitments from customers to install measures. Most did not commit to install measures until near the close of the Program, in late 2005. Implementers found that it often takes 18 months to two years for large companies to go through the corporate decision-making process. Smaller companies can make decisions locally, however they still need to get the project into the budget and approved. Even with incentives, the cost to the companies can be quite large. Corporate timing and budgeting is an issue that is out of the control of the Program managers.

The Edison and the Onsite managers both stated additional funding for this Program would have been helpful. There were several facilities that expressed strong interest in the Program, conducted the site audit and submitted an application and technical calculations for review. However, the contracts were not completed for two reasons: (1) the company could not get internal financing for their portion of project cost, and (2) the Program ran out of funding for incentives.

Onsite did not have data tracking issues with their limited number of participants. However if there were hundreds of participants, Onsite noted that data tracking could have been unbearable. Invoicing was not an issue, but timing of the inspections and incentive payments were important issues with Onsite.

In summary, this type of industry is better served by standard-offer efficiency programs where the timing is less constrained. However, incentive levels need to high enough to assist the company meet their ROI requirements. Lighting is a popular measure, yet there are large potential savings in the mechanical controls, compressors, condensers and evaporator fan VFDs. Changes are needed in marketing or structuring the program so that additional mechanical measures are incentivized and installed.

3. Impact Evaluation

Impact Evaluation Methodology

The objectives of the impact evaluation of the Refrigerated Warehouse Program were to develop ex-post adjusted gross and net savings for the Program. The methodology and activities used in the impact evaluation are discussed below.

The general methodologies employed to measure and verify energy savings attributed to the Refrigerated Warehouse Program included the following activities:

1. Complete measure installation verifications.
    a. Develop a sample for field verification activities.
    b. Conduct field verification activities and observations which included the installation of data logging equipment.
    c. Review verification activities completed by Edison, including subcontract activities undertaken by kW Engineering (kWE).
    d. Develop adjusted measures installation factors based on field activities and data reviews.
2. Complete an engineering analysis to develop ex-post realization rates.
    a. Complete a review and evaluate Program data.
    b. Analyze data provided through field activities and in-depth participant interviews.
    c. Complete analysis of data provided through logging activities.
    d. Conduct analysis of participant energy bills.
    e. Develop project and Program realization rates.
3. Develop adjusted gross and net Program ex-post savings.
4. Provide conclusions and recommendations for the Program and for the overarching Southern California Edison Innovative Design for Energy Efficiency Activities (IDEEA) program.

Each of these activities is discussed in detail in the following sections. Additional detailed information may be found Volume 2, Appendices.

Measure Installation Verification

The objectives of the Onsite 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 by the Program implementation contractor

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, determining if retrofits/installations were ever present, and/or the removal date and reason
4. Recording key facility performance data, such as daily schedules, seasonal variations in schedules, and control strategies.
5. Installing data logging equipment to verify self reported lighting system operating hour estimates and measure the impact of lighting control technologies.

The detailed measure installation verification instrument is provided in Volume 2, Appendices.

Installation Verification Sample

The Program focused primarily on the following technologies:[300]

- Lighting retrofits involving new T-5 fluorescent fixtures that can operate at very low temperatures, and associated lighting controls. All four sites participating in the Program received these measures.
- Refrigeration controls to optimize refrigeration system operations.
- High-efficiency compressors.
- High-capacity condensers.

Table 3–1 details the distribution of energy efficient installations and savings that occurred under the Refrigerated Warehouse Program according to the post installation reports provided by Onsite Energy and kW Engineering. Site 1 accounted for 59% of Program reported gross savings.

Table 3–1. Distribution of Program Installations and Savings

Customer	Retrofit Measures	kW	kWh
Site 1	Comprehensive Lighting Retrofit	175	1,528,554
	Refrigeration Controls and Evaporative Condenser	30	921,572
Site 2	Custom Freezer Lighting Fixture Retrofits	106.7	1,216,169
Site 3	Custom Freezer Lighting Fixture Retrofits	18.8	144,934
	New High Capacity Condenser	19	84,314
	New High Efficiency Compressor	7	28,950
Site 4	Custom Freezer Lighting Fixture Retrofit	32.5	199,790
Program Total		389	4,124,284

As shown in Table 3–2, lighting retrofits accounted for approximately 75% of the Program reported gross savings. The lighting retrofits involved comprehensive retrofits of both office-type

[300] While the original program was designed to accommodate VFDs for evaporator fans and quick close doors, none were installed.

spaces and warehouse retrofits that replaced high-intensity discharge (HID) fixtures with industrial fluorescent fixtures using high output T-5 or T-8 fixtures. The majority of HID retrofits also included occupancy sensors that shut off either 50% or 100% of lamps when an area was vacant. HID retrofits accounted for over 80.3% of lighting savings, and 60.2% of total Program reported savings.

Table 3–2. Distribution of Program Savings by Project Type

Mechanical kWh savings	1,034,836
Lighting kWh savings	3,089,448
Total Program savings	4,124,284
Percent of Program savings from lighting	74.9%
Lighting kWh savings from HID retrofits	2,439,051
Percent of reported gross lighting savings from HID retrofits	78.9%
Percent of reported gross Program savings from HID retrofits	59.1%

Edison and Onsite invested considerable resources in pre and post project reviews, conducted by kW Engineering. Particular attention was paid to reviewing these documents and supplementing this work with select field measurements. Because lighting represented the majority of Program-wide savings, the evaluation team focused on lighting measures, specifically retrofits of HID lighting to T-8 and T-5 fluorescent retrofits.

Due to the relatively modest participant population of this Program, the evaluation team concluded that it would be statistically viable and cost-effective to verify all participant sites. The evaluation of the HID retrofit component of the Program involved a modified IPMVP Option A approach involving engineering calculations and short-term measurements to assess the impact of the occupancy-sensor-based controls installed on HID retrofits at each site. The overall impact evaluation adhered to Chapter 6 of the California Energy Efficiency Policy Manual.[301]

Site Verification Activities

Field activities typically involved 3 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, operating conditions, etc., using the field instrument detailed in Volume 2, Appendices. Interviews were also conducted at the site representative’s convenience.

[301] Version 2, August 2003.

3. Where data logging equipment was installed, a detailed description was provided with respect to logger location and characteristics. A pick-up date was also provided to each site and the evaluation team called each site in advance of returning to retrieve loggers.

Initial field evaluation activities were conducted between August 17th and August 24th, 2006. At the time, it was anticipated that all expected installations were completed and finalized. A second round of verification visits took place during the week ending October 13 in order to further verify measures and retrieve data logging equipment installed in August. A total of four sites were verified, that is, 100% of all sites that participated in the Program. Volume 2, Appendices, provides additional sample details.

The evaluation team completed all of the key activities outlined in the final research plan filed with the CPUC. Table 3–3 provides the evaluation activities and objectives included in the final research plan objectives, and the tasks completed by the evaluation team.

Table 3–3. Completed Impact Evaluation Activities and Objectives

Evaluation Activities	Original Research Plan Objectives	Tasks Completed by the Evaluation Team
Program records review	Yes	Yes
Engineering calculations	Yes	Yes
Secondary literature	Yes	Yes
Billing data/metered data analysis	Yes	Yes
Site visits	Decision makers at census of installed projects.	5 completed
End use metering	As required	16 lighting on/off loggers and 19 lighting intensity loggers deployed.[302]

Installation Verification Results

The evaluation team's field work occurred approximately six months after installations were completed. Verification work, discussions with participants subsequent to field verification activities, and an analysis of the verified installations indicated that the installations attributed to the Refrigerated Warehouse Program by kW Engineering were correct. As such, the evaluation team considered the installation rate for the Program to be 100%.

A second objective of the verification activities was to provide input on the quality of installations completed through the Program. Overall, field observations verified that both the lighting and refrigeration retrofits appeared to be well installed and operating correctly. The lamp failure was calculated to be approximately 1.5% which was concluded to be acceptable for the lighting technologies installed. Two of the installed lighting projects indicated that several occupancy sensors installed on high bay industrial fluorescent fixtures had failed shortly after installation, but these were replaced quickly and no further problems had occurred. Figure 3–1

[302] Loggers measured lumens and were installed inside the fixtures if possible or in areas that would be subject to dimming activities from the retrofit lights.

provides an example of a four-lamp high-output T-5 fixture retrofit, while Figure 3–2 illustrates a high bay six-lamp high light output T-8 retrofit.

Figure 3–1. Four-Lamp High-Output T-5 Fixture[303]

[303] Source: kW Engineering. Site 3 - Post Install Inspection Report.doc.

Figure 3–2. High Bay Six-Lamp High Light Output T-8 Fixture[304]

As previously noted, nearly 100% of the projects received post installation verification by kW Engineering. The third-party inspections were well documented and thorough, and included visual examples of installations that are referenced in this report. These records were compared with the evaluation team's field observations, and in all cases, the contractor-reported data correlated well with the evaluation team's observations. All inspected projects had a 100% installation rate.

Engineering Analysis

An engineering analysis was conducted to develop adjusted realization rates for the Program. This included a detailed review of Program records, kW Engineering reports, documents and data-logging activities as described in the following sections.

The final Program records submitted by the implementation contractor to Edison were analyzed for accuracy and consistency, and to ensure that the underlying assumptions were reasonable. The key documents analyzed included the following:

- The final Program 'Installation Reviews' submitted in September 2006. These files documented installation activities at each participant site, including the type and number of measures installed, underlying energy savings assumptions, and the dates of the various installations. These files provided ex-ante Program gross energy savings values.
- The final Program 'workbook' dated December 11, 2006. This document provided a reporting format for the CPUC and represented a summary of the information contained

[304] Source*:* kW Engineering. Site 4 - Post Install Inspection Report.doc.

in the Program installation reviews. It did not, however, contain site specific data. This file provided ex-ante Program net energy savings values.

- The implementation contractor's post inspection reports and worksheets for the individual projects[305] completed by the Program. These files provided measure and project level ex-ante energy savings documentation.

Several observations resulted from this review.

1. The Refrigerated Warehouse Program was well documented. Consistent and detailed reporting formats were used to present both base case and measure data on all lighting retrofits. Savings estimates were provided on all projects for both pre and post installation, and any adjustments to savings estimates were documented.

2. Program implementation operating hour assumptions correlated closely with the information collected during interviews with site representatives.

3. Measure installation details (wattage, base measures, etc.) were verified to be accurate through the review of nameplate data recorded while in the field, and comparing this data with Program records.

HID Retrofit Analysis

HID Retrofit Data Logging Approach

In order to verify reported savings attributable HID lighting retrofits, data loggers were installed to confirm net lighting operating hours and the impact of the occupancy controls. Because the configuration[306] of the industrial fluorescent fixtures did not allow accurate assessment of occupancy controls using on/off loggers, the evaluation team used intensity loggers to assess when the controls were active. The sample of lamps chosen to undergo logging activities was selected based on the following factors:

1. Lamps that contributed significantly to the energy savings attributed to the specific site
2. Lamps that would allow a uniform collection of intensity readings over time (i.e., lamps that allowed for the loggers to be placed an equal distance away from the fixtures)
3. Lamps that could be logged without endangering site employees

Logging was conducted at all four participant sites. The loggers were in place for approximately three weeks during August of 2006, which corresponded with the Edison's peak summer period definition of 6/2/2006 through 10/6/206. Table 3–4 provides a summary of lighting system logging activities completed for this evaluation.

[305] Submitted by kW Engineering.

[306] In most fixtures, occupancy sensors controlled 50% of the lamps in any fixture, and it was uncertain if on/off sensors would detect switching activity due to light from the uncontrolled lamps. Instead, intensity loggers were used to assess when lamps were switched on or off, thereby indicating a control event had occurred.

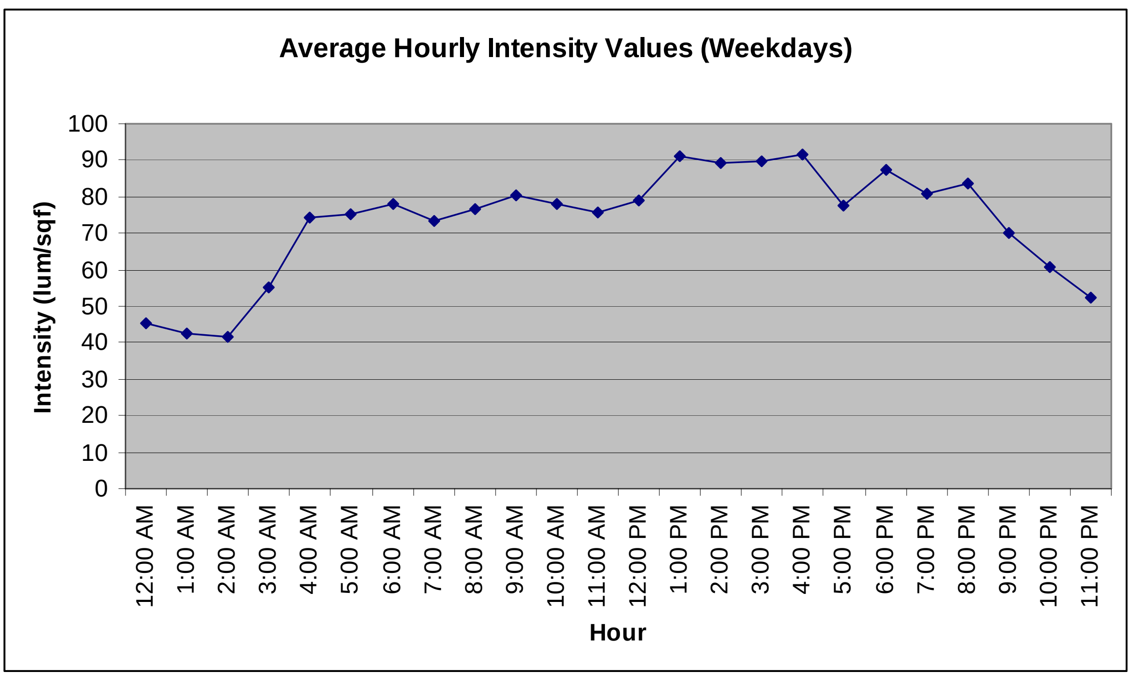
Table 3–4. Expected Distribution of Verification Activities

Customer	On / Off Loggers Deployed	Intensity Loggers Deployed
Site 1	6	6
Site 2	6	5
Site 3	4	4
Site 4	0	4
Total	16	19

Verification of Retrofit Fixture Operating Hours

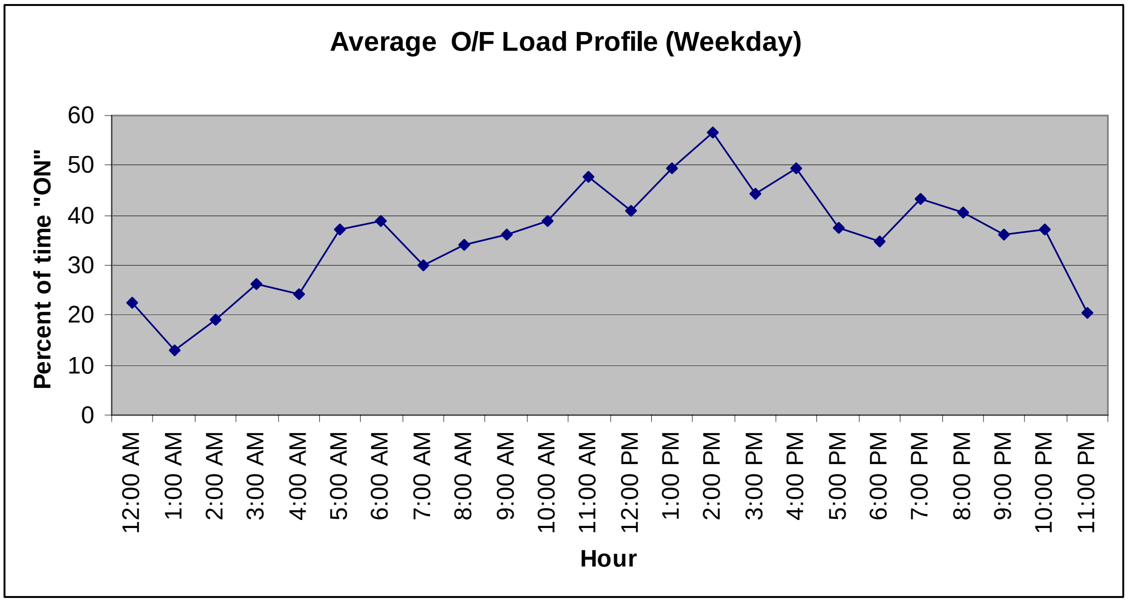
A total of 16 on-off loggers and 19 intensity loggers were deployed throughout the four participant sites in anticipation of correlating lighting operating schedules to Program records and interview conclusions. However, after collecting the loggers, it was discovered that a significant number of on-off loggers did not provide representative operating information due to the fact that they still registered the light as being "on" when they were dimmed. This complication was anticipated,[307] however, and the resulting lighting operating schedule and lighting control impact analysis was conducted utilizing the data collected from the intensity loggers supported by accurate on-off logger data as available. Figure 3–3 and Figure 3–4 provide examples of on-off and intensity load profiles of the lighting retrofits installed at Site 2.

Figure 3–3. Site 2 Average Hourly Lamp Intensity Load



[307] On / off loggers and lighting intensity loggers were frequently placed to provide redundancy

Figure 3–4. Site 2 Average Hourly Lamp Percent On/Off Load



Note that for this site, the on-off loggers managed to collect representative operating information that further verified the representative nature of the data provided by the intensity loggers. On-off loggers generally performed better when installed on lamps that completely shut off when no one was present because the surrounding area became correspondingly darker.[308] The load increased throughout the day as business picked up, and stabilized at night when the warehouse was less active. A similar analysis was conducted to derive the load profiles of each participating facility during the weekend to ensure that the operating profiles were reasonable and correlated with customer records.

Analysis of HID Lighting Control Impacts

In order to accurately quantify the percentage of lamps operating at any given time among the Program participant sites, the following methodology was employed.

1. The maximum average hourly intensity rating was selected from each participating site and it was assumed that the lamps attributed to those loggers were operating 100% of the time for that one hour period.

2. The maximum average hourly intensity rating was multiplied by a constant between .75 and .9 to account for the fact that, inevitably, some of the light level loggers were placed further away from the logged fixtures than others. Consequently, the maximum average

[308] A majority of the O/F loggers were placed on fixtures with binary, on/off states. However intensity loggers were frequently installed to provide redundancy in case ambient light caused the O/F loggers to fail to report a control event.

hourly intensity rating corresponded only with the intensity logger that was closest to a fixture.

3. The average hourly intensity rating was then divided by the adjusted maximum average hourly intensity rating in order to determine the lighting load reduction per hour.[309]

4. Based on Program records and customer interviews, it was possible to derive the overall percentage of reduction in lighting loads at each participant site post retrofits.

Table 3–5 provides the percentage reduction in operating hours attributable to the occupancy sensors installed on retrofit florescent high bay fixtures as calculated by the evaluation team using the methodology discussed. Also shown are the reductions estimated in Program records. In general, the Program assumptions agree with the evaluation values; however, because the evaluation estimates are supported by extensive data logging, the evaluation team recommends adjusting the project reported savings to reflect the evaluation calculations.

Table 3–5. Derived Lighting Schedules for Fixtures with Motion Sensors

Customer Name	Evaluation Calculated Dimming Activity	Program Assumed Dimming Activity	Percentage Difference
Site 1 (Plant 1 only)	42%	45%	-7.1%
Site 2	41%	40%	2.5%
Site 3	44%	40%	9.1%
Site 4	44%	40%	9.1%
Average	43%	41%	4.7%

Compressor Upgrades and Condenser and Controls

Participant Site 3 had over 41,000 sq. ft. of refrigerated space divided into four pre-cooling rooms with two tunnels per room and five large storage rooms. Four existing water-cooled screw compressors and two evaporative condensers provided refrigeration. In addition to installing energy-efficient lighting measures, the participant site also installed a variety of refrigeration retrofits outlined below.

1. A Frick RWF 177 screw compressor with liquid injection oil cooling.[310]
2. A third evaporative condenser (Imeco XL 785) to allow operating at a lower head pressure. The original design condensing temperature was 90°F; after the new condenser the design condensing temperature was reduced to 84°F.
3. Variable speed drives to control the new evaporative condenser fans.
4. Sensors and control programming to float the head pressure to a minimum of 65°F.

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[309] The lighting intensity measurements were instantaneous time series measurements that allowed the evaluation contractor to discretize the data into off/half on/full on states that were subsequently averaged over each hour.

[310] The Frick RWF 177 was installed in addition the three existing high speed RXF compressors.

In order to estimate the savings attributed to the refrigeration measures, a bin-temperature-based spreadsheet calculation[311] was developed specifically for the facility by Onsite Energy. The calculation procedure required annual utility information and a facility energy balance. The base case refrigeration load was then adjusted to calibrate the model to the annual utility information.

A number of interesting results were derived from this analysis:

1. It became apparent that installing additional capacity without wet bulb control and floating head pressure provided little energy savings.

2. Interactive effects between refrigeration measures were not additive

3. An RXF 101 at 100% load was more efficient than the RWF 177 at 50% load. As such, it was concluded that the new screw compressor should not be operated below 50%.

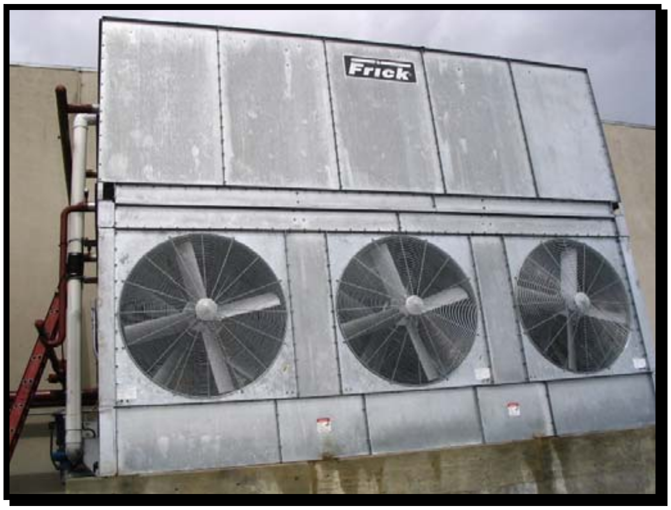
Figures 4-5 and 4-6 illustrate the RWF 177 screw compressor and Imeco XL 785 evaporative condenser installed through the Refrigerated Warehouse program.

Figure 3–5. Compressors (New Frick RWF 177 at End)[312]

[311] Bin temperature and hrs/year calculation method.

[312] Source kW Engineering. Site 3 - Post Install Inspection Report.doc.

Figure 3–6. New Imeco (Frick) XL 785 Evaporative Condenser[313]



The Evaluation team thoroughly reviewed the calculation algorithms to ensure the accuracy of the savings values.[314] Overall, the methodology was deemed appropriate and no adjustments were made to the energy saving assumptions in the Program reports.

Refrigeration Controls

The project involving mechanical controls had two primary objectives. The first was to control discharge pressure, which was completed. The second objective was to bring four compressors[315] online, stage, and sequence them. Staging and sequencing was completed on three of the four. The fourth compressor was being rebuilt. The primary design objective was met with the three operating and sequenced compressors.

Engineering Analysis Results

Based on the review of Program documents and site logging activities, the following conclusions were made.

1. The adjusted final installation rate was determined to be 100%.
2. The measure savings assumptions were calculated to be representative of the Program installations.
3. The participant facility operating schedules correlated directly with Program assumptions.
4. The algorithms used to calculate the energy savings attributed to the refrigeration measures were concluded to be accurate based on an engineering review.

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[313] Source kW Engineering. Site 3 - Post Install Inspection Report.doc.

[314] Onsite bin method spreadsheet and custom methods.

[315] Three old RXF and the one new RWF machines.

5. The savings estimates provided for the retrofit of HID to industrial florescent fixtures required several revisions, including:
    a. The savings attributable to the occupancy controls were adjusted for each project to reflect the evaluation calculated reduction in operating hours. The Program assumed that dimming activities would occur approximately 41% of the time while evaluation efforts calculated dimming activity to occur 43% of the time on average.
    b. The base case energy assumptions for Site 1 HID fixtures were understated because of an arithmetic error in the Program records that incorrectly estimated the impact from pre-existing lighting controls. The impact from the HID retrofits at Sites 2 and 3 were overstated because of a calculation error that overstated the baseline reduction in kWh from the HID retrofits.
    c. The net changes made to the savings calculations resulted in a net increase of 43,445 kWh savings attributed to HID retrofits through the Program.

Table 3–6 provides the Ex-ante and ex-post gross savings attributable to the retrofit of HID to industrial florescent fixtures

Table 3–6. Gross Savings Attributable to the Retrofit of HID to Industrial Florescent Fixtures

Project	Ex-ante	Ex-post	Change
Site 1	1,296,816	1,360,647	63,831
Site 2	848,058	814,514	-33,544
Site 3	141,663	149,733	8,070
Site 4	152,514	157,602	5,088
Net	2,439,051	2,482,496	43,445

Billing Analysis

Unlike many of the other IDEEA programs, the Refrigerator Warehouse Program installed measures at seven different locations operated by only four unique customers. Given the extremely limited sample size, the analysis was conducted at the building, rather than at the Program, level.

Since both the number of participants and the availability of post-installation monthly meter readings were limited, no filter was applied on the number of months in the matched pre- or post-installation monthly meter readings. That is, no sites were excluded based on the number of pre and post meter readings. The installation date, as well as the measures installed for each building is shown in Table 3–7. As evident in the table, only two participants, Site 1 and Site 3, had non-lighting measures installed. However, only Site 3 had the non-lighting measure installed early enough to determine the impact of the installed measures in the billing analysis.

Table 3–7. Refrigerator Warehouse Participant Information

ID	Site	Installation Date	Measures Installed	Notes
1	Site 1	June 25, 2006	Lighting/Controls	Controls were not operational until November; impact not captured in analysis
2	Site 1	June 25, 2006	Lighting/Controls	Controls were not operational until November; impact not captured in analysis
3	Site 1	June 25, 2006	Lighting/Controls	Controls were not operational until November; impact not captured in analysis
4	Site 2	May 22, 2006	Lighting	
5	Site 3	April and June 2006	Lighting/Compressors/ Condensers	Lighting in April, Compressors and Condensers in June
6	Site 4	June 2006	Lighting	Location 1
7	Site 4	June 2006	Lighting	Location 2

In fact, the only filter applied was a screen to assess whether factors other than Program factors—such as changes in business hours or warehouse production levels—may have significantly impacted energy consumption between the established pre- and post- periods. In applying the screen, the ratio of raw energy consumption between the two periods was calculated. The resulting ratio indicated the magnitude of the difference in consumption between periods. For example, a ratio of 1.10 indicates a business consumed 10% more energy in the post-period than in the pre-period, while a ratio of 0.90 indicates the opposite. While the ratio considers only raw change (no weather-normalization), it provides a reasonable metric for identifying and subsequently removing participants from the analysis exhibiting extreme changes in their consumption unlikely to be related to the Program. One such customer, Site 4, location 2, was determined to have a pre-post raw consumption ratio of 7.67, and was dropped from the analysis. Clearly such a significant increase in consumption would overshadow any potential savings generated by participating in the Refrigerator Warehouse Program.

The effect of the lone filter discussed above upon the sample size is shown in Table 3-8.

Table 3–8. Refrigerator Warehouse Billing Analysis Data Attrition

Metric	Number of Unique Participants Removed	Percentage of Total Unique Participants Removed	Number of Unique Participants	Percentage of Total Unique Participants
Total Program Participant Buildings	- - -	- - -	7	100.0%
Extreme Pre-Post Consumption Change	1	14.3%	6	85.7%
Final Sample	1	14.3%	6	85.7%

In addition to collecting and assessing participant billing data, weather data for the participating region was also gathered. The weather data utilized in this analysis was also provided by Edison, and each participant was matched to the appropriate utility weather station based on their zip code. In all, participants resided in three unique zip codes that each corresponded to a different utility weather station.

As noted above, the analysis was conducted at the participant level, rather than at the Program level. In addition, several different analysis approaches were utilized. Similar to the non-weather corrected ratio discussed above, the first approach compared the average change in raw consumption at a monthly level between the pre- and post-period. The second approach utilized a regression to account for weather differences between periods. The third approach manipulated the outputs of the regressions to state the results in terms of long-run weather rather than strictly the weather observed during the pre- and post-periods. A summary of the annual and percentage savings determined using these three methods is provided in Table 3–9.

Table 3–9. Refrigerator Warehouse Billing Analysis Results

		Average Monthly Unweatherized Pre-Post Difference		Regression Using Pre-Post Weather		Regression Using Long-Run Weather	
ID	Site	Annual Savings (kWh)	Percent Savings	Annual Savings (kWh)	Percent Savings	Annual Savings (kWh)	Percent Savings
1	Site 1	-295,146	-2%	-526,004	-4%	-250,954	-2%
2	Site 1	-301,975	-9%	-363,110	-10%	-196,163	-6%
3	Site 1	-124,622	-4%	-8,175	0%	-115,692	-4%
4	Site 2	1,718,343	6%	1,889,660	7%	1,591,779	6%
5	Site 3	675,648	29%	690,244	35%	300,653	13%
6	Site 4	-364,920	-4%	-639,407	-6%	-681,878	-7%

As evident in the table, only two buildings were determined to have saved energy using all three approaches. The most significant percentage savings were, not surprisingly, generated at Site 3 which, as noted in Table 3–7 received compressor and condenser measures in addition to lighting. Looking only at differences in weather between the pre- and post-period, Site 3 showed a 35% annual savings (690,244 kWh). However, when the results are calibrated to long-term weather, the savings drops to 13% or 300,653 kWh.

Four of the six buildings included in the final analysis, regardless of the approach used to assess savings, exhibited an increase in consumption after participating in the Program. Since converting to more energy-efficient lighting—all other things being held equal—would not result in an increase in energy consumption, there are clearly other factors impacting energy use at the assessed buildings. Whether due to a change in operating hours, an increase in production, or the addition of new electrical end uses, factors at the four buildings have obscured the impact of the Program-installed lighting and rendered the billing analysis incapable of determining the Program's true impact. This is not an uncommon problem when utilizing billing analyses to assess industrial buildings. It is also important to consider that while the other two buildings are exhibiting savings, changes may have also occurred at those buildings which are overstating or underestimating the true Program impact.

Because the billing analysis could not determine the impact from changes in facility operations, the engineering estimates will be used to determine overall Program impacts.

Impact Evaluation Results

Engineering Estimates of Ex-post Gross Program Savings

Table 3–10 provides the ex-ante gross savings reported in the final installation review documents submitted for the Program, the verified gross savings, and the ex-post adjusted gross savings numbers. The recommended adjustments are attributable solely to revised savings estimates for HID retrofits. HID retrofits to industrial fluorescent fixtures contribute approximately 59.1% of ex-post gross kWh savings.

Table 3–10. Reported Ex-ante Gross Savings, Verified and Adjusted Ex-post Gross Savings

	Ex-ante		Ex-post	
Project	Gross kW	Gross Annual kWh	Gross kW	Gross Annual kWh
Site 1	205	2,450,126	205	2,513,957
Site 2	106.7	1,216,169	106.7	1,182,625
Site 3	44.8	258,198	44.8	266,268
Site 4	32.5	199,790	32.5	204,878
Program Total	389	4,124,284	389	4,167,729

Final Program Impacts

The Program impacts were estimated collectively for all measures installed through the Refrigerated Warehouse Program. Table 3–11 presents the first year ex-ante gross and net energy savings goals and reported Program accomplishments.

Table 3–12 shows the ex-ante gross and net demand savings goals and reported Program accomplishments. The Program net ex-ante net savings goals were estimated and reported accomplishments were estimated using a NTG ratios ranging from .7 to .8, depending on the measure. The Program reported achieving approximately 103 percent of their original kW and kWh goals.

It should be noted that there was a discrepancy between the savings stated in the workbook and final Program installation reports/documentation provided through kW Engineering. The final workbook did not full disaggregate measures which may have offset the stated savings. The evaluation team based their savings assumptions on the final flat files and through kW Engineering documentation.

The final workbook stated gross annual savings to be 4,008,463 kWh while Program final installation reports stated gross annual savings to be 4,124,284 kWh. Moreover, the workbook did not specify any kW savings attributed to the Program while Program installation reports stated gross annual kW savings to be 388.53 kW.[316]

Table 3-11. Comparison of Ex-ante Energy Savings Goals and Reported Accomplishments

	Ex-ante Program Gross Annual kWh Goals	Ex-ante Program Net Annual kWh Goals	Reported Ex-ante Gross Annual kWh Savings	Reported Ex-ante Net Annual Program kWh Accomplishments
Refrigerated Warehouse	3,906,250	3,083,148	4,008,463	2,898,566

Table 3–12. Comparison of Ex-ante Demand Savings Goals and Reported Accomplishments

	Ex-ante Program Gross Annual kW Goals	Ex-ante Program Net Annual kW Goals	Reported Ex-ante Gross Annual kW Savings	Reported Ex-ante Net Annual Program kW Accomplishments
Refrigerated Warehouse	419.9	331.7	389	307.3

The Program impacts are determined by two factors:

- Program performance in terms of accomplishing Program participation goals
- Estimated ex-post savings impacts for the installed measures compared to the ex-ante measure savings assumptions

The Program gross and net realization rates have been calculated as the combined effect of these two factors. The Program goals, overall and for its constituent measures, ex-post gross and net energy savings, and respective realization rates are shown in Table 3–13. The Program evaluated ex-post gross energy savings are 4,167,729 kWh compared to the Program gross savings goal of 3,906,250 kWh. The Program evaluated ex-post net energy savings are 4,167,729 kWh compared to the Program goal of 3,083,148 kWh, yielding a 135% percent net energy savings realization rate.

Table 3–13. Comparison of Programs Goals and Ex-post Gross and Net Energy Savings

	Ex-ante Program Gross Annual kWh Goals	Ex-ante Annual Net Energy Savings Goals	Evaluated Gross Ex-post Program kWh Savings	Gross Energy Realization Rate	Evaluated Net Ex-post Program kWh Savings	Net Energy Realization Rate
Refrigerated Warehouse	3,906,250	3,083,148	4,167,729	107%	4,167,729	135%

The Program goals, ex-post gross and net demand savings, and respective realization rates are shown in Table 3–14. The Program evaluated ex-post gross and net demand savings are 389 kW.

[316] Tables 4-11 through Table 3-21 are calculated from the workbook deemed savings.

Table 3–14. Comparison of Programs Goals and Ex-post Gross and Net Demand Savings

	Ex-ante Program Gross Annual kW Goals	Ex-ante Annual Net Demand Savings Goals	Evaluated Gross Ex-post Program kW Savings	Ex-post Gross Demand Realization Rate	Evaluated Net Ex-post Program kW Savings	Net Demand Realization Rate
Refrigerated Warehouse	419.9	331.7	389	93%	389	117%

Realization rates compared to ex-ante evaluated results are shown in Table 3–15 and Table 3–16 below. The Program evaluated ex-post gross energy savings are 4,167,729 kWh compared to the Program reported ex-ante gross savings goal of 4,008,463 kWh, yielding a realization rate of 104 percent. The Program evaluated ex-post net energy savings are 4,167,729 kWh compared to the reported ex-ante net of 2,898,566 kWh, yielding 144 percent net energy savings realization rate. The Program evaluated ex-post gross demand savings are 389 kW.

Table 3–15. Comparison of Reported Program Accomplishments and Ex-post Gross and Net Energy Savings

	Ex-ante Program Gross kWh Reported	Ex-ante Net Energy Savings Reported	Evaluated Ex-post Gross Program kWh Savings	Gross Energy Realization Rate	Evaluated Ex-post Net Program kWh Savings	Net Energy Realization Rate
Refrigerated Warehouse	4,008,463	2,898,566	4,167,729	104%	4,167,729	144%

Table 3–16. Comparison of Reported Programs Accomplishments and Ex-post Gross and Net Demand Savings

	Ex-ante Program Gross kW Reported	Ex-ante Net kW Savings Reported	Evaluated Ex-post Gross Program kW Savings	Gross Energy Realization Rate	Evaluated Ex-post Net Program kW Savings	Net Demand Realization Rate
Refrigerated Warehouse	389	307.3	389	100%	389	127%

Final Program savings, NTG ratios and realization rates are shown in Table 3–17 and Table 3–18. The individual components of the Program were assumed to have a net to gross ratio of 1 for evaluation purposes. The final workbook’s assumption was NTG of .7 to .8.

Realization rates were calculated as the ratio of the evaluated net ex-post savings to the reported ex-ante gross savings. For the overall Program, the realization rate was 104 percent.

Table 3–17. Program Energy Savings

	Ex-ante Reported Gross kWh Savings	Ex-post Gross Program kWh Savings	NTG Ratio	Evaluated Ex-post Net kWh Savings	Realization Rate
Refrigerated Warehouse	4,008,463	4,167,729	1	4,167,729	104%

The Program reported gross energy savings are compared with the Program ex-post gross energy and demand savings (Table 3–18). The gross energy savings realization rate is 104 percent.

Table 3–18. Comparison of Program Reported Accomplishment and Ex-post Gross Energy Savings

	Program Reported Gross kWh Savings	Gross Ex-post kWh Savings	Gross Energy Savings Realization Rate (Percent)	Program Reported Ex-post Gross kW Savings	Gross Ex-post kW Savings	Gross Demand Realization Rate (Percent)
Refrigerated Warehouse	4,008,463	4,167,729	104%	389	389	100%

Ex-ante goals proposed, Ex-ante reported and ex-post evaluated savings are summarized in Table 3–19 below.

Table 3–19. Savings Summary

	Proposal				Reported				Evaluated		
	Ex-ante Gross	Net to Gross	Ex-ante Net		Ex-ante Gross	Net to Gross	Ex-ante Net		Ex-post Gross	Net to Gross	Ex-post Net
kWh	3,906,250	.79	3,083,148		4,008,463	.79	2,898,566		4,167,729	1	4,167,729
kW	419.9	.79	331.7		389	.79	307.3		389	1	389

Lifecycle Savings

Table 3–20 shows the Program's lifecycle savings. The Program lifecycle ex-post net energy and demand savings for this Program are shown in CPUC required format in Table 3–21 below.

Table 3–20. Program Measure EULs

Measure	EUL
Custom Freezer Lighting Fixture Retrofit	16
VFD's on Process Pumps & Fans	15
Consolidated Refrigeration Controls	15
Auto-Purger - Non-Condensables	15
Fast Acting Cooler Doors	8

The final Program Workbook did not record installation of Fast Acting Cooler Doors, and no demand savings were attributed to this measure. For this reason, no savings for cooler doors were included in the projected savings. Only savings for measures installed through the Program are included in the ex-post evaluated savings.

Table 3–21. Program Lifecycle Ex-post Energy and Demand Savings

Year	Calendar Year	Ex-ante Gross Program-Projected Program MWh Savings	Ex-post Net Evaluation Confirmed Program MWh Savings	Ex-ante Gross Program-Projected Peak Program MW Savings	Ex-post Evaluation Projected Peak MW Savings	Ex-ante Gross Program-Projected Program Therm Savings	Ex-post Net Evaluation Confirmed Program Therm Savings
1	2004						
2	2005	4,008	4,168	.389	.389	-	-
3	2006	4,008	4,168	.389	.389	-	-
4	2007	4,008	4,168	.389	.389	-	-
5	2008	4,008	4,168	.389	.389	-	-
6	2009	4,008	4,168	.389	.389	-	-
7	2010	4,008	4,168	.389	.389	-	-
8	2011	4,008	4,168	.389	.389	-	-
9	2012	4,008	4,168	.389	.389	-	-
10	2013	4,008	4,168	.389	.389	-	-
11	2014	4,008	4,168	.389	.389		
12	2015	4,008	4,168	.389	.389		
13	2016	4,008	4,168	.389	.389		
14	2017	4,008	4,168	.389	.389		
15	2018	4,008	4,168	.389	.389		
16	2019	4,008	4,168	.389	.389		
17	2020	3,082	3,133	.333	.333		
TOTAL	2004-2023	63,202	65,653				

Definition of peak MW as used in this evaluation: Average demand reduction during the summer months.

4. Conclusions and Recommendations

The Program met its energy savings goals and expended all available incentives to fund the projects. There were only four participants. More lighting measures were installed than originally anticipated, conversely, fewer mechanical measures were installed than anticipated. There is a long lead time before solicited companies commit resources to participate in efficiency upgrades. The fact that all incentives were expended and one company had to shift participation to another Program to receive incentives for installation of controls points to the available potential in the market.

Conclusion 1: *The Program successfully met kWh savings goals, was well documented, and participants were happy.*

The four participant companies reported that they were very satisfied with the Program overall. They had positive comments about the mechanical and lighting technologies and the installation process. The Program met its energy savings goals with fewer participants than anticipated. Evaluators found the documentation of baseline conditions and installed measures were accurate. The small number of participants allowed attention to detail that contributed to the Program's success.

Recommendation 1: *Continue to provide a Program of this type to the refrigerated warehouse market.*

Conclusion 2: *Lead time and incentives are critical to promote efficiency upgrades.*

Two of the challenges faced by the Program in the successful recruitment of participant firms were lead time and internal thresholds for return on investment. The process to recruit, audit, develop a proposal, and obtain commitment from corporate level is a long one. All participants required incentives before they could install efficiency measures, stating that first cost was a barrier. Some companies juggled their capital improvement plans so that measures could be installed within the Program's timeline. One participant had lighting and some controls installed under the Program and additional mechanical controls installed under Edison's SPC program because the incentive budget was expended. There were several potential participants who submitted applications but did not follow through because: (1) the company could not get internal financing for their portion of the cost, and (2) the Program ran out of funding for incentives.

Recommendation 2: *Maintain or increase incentive levels and mainstream the measures.*

Maintain or increase incentive levels to encourage efficiency upgrades and assist companies to meet their investment criteria. Mainstream the Program measures under the SPC Program so that there are no time constraints on the term of the Program, giving companies the time they need to gain corporate commitment and funding.

Conclusion 3: *The refrigerated warehouse market is an appropriate niche market for efficiency upgrades.*

All participants felt that the refrigerated warehouse market was appropriate for these efficiency technologies. However, they also felt that marketing and education were needed to inform this market segment of available technologies and available incentives. While direct mailing was one of the primary marketing tools, none of the participants learned of the Program through direct mailing. Marketing was most successful when it was one-on-one.

Recommendation 3: *Target the marketing and provide demonstration sites.*

More targeted mailing and a high level of personal follow-up, either by the Program implementer or by Edison directly, may make the difference in moving the market to install energy-efficient technologies. In addition to educating the warehouse managers, marketing targeted to educating trade allies such as the Association of Refrigerated Warehouses (IARW) could be beneficial. Participants also stated that demonstration sites and real-life examples of measures installed and energy savings would help to convince them of the feasibility of the efficiency improvements.

Conclusion 4: *There were mixed perceptions about the feasibility of T-5 installation in sub-freezing areas.*

The Program would benefit from adding lighting technology that operates at very cold temperatures to the list of efficiency measures that are eligible for incentives. One participant thought the lighting was appropriate in sub-freezing locations (it was successfully installed in a 20^{o} F freezer) and another did not (their installations were only in above-freezing dock areas). Clarification in the application is needed; the interest is there.

Recommendation 4: *Clarify measure applications and applicable installation locations.*

14. 80Plus Program

1. Program Description

Ecos Consulting (Ecos) proposed the 80 Plus Program in response to Southern California Edison's requests for innovative energy-efficiency proposals. Southern California Edison awarded Ecos a contract to implement 80 Plus under the 2004-2005 Innovative Designs for Energy Efficiency Activities (IDEEA) program. 80 Plus is an upstream buy-down program that encouraged utilities and computer manufacturers to get more energy-efficient power supplies into desktop computers and desktop-derived servers. The 80 Plus Program was officially launched in spring 2004 and SCE launched its version in the winter of 2005. Initial efforts were focused on the recruitment of manufacturers and system integrators in an effort to increase market supply. The strategy of the 80 Plus IDEEA Program was to overcome the price barrier of premium power supplies, while educating customers about the benefits of efficient power supplies to increase the market demand for the more efficient power supplies.

The 80 Plus activities were not restricted to Edison's service territory. This was, and continues to be, an industry wide Program, with market actors nationwide. The 80 Plus Program included activities to recruit original equipment manufacturers and system integrators, while simultaneously recruiting Program sponsors to assist in general promotional efforts and to provide financial support. In essence, this was a large market transformation effort which included both hardware incentives and the education of many market actors.

The 80 Plus performance specification requires power supplies in computers and servers to operate with 80% or greater energy efficiency at 20%, 50% and 100% of rated load with a true power factor of 0.9 or greater.[317] The 80 Plus Program is built around the concept of rewarding manufacturers for installing 80 Plus compliant power supply by offering hardware incentives. Power supply manufacturers receive a rebate for power supply units sold within sponsor utility territories. Rebates are $5 per desktop and $10 per server that include 80 Plus power supplies.

This evaluation included only a process evaluation and not an impact evaluation. At the time the workplan was developed for this evaluation, there were no participating Tier 1 OEMs in California and no 80 Plus systems sold in California. In addition, no sales of 80 Plus units were projected for the Program period. Therefore, no impact evaluation was proposed or conducted. The process evaluation included discussions with market actors and secondary literature reviews.

The key finding of this evaluation is that it takes a long time and concerted effort to implement a significant change in this market. Ecos Consulting, through the 2004-2005 IDEEA Program, was instrumental in laying solid groundwork. During this period, 80 Plus made progress in two areas. (1) the Program recruited new power supply manufacturers and additional sponsors. More specifically, 80 Plus attracted the participation of 18 power supply manufacturers; the number of

[317] The 80 Plus web page describes this specification <www.80plus.org>

Program sponsors also grew to 12.[318] Additionally, several tier II System integrators has been recruited into the program. Implementers estimated that the use of more efficient power supplies could result in energy savings of more than 100 kWh annually per personal computer. Given the size of the of personal computer market in the US referenced above, the potential for gross energy savings is significant. (2) Ecos worked with the EPA to incorporate the 80 Plus product standards in the new Energy Star requirements for personal computers with external power supplies. In addition, the Program benefited and learned from other 80 Plus activities outside the region.

The original Program goal was the sale of 110,500 computers with 80 Plus power supplies. The goal was revised downward to 19,501. Within Southern California Edison's territory, a total of 38 units were committed and/or purchased and shipped in the final six months of the Program.[319] Within this same Program time period, almost 1300 certified personal computers were shipped nation-wide. As a gauge of the US PC market, approximately 17,500 personal computers of all types were shipped in Quarter 4, 2005.[320]

The process evaluation generated a number of conclusions and recommendations.

Conclusion 1. *Market adoption of 80 Plus power supplies has been slower than projected.*

The market for 80 Plus power supplies has grown far more slowly than was initially anticipated by 80 Plus Program staff. Incremental cost, the primary market barrier, proved to be larger than predicted by the Program designers. Other market barriers included the time needed to develop and test a new power supply and an underestimation of product demand. However, all the activities and work undertaken during the Program were needed to help lay the groundwork for slow and steady progress toward introducing the 80 Plus power supply into the marketplace.

Although occurring after the 2004-05 Program period, two significant events occurred in the later half of 2006 that should have a positive impact on the sale of 80 Plus units. These include: (1) the announcement by Hewlett Packard that it will begin to offer 80 Plus compliant units; (2) the adoption of 80 Plus as the standard specification for Energy Star computers.[321] Given the anticipated impact of these events on the sale of 80 Plus units, it will be most important to evaluate the continuing Program.

Recommendation 1. *Evaluate the impact of the recent activity in the personal computer industry on continuing Program achievements.*

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[318] An Ecos Consulting report dated May 2, 2006 listed the following program sponsors: Southern California Edison, SMUD, NYSERDA, National Grid, NSTAR, Western Mass Electric, VEIC, Pacific Gas & Electric, NW Energy Efficiency Alliance, Midwest Energy Efficiency Alliance, Natural Resources Canada, and Xcel Energy (MN)

[319] June 2006 Monthly Report Narrative, 2004-2005 Energy Efficiency Programs. Provided by Ecos Consulting.

[320] Alex Moskalyuk, ZD Net web site <http://blogs.zdnet.com/ITFacts/?p=9974>

[321] As of April 2007, Hewlett Packard had four 80 PLUS models available.

Activities throughout the 2004-2005 Program and on into 2007 should have a significant impact on increasing energy efficiency within the personal computer market. Both the Program's process and the impact (energy savings) of the 80 Plus power supplies in personal computers and servers should be evaluated.

Conclusion 2. *The incremental cost of 80 Plus power supplies remains a market barrier for both nonparticipant manufacturers and system integrators.*

The Program was designed to accommodate a $5 price differential for individual personal computers power supplies and a $10 price differential for PC servers. Participants experienced actual incremental costs between $8 and $20. Nonparticipants projected incremental costs between $10 to $20.

Participant and nonparticipant manufacturers generally had different target end-users, with different sensitivities to price. For example, one of the leading manufacturers of 80 PLUS power supplies reported serving educational and government sector clients. These clients may have received mandates to encourage the purchase of more energy efficient personal computers. The nonparticipant manufacturers, by contrast, reported serving large retail distributors. These distributors could be more sensitive to price increases.

Recommendation 2. *Determine whether nonparticipants would participate with increased rebates.*

While some of the participants are not taking full advantage of the rebates, the nonparticipants stated that incremental cost was the primary barrier. For these manufacturers an increase in the rebate may encourage participation. Further discussions with nonparticipants are needed to determine if they would participate if the rebate were increased.

Conclusion 3. *Efforts to increase participation of power supply manufacturers have been successful. Program emphasis should now expand to increase product demand.*

The 80 Plus Program design included a phased approach to market transformation, and included activities on both the supply and demand side. This Program focused on the supply side. While continuing to recruit additional manufacturers and system integrators, the Program should now focus more attention on demand-side activities. Manufacturers noted that most commercial consumers are typically unaware of the energy savings, and long-term cost savings, that may be realized by utilizing a more energy efficient machine. Companies that operate hundreds or thousands of computers stand to realize significant energy and cost savings, and need to be made aware of these savings in order to be prompted to take some action. Increased outreach is needed to educate the average commercial consumer about the advantages of more energy efficient personal computers.

Recommendation 3. *The Program should promote industry and public awareness of 80 Plus to build product demand.*

Promotions in trade and popular magazines and further cooperative advertising with Program sponsors were marketing suggestions made by participants. Joint meetings between Ecos, sponsors, and market actors should continue; these meetings could result in a large purchase commitments.

Conclusion 4. *The 80 Plus Program is inconsistently promoted throughout the Edison territory.*

Edison staff reported some disparities in the level of knowledge among the different account managers regarding 80 Plus, leading to inconsistent outreach efforts across Edison's service territory. Staff also reported that a number of internal training sessions had taken place to familiarize Edison account representatives with the program. The program is difficult to promote internally due in part to the fact that it is an upstream program, that is, one whose incentives are geared toward the manufacturers and not the end consumer.

Recommendation 4*. Partner with 80 Plus staff to participate in joint meetings and selected promotions.*

Edison account managers should be invited to attend future trade events or other joint promotional meetings with staff from 80 Plus to keep informed about the product. Edison has undertaken internal trainings to ensure that all large account managers are aware of the 80 Plus Program – this should be continued. Increased joint efforts between Edison and Ecos staff, could lead to increased Program awareness and sales to large commercial, governmental, and educational customers. Ecos should be able to provide regular reports to Edison regarding the number of units sold in Edison's territory, providing some indication of account managers' outreach.

Southern California Edison awarded Ecos a $1,144,480 contract to implement 80 Plus under the 2004-2005 Innovative Designs for Energy Efficiency Activities (IDEEA) Program. The 80 Plus Program was developed and implemented by Ecos Consulting (Ecos). Ecos officially began operating 80 Plus in 2004 and is implementing the Program nationwide.[322] 80 Plus daily operations are managed by a team of five at the Portland Oregon Ecos office. The Ecos team coordinates communication with 80 Plus sponsors, facilitates promotional activities such as trade show demonstrations, and assists in processing Program rebates.

80 Plus was designed to be an upstream buy-down Program that transformed the market for desktop computers and low-end servers. The Program engaged many different market actors in the personal computer and related computer electronics industries. These included original equipment manufacturers (OEMs) who manufacture the power supplies, system integrators who build computers from component parts including the power supplies, utilities, the Environmental Protection Agency, and the end users of the product.

In its proposal to Edison, Ecos presented a number of goals for the 2004-2005 IDEEA Program. These goals included outreach to secure new partnerships with computer manufacturers and system integrators. Ecos also proposed the development and implementation of a comprehensive marketing strategy for 80 Plus.

[322] Ecos also spent more than a year over 2002-2003 conducting pre-program research and related activities.

The 2004-2005 80 Plus Program was innovative in a number of ways. First, the Program recognized the large potential energy savings that could be realized by encouraging the adoption of more efficient personal computer (PC) power supplies. The typical PC power supply consumes approximately 149 kWh/year while an 80 Plus unit consumes approximately 61 kWh/year.[323] Implementers estimated that each 80 Plus computer represents 85 kWh savings per year over four years and a demand reduction of 16 watts per unit.

Secondly, by engaging a variety of market actors, the Program sought to transform the market through incremental change, beginning first with actors who demand relatively smaller shares of the computer market (such as regional computer system integrators) and then working to engage companies that command larger market share.

Product certification involves testing new power supplies and verifying their compliance with 80 Plus standards. The testing and certification is currently conducted at EPRI.[324] Manufacturers pay a $400 testing fee to EPRI. 80 Plus refunds the fee when the submitted unit passes the test. The creation of a compliance standard was critically important for two reasons. First, it demonstrated that the technology did in fact exist and could be achieved within reasonable budget and technical parameters. Second, it provided the opportunity for companies to offer products on a level playing field.

Program implementers felt the time was right to undertake the 80 Plus Program for the following reasons.[325]

- Current inefficiency in power supplies creates enormous opportunity for energy savings.
- Hardware incentives provide a means to overcome the primary market barrier (incremental cost).
- Energy Star announced it is revising its desktop computer specification, and has indicated it will likely include low-end servers as well.
- Numerous utilities and market transformation organizations are joining the Program.

The Program marketing included print and web-based materials developed by Ecos. The Program motto was *"Run Cool. Run Reliably. Run with 80 Plus."* Some of the marketing tools used to promote the Program included the 80 Plus website, mini-trade shows, and direct "one-on-one" meetings with potential end-users and sponsors.

Ecos initially projected a 5% market penetration rate among desktop computers sold in Edison territory. This penetration rate would have resulted in the sale of approximately 110,500

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[323] Ecos, Stage 2 IDEEA Technical Proposal, p. 3.

[324] In 2003 and 2004, the 80 Plus team worked with Intel and the Natural Resources Defense Council to develop performance tests. This work was supported by a grant from the California Energy Commission Public Interest Energy Research Program (PIER). The intent was to engage a third party contractor to provide objective testing that would be accepted by the computer industry.

[325] Ecos Consulting, 80 Plus Program Proposal submitted to Edison, Oct. 2004.

compliant desktop units and projected ex-ante gross annual energy savings of more than 9.3 million kWh. Ecos and Edison revised the goals in July 2005, making a downward adjustment to 19,501 units and 1,745 PC servers. The reduced number of units would also reduce projected ex-ante gross annual energy savings to 1.75 million kWh.

Quantec, LLC completed a process evaluation of this Program which involved interviews with Program staff , implementers, Program participants, and nonparticipants. No impact evaluation was proposed or conducted. Section 2 presents the process evaluation component of the evaluation. The process evaluation includes a discussion of the Program logic model, design and implementation, contractor and participant decision making and satisfaction. The final section, Section 4, presents the major conclusions and recommendations.

2. Process Evaluation

Process Evaluation Methodology

The process evaluation reviews the Program design, assesses whether the intended activities were conducted, and whether or not these activities moved the Program toward the accomplishment of its goals. Care was taken not to interfere with ongoing negotiations and discussions between Ecos, manufacturers, and suppliers.

Program Logic Model

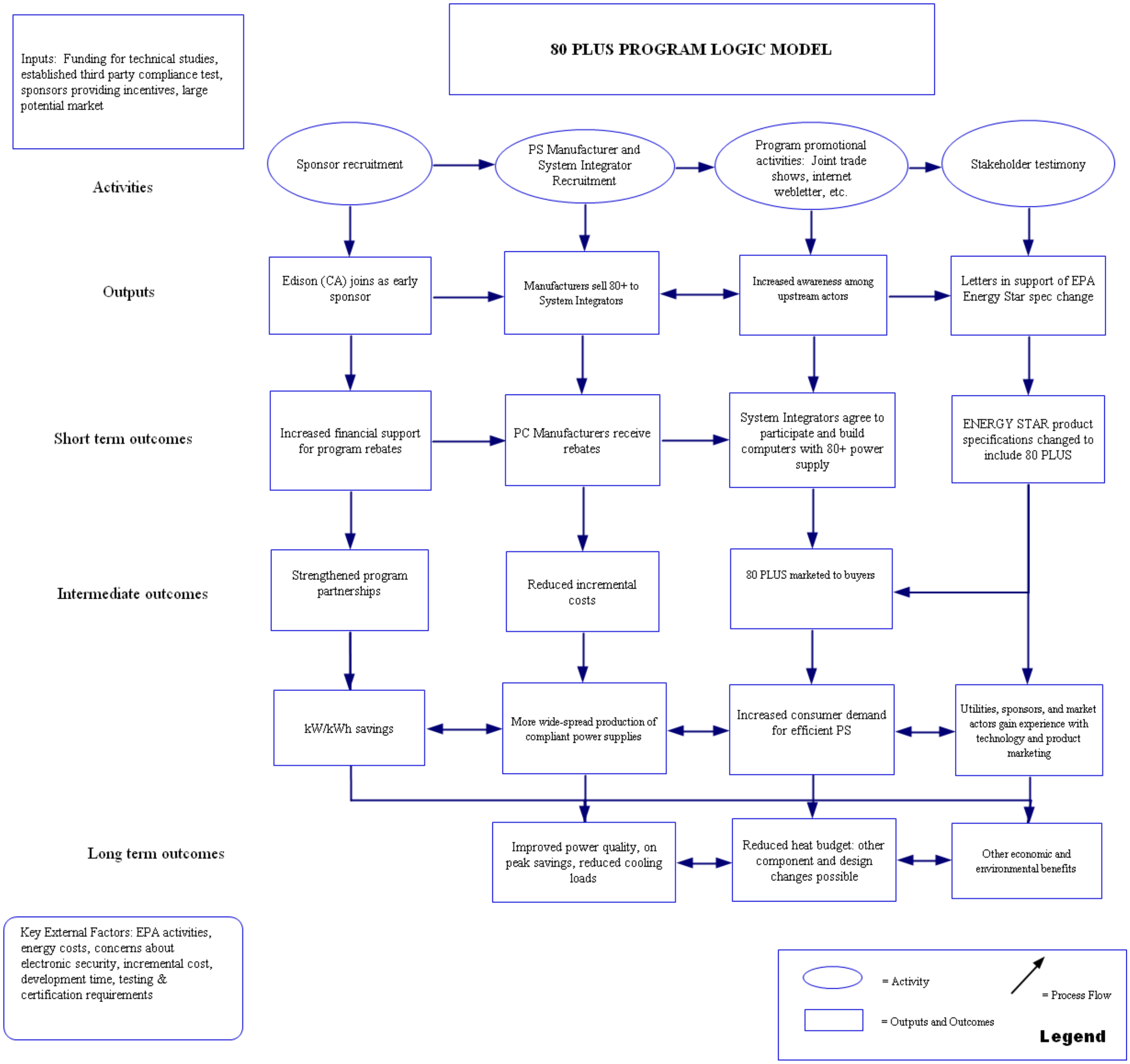
The logic model developed for the 80 Plus Program includes activities by the industry actors, including the Program's target market. The Program's target market included power supply manufacturers, original equipment manufacturers (OEM), system integrators, the administrators of the Energy Star Program, 80 Plus Program sponsors, and end users. Activities included recruiting sponsors, manufacturers and system integrators. In addition, stakeholder testimony was given in support of EPA efforts to change the Energy Star specifications for personal computers to include 80 Plus requirements for PC power supplies.

Some of the short-term goals that were realized included certification of 80 Plus units, power supply sales, recruitment of manufacturers and system integrators who sold 80 Plus units, system integrators offered 80 Plus units, and sponsors who joined the 80 Plus effort to market the power supplies.

Intermediate goals included strengthened Program partnerships, and an enrollment of increased number of Program sponsors. The increased marketing of 80 Plus to buyers was an additional mid-term goal.

Over the long-term, anticipated outcomes included more wide-spread production of compliant units (both as a result of an increased number of models and production by more manufacturers). The result of more 80 Plus units in the marketplace will be sustained kWh savings.

Figure 2-1. Final Logic Model



Process Evaluation Sample Design

The process evaluation included interviews of both participants and nonparticipants, as specified in the table below. A participant is a company that produces or distributes an 80 Plus certified system, or that has submitted a power supply for certification. A system integrator is a company that assembles and sells computers. A total of 15 interviews were conducted via telephone and in-person. Table 2-1 summarizes the surveys planned and achieved.

Table 2-1. Survey Sample Goal and Achievement

	Goal	Achieved
Program implementer/sponsor	2	5
EPA staff	1	2
Participant manufacturers	2	3
Nonparticipants manufacturers	2	2
Participant system integrator	1	2
Nonparticipant system integrator	1	1
Total	9	15

The interviews took place from August through October, 2006. Before interviewing participants, interviewers confirmed that the respondent was involved in the company's decision to participate in 80 Plus. All respondents were involved in the decision making process, or were aware enough of the Program details to provide meaningful information.

Research questions were developed as part of the work plan and then used to develop interview guides. The questions explored the decision-making process used by participants in their determination to participate, and also explored the participants' experiences with the technology. Interviews also took place with Program implementers and with staff at the Environmental Protection Agency. Staff at the EPA were asked about the evolution of 80 Plus, and the potential impact that the Program may have had on the development of new personal computer specifications released in 2006. Four Ecos staff were interviewed as part of this evaluation.

Process Evaluation Results

In this section, the Program is described as experienced by individuals who designed and implemented the Program, by the sample of businesses that participated in the Program and the sample who chose not to participate.

Program Design

The Program design as proposed focused on providing hardware incentives to encourage power supply manufacturers to build units that would meet the 80 Plus efficiency standards. In parallel, the Program as initially designed also included steps to increase demand and increase level of Program sponsor support nationwide. Increasing demand through a customer educational component was considered a secondary aspect, at least in the initial implementation phases.

The Program was implemented largely as designed. That is, specific steps were taken to advance the Program within the target audiences described in the Program documents. The Program increased manufacturer participation. However, the amount of time required to identify and engage market actors took longer than anticipated. The amount of time required for interested manufacturers to develop and test compliant units also delayed the process. Because it took longer to build market supply and demand, far fewer compliant personal computers were sold than anticipated. During the Program period, Ecos discussed production of 80 Plus power supplies with manufacturers including two of the largest OEMs, Hewlett Packard and Dell, among others. While occurring after the Program period, Hewlett Packard announced that they would begin offering power supplies that meet the 80 Plus standard. These significant changes in the personal computer market should contribute to increased sales of compliant power supplies in subsequent phases of the Program.

The Program implementers also proposed to develop tracking systems in the initial phases of the project. A tracking system was completed during the Program period. The system gives Ecos the ability to maintain records of the number of power supply units that have been approved and that have been shipped.

Also of significance was the implementer's continuing work with the EPA toward changing the Energy Star specifications to include an efficient power supply. The Energy Star power supply specifications were essentially the 80 Plus specifications.

The Program was based on the assumption that the $5 or $10 rebate offered for personal computers and desktop-derived servers would be a sufficient financial incentive for the majority of manufacturers in the industry. This rebate was designed to cover the incremental cost of producing the 80 Plus power supply. However, the rebate amount did not prove by itself to be as strong an incentive as anticipated. As described in more detail below, manufacturers and system integrators generally reported larger incremental costs.

The Program was structured such that manufacturers must submit proof that a compliant system has been installed within a given utility's district. The manufacturers provided sales information to Ecos, who in turn, provided the sales information to the Program sponsors. Program sponsors then provided the rebate funds to Ecos, and Ecos then forwarded them back to the manufacturers. Ecos and the manufacturers noted that the rebate forms were not always submitted, for two intertwined reasons. The first was that the rebate did not cover the incremental cost of the power supply and the second was the hassle factor of submitting the forms.

The original Program goal was the sale of 110,500 computers with 80 Plus power supplies. The goal was revised downward to 19,501. Within Edison's territory, a total of 38 units were committed to or purchased and shipped in the final six months of the Program.

The Program built a solid base during the IDEEA Program period and continues to move forward, increasing the number of involved sponsors, manufacturers, and system integrators. In addition to gaining the support of one of the nation's largest manufacturers, Ecos was successful in moving the EPA to include the 80 Plus specifications in their new round of efficiency specifications. These events are likely to move the market in a large way, increasing sales. It will be important to evaluate both the continuing process of this market's evolution and transformation, as well as the energy impacts with the additional anticipated sales.

Market Assumptions and Marketing

Program implementers felt that the current level of inefficiencies in power supplies provided the potential for enormous energy savings. Desktop computers and low-end servers contain power supplies that convert alternating current (ac) to low-voltage direct current (dc), that range in size from 200 to 600 watts. Ecos' technical proposal notes that power supplies can require 300 to 850 watts of ac input, wasting 30 to 45 percent of the electricity input, converting it to heat.[326] Program documents noted that each 80 Plus efficient desktop computer in the marketplace represented 85 kWh savings per year over four years and a demand reduction of 16 watts per unit. Each efficient desktop-derived server represented 301 kWh savings per year, with a four-year life and a demand reduction of 34 watts per unit.[327]

> *With 40 million new desktop computers sold each year in the U.S. and roughly 205 million in use, the energy savings opportunity is enormous. Installing the most efficient commercially available power supply in each desktop computer sold in 2005 and early 2006 would save about 19 billion lifetime kWh and reduce national energy bills by nearly $1.6 billion.*[328]

At the same time the IDEEA Program proposal was presented to Edison, EPA announced it was adding power supply efficiency specifications to their labeling program for computers. Program implementers had been talking with the EPA, and their work was moving the EPA toward adding efficiency labeling.

Because of the EPA activities and potential for savings, implementers anticipated swift adoption of the Program by manufacturers and system integrators, ramping up to delivery of 80 Plus units in late 2005 and early 2006, within the Program's timeframe. In its proposal, the Ecos team predicted that there would be a 5% market penetration of 80 Plus compliant sales among desktop computers sold in the state of California, that is, sales would exceed 110,000 units.

Ecos proposed to work with Edison's commercial account representatives so the representatives could market 80 Plus along with their other offerings. Ecos developed an 80 Plus logo and website that listed certified power supplies and suppliers along with testing requirements. Ecos also planned to market to, and through, computer manufacturers. At the same time, work proceeded in parallel to bring additional utility sponsors on board who could offer incentives to OEMs in other service territories. The Program's progress and success hinged on convincing OEMs to manufacture the efficient power supply. However, OEMs were slow to commit and, once committed, it could take a year to develop the product. Testing and certification could also take weeks to months. During the 2005 calendar year, 35 personal computer power supplies were

[326] Ecos, Stage 2 IDEEA Technical Proposal, p. 2

[327] Ecos Consulting, 80 Plus Program Proposal submitted to Edison, Oct. 2004

[328] Ibid.

certified as 80 Plus compliant, and a handful of Edison customers purchased 80 Plus certified units.

Edison and Ecos adjusted the Program's sales goal in July 2005, lowering it from 110,000 personal computers to approximately 19,000 units. By Program's end, far fewer had been sold in Southern California Edison service territory, that is, only 38 units. In terms of projected sales, the Program fell far short of its goal.

Despite this, Ecos remained optimistic about the Program's current and projected accomplishments. In part because of the comments made by one large OEM, the Ecos team and other participants believed large market actors would begin to offer 80 Plus compliant units. The sentiment was that once one large OEM committed to manufacture 80 Plus, others would follow.

Marketing and Participation Decisions

Participating manufacturers and system integrators generally reported that they did not know about the 80 Plus Program before they were approached by Ecos. Potential participants needed to weigh the relative advantages of potentially increased market opportunities with the increased cost of integrating manufacture of the 80 Plus power supplies into current practice. One of three participating manufacturers interviewed stated that his company decided the use and promotion of improved energy efficient components presented a good opportunity to increase market share. They also reported that local utilities were doing some marketing that helped them to expand their market base. One OEM noted:

> *"Most system integrators did not have a knowledge of energy efficiency for power supplies before 80 Plus."*

In summary, reasons for participation included:

- This was a good opportunity to increase market share (indicated by two participating manufacturers).
- This was an opportunity to increase brand loyalty among existing customers, with the realization that there was a demand for more energy efficient electronic products from their core market group.

The reasons manufacturers chose not to participate included:

- The cost differential between 80 Plus compliant and non-compliant units was too great.
- There was not enough demand from their primary customer groups.

Nonparticipant manufacturers projected an $8-$20 incremental cost per unit, which was too great. Additional nonparticipant manufacturers should be surveyed to determine whether increasing the $5 incentive to more fully cover their projected incremental cost would lead them to participate in the Program. Note however, that the incremental costs were expected to fall as unit shipments picked up. Nonparticipants deciding to offer 80 Plus compliant units will likely experience time constraints similar to those encountered by participating companies when they first developed units for testing. Internal product testing procedures could be an additional topic to discuss with current nonparticipants as a means to gauge how long it would likely take them to develop a compliant power supply unit.

As was the case for manufacturers, system integrators based their decision to offer 80 Plus models on customer demand. System integrators who distributed primarily to large retailers had generally received only minor indications of market demand. System integrators who were among the first to offer 80 Plus products, by contrast, supply educational and governmental institutions who may have a mandate to offer more energy efficient projects.

Program Delivery and Implementation

Ecos structured the 2004-2005 IDEEA Program implementation into three primary phases: Recruitment (to attract new participant power supply desktop manufacturers); Qualification (to encourage manufacturers to submit their products for certification); and, Implementation (to market the Program and begin to enroll participants). Deliverables were proposed for each of the Program phases, as follows.

- Recruitment phase – Recruitment of power supply manufacturers, system integrators and 80 Plus sponsors.
- Qualification phase – Successful testing of power supply prototypes at the Electronic Power Research Institute for 80 Plus certification.
- Implementation phase – The completion of a marketing plan, the shipment of 80 Plus units, and the processing of rebates to manufacturers.

The 80 Plus Program took a number of important steps within the three phases of Program delivery during the 2004-2005 Program period. The three phases and accomplishments are discussed below.

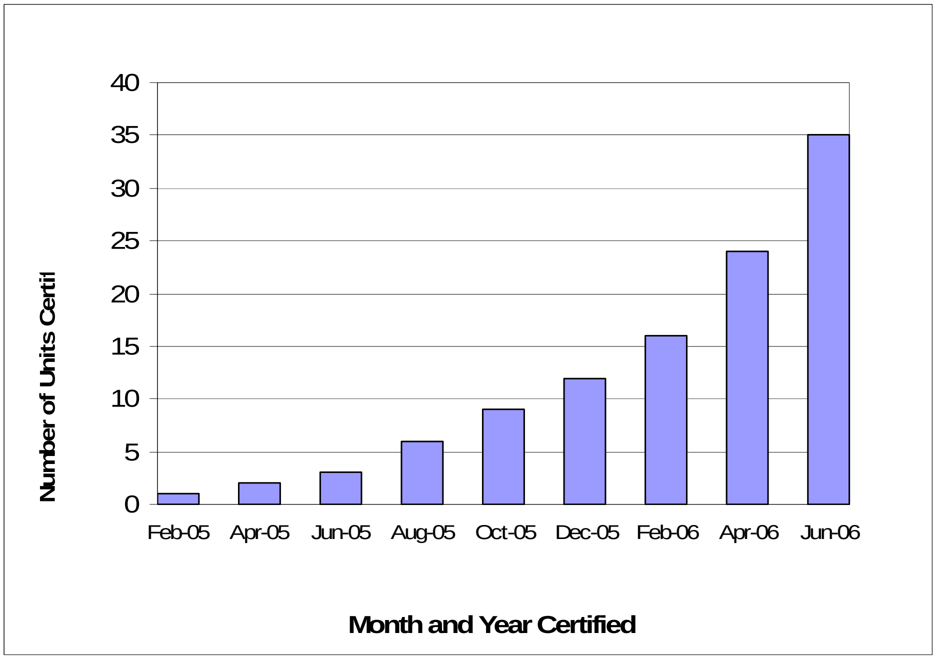
Recruitment

Following the first successful certification of an 80 Plus power supply unit, Ecos continued their outreach efforts to encourage other manufacturers to certify their products. During the 2005 calendar year, 11 manufacturers received 80 Plus certification. In January 2006, there were 12 participating power supply manufacturers, by May 2006 there were 18, and in July 2006 there were 19 (i.e., approximately one new participating power supply manufacturer per month, on average). This group of manufacturers included the top three producers, by the number of available units.[329]

[329] By April 2007, there were 34 manufacturers listed on the 80 PLUS website that produce one or more compliant units.

Figure 2-2 shows the number of power supplies that were certified by EPRI between February 2005 and June 2006. The chart indicates an acceleration in the number of power supply models which qualified for the 80 Plus label.

Figure 2-2. Number of Certified Power Supply Models



Source: 80 Plus *Plugged In* Newsletter, July 2006, with additional information from Ecos

During the first phase of the IDEEA Program, Edison contributed $99,800. This financial support assisted with Program start-up costs incurred during the summer of 2005. Edison subsequently transitioned away from this kind of support and moved to a per unit rebate – or "performance-based" support. The rebate to manufacturers was $5 per desktop unit and $10 for servers.[330]

In addition to recruiting power supply manufacturers, Program implementers entered into discussion with system integrators (SIs). In a number of cases, SIs found it easier to introduce 80 Plus units into their product lines than their manufacturing counterparts. This was due in part to the fact that system integrators don't need to develop or manufacture a new product line. The significantly smaller capital costs associated with purchasing a product rather than producing one allowed system integrators to be more adaptive to market changes than manufacturers.

The recruitment of additional Program sponsors was another important task in this Program's implementation. Program sponsors play a significant role by helping to increase awareness of the

[330] The reported cost to Edison is approximately $5.89 per unit, as reflected in the program summary sheet from June 2006.

80 Plus Program and by providing needed financial support. The sponsors may also support the Program by organizing product demonstration events. Southern California Edison became an 80 Plus sponsor in February, 2005. Edison played an important role as the pioneering utility sponsor. Edison was second only to the Northwest Energy Efficiency Alliance (NEEA), a market transformation organization, to become a sponsor. Edison's sponsorship was a significant milestone that captured attention within the industry nation-wide. Their sponsorship encouraged other utilities to become sponsors. A fellow sponsor indicated that Edison's decision to become a sponsor provided early Program credibility and an important resource.

According to the 80 Plus website, there were 12 Program sponsors recruited during the 2004-2005 IDEEA Program period. In addition to Southern California Edison, these included PG&E, Sacramento Municipal Utility District, the Northwest Energy Efficiency Alliance, NYSERDA, National Grid, and Efficiency Vermont, among others.[331]

Edison's sponsorship and contributions were instrumental in moving the Program forward. The implementers were successful in recruiting market actors.

Qualification

The Seasonic SS-400HT power supply, 80 Plus version, was the first model to pass the test in February, 2005.[332] Seasonic is headquartered in Taipei, with US offices in Azusa, CA. Seasonic currently offers 26 different 80 Plus certified power supplies.

The 18 manufacturers participating in May 2006 offered 32 different compliant power supplies. By April 2007, the number of participating manufacturers had grown to 32, who together offered 136 compliant units. An additional 4units were in a "reference design phase." Table 2-2 below shows the number of units available as of May 2006.

[331] A complete list of sponsors and staff names may also be found on the 80 Plus website <http://www.80plus.org>

[332] Referenced in 80 PLUS press releases and at the Silent Preview technology website, <http://www.silentpcreview.com/article261-page1.html>

Table 2-2. Number of Power Supply Units Submitted and Approved by EPRI as of May 2006

Manufacturer ID	Number of Units Submitted	Number of Units Approved
1	1	0
2	3	2
3	1	1
4	1	1
5	1	1
6	1	0
7	2	1
8	2	1
9	14	12
10	1	1
11	1	1
12	1	0
13	1	1
14	1	0
15	6	4
16	1	0
17	3	2
18	2	0

Source: Ecos Consulting presentation, May 2006.

Implementation

The 80 Plus Program team promoted discussions among industry members. For example, within Edison's territory, a mini-trade show was held in October 2005 to introduce potential buyers to the 80 Plus product. The 80 Plus team also met with a large New England utility and a potential institutional buyer. This meeting facilitated the buyer's decision-making, which increased the potential for sales of hundreds of units. Additional meeting and presentations of this nature occur on an ongoing basis.

In March 2006, a significant accomplishment was realized when the EPA Energy Star Program formally announced plans to include 80 Plus specifications in the revised Energy Star computer specifications scheduled for release in 2007. The revised specifications were officially released in October, 2006. The Energy Star announcement was significant in that it represented the first time that active computer operations (not just "sleep mode") were included in the computer specifications. Computer and power supply manufacturers who appreciate the Energy Star brand recognition are likely to offer 80 Plus compliant units.

Discussions with Hewlett Packard, one of the largest OEMs in North America, occurred during the IDEEA Program period. After the close of the 2004-2005 Program, in November 2006, Hewlett Packard announced that it would begin to offer 80 Plus compliant systems for two of its major product lines in 2007. This significant industry event was the announcement the Ecos team and others were hoping for. The inclusion of 80 Plus units signals major market acceptance for the standard and is expected to result in the introduction of additional 80 Plus compliant personal computers into the market.

During the Program year, 38 units were sold for a total of $224 in rebates and associated fulfillment costs. The Edison Program Manager stated that it was difficult for Edison field representatives to encourage their clients to adopt 80 Plus. He observed that it was hard for the field representatives to get credit for their work. For example, even if a particular unit was sold within Edison's territory, it was often difficult to verify whether the final location of the computer was a specific representative's customer.

As described above, the Program incentive structure depended upon manufacturers sending sales information to Ecos; Ecos in turn submitted the sales information to the proper utility. This process may be hindered if the manufacturer did not want, or was not able, to document the final location of a given power supply.

One Ecos staff person observed that manufacturers are often slow in submitting their rebate requests. He occasionally calls participating companies and reminds them to submit their paperwork needed to process incentive payments. In some cases, companies wait to bundle rebate requests. He also acknowledged that it can be difficult to determine the final geographic location of a power supply after it is purchased. There appears to be two issues for the manufacturers. First, the rebate is not large enough to cover incremental cost. Second, the paperwork may be too burdensome to justify the rebate, or sufficient tracking systems by the manufacturers may not be in place. This sentiment may change as more units are sold and the total amount and number of rebates increase. A simplified tracking and rebate process may be needed for manufacturers to readily request their rebates. Maintaining customer confidentiality may also be an issue for some manufacturers. It will be useful to revisit the incentive-rebate issue in the next round of evaluation.

According to Edison staff, Edison has completed a series of internal training sessions for program managers to learn about 80 PLUS, including a general roll-out session. Selling this program internally has been difficult for the following reasons:

1. 80 Plus is an up-stream program – rebates are given to the manufacturer, rather than the customer. Given this, program managers may have a harder time promoting the program, if their client contacts are primarily with potential end-users.

2. OEMs have often refused to give out bulk customer information, making it difficult for Edison program managers to track the shipments at a customer level. As a result, program managers cannot claim credit for these sales.

3. There is also some hesitancy to sell third party implemented programs.

Market Barriers

As noted above, the shipment of 80 Plus compliant power supplies was an important part of the implementation plan. The 80 Plus team projected sales during the period of approximately

19,500 units. Instead, 40 units were sold in CA, including 38 within Edison territory and 2 elsewhere in the state. Table 2-2 shows the distribution of sales within California, the Northwest, and the rest of the country. The CA numbers include units for which rebates were processed and units whose orders had been confirmed by June 2006.

Table 2-2. Sale of 80 Plus Desktop Units

	2005	Jan-June 2006
CA	2	38
Northwest	395	1,185
Rest of US	3	118

Source: Ecos Consulting

A combination of factors contributed to the large gap between the projected number of computers sold and actual shipments, including:

- Underestimation of the incremental cost to produce the 80 Plus compliant power supply
- Time required to develop and test a new power supply
- Underestimation of product demand

Perhaps the single most important market barrier mentioned by survey respondents was the cost differential between 80 Plus compliant power supplies and standard power supplies. The initial estimates of the incremental cost to produce a 80 Plus personal computer power supply was $5. The rebate amount was designed to cover this anticipated incremental cost. In practice, the incremental cost proved to be higher. Most respondents, including seven manufacturers and system integrators interviewed, estimated the incremental cost to be between $8 and $20.

> *"Cost is the big one. The technology is there, everybody has the 'know-how,' but it is cost that is the barrier."*

The nonparticipant respondents indicated that it was not economically feasible to manufacture the 80 Plus power supplies; the incremental cost was too high.

The expansion of the compliant power supply market following increased market share should help to decrease this cost difference over the next several years.

In terms of the time needed to develop a compliant system, two participants reported that it took their respective firms more than one year. They indicated that twelve to fourteen months elapsed between the time the decision was made to offer an 80 Plus system, and the time a system was developed, tested and approved. A firm will typically test a new power supply internally before sending it to EPRI for the formal certification. In fact, one manufacturer reported that his company had developed a test lab duplicating the EPRI lab so they could test their products internally before sending them out for certification. The certification process itself may take several weeks to a number of months, depending on the number of units waiting to be tested.

One nonparticipant power supply manufacturer stated that increased awareness and increased availability of these products needs to take place. This manufacturer stated that very few of his customers, less than 1%, requested computer systems with the 80 Plus power supply. He stated that lack of consumer awareness was a significant market barrier and recognized that this could be a result of the customers with whom he worked. His customer base was comprised of approximately 50% large retailers and 50% distributors. In his opinion, power supply manufacturers will experience larger demand if they sell to school districts or government agencies that have a mandate to use more energy efficient equipment.

This nonparticipant manufacturer also stated that, in his opinion, there is a lack of design knowledge and technological sophistication on the part of some nonparticipant companies. He stated that some manufacturers sell their product based on the cost alone, and do not have the depth of background to be able to speak to other advantages, such as longer lifetime of the units, or power factor correction.

Participants’ Experience with the Program and the Technology

The early adopters among power supply manufacturers and system integrators differed from their industry counterparts in part by the customers they served. One manufacturing company made the decision that they would convert all of their power supplies to 80 Plus units. This company sells primarily to government agencies, schools and non-profit organizations. Another manufacturer has decided to convert about 5% of their product line to 80 Plus.

Among these two participants, the amount of time initially needed to complete the product design and internal testing prior to testing at EPRI ranged from just under, to just over, one year. The cost per unit for both development and testing will decrease as more units are produced. The first manufacturer produced between 2,000 and 3,000 certified units in 2005. Between the second quarter of 2006 and the second quarter in 2007, they expect to sell more than 60,000 power supply units (of all types) world-wide.

One manufacturer reported that the company would like to transfer their entire line of computer power supplies to the 80 Plus standard. They offered 27 units ranging from 250 to 750 watts. One system integrator promoted the energy efficiency levels of their power supplies as an advantage to their customers. Other power supply manufacturers and system integrators were similarly taking advantage of the energy savings to market their systems as more “environmentally friendly” than comparable systems.

Respondents uniformly acknowledged that there are non-energy benefits associated with 80 Plus power supplies, another important market driver. Non-energy benefits included:

- Power factor correction
- Reduced heat production “inside the box”
- Lower maintenance costs
- Increased system longevity

- Reduced operating noise
- Increased product design options due to the smaller size of 80 Plus power supplies

A number of respondents observed that over the long-term, system savings that result from lowered operation and maintenance costs could prove to be significant. Some OEM and system integrators recognized that there are some customers who value the long-term benefits (such as improved computer longevity and reduced maintenance costs) of an 80 Plus system and are willing to pay the difference. According to the trade allies interviewed, public agencies such as local governments and schools are often willing to pay higher up-front costs in order to meet other policy objectives.

One participating manufacturer suggested that the annual savings in electric costs for a single 80 Plus power supply is approximately $12. If a company has a large number of personal computers, hundreds or thousands, then the annual cost savings can become important. He thought that further cost savings result from improved system reliability, as fewer service disruptions take place and less time is required for on-going maintenance. Reduced heat production in the system also means that less air conditioning is required to maintain system operations. Reduced cooling load is another source of both energy and financial savings.

According to one participating manufacturer, the technology for power supplies hadn't changed in more than ten years. He stated that by improving the performance of the power supply, the whole system will operate better. Risks that may be encountered by temporary power outages or power surges are also reduced. Operating a more efficient system results in reduced risk of the power supply and/or box overheating.

Participant actors stated that growing consumer awareness of energy efficiency will continue to play a direct role in shaping trends in the personal computer industry. Two participants commented that there has been a positive opportunity for their companies to promote their product with the specific marketing messages geared toward consumers who are concerned with issues related to global warming and the environment. This trend in personal computer and other consumer electronics was noted in the Wall Street Journal on June 13, 2006.[333] One nonparticipant, by contrast, indicated that this was not an issue of concern among his target market.

Participant system integrators commented that the anticipated announcement of new Energy Star specifications could cause more units to become available and could therefore drive down the market price.[334] The time frame over which this price change will occur, however, remains unknown. Naturally, the arrival of new Energy Star specifications won't have an immediate or complete impact on the market. "*As long as there is a demand for cheaper, non-80 Plus units, then those units will be available,"* observed one nonparticipant manufacturer. Manufacturers

[333] This Wall Street Journal article specifically refers to the 80 Plus Program as a positive example of growing consumer demand for improved efficiencies in the computer industry.

[334] Energy Star released the new computer specifications on October 20, 2006. These will go into effect in July 2007.

who are large enough to produce a wide range of products will serve both the “high-end” and “low-end” users.

The initial emphasis in the 2004-2005 Program period was to increase product supply, i.e., the recruitment of manufacturers and system integrators to produce and incorporate 80 Plus power supplies into their products. Now that progress has been made in this regard, one respondent observed that the 80 Plus Program should expand its focus to include an increase in consumer awareness. One system integrator stated that 80 Plus should *“focus more on the end-user”* in its promotional efforts.

In summary, respondents felt that 80 Plus positively impacted the market and increased energy efficiency through:

- The ability to differentiate their product with the 80 Plus label
- The non-energy and the extended-energy benefits that result from operating more efficient computer power supplies
- The inclusion of 80 Plus standards in the EPA’s Energy Star standards

Free Riders

Manufacturers received a rebate for each power supply sold. The three participating manufacturers interviewed indicated that they had not been specifically considering 80 Plus before they were contacted by the Program implementers. One respondent indicated that his company had been exploring ways to improve the energy efficiencies of their machines, but had not made any decisions prior to offering 80 Plus power supplies. There were no free riders among the manufacturers.

Potential Spillover

In October 2006, the EPA adopted new Energy Star certification standards for personal computers. The standard includes the 80 Plus power supply requirements. According to interviews with manufacturers and system integrators, the approval of new Energy Star specifications for personal computers should spillover to the rest of the industry. The new specifications should lead to an increased awareness of energy efficient power supplies, and influence purchasing decisions. Cost and market stratification will probably remain, but market expansion is likely to follow the adoption of the new standard. In the meantime, the early adopters of 80 Plus plan to capitalize on their product differentiation as “green electronics” and “energy efficient” computers. They recognize that once the 80 Plus certified computer is more common, or mainstreamed, this early product differentiation will no longer exist.

Lessons Learned by Program Staff, Future Plans

Ecos staff focused their efforts during this Program on increasing the market supply of 80 Plus units. The Program implementers underestimated the amount of time it would take to increase the market share of 80 Plus power supplies in the California market and elsewhere. This may be attributed to an underestimation of the incremental cost to produce 80 Plus power supplies, and the general lack of awareness among consumers regarding the significant inefficiencies of standard power supplies. However, properly laying a solid foundation to build the market was critical to the continued progress toward increasing the supply of 80 Plus certified computers. In the future, attention will need to shift to increasing market demand for 80 Plus.

Program staff cited the value of targeted marketing efforts, including joint efforts between Ecos and Edison staff. Joint marketing projects such as targeted trade shows with potential end-users or vendors are scheduled to take place in the 2006-2008 Program continuation.

During the 2004-2005 Program, 80 Plus pushed the Environmental Protection Agency toward strengthening the new Energy Star computer specifications for power supplies. The inclusion of 80 Plus in the new personal computer specifications served as a positive market driver. This demonstrated the valuable role that the Energy Star Program can play in providing a forum for discussing and improving industry standards.

The Edison manager observed that some of the Program promotions were not effective. In particular, Edison hoped the trade show they co-sponsored in October 2005 would result in 1 or 2 new accounts but no new accounts resulted from that effort. Perhaps a more targeted audience could improve the effectiveness of this kind of an event.

In terms of direct promotions and trade journal coverage, the Edison Manager felt implementers had done a *"fairly substantial amount of work"* and the 80 Plus team had increased awareness of their Program and the 80 Plus product.

3. Impact Evaluation

No impact evaluation was conducted for this Program.

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4. Conclusions and Recommendations

The 80 Plus Program design emphasized increasing both product supply and demand. Increased product supply was accomplished by recruiting manufacturers and system integrators to produce and distribute 80 Plus systems. The 80 Plus team established the needed infrastructure to track rebates and provide regular progress reports to Edison. Increasing product demand was accomplished through marketing tools and outreach to potential new Program participants.

The evaluation report resulted in several conclusions and recommendations.

Conclusion 1. *Market adoption of 80 Plus power supplies has been slower than projected.*

The market for 80 Plus power supplies has grown far more slowly than was initially anticipated by 80 Plus Program staff. Incremental cost, the primary market barrier, proved to be larger than predicted by the Program designers. Other market barriers included the time needed to develop and test a new power supply and an underestimation of product demand. However, all the activities and work undertaken during the Program were needed to help lay the groundwork for slow and steady progress toward introducing the 80 Plus power supply into the marketplace.

Although occurring after the 2004-05 Program period, two significant events occurred in the later half of 2006 that should have a positive impact on the sale of 80 Plus units. These include: (1) the announcement by Hewlett Packard that it will begin to offer 80 Plus compliant units; (2) the adoption of 80 Plus as the standard specification for Energy Star computers.[335] Another major manufacturer, Dell, achieved 80 Plus certification for it first compliant unit in February 2007. Given the anticipated impact of these events on the sale of 80 Plus units, it will be most important to evaluate the continuing Program.

Recommendation 1. *Evaluate the impact of the recent activity in the personal computer industry on continuing Program achievements.*

Activities throughout the 2004-2005 Program and on into 2007 should have a significant impact on increasing energy efficiency within the personal computer market. Both the Program's process and the impact (energy savings) of the 80 Plus power supplies in personal computers and servers should be evaluated.

Conclusion 2. *The incremental cost of 80 Plus power supplies remains a market barrier for both nonparticipant manufacturers and system integrators.*

The Program was designed to accommodate a $5 price differential for individual personal computers power supplies and a $10 price differential for PC servers. Participants experienced actual incremental costs between $8 and $20. Nonparticipants projected incremental costs between $10 to $20.

[335] As of April 2007, Hewlett Packard had four 80 PLUS models available.

Participant and nonparticipant manufacturers generally had different target end-users, with different sensitivities to price. For example, one of the leading manufacturers of 80 PLUS power supplies reported serving educational and government sector clients. These clients may have received mandates to encourage the purchase of more energy efficient personal computers. The nonparticipant manufacturers, by contrast, reported serving large retail distributors. These distributors could be more sensitive to price increases.

Recommendation 2. *Determine whether nonparticipants would participate with increased rebates.*

While some of the participants are not taking full advantage of the rebates, the nonparticipants stated that incremental cost was the primary barrier. For these manufacturers an increase in the rebate may encourage participation. Further discussions with nonparticipants are needed to determine if they would participate if the rebate were increased.

Conclusion 3. *Efforts to increase participation of power supply manufacturers have been successful. Program emphasis should now expand to increase product demand.*

The 80 Plus Program design included a phased approach to market transformation, and included activities on both the supply and demand side. This Program focused on the supply side. While continuing to recruit additional manufacturers and system integrators, the Program should now focus more attention on demand-side activities. Manufacturers noted that most commercial consumers are typically unaware of the energy savings, and long-term cost savings, that may be realized by utilizing a more energy efficient machine. Companies that operate hundreds or thousands of computers stand to realize significant energy and cost savings, and need to be made aware of these savings in order to be prompted to take some action. Increased outreach is needed to educate the average commercial consumer about the advantages of more energy efficient personal computers.

Recommendation 3. *The Program should promote industry and public awareness of 80 Plus to build product demand.*

Promotions in trade and popular magazines and further cooperative advertising with Program sponsors were marketing suggestions made by participants. Joint meetings between Ecos, sponsors, and market actors should continue; these meetings could result in a large purchase commitments.

Conclusion 4. *The 80 Plus Program is inconsistently promoted throughout the Edison territory.*

Edison staff reported some disparities in the level of knowledge among the different account managers regarding 80 Plus, leading to inconsistent outreach efforts across Edison's service territory. Staff also reported that a number of internal training sessions had taken place to familiarize Edison account representatives with the program. The program is difficult to promote internally due in part to the fact that it is an upstream program, that is, one whose incentives are geared toward the manufacturers and not the end consumer.

Recommendation 4. *Partner with 80 Plus staff to participate in joint meetings and selected promotions.*

Edison account managers should be invited to attend future trade events or other joint promotional meetings with staff from 80 Plus to keep informed about the product. Edison has undertaken internal trainings to ensure that all large account managers are aware of the 80 Plus Program – this should be continued. Increased joint efforts between Edison and Ecos staff, could lead to increased Program awareness and sales to large commercial, governmental, and educational customers. Ecos should be able to provide regular reports to Edison regarding the number of units sold in Edison's territory, providing some indication of account managers' outreach.