STATE OF SOUTH CAROLINA

BEFORE THE
PUBLIC SERVICE COMMISSION
OF SOUTH CAROLINA

South Carolina Electric & Gas Company - Annual Update on Demand Side Management Programs and Petition to Update Rate Rider and for Approval of New Demand Side Management Program

COVER SHEET

DOCKET NUMBER: 2013 - 50 - E

(Please type or print)

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DOCKETING INFORMATION (Check all that apply)

☐ **Emergency Relief demanded in petition** ☐ **Request for item to be placed on Commission's Agenda expeditiously**

☐ **Other:**

INDUSTRY (Check one)

- ☒ Electric
- ☐ Electric/Gas
- ☐ Electric/Telecommunications
- ☐ Electric/Water
- ☐ Electric/Water/Telecom.
- ☐ Electric/Water/Sewer
- ☐ Gas
- ☐ Railroad
- ☐ Sewer
- ☐ Telecommunications
- ☐ Transportation
- ☐ Water
- ☐ Water/Sewer
- ☐ Administrative Matter
- ☐ Other:

NATURE OF ACTION (Check all that apply)

- ☐ Affidavit
- ☐ Agreement
- ☐ Answer
- ☐ Appellate Review
- ☐ Application
- ☐ Brief
- ☐ Certificate
- ☐ Comments
- ☐ Complaint
- ☐ Consent Order
- ☐ Discovery
- ☐ Exhibit
- ☐ Expedited Consideration
- ☐ Interconnection Agreement
- ☐ Interconnection Amendment
- ☐ Late-Filed Exhibit
- ☒ Letter
- ☐ Memorandum
- ☐ Motion
- ☐ Objection
- ☐ Petition
- ☐ Petition for Reconsideration
- ☐ Petition for Rulemaking
- ☐ Petition for Rule to Show Cause
- ☐ Petition to Intervene
- ☐ Petition to Intervene Out of Time
- ☐ Prefiled Testimony
- ☐ Promotion
- ☐ Proposed Order
- ☐ Protest
- ☐ Publisher's Affidavit
- ☒ Report
- ☐ Request
- ☐ Request for Certificatio
- ☐ Request for Investigatior
- ☐ Resale Agreement
- ☐ Resale Amendment
- ☐ Reservation Letter
- ☐ Response
- ☐ Response to Discovery
- ☐ Return to Petition
- ☐ Stipulation
- ☐ Subpoena
- ☐ Tariff

K. Chad Burgess
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May 31, 2013

VIA ELECTRONIC FILING

The Honorable Jocelyn G. Boyd
Chief Clerk/Administrator
Public Service Commission of South Carolina
101 Executive Center Drive
Columbia, South Carolina 29210

RE: South Carolina Electric & Gas Company
Annual Update on Demand Side Management Programs and Petition to Update Rate Rider and for Approval of New Demand Side Management Program; Docket No. 2013-50-E

Dear Ms. Boyd:

In accordance with Order No. 2013-266 in the above-referenced docket, South Carolina Electric & Gas Company hereby files with the Public Service Commission of South Carolina a copy of the Company's Evaluation, Measurement and Verification report ("EM&V Report") for Program Year 2, which consists of the time period December 1, 2011, to November 30, 2012.

By copy of this letter, we are also providing a copy of the EM&V Report to the South Carolina Office of Regulatory Staff and enclose a certificate of service to that effect. We are also providing counsel for the Southern Alliance for Clean Energy and the South Carolina Coastal Conservation League with a courtesy copy of the report.

If you have any questions, please advise.

Very truly yours,

K. Chad Burgess

KCB/kms
Enclosure
cc: John W. Flitter
Jeffrey M. Nelson, Esquire
Shannon Bowyer Hudson, Esquire
J. Blanding Holman, IV, Esquire
(all via electronic mail and U.S. First-Class Mail)

BEFORE

THE PUBLIC SERVICE COMMISSION OF

SOUTH CAROLINA

DOCKET NO. 2013-50-E

IN RE:

South Carolina Electric & Gas Company Annual Update on Demand Side Management Programs and Petition to Update Rate Rider and for Approval of New Demand Side Management Program.	)	**CERTIFICATE OF SERVICE**

This is the certify that I have caused to be served this day one (1) copy of South Carolina Electric & Gas Company's **Evaluation, Measurement and Verification report ("EM&V Report")** to the persons named below via electronic mail and U.S. First Class Mail at the addresses set forth below:

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This 31st day of May 2013

SCE&G ENERGYWISE PROGRAM YEAR 2: EVALUATION, MEASUREMENT AND VERIFICATION REPORT

Prepared for:

SOUTH CAROLINA ELECTRIC & GAS COMPANY

Prepared by:

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May 2013

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1. EXECUTIVE SUMMARY

South Carolina Electric & Gas Company (SCE&G) began offering customer energy efficiency programs in October 2010. The period from December 2011 through November 2012 constituted their second program year (PY2). Over this period, SCE&G continued to implement eight programs for their residential customers, and two programs for their commercial and industrial (C&I) customers. This document verifies the claimed savings for PY2 (December 2011-November 2012). The purpose of this report is to verify the actual gross and net program energy and demand saving estimates as compared to the company's forecasted savings.

Based on SCE&G's planning model for this portfolio of programs, the programs were forecasted to achieve net 121,625 MWh and 20.72 MW in PY2. While the programs grew in terms of absolute numbers compared to the first year, the savings claimed by SCE&G over this period fell slightly short of forecast, achieving net 110,623 MWh and 14.88 MW, or 91% of energy and 72% of demand forecasts. Overall in PY2, SCE&G spent just over $16M dollars implementing this portfolio of programs[1], which was 80% of what was forecasted.

In terms of energy savings, the Residential ENERGY STAR Lighting, Home Energy Check-Up and ENERGY STAR New Homes programs (representing close to two-thirds of the energy savings) performed far better than forecasted. While other programs such as the Heating & Cooling Efficiency Improvement and Residential Energy Information Display programs represented less than ten percent of the energy savings saved significantly less than forecasted. This report dedicates a chapter to each program whereby we present the verified gross and net savings and discuss the programs' performance against forecasts and program tracking records.

[1] Program costs reported here do not account for amortization or interest.

Table 1. Portfolio Net Savings, Program Costs and Participation

	NET Savings				Program Costs		Participation		
Program Name	**MWh Actual**	**% of Forecast**	**MW Actual**	**% of Forecast**	**Actual**	**% of Forecast**	**Actual**	**% of Forecast**	**Def**
ENERGY STAR Lighting	65,919	245%	6.00	172%	$ 4,221,791	116%	2,654,041	321%	Bulbs
Heating & Cooling and Water Heating	10,027	113%	3.05	141%	$ 2,572,898	70%	6,006	84%	Measures
Home Energy Report	3,723	45%	1.37	45%	$ 349,767	81%	28,012	111%	Customers
Home Energy Check-up	1,918	257%	0.43	287%	$ 751,389	125%	2,677	129%	Customers
ENERGY STAR New Homes	910	200%	0.3	188%	$ 555,763	162%	353	70%	Homes
Heating & Cooling Efficiency Improvement	501	7%	0.16	5%	$ 904,975	36%	1,026	8%	Customers
Home Performance with ENERGY STAR	502	19%	0.18	31%	$ 1,174,442	47%	258	25%	Customers
Energy Information Display	303	16%	0.048	16%	$ 501,482	61%	1490	31%	Customers
C&I Prescriptive & Custom	26,821	42%	3.34	46%	$ 5,017,526	91%	572	103%	Customers
Total	**110,623**	**91%**	**14.88**	**72%**	**$ 16,050,032**	**80%**	**2,694,435**	**306%**	
**Actuals are compared to PY2 forecasts in the Evaluation Plan.*									
*Program costs presented in this report do not account for amortization or interest (carrying cost)									

As shown in Table 2, most of the second year's energy savings came from lighting sales through the ENERGY STAR Lighting Program. The C&I programs also contributed a significant amount. The Heating, Cooling and Water Heating program is gaining traction in the market and starting to contribute a larger amount to the overall portfolio than last year.

Table 2. Program Contribution to Overall Portfolio Savings

Program	PY2
ENERGY STAR Lighting	60%
C&I Prescriptive and Custom	24%
Heating & Cooling and Water Heating	9%
Home Energy Report	3%
Home Energy Check-up	2%
ENERGY STAR New Homes	0.8%
Heating & Cooling Efficiency Improvement	0.5%
Home Performance with ENERGY STAR	0.5%
Energy Information Display	0.3%

The PY2 evaluation effort was two-fold for most programs: (1) Reviewing the program's databases, verifying that the program's tracking databases were accurately applying energy and demand savings[2] to estimate gross savings and (2) Verifying gross and net energy savings through on-site visits, telephone surveys, metering, and billing analyses. Currently, SCE&G is planning to take the evaluation findings into consideration as it plans for the next program cycle, PY4-PY6, to better refine its forecasted savings and participation.

Table 3 shows the gross and net realization rates (RR) that were found in PY2, and the definition of each rate. Gross realization rates show the difference between tracked and verified gross savings per program. As shown in the table below, the Heating and Cooling and Home Energy Check-Up programs have the largest gross realization rates indicating that these programs produced more savings than SCE&G predicted through its planning model. Alternatively, the ENERGY STAR Lighting and Heating and Cooling Efficiency Improvement programs have the lowest gross realization rates. The Lighting program's low rate is due to accounting for installation and leakage rates. This type of adjustment is common for the evaluation of an upstream Lighting program.

Net realization rates show the difference between tracked net savings and verified net savings. As shown in the table below, the Heating & Cooling and Home Energy Check-Up programs have the largest gross realization rates and the largest net realization rates due to both the increase in verified gross savings and strong self-reported net-to-gross-ratios (NTGR). However, the Home Energy Report and Heating & Cooling Efficiency Improvement programs have the lowest net realization rates. Through billing analysis we found that participants in the Home Energy Report program were saving about 39% of the assumed savings per participant. While this is lower than predicted, the savings per participant are on par with the savings found in similar programs throughout the country. The Heating & Cooling Efficiency Improvement program's weak net savings realization rate is largely

[2] The evaluation team conducted an engineering desk review of all deemed savings estimates in PY1. The result of which recommended some revised estimates to be used prospectively in PY2. The evaluation team reviewed all program databases to ensure that the recommended deemed savings values were applied. The evaluation conducted a desk review of any new measures in PY2 that were not reviewed in the PY1 evaluation.

due to a low participant self-reported NTGR. Through surveying participants, the evaluation team found that many of the participants were free-riders in this program and would have likely performed the measures without the program's intervention.

Table 3. Portfolio Gross and Net Savings Realization Rates by Program

	Gross			Net				
Program Name	kWh RR	KW RR	Reasons for Difference	kWh Verified NTGR	KW Verified NTGR	kWh RR	KW RR	Reasons for Difference
ENERGY STAR Lighting	0.71	0.71	Adjusted deemed savings for new PY2 measures, applied installation and leakage rate assumptions	0.83	0.83	0.84	0.84	Gross savings adjustments and applied self-reported NTG ratio higher than tracked .70
Home Energy Report	n/a	n/a	n/a	n/a	n/a	0.40	0.40	Difference between tracked net savings per participant and actual from billing analysis
Heating & Cooling	1.46	1.44	Adjusted deemed savings based on billing analysis, Adjusted deemed savings for new PY2 measures	0.84	0.84	1.75	1.72	Gross savings adjustments and applied self-reported NTG ratio higher than tracked .70
Water Heating	1.00	1.00	No adjustments needed	0.76	0.76	0.78	0.78	Applied self-reported NTG ratio lower than tracked .98
Home Energy Check-up	2.37	2.33	Verified number of participants; verified accounts for installation rates of leave behind measures and recommended actions taken post-audit	0.68	0.78	1.79	1.98	Gross savings adjustments and applied self-reported NTG ratio lower than tracked .90
Energy Information Display	n/a	n/a	n/a	n/a	n/a	0.95	0.95	Difference between net assumed savings per participant and actual from billing analysis
ENERGY STAR New Homes	N/A: Modeling analysis to occur in PY3. No database errors therefore tracked and verified are equal. Planning model NTGR of .9 was used to estimate PY2 net savings.							
Home Performance w ENERGY STAR	1.0	1.0	No adjustments needed	0.79	0.78	0.88	0.86	Applied self-reported NTG ratio lower than tracked .90
Heating & Cooling Efficiency Improvement	0.65	0.64	Made database corrections/removed duplicate entries	0.38	0.40	0.31	0.31	Gross savings adjustments and applied self-reported NTG ratio lower than tracked .80
Commercial and Industrial - Prescriptive & Custom	1.07	1.02	Adjusted based on metering data, desk reviews and database corrections	0.75	0.76	1.01	0.97	Gross savings adjustments and applied self-reported NTG ratio lower than tracked .80

2. EVALUATION METHODS

The purpose of this PY2 report is to verify the actual gross and net program energy and demand savings estimates as compared to the company's forecast. The evaluation team conducted a variety of data collection and analytical methods to verify gross and net savings for each program. A high level description of each evaluation method is provided below:

Database Review Verification: The evaluation team reviewed program tracking databases to ensure there were no duplicates or database errors and that all agreed-upon deemed savings for PY2 were applied accurately for each measure.

On-Site Measure & Project Desk Review Verification: The evaluation team conducted site inspections at a sample of C&I customer participating sites. During the onsite inspection the reported equipment, installation quantities, and efficiency levels of all measures were visually confirmed to ensure the equipment installed matched what was rebated by the program. Engineers gathered information on the equipment that was in place prior to the retrofit to establish an accurate baseline for savings calculations. The evaluation team also conducted engineering desk reviews for a sample of C&I participants. For projects analyzed using desk review only, several sources of information were reviewed to inform savings calculations. All invoices, equipment specifications, and energy savings calculations included in project files were reviewed. Phone interviews with equipment operators were conducted to verify equipment installation and increase understanding of annual equipment usage patterns, hours of operation, and loading conditions. Additional equipment data was collected from manufacturers as necessary.

Billing Analysis Verification: Billing analysis takes large amounts of monthly consumption data and other data that relate to the consumption, such as weather, and uses statistical principles to test whether the program has had an effect on the actual consumption. There are three major steps in this type of analysis: 1) prepare data, transform it to fit the chosen model, and integrate it to support the analysis, 2) create descriptive statistics to describe the data in the study, and 3) conduct statistical analysis to test the hypotheses.

Phone Survey Measure Verification: The evaluation team conducted telephone surveys with PY2 participants. Samples were drawn to ensure that results meet the industry-standard 90/10 criteria in terms of sampling error. Telephone surveys were designed to verify installation and operation of measures and to explore program attribution.

In-Store Intercept Survey Verification: The evaluation team conducted in-store intercept surveys with people who purchased program discounted lighting at participating retailers. The surveys were designed to calculate a leakage rate for the program, i.e. the proportion of non-SCE&G customers purchasing program lighting. The surveys were also designed to explore program attribution.

Engineering Desk Review Verification: The evaluation team conducted a full engineering desk review of measures in PY1. As a result, the evaluation recommended some new deemed savings estimates to be applied prospectively in PY2. This activity was conducted again in PY2 but only for new measures that were not reviewed in PY1. This activity consisted of an engineer reviewing written documentation from the program around impacts and assessing whether the inputs are reasonable and in line with standard practice.

Net Savings Verification Analysis: Verified net savings were often calculated based upon self-reported information collected from participants through survey efforts. We summarize this approach below but note that a billing analysis was conducted to verify the net savings from the Home Energy

Report and Residential Energy Information Display programs (please refer to Appendices C and Appendix G for detailed methods). For most programs we derive net program impacts by applying a NTGR to gross program savings. This NTGR typically comprises two concepts—free ridership (FR) and spillover (SO). Both concepts use self-reported information from telephone interviews or in-store intercept surveys with program participants. We calculate the overall NTGR as (1 - FR + SO). The final ratio represents the percentage of gross program savings that we can reliably attribute to the program. The following is a high-level description of the free ridership and spillover concepts, and the general types of questions we used to assess both free ridership and spillover.

Free Ridership

Free riders are program participants who would have implemented the incented energy efficient measure(s) even without the program. Free ridership estimates are based on a series of questions that explore the influence of the program in making the energy efficient installations, as well as likely actions had the incentive not been available.

Spillover

For purposes of this evaluation, spillover consists of participant spillover. Participant spillover refers to the installation of energy efficiency measures or adoption of energy efficient practices by a program participant due to program influences but without financial or technical assistance through a SCE&G program. An example of participant spillover is a customer who installed a new heat pump through a SCE&G program and, as a result of the positive experience, installs additional energy efficient equipment in his or her home, but does not request an incentive.

Table 4 below shows the data collection and analytical methods that were applied in this impact evaluation report for each program. Detailed data collection and analytical methods for each program are provided in each program chapter and in the Appendices.

Table 4. Portfolio Evaluation Methods

	C&I Prescriptive & Custom	ENERGY STAR Lighting	Heating & Cooling and Water Heating Equipment	Efficiency Improvement	Home Energy Check-up	Home Performance with ENERGY STAR	ENERGY STAR New Homes	Home Energy Report	Energy Information Display
Reviewed Data Tracking Systems Against Deemed Savings & Corrected Tracking Errors	Yes for All Programs								
On-Site Visits and Project Desk Reviews	n=76								
Billing Analysis			Yes					Yes	Yes
Participant Telephone Surveys*	n=91		n=294	n=101	n=132	n=62			
In-Store Intercept Surveys		n=228							
Engineering Desk Review		Yes	Yes						
Net-to-gross ratio adjustments based on self-report	Yes	Yes	Yes	Yes	Yes	Yes		n/a	n/a

* Phone surveys conducted with participants to ensure measures were received and still operating. All measures were verified in the survey; therefore, no adjustments were made with the exception of the Home Energy Check-Up program where the program leaves measures with customers for them to self-install. This program's database assumes that all measures are installed, phone surveys calculated the actual installation rate per measure and adjusted the energy savings accordingly. Installation rates met the industry standard of precision, 90% confidence internal +/- 10%

3. PROGRAM-SPECIFIC FINDINGS

This section provides the program-by-program write-ups. Each section includes a program description, a summary of the program performance, and a detailed assessment of the evaluation of program impacts. The residential programs are presented first (in order of their energy savings contribution to the overall portfolio), followed by the commercial programs.

3.1 RESIDENTIAL ENERGY STAR® LIGHTING

3.1.1 PROGRAM DESCRIPTION

The SCE&G Residential ENERGY STAR® Lighting Program provides upstream price reductions on energy efficient lighting. The purpose of the program is to increase market share and the purchase of ENERGY STAR qualified lighting and lighting products through retail sales channels by discounting prices. In PY2, the program discounted standard and specialty CFL bulbs, CFL fixtures, LED reflector bulbs, LED nightlights and LED holiday strings. The program targets residential electric customers within SCE&G's service territory, specifically focusing on single-family homeowners and renters.

The program is designed to overcome the most common barriers for upgrading to energy efficient lighting including:

- Higher first cost of energy efficient technologies compared to existing technologies
- Lack of consumer understanding about the benefits, savings, and features associated with energy efficient lighting

Additional barriers addressed by the program are product availability and performance or quality perceptions. Similar to PY1, these barriers are addressed through incentives, education, marketing and collaboration with retailers.

3.1.2 PROGRAM PERFORMANCE SUMMARY

The SCE&G Lighting program was very successful, exceeding the PY2 participation forecast and accounting for 60% of the total savings from SCE&G's EnergyWise programs. SCE&G forecasted that they would sell 825,853 bulbs through the program in PY2. At the end of the program year, SCE&G provided incentives on 2,654,041 bulbs, reaching 321% of the forecasted number.

Table 5 summarizes the forecasts and overall results for the program in terms of participation and energy and demand savings. Because of the success of the program, SCE&G exceeded the forecast budget allocation for the program, spending 116%. Notably the program exceeded the participant forecast reaching 321% of the forecasted bulb sales. The program database includes all bulb and fixture sales from retailers between December 2011 and November 2012.

Table 5. Lighting Program Forecasts and Results

	Forecast	Actual	% of Forecast Accomplished
Cost	$3,637,457	$4,221,791	116%
Participants (number of bulbs/fixtures sold)	825,853	2,654,041	321%
Net MWH	26,921	65,919	245%
Net MW	3.48	6.00	172%

Participation was most significant at home improvement, deep discount, club, and big box merchants with emerging participation at smaller co-operative and drug and specialty stores. Table 6 below provides a summary of the bulb sales by retailer in the SCE&G electric service territory in PY2.

Table 6. Bulb Sales by Retailer[3]

Retail Type	Retailer	Total Bulbs Sold
Home improvement, deep discount, club, and big box stores	Retailer A	834,715
	Retailer B	603,233
	Retailer C	465,744
	Retailer D	434,106
	Retailer E	173,888
	Retailer F	724
	Retailer G	231
Co-operative drug and specialty stores	Retailer H	132,853
	Retailer I	4,623
	Retailer J	3,030
	Retailer K	894
	Total	2,654,041

3.1.3 Impact & Data Tracking Findings

In PY2, the program achieved verified net savings of 65,919 MWh and 6.00 MW, or 245% of its electric goal and 172% of its demand goal, as noted previously. Over 2.11 million CFLs were sold[4],

[3] Store names are held back in order to keep proprietary sales information confidential

[4] Includes both Fixtures and Bulbs

accounting for over 99% of the program's energy savings (LEDs account for the remaining bulbs and savings.) In PY2, the program also sold 2,937 LED reflector bulbs, 4,506 LED nightlights, and 535,535 holiday light bulbs (7,225 LED holiday strings), representing a total of 542,978 LED bulbs[5].

Table 7 below shows adjustments made at each level of savings. Overall, the program realized 71% of its tracked gross energy and demand savings.

Table 7. Verified Gross and Net Savings for the Lighting Program

Bulb type	Verified Units Sold	Tracked Gross Savings		Verified Gross Savings		Gross Savings Realization Rate [a]		Verified Net Savings	
		MWh	MW	MWh	MW	MWh	MW	MWh	MW
CFLs	2,111,063	111,375	10.17	79,091	7.22	71%	71%	65,645	5.99
LEDs	542,978	1,177	0.01	330	0.01	28%	69%	274	0.01
Total	**2,654,041**	**112,552**	**10.18**	**79,421**	**7.23**	**71%**	**71%**	**65,919**	**6.00**

[a] The realization rate is calculated by dividing the Ex-post Gross Savings by the Tracked Ex-Ante Savings

The sections below walk through how tracked savings were adjusted for verified gross and net savings.

Verified Gross Savings Adjustments

Program tracked savings values were analyzed to calculate:

- Any changes to measure participation counts, based on a review of the program database
- Any engineering modifications, as deemed appropriate through a review of deemed savings values and assumptions

The independent review of tracking data produced measure counts that matched those tracked by the program. For most lighting measures, savings values tracked by the program were equal to deemed savings values that were recommended from the PY1 engineering review of deemed savings values. However, the database included new measures in PY2 that were not reviewed in the PY1 review. Therefore, we performed an engineering review of these new PY2 measures, as discussed below, and documented the differences.

[5] LED holiday light strings were counted at the bulb level in the program data as opposed to the string level. The program reports that in future years, holiday lights will be reported at the string level.

In PY2, the program offered discounts on 22 additional lighting products. These types of lighting include CFLs, LED reflectors, and holiday lighting. We performed an engineering review to determine whether the deemed savings assumptions were reasonable.

The table below lists each measure, the per unit savings values tracked by the program, and revised savings values as determined by an engineering review[6].

Table 8. Overview of Revised Deemed Savings for new Lighting Measures

Measure	Program Tracked Savings Assumptions		Revised Energy Savings Assumptions		Notes on Differences between Tracked and Verified Savings
	Energy (kWh/lamp)	Demand (kW/lamp)	Energy (kWh/lamp)	Demand (kW/lamp)	
CFL - 25W	66.7	0.008	82.1	0.008	Hours per day increased from 2.44 hrs/day to 3.0 hrs/day
CFL - 36W	56.9	0.006	97.5	0.009	Hours per day increased from 2.44 hrs/day to 3.0 hrs/day; Baseline wattage increased from 100W to 125W
CFL - 42W	96.0	0.011	118.3	0.011	Hours per day increased from 2.44 hrs/day to 3.0 hrs/day
CFL - 54W	85.3	0.010	159.9	0.015	Hours per day increased from 2.44 hrs/day to 3.0 hrs/day; Baseline wattage increased from 150W to 200W
CFL - 55W	84.5	0.010	213.5	0.020	Hours per day increased from 2.44 hrs/day to 3.0 hrs/day; Baseline wattage increased from 150W to 250W
CFL - 68W	72.9	0.008	254.0	0.023	Hours per day increased from 2.44 hrs/day to 3.0 hrs/day; Baseline wattage increased from 150W to 300W
LED - 8W	62.0	0.003	35.0	0.003	Hours per day decreased from 6.7 hrs/day to 3.0 hrs/day; Baseline wattage increased from 33.3W to 40W
LED - 9.6W	74.4	0.003	33.3	0.003	Hours per day decreased from 6.7 hrs/day to 3.0 hrs/day
LED - 10W	77.5	0.003	32.9	0.003	Hours per day decreased from 6.7 hrs/day to 3.0 hrs/day; The tracked incandescent equivalent assumption is unknown, but a 40W incandescent equivalent was applied to calculate the verified per unit savings
LED - 11W	85.2	0.004	31.8	0.003	
LED - 12W	93.0	0.004	30.7	0.003	

[6] Appendix A shows the deemed saving estimates that were applied to each bulb type sold in PY2.

Measure	Program Tracked Savings Assumptions		Revised Energy Savings Assumptions		Notes on Differences between Tracked and Verified Savings
	Energy (kWh/lamp)	Demand (kW/lamp)	Energy (kWh/lamp)	Demand (kW/lamp)	
LED - 13W	100.7	0.004	51.5	0.005	Hours per day decreased from 6.7 hrs/day to 3.0 hrs/day; The tracked incandescent equivalent assumption is unknown, but a 60W incandescent equivalent was applied to calculate the verified per unit savings
LED - 15W	116.2	0.005	49.3	0.005	
LED - 16W	123.9	0.005	48.2	0.004	
LED - 17W	131.7	0.005	63.5	0.006	Hours per day decreased from 6.7 hrs/day to 3.0 hrs/day; Baseline wattage increased from 70.8W to 75W
LED - 18W	139.4	0.006	62.4	0.006	Hours per day decreased from 6.7 hrs/day to 3.0 hrs/day; The tracked incandescent equivalent assumption is unknown, but a 75W incandescent equivalent was applied to calculate the verified per unit savings
LED - 20W	154.9	0.006	60.2	0.006	
LED - 24W	185.9	0.008	55.9	0.005	
LED-Mini Holiday Lights (Icicle, Net, Mini, Dome, snowflake)	0.122	0.000	0.054	0.000	Hours of use decreased from 370 hrs/holiday season to 225 hrs/holiday season (assuming 5 hrs/day per Maine TRM; assuming 45 days) ; Baseline wattage increased from 0.40W to 0.43W; LED wattage decreased from 0.071W to 0.069W
LED-C9 Holiday Lights	2.554	0.000	1.029	0.000	Hours of use decreased from 370 hrs/holiday season to 225 hrs/holiday season (assuming 5 hrs/day per Maine TRM; assuming 45 days) ; LED wattage increased from 0.096W to 0.141W
LED-C7 Holiday Lights (C3, C5, C6, C7)	1.814	0.000	0.720	0.000	Hours of use decreased from 370 hrs/holiday season to 225 hrs/holiday season (assuming 5 hrs/day per Maine TRM; assuming 45 days) ; LED wattage increased from 0.096W to 0.202W
LED-Globe Holiday Lights (G12, G30. G40. G50, C3)	0.568	0.000	0.721	0.000	Hours of use decreased from 370 hrs/holiday season to 225 hrs/holiday season (assuming 5 hrs/day per Maine TRM; assuming 45 days) ; Baseline wattage increased from 1.75W to 5W; LED wattage decreased from 0.214W to 0.193W

A program Leakage Rate and Installation Rate were then applied to the revised gross savings to estimate verified gross savings. The Leakage Rate represents the percent of non-SCE&G customers purchasing program-discounted lighting (estimated at 14.5%). As these savings are not accruing in

SCE&G territory, the program cannot claim them. The program Installation Rate represents the percent of lighting sold through the program that is installed in PY2 and not stored away for future use (estimated at 83%).

These input values are applied using the following algorithm:

Verified Gross Savings = Revised Gross Savings[7] * Installation Rate * (1 – Program Leakage Rate)

Table 9 shows the resulting verified gross savings after making adjustments for the Leakage Rate and Installation Rate. A total of 79,421 MWh and 7.23 MW were saved at the verified gross savings level, resulting in a gross savings realization rate of 71%.

Table 9. Verified Gross Savings for Lighting

	MWh	MW
Tracked Gross Savings	112,552	10.18
Revised Gross Savings	111,915	10.19
In-Service Territory Rate (1-program leakage, or 1-.145)	.855	.855
Installation Rate	.83	.83
Verified Gross Savings	79,421	7.23
Gross Savings Realization Rate	71%	71%

Adjustments at the Net Savings Level

The program planning model assumed a NTG ratio of 0.70. In PY2, the evaluation team calculated a new NTG ratio through an in-store intercept survey (a detailed methodology for how we calculated the NTG ratios is provided in Appendix A). As such, we found a higher NTG ratio of 0.83 for PY2. Table 10 displays PY2 Verified Net savings after applying the NTG ratio of 0.83. Verified Net savings are 65,919 MWH and 6.00 MW.

Table 10. Verified Net Savings for Lighting

Bulb type	Verified Gross Savings		NTG Ratio		Verified Net Savings	
	MWh	MW	MWh	MW	MWh	MW
CFLs	79,091	7.22	0.83	0.83	65,645	5.99
LEDs	330	0.01	0.83	0.83	274	0.01
Total	**79,421**	**7.23**	**0.83**	**0.83**	**65,919**	**6.00**

[7] Includes any engineering modifications made at the per-unit deemed savings level.

3.2 RESIDENTIAL HEATING & COOLING AND WATER HEATING PROGRAM

3.2.1 PROGRAM DESCRIPTION

The Residential Heating & Cooling and Water Heating Program offers incentives to residential customers to purchase and install high efficiency HVAC systems. The program's major goals are to assist customers with reducing electric consumption without compromising comfort in the home. The rebates help to offset the upfront cost for purchases of energy-efficient ENERGY STAR qualified equipment. To participate in this program, the customer must receive residential electric service from SCE&G in a new or existing separately metered residence. The incentives vary according to the type and efficiency level of the equipment installed.

In addition to offering rebates on high efficiency HVAC equipment, the program incents customers for removing electric-resistance water heaters and installing non-electric resistance water heaters (i.e. natural gas, propane, heat pump water heaters, or solar). Additionally, the program also incents builders to install non-electric-resistance water heaters in newly constructed homes.

Table 11 shows the measures eligible under this program and the corresponding rebate amount.

Table 11. Eligible Program Measures for Heating & Cooling and Water Heating

Equipment Type	Efficiency	Rebate Amounts
Package Central A/C	≥ 14 SEER and ≥ 11 EER	$200
	≥ 15 SEER and ≥ 12 EER	$300
Split Central A/C	≥ 14.5 SEER and ≥ 12 EER	$200
	≥ 16 SEER and ≥ 12.5 EER	$300
Packaged Air Source Heat Pump	≥ 14 SEER and ≥ 11 EER	$200
	≥ 15 SEER and ≥ 12 EER	$300
Split Air Source Heat Pump	≥ 14.5 SEER and ≥ 12 EER	$200
	≥ 16 SEER and ≥ 12.5 EER	$300
Ground Source Heat Pump	≥ 17 EER and ≥ 4.3 COP	$375
	≥ 19 EER and ≥ 4.6 COP	$525
Water Heater	Non-electric resistance	$250

3.2.2 OVERALL PROGRAM PERFORMANCE SUMMARY

Overall, the program accounted for 9% of SCE&G's energy savings. Table 12 summarizes the PY2 forecasts and overall results for the program in terms of costs, participation, and net energy and demand savings. Although the program spent less than forecasted and installed fewer measures than forecasted, it exceeded its savings forecast by a substantial percentage. There are two reasons why this occurred. First, the program had a higher self-reported net to gross than was used in the planning model. Second, a billing analysis showed that the per-measure savings for heat pumps were higher than the estimated savings based on current deemed values.

Table 12. Heating & Cooling and Water Heating Program Forecasts and Results

	Forecast	Actual	% of Forecast Accomplished
Cost	$3,665,163	$2,572,898	70%
Measures	7,108	6,006	84%
Net MWH	8,854	10,027	113%
Net MW	2.16	3.05	141%

The program had 2,873 customers participate in the HVAC side of the program and 2,834 customers participate in the water heating side of the program. Table 13 shows the population size and the total number of measures installed.

Table 13. Heating & Cooling and Water Heating Program Population Size

Equipment	Number of Participants	Number of Measures
HVAC	2,873	3,146
Water Heating	2,834	2,860

3.2.3 Impact & Data Tracking Findings

HVAC Impact Performance

In PY2, the HVAC program achieved verified net savings of 2,093.32 MWh and 1.72 MW. Table 14 below shows the savings adjustments by equipment type. Overall, the program realized 146% of its tracked gross energy savings and 144% of demand savings.

Table 14. Verified Gross and Net Savings for HVAC Equipment

Measure Type	Tracked Gross Savings		Verified Gross Savings		Gross Realization Rate		Verified Net Savings	
	MWh	MW	MWh	MW	MWh	MW	MWh	MW
Central A/C	421.53	.35	189.68	.16	45%	45%	159.33	0.13
Air Source Heat Pump	1,220.06	1.01	2,208.40	1.83	181%	181%	1,855.06	1.53
Dual Fuel Heat Pump	35.92	.03	16.33	.01	45%	45%	13.72	0.01
Ground Source Heat Pump	26.84	.03	77.63	.04	289%	151%	65.21	0.04
Total	**1,704.35**	**1.42**	**2,492.04**	**2.04**	**146%**	**144%**	**2,093.32**	**1.72**

The majority of the HVAC measures installed in PY2 were heat pumps (67%). The HVAC program's impact savings are largely driven by this measure as the total savings account for both heating and cooling seasons. Table 15 shows the distribution of HVAC installation for PY2 by the type of system installed.

Table 15. Quantity of Measures per HVAC Type

HVAC Type	Tracked Quantity of Measures	% of Total
Heat Pumps	2,095	67%
Central A/C	1,051	33%
Total	**3,146**	**100%**

The total number of installed measures by measure type is in the table below. Over one-third of the rebated HVAC measures are from the installation of air source heat pumps with a minimum SEER rating of 15.

Table 16. HVAC Systems Installed by SEER Level

HVAC Type	SEER/EER Level	Tracked Quantity of Measures	% of Total
Split/Packaged ASHP	SEER 15	1,052	33.44%
Split/Packaged Furnace/AC	SEER 14 and SEER 14.5	596	18.94%
Split/Packaged ASHP	SEER 14 and SEER 14.5	415	13.19%
Split/Packaged ASHP	SEER 16	302	9.60%
Split/Packaged Furnace/AC	SEER 16	251	7.98%
Split/Packaged Furnace/AC	SEER 15	169	5.37%
Split/Packaged ASHP	SEER 17	130	4.13%
Split/Packaged ASHP	SEER 18 or higher	115	3.66%
Split/Packaged Furnace/AC	SEER 17	26	0.83%
Split/Packaged DFHP	SEER 14 and SEER 14.5	28	0.89%
Ground Source Heat Pump	EER 19 (w/ ASHP baseline)	18	0.57%
Split/Packaged DFHP	SEER 15	15	0.48%
Split/Packaged Furnace/AC	SEER 18 or higher	9	0.29%
Split/Packaged DFHP	SEER 16	9	0.29%
Split/Packaged DFHP	SEER 17	5	0.16%
Ground Source Heat Pump	EER 19 (w/ AC baseline)	2	0.06%
Ground Source Heat Pump	EER 17 (w/ ASHP baseline)	2	0.06%
Split/Packaged DFHP	SEER 18 or higher	1	0.03%
Ground Source Heat Pump	EER 17 (w/ AC baseline)	1	0.03%
Total		**3,146**	**100%**

The sections below walk through how tracked savings were adjusted for verified gross and net savings.

Verified Gross Savings Adjustments

Data Tracking Analysis

Program tracked savings values were analyzed to calculate:

- Any changes to measure participation counts, based on a review of the program database

- Any engineering modifications, as deemed appropriate through a review of deemed savings values and assumptions. Specifically, we checked to see if the database was applying the deemed savings values per measure that were recommended based upon an engineering review of these values in the PY1 evaluation. Further, we check to see whether any new measures were present in PY2 and applied new deemed values for those measures.

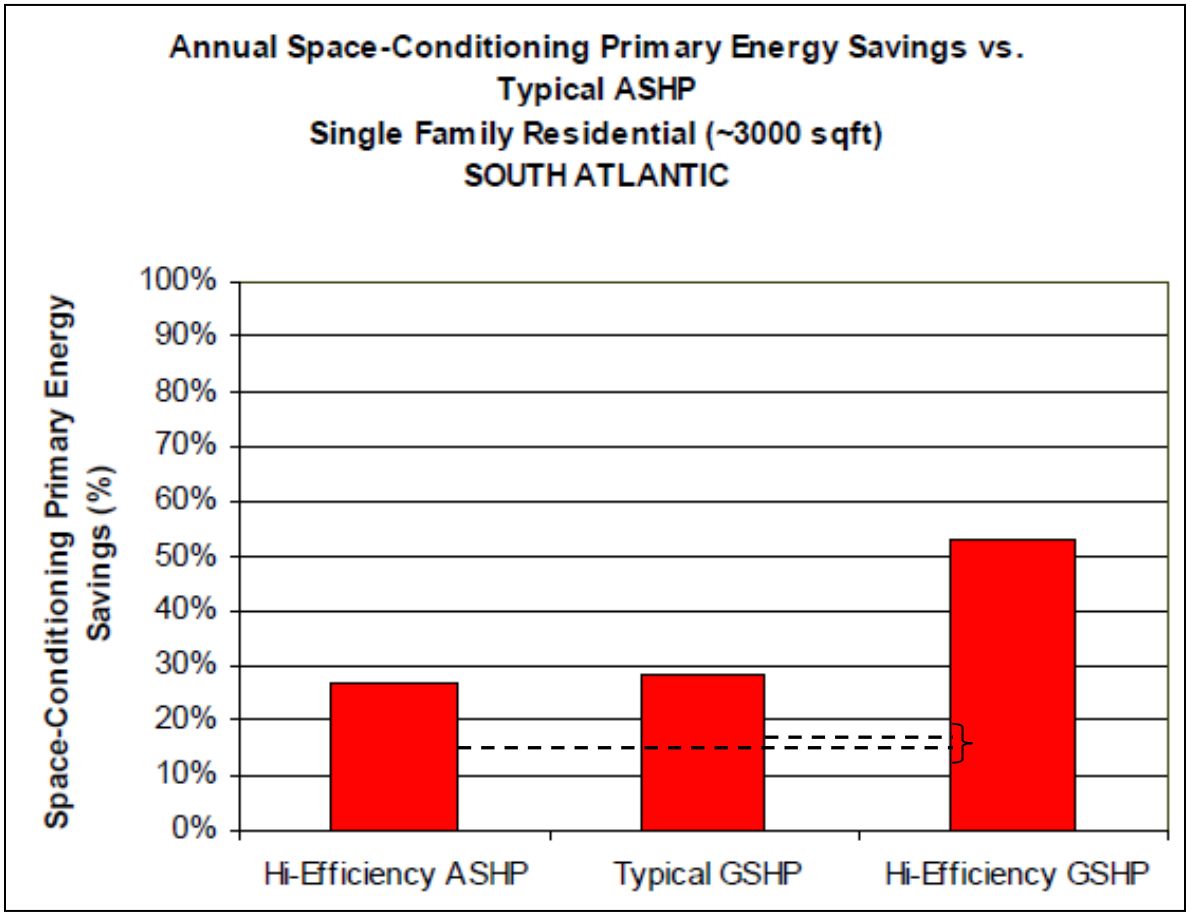
The following table identifies the data tracking issues and the corrections made to resolve these issues.

Table 17. HVAC Database Issues and Applied Corrections

Identified Issue	Changes Applied
Deemed values for 25 SEER ASHPs were applied to all ASHPs with SEER ratings > 25	Calculated the per unit deemed savings for a 26 SEER ASHP and applied it to this unit (900.41 kWh/ton and 0.491 kW/ton)
Deemed values for 18 SEER DFHPs were applied to all DFHPs with SEER ratings > 18	Calculated the per unit deemed savings for a 20 SEER DFHP and applied it to this unit (538.4 kWh/ton and 0.320 kW/ton)
In PY1 all GSHPs were assumed to have replaced AC systems. In PY2 a measure was added that indicated when a GSHP had replaced an ASHP, but the deemed value was not adjusted for the new baseline.	Conducted additional research to obtain and apply the appropriate savings for this new measure (deemed savings for ASHP with identical SEER rating applied)

Additional research was performed to quantify energy and demand savings for installing ground source heat pumps with the removal of an air source heat pump. It was found that for an air source heat pump with high efficiencies, the energy savings for upgrading to a ground source heat pump is increased by about 2%. Because of this, we applied the same per unit deemed savings for an ASHP with a SEER value (SEER 20 for EER 17 GSHP and SEER 22 for EER 19 GSHP) that is equivalent to the EER efficiency of the GSHP that is installed. Figure 1 shows the energy savings one would expect for upgrading to a GSHP from an efficient ASHP.

Figure 1. Energy Savings Comparison for ASHP and GSHPs



Source: Navigant Consulting, Inc. "Ground-Source Heat Pumps: Overview of Market Status, Barriers to Adoption, and Options for Overcoming Barriers". Feb 2009. pp 109

The following table includes the per unit energy and demand savings that are applied to those who received rebates for installing GSHPs and removing ASHPs. The per unit value that was used is identical to the savings one would expect for upgrading from an A/C SEER 13 to an ASHP with a SEER value that is equivalent to the EER efficiency of the GSHP. These changes increased the per-unit energy savings by more than 100% but decreased the per unit demand savings by 82% when compared to the tracked estimates.

Table 18. Per Unit Deemed Savings for New HVAC Measures

HVAC Type	Unit	Tracked kWh savings per Unit	Tracked kW savings per Unit	Revised kWh savings per Unit	Revised kW Savings per Unit	kWh Savings Impact	kW Savings Impact
EER 17 GSHP (w/ ASHP baseline)	Per ton	245.1	0.386	518.8	0.318	211% Increase	82% Decrease
EER 19 GSHP (w/ ASHP baseline)	Per ton	375.5	0.459	646.0	0.375	172% Increase	82% Decrease

A detailed table of gross savings by measure based upon the tracking database and engineering review can be found in Appendix B.

Billing Analysis

Gross savings derived from HVAC equipment was further verified through a billing analysis of PY1 participants since these participants had enough billing data to conduct a rigorous pre/post billing analysis using at least 12 months of pre and post billing data. We generated these findings using a linear fixed-effects regression (LFER) model, which estimates the change in observed consumption that follows participating in the program. We compared the ex-post gross billing analysis savings estimates with the evaluated deemed savings estimates to develop an evaluated savings adjustment factor, which we used to adjust the savings claimed by the program for PY2.[8]

Overall we found that the deemed savings for HVAC equipment appear to be over- and underestimated for certain measures. The results of the billing analysis suggest that evaluated deemed savings are underestimated for heat pumps (by 81%) and overestimated (by 55%) for non-heat pump measures installed through the program. A detailed methodology and analysis can be found in Appendix B.

Overall verified net savings were calculated from both revising tracked savings and applying adjustment factors based on the billing analysis.

Table 19. Verified HVAC Gross Savings Summary

Measure Type	Tracked Gross Savings		Revised Gross Savings		Billing Analysis Adjustment Factor	Verified Gross Savings		Gross Realization Rate	
	MWh	MW	MWh	MW		MWh	MW	MWh	MW
Central A/C	421.53	.35	421.51	.35	0.45	189.68	.16	45%	45%
Dual Fuel Heat Pump	35.92	.03	36.29	.03	0.45	16.33	.01	45%	45%
Air Source Heat Pump	1,220.06	1.01	1,220.11	1.01	1.81	2,208.40	1.83	181%	181%
Ground Source Heat Pump	26.84	.03	42.89	.02	1.81	77.63	.04	289%	151%
Total	**1,704.35**	**1.42**	**1,720.81**	**1.41**	**1.44**	**2,492.04**	**2.04**	**146%**	**144%**

Verified Net Savings Adjustments

The program planning model assumed a NTG ratio of .70. In PY2, the evaluation team calculated a new NTG ratio through a telephone survey of PY2 participants (a detailed methodology for how we calculated the NTG ratios is provided in Appendix B). As such, we found a higher NTG ratio of 0.84 for PY2. Table 20 displays PY2 Verified Net savings after applying the NTG ratio of 0.84.

[8] The evaluation team carefully compared the PY1 and PY2 participants to be sure that this was an appropriate use of the billing analysis.

Table 20. Verified Net Savings for HVAC

Verified Gross Savings		NTG Ratio		Verified Net Savings	
MWh	MW	MWh	MW	MWh	MW
2492.04	2.04	0.84	0.84	2093.31	1.71

Water Heating Impact Performance

In PY2, the water heating program achieved verified net savings of 7,933.39 MWh and 1.34 MW. Table 21 below shows the savings adjustments by equipment type. Overall, the program realized 100% of its tracked gross energy and demand savings.

Table 21. Verified Gross and Net Savings for Water Heating Equipment

Measure Type	Tracked Gross Savings		Verified Gross Savings		Gross Realization Rate		Verified Net Savings	
	MWh	MW	MWh	MW	MWh	MW	MWh	MW
Gas tankless	6,847.86	1.16	6,847.86	1.16	1.00	1.00	5,209.02	0.88
Gas storage	3,074.40	0.52	3,074.40	0.52	1.00	1.00	2,338.63	0.40
Propane tankless	428.22	0.07	428.22	0.07	1.00	1.00	325.74	0.06
Heat pump	45.93	0.01	45.93	0.01	1.00	1.00	34.94	0.01
Solar	25.62	0.00	25.62	0.00	1.00	1.00	19.49	0.00
Propane storage	7.32	0.00	7.32	0.00	1.00	1.00	5.57	0.00
Total	**10,429.35**	**1.76**	**10,429.35**	**1.76**	**1.00**	**1.00**	**7,933.39**	**1.34**

In PY2, the program incented the installation of 2,860 non-electric-resistance water heaters. Nearly two thirds of these measures (65%) were gas tankless water heaters, followed by gas storage water heaters (29%). Non-electric-resistance water heaters installed by builders in newly constructed homes represented the vast majority (73%) of measures (2,094) incented by the program. Table 22 shows a detailed breakdown of the number of installations by water heater type.

Table 22. Water Heating Systems Installed by Measure and Participant Type

Measure Type	New Construction	Existing Homes	Total Measures	% of Total Measures
Gas tankless	1275	598	1,873	65%
Gas storage	817	23	840	29%
Propane tankless	2	115	117	4%
Heat pump	-	21	21	1%
Solar	-	7	7	0.24%
Propane storage	-	2	2	0.07%
Total	**2,094**	**766**	**2,860**	**100%**

Verified Gross Savings Adjustments

Program tracked savings values were analyzed to calculate:

- Any changes to measure participation counts, based on a review of the program database

- Any engineering modifications, as deemed appropriate through a review of deemed savings values and assumptions. Specifically, we checked to see if the database was applying the deemed savings values per measure that were recommended based upon an engineering review of these values in the PY1 evaluation.

The evaluation team performed an engineering desk review of all deemed savings values for this program in PY1 and recommended some new values to be used in PY2 tracked savings. The water heating side of the program had no data tracking errors and applied all appropriate PY2 deemed savings values, resulting in a 1.00 gross savings realization rate. Table 23 below presents tracked and verified gross savings for the program by measure type.

Table 23. Summary of Verified Gross Savings for Water Heating Equipment

Measure Type	# Tracked Units	# Verified Units	Tracked Gross Savings		Verified Gross Savings		Gross Savings Realization Rate	
			MWh	MW	MWh	MW	MWh	MW
Gas tankless	1,873	1,873	6,847.86	1.16	6,847.86	1.16	1.00	1.00
Gas storage	840	840	3,074.40	0.52	3,074.40	0.52	1.00	1.00
Propane tankless	117	117	428.22	0.07	428.22	0.07	1.00	1.00
Heat pump	21	21	45.93	0.01	45.93	0.01	1.00	1.00
Solar	7	7	25.62	0.00	25.62	0.00	1.00	1.00
Propane storage	2	2	7.32	0.00	7.32	0.00	1.00	1.00
Total	**2,860**	**2,860**	**10,429.35**	**1.76**	**10,429.35**	**1.76**	**1.00**	**1.00**

Verified Net Savings Adjustments

The program planning model assumed a NTG ratio of .98. In PY2, the evaluation team calculated a new NTG ratio through a telephone survey of PY2 participants (a detailed methodology for how we calculated the NTG ratio is provided in Appendix B). As such, we found a lower NTG ratio of 0.76 for PY2. Table 24 displays PY2 Verified Net savings after applying the NTG ratio.

Table 24. Summary of Verified Net Savings for Water Heating Equipment

Measure Type	Verified Gross Savings		NTGR		Verified Net Savings	
	MWh	MW	MWh	MW	MWh	MW
Gas tankless	6,847.86	1.16	0.76	0.76	5,209.02	0.88
Gas storage	3,074.40	0.52	0.76	0.76	2,338.63	0.40
Propane tankless	428.22	0.07	0.76	0.76	325.74	0.06

Measure Type	Verified Gross Savings		NTGR		Verified Net Savings	
	MWh	MW	MWh	MW	MWh	MW
Heat pump	45.93	0.01	0.76	0.76	34.94	0.01
Solar	25.62	0.00	0.76	0.76	19.49	0.00
Propane storage	7.32	0.00	0.76	0.76	5.57	0.00
Total	**10,429.35**	**1.76**	**0.76**	**0.76**	**7,933.39**	**1.34**

3.3 HOME ENERGY REPORT

3.3.1 PROGRAM DESCRIPTION

The Residential Home Energy Report program (HER) offers monthly/bi-monthly reports at no additional costs to customers comparing their energy usage to a peer group and to themselves over time. The reports also provide information to help participants identify, analyze, and act upon energy efficiency upgrade opportunities and energy saving behaviors to reduce their household energy use. After the introduction of the Home Energy Report, subsequent monthly/bi-monthly Home Energy Updates are issued to customers comparing their usage to a peer group and promoting a variety of customized energy efficiency tips and information about other SCE&G demand-side management programs. These Home Energy Updates began in June 2011.

The HER program offers three different treatment options, including a report that is mailed to the customer's home; an electronic copy that is emailed to the customer; and starting at the end of September 2011, the online portal that customers can access to view their report and where customers have the option to create a Home Energy Plan where they can develop personalized energy efficiency forecasts and plans. Customers using the online portal have the option to create a Home Energy Plan where customers can develop personalized energy efficiency forecasts and plans. A total of 28,215 customers enrolled in the program in PY1 and an additional 1,780 customers enrolled in the program in PY2 (starting from December 2011 through November 2012).

3.3.2 PROGRAM PERFORMANCE SUMMARY

This program made up 3% of the energy savings of SCE&G's portfolio in PY2. The program forecasted having 25,312 customers participating in the program by PY2. The program annual net energy savings planning assumptions are 330 kWh per household, based on an assumption of 2% of the average residential energy consumption as savings.[9] The HER program exceeded its forecasted number of participants by 11%, while achieving 45% of its net MWh and MW savings. Savings estimates incorporate a deduction of savings from customers participating in other SCE&G residential energy efficiency programs.[10] The program verified annual net adjusted energy savings estimates are 133 kWh per household.

[9] Average residential consumption per year estimated at 14.3 MWh based on sales and customer numbers provided in the Testimony of Randy Gunn on behalf of the Office of Regulatory Staff in conjunction with the evaluation.

[10] Adjusted net program savings are calculated by removing the channeling adjustment (i.e. savings counted in other SCE&G residential energy efficiency programs) from the net billing analysis estimates as further explained in Appendix C.

Table 25. HER Program Forecast and Actuals

	Forecast	Actuals (Applying PY1 estimated values)	% of Forecast Accomplished
Cost	$432,843	$349,767	81%
Participants	25,312	28,012*	111%
Net MWH	8,352	3,723	45%
Net MW	3.06	1.36	45%

* Total participants exclude 1,252 EID customers to avoid double counting of savings.

3.3.3 IMPACT FINDINGS

The evaluation team reviewed the program participant database and found no duplicate accounts or data entry errors. The evaluation team then conducted a billing analysis to quantify the actions taken among the program participants. This type of comparison results in an estimate of net program energy savings. A billing analysis by its nature estimates net program savings. As such, we do not report estimated gross energy savings. Billing data was available for customers' first full year of participation and part of their second year. The evaluation team then removed any savings counted in other SCE&G residential energy efficiency programs from the net billing analysis estimates. Given that customers in the second year of the program did not have sufficient post billing data, the PY1 impacts were estimated and applied to PY2 participants. As such, the estimates are expected to change when the team conducts an impact analysis in January 2014, which will provide full impacts for PY2 applied to PY3. As a result, we provide our interim impact findings below.

After applying the PY1 estimated energy and demand savings to the PY2 participants, the annual net adjusted savings for this program are 3,723 MWh and 1.36 MW. Table 26 shows the energy and demand savings that were estimated for each participant.

Table 26. Application of Estimated Savings Per HER Program Participant

Description	Number of Participants	kWh Savings Per Participant	kW Savings Per Participant	Gross Savings*		NTGR	Net Savings	
				kWh	kW		kWh	kW
Tracked Total	28,012	330	0.121	9,243,960	3,389.45	1	9,243,960	3,389.45
Billing Estimate Total	28,012	133	0.049	NA	NA	NA	3,723,240	1,365
% of Tracked	1.0	0.40	0.40	NA	NA	NA	0.40	0.40

* The billing analysis compares participants to a selected comparison group to reflect– what the energy use of participant households would have been in the absence of the program, making the resulting differences between the energy consumption of participant households and the energy consumption of the comparison group during the program period an estimate of net program energy savings.

The PY2 savings values identified in this report are estimated using PY1 billing estimates, and the actual PY2 savings associated with the HER program may increase or decrease depending on the actual consumption patterns of the participants in the second year of participation.

3.4 HOME ENERGY CHECK-UP

3.4.1 PROGRAM DESCRIPTION

The Residential Home Energy Check-up (HEC) Program provides electric customers in SCE&G's territory with a home visit that includes a visual inspection of the home and an energy consultation with the customer. During the check-up, SCE&G representatives, who are Building Performance Institute (BPI) certified, identify sources of high energy use and provide the customer with a list of various low and no-cost energy-saving recommendations and tips. As part of the consultation, SCE&G reviews up to two years of consumption data and weather impacts, as well as discusses energy-saving behaviors with the customer (e.g. thermostat settings, water heater settings). During the check-up, participants are also provided with 10 CFLs, and, if applicable, free hot water pipe insulation and an electric water heater insulating external blanket. Customers are also provided a list of "11 Ways to Save Energy" [11], which encourages them to take further energy conservation actions following the check-up. The tables below present the measures given and the actions recommended to customers during the home visits.

Table 27. Leave Behind Energy Efficient Measures Offered through the HEC Program

Measure
13 Watt CFL Light Bulbs (10 pack)
Hot Water Pipe Insulation (6 feet)
Electric Water Heater Insulating External Blanket

Table 28. Energy Conservation Actions Recommended During the Home Visit for the HEC Program

Measure/Action
Replace standard incandescent light bulbs with compact fluorescent (CFL) bulbs
Unplug appliances, lights, TVs, computers, etc. when not in use
Set thermostat at 68°F or lower in the winter and 78°F or higher in the summer
Install a programmable thermostat specifically designed for home's heating and cooling unit
Check air filters monthly and change when dirty
Repair fallen or crushed duct work and use mastic to seal leaks
Have central heating and cooling system serviced
Upgrade attic insulation to a minimum of R-38
Caulk, seal, and weather-strip windows or doors
Set the water heater at 120°F or lower

[11] 10 specific actions/measures are listed in a hand-out to all participants. The 11th way to save energy listed is to call SCE&G or visit the EnergyWise website.

3.4.2 PROGRAM PERFORMANCE SUMMARY

This program accounts for 2% of the total savings from SCE&G's portfolio in PY2. Total participation in the program exceeded the forecast originally set for the program by almost 30%. Total energy and demand savings from the program were more than double the original forecasts. Much of this difference is due to changes in the program impact estimation in PY2. In addition to savings from leave behind measures offered to participants, savings from measures recommended to participants during the home visits were also counted toward total savings. The table below summarizes the forecast and actual results in terms of costs, participation, and energy and demand savings.

Table 29. HEC Program Forecasts and Results

	Forecast	Actual	% of Forecast Accomplished
Costs	$602,064	$751,389	125%
Participants	2,076	2,677	129%
Net MWH	747	1,918	257%
Net MW	0.15	0.43	287%

The program performed check-ups for 2,677[12] residential customers during PY2, from December 2011 through November 2012. Of these, 2670 accepted CFLs.

Table 30. HEC Program Participation by Leave Behind Measure

Leave Behind Measure	Number of Unique Participants (n=2,677)	% of Participants (n=2,677)	Total Measures Leave Behind in PY2
13 Watt CFL Bulbs (10 pack)	2,670	99%	26,700 bulbs
Hot Water Pipe Insulation (6 feet)	1,155	43%	6,930 feet
Electric Water Heater Insulating External Blanket	881	33%	881 blankets

We completed a telephone survey of the participants to determine which recommended measures, if any, customers stated to have implemented. Table 31 shows that HEC participants followed through on many recommendations

Table 31. HEC Program Participation by Recommended Measure

Implemented Measure	% of Surveyed Participants (n=132)
Check air filters monthly and change when dirty	91%
Set the water heater at 120°F or lower	75%
Set thermostat at 68°F or lower in the winter and 78°F or higher in the summer	73%

[12] Two participants were removed from the original total (2,680) due to duplicate entries in the tracking database. One additional account number was removed because the residence was converted from two apartments (with two meters) to one home. One audit was performed and one kit of measures was left.

Implemented Measure	% of Surveyed Participants (n=132)
Unplug appliances, lights, TVs, computers, etc. when not in use	70%
Have central heating and cooling system serviced	69%
Replace standard incandescent light bulbs with compact fluorescent (CFLs) bulbs	55%
Repair fallen or crushed duct work and use mastic to seal leaks	45%
Caulk, seal, and weather-strip windows or doors	39%
Install a programmable thermostat specifically designed for home's heating and cooling unit	36%
Upgrade attic insulation to a minimum of R-38	22%

3.4.3 Impact and Data Tracking Findings

After reviewing the databases, the agreed-upon savings estimates, and phone survey results that determined the installation rate for each of the measures, the net savings for this program are 1,918 MWh and .43 MW. Verified gross savings per participant are 1,058 kWh and 0.21 kW which is more than double of what was estimated per participant in the planning model for this program.

Table 32. HEC Program Application of Estimated Savings Per Participant

Description	Number of Participants	Gross kWh Savings Per Participant	Gross kW Savings Per Participant	Gross Savings*		NTGR	Net Savings	
				MWh	MW		MWh	MW
Tracked Total	2,680	444	.09	1,190	.24	0.9	1,070	.22
Verified Total	2,670	1,058	.21	2,826	.55	.68 kWh, .78 KW	1,918	.43
% of Tracked	99%	238%	233%	237%	233%	75-86%	179%	195%

* The tracked total applies the gross savings per participant from the planning model to the participant counts in PY2. The total of 2,670 participants is used since this is the number of participants who received CFLs.

Verified savings for this program are derived from verifying the proportion of leave behind measures that participants installed in PY2 and the proportion of participants taking additional actions to save energy post-audit. Based on the results of the participant survey, per participant gross savings from recommended measures was determined by averaging total savings from recommended measures across the survey population. This per participant savings estimate was then extrapolated to the entire program population to determine verified gross savings from recommended measures. The NTG ratio for recommended measures was based on survey participant self-reported influence of the program in their decision to takes actions recommended during the Check-up. Telephone survey efforts verified the installation of leave behind measures and incidence of additional actions taken.

Survey efforts also explored the net-to-gross ratio for each program component. Please refer to Appendix D for detailed methods on how we estimated the net-to-gross ratio for PY2. The table below shows the total verified gross and net savings for PY2 coming from each program component. The majority of program savings are coming from additional actions participants take post-audit.

Table 33. HEC Program Verified Gross and Net Savings per Program Component

Component	Verified Gross Savings		NTGR		Verified Net Savings	
	MWh	MW	MWh	MW	MWh	MW
Leave Behind Measures Installed	1,315	0.13	0.65	0.79	852	0.11
Recommended Measures/Actions Taken Post-Audit	1,511	0.41	0.71	0.77	1,066	0.32
Overall Program	**2,826**	**0.55**	**0.68**	**0.78**	**1,918**	**0.43**

Table 34 below details the differences between tracked and verified savings for each of the leave behind measures, taking into account the installation rates derived from the participant survey. Please refer to Appendix D for detailed methods employed to calculate installation rates for leave behind measures.

Table 34. HEC Program Leave Behind Measure Verification Analysis Overview

Measure	Verified Savings Assumptions		Tracked Quantity	Verified Quantity	Notes on Differences between Tracked and Verified Savings
	Energy	Demand			
CFL 13 Watt Bulbs (10 pack)	51.5 kWh/lamp	0.0047 kW/lamp	2,672 installs 26,720 lamps	1,461installs 14,613 lamps	Participant survey verified that 55% of bulbs distributed were actually installed; twenty bulbs were removed (given to two customers)
Pipe Insulation (6 feet)	85.6 kWh/ft	0.010 kW/ft	1,156 installs 6,936 ft of pipe insulation	744 installs 4,462 ft of pipe insulation	Participant survey verified that 64% of pipe insulation distributed was actually installed; six duplicates (one customer) was removed
WH Insulating Blanket	360.8 kWh/ blanket	0.041 kW/ blanket	882 installs 882 blankets	503 installs 503 blankets	Participant survey verified that 57% of WH blankets distributed were actually installed; one duplicate (one customer) was removed

Compact Fluorescent Lighting (CFL)

During PY2, 2,670 participants received a ten pack of low wattage CFL bulbs to install in their homes. Each CFL was assigned a deemed savings of 51.5 kWh and .0047 kW. The validated quantity of CFLs distributed was 26,700 bulbs . The quantity of CFLs tracked by the program was overstated by 20 bulbs, as two customers were believed to have been entered twice each.

The participant survey conducted verified the number of CFLs each respondent installed in their home. It was found that 55% of the CFLs received through the program, or 5.5 out of every 10 CFLs given to participants, were installed in homes. These numbers were reflected in the verified quantity, thus reducing the actual energy and demand impacts by these installation rates.

Hot Water Pipe Insulation

During PY2, approximately 43% of program participants received six feet of hot water pipe insulation. These participants have electric water heaters and un-insulated hot water pipes. The deemed savings values that were applied to calculate the tracked energy and demand savings were 85.6 kWh and 0.010 kW. The validated quantity of pipe insulation distributed was 6,930 feet. The quantity of pipe insulation tracked by the program was overstated by six feet, as one project was believed to have been entered twice. Since each participant who received the hot water pipe insulation was supposed to install the insulation on their own (not installed by program staff), the participant survey obtained an installation rate to accurately quantify the proportion of participants who did install the measure. As a result of the survey, an installation rate of 64% was applied to the 1,155 participants who received hot water pipe insulation.

Water Heater Insulation Blanket

Water Heater insulation blankets were provided to 33% of the program participants with electric water heaters installed in their home. The deemed savings values that were applied to calculate the tracked energy and demand savings were 360.8 kWh and 0.041 kW. The validated quantity of insulation blankets distributed was 881. Similar to the pipe insulation, participants were supposed to install the water heater insulation blankets on their own. The quantity of insulation blankets tracked by the program were overstated by one blanket, as one project was believed to have been entered twice. From participant surveys, it was found that 57% of respondents had installed the insulation blanket around their water heater tanks. This installation rate was applied to the 881 participants who received insulation blankets and is reflected in the verified quantity, resulting in reduced energy and demand savings when compared to the tracked savings.

Table 35 provides an overview of verified savings per participant for recommended measures. An engineering analysis conducted by the evaluation team indicates that several measures included in the list of "11 Ways to Save Energy" cannot be counted towards recommended measure savings for the Home Energy Check-up program at this time.[13]

[13] Savings from additional CFLs were not included as we assumed these would show up in the Residential ENERGY STAR® Lighting program which, as an upstream incentive program, takes into account all CFLs purchased in SCE&G's service area. Manually adjusting a thermostat cannot be counted because we cannot be sure of the type of thermostat the participant uses or whether the behavior has been sustained over time. Unplugging appliances cannot be counted because we cannot be sure if these appliances actually have "phantom" loads or if the behavior has been sustained over time.

Table 35. HEC Program Recommended Measure Savings Overview

Recommended Measure	Number of Measures Implemented	Gross Verified Savings Per Participant	
		kWh	**kW**
Replaced air filters	120	37	0.02
Set the water heater at 120 degrees or lower	99	43	0.00
Had central heating and cooling system serviced	91	47	0.04
Repaired duct work	60	245	0.11
Weather-stripped or sealed windows or doors	52	21	0.01
Installed and programmed a programmable thermostat	48	153	-0.05
Upgraded attic insulation	29	19	0.01
Total	**n/a**	**566**	**0.15**

3.5 ENERGY STAR® NEW HOMES

3.5.1 PROGRAM DESCRIPTION

Overall, the Residential ENERGY STAR® New Homes Program is a small component of the SCE&G portfolio (0.8%) but one with long-term ramifications as the homes built to the ENERGY STAR standards will be in place for decades. This is a national program created through the U.S. Environmental Protection Agency (EPA). The program is designed to improve the energy efficiency of the residential construction market by labeling qualifying homes as ENERGY STAR. The homes in PY2 were built to ENERGY STAR Version 2.5 and 3.0 specifications. Increased efficiency, and therefore energy savings is typically achieved through a combination of building envelope upgrades, high performance windows, controlled air infiltration, upgraded heating and air conditioning systems, tight duct systems, and upgraded water-heating equipment.

The objective of the program is to accelerate the penetration of ENERGY STAR New Homes. The expected savings from the program are based on the number of ENERGY STAR qualifying homes built in SCE&G territory per program year.

Typically, Home Energy Rating System (HERS) raters review home plans, and then inspect built homes to ensure performance. After a home passes a HERS rater inspection and several EPA required checklists, a home will receive the ENERGY STAR label; and the builder receives a $750 rebate from SCE&G for each home built to ENERGY STAR standards.

New construction builders who participate in the program are required to hire a third party Residential Energy Services Network (RESNET) certified HERS rater who verifies that each home complies with V2.5 or V3.0 criteria. The HERS rater inspects the home in two different phases: mid-construction and final completion phases. The mid-construction phase is to ensure that all envelope measures are installed according to ENERGY STAR standards prior to the installation of drywall or sheetrock. A second inspection is conducted once the home construction is completed, where a blower door and duct leakage test is conducted to test and measure the infiltration of the home and the duct leakage. All characteristics for each home are modeled in RESNET-accredited software (REM/Rate or Energy Gauge) to generate a HERS score and to qualify the home passes ENERGY STAR standards.

The ENERGY STAR requirements changed in 2012 as all new homes permitted on or after July 1, 2012 had to meet ENERGY STAR Version 3 requirements to be certified as an ENERGY STAR home. Version 3 requirements are more stringent than V2.5 versions. They include stricter guidelines for large homes, two new HVAC system checklists, and a Water Management System checklist in addition to the existing Thermal Enclosure System Checklist and a required HERS rating that is individualized based on the ENERGY STAR Reference Design Home.[14] These were large changes that increased the complexity of the requirements. Therefore, program activities in PY2 were largely focused on educating builders and HERS raters on the changing requirements. In addition to training activities, the program provides builders with ENERGY STAR yard signs and flags to help market ENERGY STAR rated homes in South Carolina.

[14] Version 3 guidelines can be found here: http://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/NationalProgramRequirements_v3.pdf

3.5.2 PROGRAM PERFORMANCE SUMMARY

The program provided incentives to a total of 353 homes in PY2, which was about 70% of what was forecasted. The actual number of participating homes was less than forecasted due to a number of factors including difficult economic times leading to reduced home building in general, and the ongoing changes to the ENERGY STAR version requirements. While the program provided incentives to fewer homes than forecasted, the savings per home were almost three times the amount anticipated given that the program forecasting was based on ENERGY STAR V2.0 while the program operated under V2.5 and V3.0 requirements in PY2.

Table 36. ENERGY STAR New Homes Program Forecast and Actual

	Forecast	Actual	% of Forecast Accomplished
Cost	$343,819	$555,763	162%
Homes	506	353	70%
Net MWh	456	910	200%
Net MW	0.16	0.30	188%

In PY2, the program doubled the number of active, participating builders from 8 (PY1) to 16 (PY2). The majority of PY2 homes were V2.5 homes, with less than 20% of the homes receiving incentives for V3.0. As shown in the table below, participating builders built between 1 and 86 homes to ENERGY STAR standards in PY2 and one builder built nearly all the V3.0 homes.

Table 37. ENERGY STAR New Homes Program Participation by Builder

Builder	Homes Built to V2.5	Homes Built to V3	Total Homes Built
Builder 1	29	57	86
Builder 2	49	-	49
Builder 3	48	-	48
Builder 4	48	-	48
Builder 5	37	-	37
Builder 6	31	-	31
Builder 7	17	-	17
Builder 8	13	-	13
Builder 9	11	-	11
Builder 10	7	-	7
Builder 11	1	-	1
Builder 12	1	-	1
Builder 13	1	-	1
Builder 14	1	-	1
Builder 15	1	-	1
Builder 16	-	1	1
Grand Total	**295**	**58**	**353**

In PY2, the number of active HERS raters increased from 4 (PY1) to 6 (PY2). Two raters make up the majority of participation.

Table 38. ENERGY STAR New Homes Program Participation by HERS Rater

HERS Rater	Total Homes
Rater 1	166
Rater 2	134
Rater 3	48
Rater 4	3
Rater 5	1
Rater 6	1
Grand Total	**353**

As shown in Table 39, the greatest proportion of PY2 homes (43%) received HERS ratings between 66 and 70. The HERS ratings ranged from 51 to 80. Homes built to V3.0 received lower HERS scores on average than those built to V2.5 (55.6 vs. 67.2) indicating that V3.0 homes were more efficient than V2.5 homes.[15]

Table 39. ENERGY STAR New Homes Program Home Energy Rating (HERs) Score

HERs Index Score	Homes Built to ES V2.5	Homes Built to ES V3	Total Homes Built	% of Total
51 – 55	3	42	45	13%
56 – 60	11	12	23	7%
61 – 65	74	-	74	21%
66 – 70	152	-	152	43%
71 – 75	51	4	55	16%
75 – 80	4	-	4	1%
Total	**295**	**58**	**353**	**100%**

PY2 was another transitional year for the program. The planning model for this program was based on ENERGY STAR V2.0 (which was 15% more efficient than a 2006 IECC built home which was the code within South Carolina); however, V2.5 and then V3.0 were actually in effect during PY2. Therefore, the program garnered more savings per home than it originally expected.

3.5.3 IMPACT FINDINGS

Program Database Review

The evaluation team performed a high level program database review and determined that the database was complete and consisted of valid entries. We base our conclusion on the following:

- All *Premise Numbers* were unique
- All address information (i.e., *Street Number, Street Name, City, Zip Code*) was complete and there were no duplicate entries
- The *HERS Index*, *kW Savings* and *kWh Savings* all c*orrelated i*n *expected w*ays:

[15] For comparison, PY1 homes, which were also built to v2.5 levels, had a similar average HERS rating of 67.9.

- *kW and kWh* savings are positively correlated (r = 0.79 [16])
- kWh savings and HERS index scores are negatively correlated (r = -0.17 [17]), i.e., as intended, lower HERS index scores indicate more efficient homes and thus higher savings
- kW savings and HERS index scores are negatively correlated (r = -0.24 [18]), i.e., as intended, lower HERS index scores indicate more efficient homes and thus higher savings

Given that we found no database errors, the verified and tracked savings for this program are identical for PY2. PY3 evaluation efforts will involve independent modeling of a statistically significant sample of homes to see if any tracked savings need to be adjusted in PY3 savings claims.

Energy savings for this program are calculated through a predictive savings tool which draws from data inputted into REM/Rate or Energy Gauge software. Therefore, the energy savings for each home are unique. Impact evaluation of this program is limited in PY2 given the ongoing changes with version requirements and that this program comprises a small percentage (0.8%) of the overall SCE&G portfolio of programs. After reviewing the database, the PY2 net savings for this program are estimated to be 910 MWh and .30 MW. Overall, the program achieved 200% of its forecasted energy savings and 190% of its demand savings. Table 40 compares the program's forecasted energy savings to the tracked energy savings.

Table 40. Forecast versus Actual Energy and Demand Savings Summary for the ENERGY STAR New Homes Program

Description	Number of Homes	Gross Savings		PY1 NTGR	Net Savings	
		MWh	MW		MWh	MW
Forecast Total	506	507	0.18	0.9	456	0.16
Tracked Total	353	1,011	0.34	0.9	910	0.30
% of Forecast	70%	200%	190%	n/a	200%	190%

Overall, the program realized 286% of its forecasted average energy savings per home and 273% of its forecasted average demand savings per home. Table 41 compares the program forecasted savings per home to its actual tracked energy savings.

[16] Correlation is significant at greater than 99% confidence, one-tailed

[17] Correlation is significant at 99% confidence, one-tailed

[18] Correlation is significant at greater than 99% confidence, one-tailed

Table 41. Summary of Average Energy (kWh) and Demand (kW) Savings per Home

Description	Number of Homes	Gross Savings		PY1 NTGR	Net Savings	
		kWh	kW		kWh	kW
Forecast Average per Home	506	1,001	0.35	0.9	901	0.32
Tracked Average per Home	353	2,864	0.96	0.9	2,577	0.86
% of Forecast	n/a	286%	273%	n/a	286%	273%

3.6 HEATING & COOLING EFFICIENCY IMPROVEMENT

3.6.1 PROGRAM DESCRIPTION

The Residential Heating and Cooling Efficiency Improvement Program provides one-time incentives to encourage customers to improve the efficiency of existing in-service central air conditioners and heat pump systems in existing homes. The program's major goal is to assist customers with energy efficiency maintenance and repair opportunities, including system optimizers (formerly named tune-up, i.e., refrigerant charge and air-flow correction), duct sealing, and duct insulation. To participate in this program, the customer must receive residential electric service from SCE&G in an existing separately metered residence.

Table 42. Efficiency Improvement Program Incentives Offered

Eligible Efficiency Improvement Services	Rebate Amounts
System Optimizer of Existing Central A/C or Heat Pump	$60
Duct Insulation in Existing Home	$150
Duct Sealing in Existing Home	$150
Complete Duct Replacement	$300

3.6.2 PROGRAM PERFORMANCE SUMMARY

Table 43 summarizes the forecasts and overall results for the program in terms of costs, participation, and energy and demand savings. In total, this program makes up 0.5% of the total savings delivered from SCE&G's energy efficiency programs. The program achieved less than 10% of the forecasted savings and spent just over a third of the forecasted budget. The program's low realization rate is primarily due to lower than predicted participation rates, although the program's participation did ramp up significantly from PY1. The net to gross ratio was significantly lower than in the planning model which also contributed to lower than expected performance this year against forecast.

Table 43. Efficiency Improvement Forecasts and Results

	Forecast	Actual	% of Forecast Accomplished
Cost	$2,533,230	$904,975	36%
Participants	13,317	1,026	8%
Net MWH	7,604	501	7%
Net MW	3.48	.16	5%

Table 44 shows the total measures installed in customer homes and the savings associated with each measure. The most commonly installed measures are system optimizers followed by complete duct replacements, although complete duct replacements accounted for the greatest share of savings.

Table 44. Efficiency Improvement Participation by Measure

Measures	Measure Counts	Verified Net kWh	Verified Net kW
System Optimizers	705	154,339	42.17
Duct Insulation	43	7,562	2.70
Duct Sealing	53	25,730	9.86
Complete Duct Replacement	447	313,157	107.87
Total Measures*	**1,248**	**500,788**	**162.60**

* The total number of unique customers is not a sum of the services provided given that some participants implemented multiple measures.

3.6.3 IMPACT AND DATA TRACKING FINDINGS

In PY2 the program achieved verified net savings of 501 MWh and 0.16 MW. Table 45 below shows the overall gross and net savings. Overall, the program realized 65% of its tracked gross energy savings and 64% of demand savings. The difference in verified gross savings is largely due to duplicate participant entries in the program tracking database. SCE&G has corrected these issues and coordinated with the evaluation team to identify all duplicate entries throughout the verification process.

Table 45. Efficiency Improvement Verified Gross and Net Savings

Measure Type	Tracked Gross Savings		Verified Gross Savings		Gross Savings Realization Rate		Verified Net Savings	
	MWh	MW	MWh	MW	MWh	MW	MWh	MW
Total	2,018	.638	1,317	.407	.65	.64	501	.16

Verified Gross Savings Adjustments

Data Tracking Analysis

Program tracked savings values were analyzed to calculate:

- Any changes to measure participation counts, based on a review of the program database
- Any engineering modifications, as deemed appropriate through a review of deemed savings values and assumptions. Specifically, we checked to see if the database was applying the deemed savings values per measure that were recommended based upon an engineering review of these values in the PY1 evaluation.

Throughout this process we reviewed 24 customer application files to ensure that application and data tracking information aligned. The table below provides an overview of the adjustments made to gross savings from this review. Notably, evaluation efforts in PY1 and PY2 applied the program's deemed values per measure. Based on the PY1 engineering desk review of savings assumptions, the evaluation team recommended that the system optimizer savings estimates be further evaluated through a billing analysis. Due to limited participation in PY1, a billing analysis is expected in Q4, 2013 with PY2 participants and findings will be applied prospectively to PY3 savings claimed for system optimizer participants.

Table 46. Efficiency Improvement Verification Analysis Overview

Measure	Program Tracked Savings Assumptions		Verified Energy Savings Assumptions		Tracked Quantity	Verified Quantity	Notes on Differences between Tracked and Verified Savings
	Energy	Demand	Energy	Demand			
SF - Duct Insulation in Existing Home AC	120.1 kWh/ton	0.056 kW/ton	120.1 kWh/ton	0.056 kW/ton	31 installs 86.80 tons	28 installs 78.40 tons	Removed duplicate entries
SF - Duct Insulation in Existing Home HP	249.6 kWh/ton	0.056 kW/ton	249.6 kWh/ton	0.056 kW/ton	16 installs 44.80 tons	15 installs 42.00 tons	Removed duplicate entries
SF - Duct Sealing in Existing Home AC	356.3 kWh/ton	0.165 kW/ton	356.3 kWh/ton	0.165 kW/ton	40 installs 111.90 tons	40 installs 111.90 tons	No changes
SF - Duct Sealing in Existing Home HP	740.4 kWh/ton	0.165 kW/ton	740.4 kWh/ton	0.165 kW/ton	13 installs 37.60 tons	13 installs 37.60 tons	No changes
SF - Complete Duct Replacement in Existing Home AC	464.43 kWh/ton	0.215 kW/ton	464.43 kWh/ton	0.215 kW/ton	517 installs 1419.50 tons	275 installs 741.00 tons	Removed duplicate entries
SF - Complete Duct Replacement in Existing Home HP	965.08 kWh/ton	0.215 kW/ton	965.08 kWh/ton	0.215 kW/ton	313 installs 854.60 tons	172 installs 457.30 tons	Removed duplicate entries
SF - System Optimizer Existing Central AC with 15% Performance	112.6 kWh/ton	0.052 kW/ton	112.6 kWh/ton	0.052 kW/ton	181 installs 559.67 tons	181 installs 559.67 tons	No changes
SF - System Optimizer Existing Heat Pump with 15% Performance	234.0 kWh/ton	0.052 kW/ton	234.0 kWh/ton	0.052 kW/ton	524 installs 1459.45 tons	524 installs 1459.45 tons	No changes

Duct Insulation

During PY2, duct insulation represented 3% of the measures installed through the program. There were no problems found with the savings values applied to the 43 duct insulation measures in the program. The tracked energy and demand savings match the deemed values listed in the SCMDB. However, the tracked quantity of duct insulation was reduced by four after a review found there to be some duplicates on record.

Duct Sealing

During PY2, duct sealing represented 4% of the measures installed through the program. There were no problems found with either the quantities or the savings values applied to the 53 duct sealing measures. The tracked energy and demand savings match the deemed values listed in the SCMDB.

Complete Duct Replacement

During PY2, complete duct replacement represented 36% of the measures installed through the program. There were no problems found with the savings values applied to the 447 duct sealing measures. However, the total number of tracked complete duct replacements was reduced to account for duplicates in the tracking sheet. The tracked energy and demand savings match the deemed values listed in the SCMDB.

HVAC System Optimizer

During PY2, system optimizers represented 56% of the measures installed through the program. There were no discrepancies found with either the quantities or the savings values applied to the air conditioning and heat pump performance system optimizers. The tracked energy and demand savings match the deemed savings values listed in the South Carolina Measures Database (SCMDB).

Table 47. Verified Gross Energy and Demand Savings Summary by Efficiency Improvement Measure Type

Measure Type	Total Implemented Measures (Tracked)	Total Implemented Measures (Verified)	Tracked Gross Savings		Verified Gross Savings		Gross Savings Realization Rate	
			MWh	MW	MWh	MW	MWh	MW
SF - Duct Insulation in Existing Home AC	31	28	10.43	.00	9.42	.00	.90	.90
SF - Duct Insulation in Existing Home HP	16	15	11.18	.00	10.48	.00	.94	.94
SF - Duct Sealing in Existing Home AC	40	40	39.87	.02	39.87	.02	1.00	1.00
SF - Duct Sealing in Existing Home HP	13	13	27.84	.01	27.84	.01	1.00	1.00
SF - Complete Duct Replacement in Existing Home AC	517	275	673.56	.31	358.45	.17	.53	.53
SF - Complete Duct Replacement in Existing Home HP	313	172	849.08	.19	465.65	.10	.55	.55
SF - System Optimizer Existing Central AC with 15% Performance	181	181	63.33	.03	63.33	.03	1.00	1.00
SF - System Optimizer Existing Heat Pump with 15% Performance	524	524	342.82	.08	342.82	.08	1.00	1.00
Total	**1635**	**1248**	**2,018.11**	**.64**	**1,317.86**	**.41**	**.65**	**.64**

Verified Net Savings Adjustments

The program planning model assumed a NTG ratio of .80. In PY2, the evaluation team calculated a new NTG ratio through a telephone survey of PY2 participants (a detailed methodology for how we calculated the NTG ratios is provided in 0). As such, we found a lower NTG ratio of 0.38 for energy savings and .40 for demand savings. Table 48 displays PY2 Verified Net savings after applying these ratios.

Table 48. Verified Net Savings for Efficiency Improvement

Verified Gross Savings		NTG Ratio		Verified Net Savings	
MWh	MW	MWh	MW	MWh	MW
1,317	.41	0.38	0.40	501	.16

3.7 HOME PERFORMANCE WITH ENERGY STAR®

3.7.1 PROGRAM DESCRIPTION

The Home Performance with ENERGY STAR (HPwES) program includes a comprehensive assessment and diagnostic testing of a customer's home by trained contractors. The program is designed to help customers recognize energy solutions for their home by taking the "whole-house" approach to energy efficiency. Contractors provide participants with a comprehensive report that is generated using *BEACON Home Energy Advisor™*, a trademark of the program implementer, ICF International (ICF). The report outlines recommended energy efficient improvements and specifies the estimated energy savings associated with these measures. If at least one eligible measure is installed and rebated through the program, the customer can receive a $200 rebate to offset the cost of the audit. See the following table for a complete list of measures that are eligible for rebates through the HPwES program.

Table 49. HPwES Program Eligible Rebated Measures

Eligible Measure	Rebate
Home Performance Assessment (requires completion of eligible improvements)	$200
Air Infiltration Reduction of 15% or greater	25% of cost up to $850
Attic Insulation	
Wall Insulation (includes rim joist)	
Encapsulated attic/crawl space	
Duct Sealing (50% Reduction in leakage or 150 CFM)	$150
Duct Insulation (or replacement)	$150
Central AC or Heat Pump System optimizer	$60
Programmable Thermostat (requires ramp-up technology for heat pumps)	$50
Split System Central A/C	$200-$300
Packaged Central A/C	$200-$300
Split System Heat Pump (Air Source or Dual Fuel)	$200-$300
Packaged Heat Pump	$200-$300
Ground Source Heat Pump	$375-$525
Non-Electric Resistance Water Heater (Gas Storage, Gas Tankless, Propane, Heat Pump and Solar Water Heater)	$250
Bonus Incentive: Install at least one measure from three categories (Envelope Improvements, Heating and Cooling Performance Improvements, Heating and Cooling Equipment, and/or Water Heating Equipment)	$400

To be eligible to receive rebates for the home assessment and qualified measures installed, the inspection and installations must be completed by an SCE&G HPwES participating BPI-certified contractor. Participating contractors are recruited and trained by the program implementer on both the program and the BEACON audit assessment tool. A directory of participating contractors who

have Building Performance Institute BPI- Building Analysts certification is listed on the SCE&G website.

3.7.2 Program Performance Summary

In PY2, the HPwES program contributed 0.5% of the overall savings from SCE&G's portfolio. The program achieved 19% of net energy savings and 31% of net demand savings forecasted. The program did not achieve the savings levels it had forecasted for PY2 due to lower participation than expected, only 25% of forecast. The following table summarizes the goals and overall results for the program in terms of costs, participation, and energy and demand savings.

Table 50. HPwES Program Forecasts and Results

	Forecast	Actual	% of Forecast Accomplished
Costs	$2,491,298	$1,174,442	47%
Participants	1,038	258	25%
Net MWh	2,670	502	19%
Net MW	0.58	0.18	31%

The HPwES program had a total of 258 participants during PY2. These participants received a home energy audit and a rebate for one or more of the recommended energy efficiency measures. Table 51 shows the types of measures that were rebated to participants.

Table 51. HPwES Program Participation by Measure

Implemented Measure	Number of Participants	% of Participants (n=258)
Air Sealing Package	246	95%
Attic Insulation	187	72%
Duct System Sealing	156	60%
Seal/Insulate Attic Access Hatches	141	55%
Treat Major Attic Bypasses	134	52%
Kneewalls/Vertical Attic Wall Insulation	90	35%
Programmable Thermostat	87	34%
Seal/Insulate Recessed Lights	79	31%
Basement/Enclosed Crawlspace Insulation	54	21%
Duct System Insulation	53	21%
Duct System Move to Conditioned Space	51	20%
Vent Existing Exhaust Fan	40	16%
Cooling System ECM-type Blower Fan	40	16%
DHW Tank Wrap	40	16%
Heating System ECM-type Blower Fan	39	15%
Heat Pump	37	14%
Attic Ventilation	35	14%
Rim Joist Insulation	35	14%
Water/Vapor Barrier	27	10%
Water Heater	21	8%

Implemented Measure	Number of Participants	% of Participants (n=258)
Water Heater Temperature Turn Down	18	7%
Furnace	17	7%
Central AC	16	6%
DHW Pipe Insulation	16	6%
SF - Central AC System Optimizer (Tune Up)	10	4%
Low Flow Showerhead	7	3%
SF - Heat Pump System Optimizer (Tune Up)	7	3%
Radiant Barrier	6	2%
Exhaust Fan	6	2%
Ceiling over Garage Insulation	4	2%
Address House Drainage Concerns	4	2%
Replacement Door	4	2%
Repair Exterior Siding, Facia, Trim, or Flashing	4	2%
Furnace System Optimizer (Tune Up)	3	1%
Low Flow Faucet Aerator	3	1%
Living Area CO/Smoke Detector	3	1%
Exterior Wall Insulation	3	1%
Cantilever Insulation	3	1%
Water Heater Health and Safety Repair	2	1%
Pool Timer	2	1%
Window and Glass Door Improvement	2	1%
Refrigerator Turn In	2	1%
Window AC	2	1%
Extend Downspouts	2	1%
Heating System Health and Safety Repair	1	0.4%
Floor over Open Crawlspace Insulation	1	0.4%
Freezer Turn In	1	0.4%
Oven Safety Improvement	1	0.4%
Storm Door	1	0.4%
Gas Leak Correction	1	0.4%
Home Performance Assessment (Total Participants)	**258**	**100%**

3.7.3 IMPACT AND DATA TRACKING FINDINGS

We reviewed the database for duplicates and accuracy as well as fielded a participant survey to verify gross savings from the tracking database. We found no database errors and all survey respondents verified the measures installed. Therefore, the tracked and verified gross savings for this program are identical and the gross realization for this program 100%.

The savings per participant varies widely depending on the measures installed and whether the customer has electric or non-electric heat. Note that for whole house programs, measure-by-measure

deemed savings estimates are not the best indication of savings due to the interactive effects of the measures and the unique characteristics of the house. In addition, some of the measures installed through the program are not currently captured in the SCMDB so it is not possible to estimate savings on a measure-by-measure level using a deemed savings value from this specific source. As part of the program, contractors estimate unique household level savings through the BEACON modeling software, which models the recommended measures within the unique household. For whole home programs, modeled energy savings are more accurate than calculations that are based on system-by-system analyses and include interactive effects. Note that while additional research is needed to gain a better sense of the actual savings from this program, the overall program contributed less than 1% of overall portfolio savings in PY2. As such, we defer to the program modeled savings for the PY2 estimates. A billing analysis is planned in 2013 with PY2 participants to compare actual savings to modeled estimates and PY3 savings claims will be adjusted accordingly.

Net savings were explored in PY2 by fielding a telephone survey to participants and asking a battery of net-to-gross questions. Please refer to Appendix F for detailed methods on how we derived a net-to-gross ratio for this program. Table 52 below summarizes the verified gross and net savings.

Table 52. Verified Gross and Net Savings for the HPwES Program

Total Participants	Verified Gross Savings		NTGR		Verified Net Savings	
	kWh	kW	kWh	kW	kWh	kW
258	635,289	242	0.79	0.78	500,900	188

3.8 ENERGY INFORMATION DISPLAY

3.8.1 PROGRAM DESCRIPTION

The Energy Information Display program is an opt-in program that provides discounted energy information displays (EID) to SCE&G customers to increase awareness of energy consumption in their homes. The energy information displays provide feedback on energy usage in customers' homes. Based on the program theory, this feedback increases customer awareness of their energy use and thus prompts action to conserve energy or invest in energy efficiency upgrades.

Over the course of the program, a total of 1,554 customers received an energy information display through the program. The roll-out of this program took place in two phases and used two different devices. During the Phase I program ((November 1, 2010 – October 31, 2011), 244 residential customers received an energy information display device (Device #1). During the Phase II program (November 1, 2011 – October 31, 2012), the program switched to a different energy information display, (Device #2). Device #2 was mailed to 1,310 customers.

3.8.2 PROGRAM PERFORMANCE SUMMARY

This program made up 0.3% of the energy savings of the SCE&G's portfolio in PY2. In PY2, the program forecasted 4,849 customers participating in the program. The EID program reached 31% of its forecasted number of participants in PY2 (1,490 enrollees[19]). Due to the limited availability of Device #2, program staff reduced the planned number of participants that would receive a device. The program achieved 16% of its MWh and MW savings forecast to date. The program annual net energy savings estimates are 380 kWh household as of September 2012. Table 53 below summarizes the forecasted participation and savings as compared to the actual participation and savings in PY2.

Table 53. EID Program Forecast and Results

	Forecasts	Actuals*	% of Forecast Accomplished
Cost	$825,190	$501,482	61%
Participants	4,849	1,490	31%
Net MWH	1,940	303 as of September, 2012*	16% as of September, 2012*
Net MW	0.31	0.048 as of September, 2012*	16% as of September, 2012*

Forecasts calculated based on assumed energy and demand savings per participant, multiplied by participation forecast and assumed NTG ratio.
*PY2 impact findings are based on less than a full year of program participation data. Appendix G for more details regarding the billing analysis methodology and savings estimation.

3.8.3 IMPACT FINDINGS

For PY2, the total net savings for this program are estimated to be 303 MWh and 0.048 MW as of September 2012. PY2 impact findings are based on less than a full year of program participation

[19] Of the total 1,554 customers in the program 45 returned the device #2, 10 customers had a final bill in PY1 and 9 customers received both the Device #1 and Device #2. As such, the program reached a total of 1,490 customers in PY2.

data. As such, the estimates are expected to change when the team conducts an impact analysis in January 2014, which will provide full impacts for PY2 applied to PY3. Table 54 shows the energy and demand savings that were estimated for each participant in PY2.

Table 54. Application of Estimated Savings Per EID Program Participant

Description	Number of Units	Assumed Net[a] kWh Savings Per Participant	Assumed KW Savings Per Participant	Gross Savings		NTGR	Net Savings	
				kWh	kW		kWh	kW
Forecast Total	4,849	400	0.08	2,424,500	388	0.8	1,939,600	310
Estimated Total	1,490	380 as of September, 2012*	0.076	NA	NA	NA	302,612 as of September, 2012*	48.4 as of September, 2012*
% of forecast	0.31	0.95	0.95	NA	NA	NA	0.16	0.16

[a] Note that we report the kWh savings per participant as a net value rather than gross value.
*PY2 impact findings are based on less than a full year of program participation data, and as such are expected to change when the full PY2 billing analysis is conducted. See Appendix G for more details regarding the billing analysis methodology and savings estimation.

3.9 COMMERCIAL AND INDUSTRIAL PRESCRIPTIVE AND CUSTOM

3.9.1 PROGRAM DESCRIPTION

The SCE&G EnergyWise for your Business program includes both prescriptive and custom incentives. We combined these two program elements in this report for simplicity and because they are implemented in tandem. The programs offer incentives to businesses to encourage installation of high-efficiency equipment and building improvements that reduce energy costs. The programs are available to all eligible commercial and industrial customers in the SCE&G service territory. Note that industrial customers were given the opportunity to opt-out of the DSM programs and many have chosen to do so. As a result, the programs still fall short of the original planning assumptions which, given the opt out, makes the original goals overstated. SCE&G lifted the incentive cap in PY2 which may cause some larger customers to opt back in to the program.

3.9.2 PROGRAM PERFORMANCE SUMMARY

In PY2, the program received more participation than forecasted but received less energy savings than forecasted. This is largely due to the program's forecasting assumptions which assumed larger energy saving projects would be conducted with SCE&G's industrial customers. The original forecast was developed before the large industrial customers were known to have the ability to opt out. About seventy percent of those very large customers did choose to opt out and as a result the forecast is not a good comparison to actual program performance.

Table 55. C&I Prescriptive and Custom Program Forecasts and Results

	Forecast	Actual	% of Forecast Accomplished
Cost	$5,520,828	$5,017,526	91%
Participants	555	572	103%
Net MWH	64,081	26,821	42%
Net MW	7.34	3.34	46%

The program receives more prescriptive applications than it does custom, which is typical of a program of this nature. Because there were few custom projects (28, or 5% of the total projects) and some of these projects were completed by customers that also did prescriptive projects we have bundled this report; however, where appropriate we have called out differences between the two program elements.

Table 56 shows the prescriptive program performance in comparison to the original forecast. Although the number of participants was higher than forecast the overall savings is lower, this is likely because the larger customers (which would have likely had larger projects) opted out of the program.

Table 56. Prescriptive Program Summary

	Forecast from Planning Model	Actual	% Difference
Program Cost	$3,103,619	$3,702,082	119%
Participation	433	544	126%
Net MWh	42,053	23,870	57%
Net MW	4.02	2.84	71%

Table 57 shows the custom program element summary in comparison to the forecast. Participation in the custom program is lower than forecast, most likely because custom projects are generally larger and more complex. This type of project would more likely be completed by the same customers that opted out of the program.

Table 57. Custom Program Summary

	Forecast from Planning Model	Actual	% Difference
Program Cost	$2,417,209	$1,315,444	54%
Participation	122	28	23%
Net MWh	22,028	2,950	13%
Net MW	3.32	0.50	15%

3.9.3 Impact & Data Tracking Findings

Overall, the program realized 107% of its gross tracked savings. The impact analysis included three levels of analysis: revised gross savings, verified gross savings and verified net savings. The revision step checks for the accuracy of the program database, the verified step checks the accuracy/reasonableness of the engineering estimates used to calculate the savings and the net step accounts for program free ridership and spillover. Table 58 shows the MWh and MW for the combined prescriptive and custom efforts found at each level in the evaluation process.

Table 58. Verified Gross and Net Savings Prescriptive and Custom Combined

	Gross Tracked Savings	Gross Revised Savings	Gross Verified Savings	Gross Realization Rate	Net Verified Savings
MWh	33,341	33,116	35,762	1.07	26,821
MW	4.3	4.3	4.4	1.02	3.34

Verified Gross Savings Adjustments

The revised gross energy savings were calculated by reviewing the program tracking database supplied by the program implementer and summing the stipulated savings for each completed project. Generally the program database accurately reflected the appropriate application of stipulated savings. The database review found two issues in the Food Service and High Efficiency Kitchen Equipment program element and these were corrected in the validation analysis.

Table 59 shows the measure categories and the revised savings by measure type. The adjustments described above explain the lower verified savings for Food Service.

Table 59. C&I Prescriptive and Custom Program Revised Gross Savings by Application Type

	Tracked		Revised		% Difference	
Application Type	**MWh**	**MW**	**MWh**	**MW**	**MWh**	**MW**
Custom Incentives	3,672	.638	3,672	.638	100%	100%
Food Service and High Efficiency Equipment	2,388	.066	2,164	.066	91%	100%
HVAC Chillers	1,131	.270	1,131	.270	100%	100%
HVAC VFD	4,969	.353	4,969	.353	100%	100%
New Construction Lighting	865	.135	865	.135	100%	100%
Prescriptive LED Lighting	3,478	.354	3,478	.354	100%	100%
Prescriptive Lighting	16,686	2.425	16,686	2.425	100%	100%
Unitary HVAC PP	151	.090	151	.090	100%	100%
Grand Total	33,341	4.3	33,116	4.3	99%	100%

The verified savings include adjustments made to the tracked savings based on engineering findings discovered through the site visits, metering, desk reviews and phone interviews. The verified savings for PY2 were determined by drawing a stratified random sample of measures and conducting onsite visits and desk reviews to determine the actual savings of each measure. The realization rates for each stratum were then weighted and averaged in order to determine the program level realization rate. For the complete methodology please see Appendix H.

Table 60. C&I Program Tracked and Verified Results

	Tracked Gross Savings	Verified Gross Savings	Gross Savings Realization Rate	90% Confidence Level	
				Relative Precision	Error Bound
MWh	33,341	35,762	1.07	7.1%	2,524
MW	4.3	4.4	1.02	9.5%	421.7

The gross impact evaluation used stratified ratio estimation[20] to develop estimates of program savings based on the results observed in the evaluation sample. Ratio estimation relies on the ratio of gross verified savings to tracked savings to assess the rate at which tracked savings are being realized. This ratio of verified savings to tracked savings in the evaluation sample is referred to as the realization rate of the program.

Figure 2. Stratified Ratio Estimation

$$\frac{\sum Verified\ Gross\ \ Savings}{\sum Tracked\ \ Gross\ Savings} = Realization\ Rate$$

Energy and demand savings estimates were developed for each verified project based on metered data from the site and key equipment parameters and operating conditions gathered through site inspections, desk reviews and phone interviews. The results from each of these project-level analyses were summed by stratum and presented in Table 61 (for energy savings) and Table 62 (for

[20] Stratified ratio estimation is presented in Chapter 13 of *The California Evaluation Framework*. http://www.calmac.org/publications/California_Evaluation_Framework_June_2004.pdf

demand savings). Approximately 30% of the tracked energy and demand savings from the program were included in the verification sample.

The energy realization rates for stratum 2 and stratum 3 (medium and large measures) were very similar and only marginally greater than 100%. Measures in stratum 1 exhibited a higher realization rate, with verified savings estimates 23% higher than tracked savings estimates, on average. It is important to note that the program realization rate is closer to the value observed for strata 2 and 3 because those strata contributed far more savings to the program and are weighted more heavily in the final realization rate for the program.

Table 61. Sample Project Stratum Energy Savings and Error Ratios

Stratum	MWh Boundaries	Tracked MWh Savings	Verified MWh Savings	Realization Rate MWh[21]	Error Ratio
1	0 to 30	562	691	1.23	0.62
2	30 to 150	2,564	2,673	1.04	0.50
3	Greater than 150	6,854	7,123	1.03	0.41
Total	N/A	9,980	10,487	1.07	0.48

Table 62. Sample Project Stratum Demand Savings and Error Ratios

Stratum	MW Boundaries	Tracked MW Savings	Verified MW Savings	Realization Rate MW	Error Ratio
1	0 to .030	.079	.093	1.184	0.66
2	.030 to .150	.403	.347	0.860	0.91
3	Greater than .150	.879	.960	1.092	0.67
Total	N/A	1.361	1.400	1.024	0.76

[1] The clarification regarding realization rate calculations above also applies to peak demand.

The sampling uncertainty associated with the evaluated savings estimates for the program is quantified in Table 60 at the 90% confidence level. A confidence interval, or margin of error, for the evaluated savings can be created by adding and subtracting the error bound term from the estimate. The verified gross energy savings estimate for the program is 35,762 MWh per year so we can say with 90% confidence that the true impact of the PY2 measures is between 33,229 MWh and 38,278 MWh per year.

Implementer assumptions about baseline equipment types, which can often lead to over or under estimating savings, were found to be very reliable when compared to primary data collected by the evaluation team. The evaluation team's site inspections and phone interviews revealed very few discrepancies between the tracked quantities and equipment types contained in the program tracking database and supporting documentation. The primary sources of variation between tracked and verified savings impacts for lighting measures were the annual hours of use (HOU) and coincidence factor (CF) values used in the tracked savings calculations.

[21] A weighted realization rate was applied to projects from all three strata in accordance with *The California Evaluation Framework*. Individual stratum realization rates were calculated and presented for reference only. Because of weighting, the total realization rate (1.072) does not equal the total ex-post kWh divided by the total ex-ante kWh for the sample.[22] SCE&G 2011 Baseline Study.

Adjustments at the Net Savings Level

The program planning model assumed a NTG ratio of 0.80. In PY2, the evaluation team calculated a new NTG ratio through a survey of program participants. A detailed methodology for how we calculated the NTG ratios is provided in Appendix H. As such, we found a slightly lower NTG ratio of 0.75 for energy and a .76 for demand in PY2.

Table 63. Verified Net Savings for C&I Program

	Verified Gross Savings		NTG Ratio		Verified Net Savings	
	MWh	MW	MWh	MW	MWh	MW
C&I	35,762	4.4	.75	.76	26,821	3.34

Appendix A. Residential Lighting Program Detailed Methods

Deemed Savings Values: Tracked versus Revised by Bulb Type

Table 64. Summary of Gross Tracked and Revised Energy (MWh) and Demand (MW) Deemed Savings by Bulb Wattage

Measure Type	Units Sold	Units Returned	Total Units Sold	Verified Units Sold	Gross Tracked Savings		Gross Revised Savings		Percent Difference	
					MWh	MW	MWh	MW	MWh	MW
CFL - 7 Watt	2,084	44	2,040	2,040	40	0.004	40	0.004	100%	100%
CFL - 9 Watt	28,423	164	28,259	28,259	958	0.088	958	0.088	100%	100%
CFL - 10 Watt	42,118	4	42,114	42,114	1,386	0.126	1,386	0.126	100%	100%
CFL - 11 Watt	19,100	38	19,062	19,062	606	0.055	606	0.055	100%	100%
CFL - 12 Watt	8,057	21	8,036	8,036	247	0.023	247	0.023	100%	100%
CFL - 13 Watt	1,447,663	52	1,447,611	1,447,611	74,552	6.804	74,552	6.804	100%	100%
CFL - 14 Watt	91,089	345	90,744	90,744	4,573	0.417	4,573	0.417	100%	100%
CFL - 15 Watt	58,512	115	58,397	58,397	2,879	0.263	2,879	0.263	100%	100%
CFL - 16 Watt	14,495	22	14,473	14,473	698	0.064	698	0.064	100%	100%

Measure Type	Units Sold	Units Returned	Total Units Sold	Verified Units Sold	Gross Tracked Savings		Gross Revised Savings		Percent Difference	
					MWh	MW	MWh	MW	MWh	MW
CFL - 18 Watt	87,563	69	87,494	87,494	5,460	0.499	5,460	0.499	100%	100%
CFL - 19 Watt	9,124	14	9,110	9,110	558	0.051	558	0.051	100%	100%
CFL - 20 Watt	45,153	9	45,144	45,144	2,718	0.248	2,718	0.248	100%	100%
CFL - 22 Watt	63	-	63	63	4	0.000	4	0.000	100%	100%
CFL - 23 Watt	178,659	144	178,515	178,515	10,158	0.928	10,158	0.928	100%	100%
CFL - 25 Watt	21	-	21	21	1	0.000	2	0.000	123%	100%
CFL - 26 Watt	75,522	50	75,472	75,472	6,113	0.558	6,113	0.558	100%	100%
CFL - 27 Watt	61	6	55	55	4	0.000	4	0.000	100%	100%
CFL - 29 Watt	9	-	9	9	1	0.000	1	0.000	100%	100%
CFL - 30 Watt	99	5	94	94	7	0.001	7	0.001	100%	100%
CFL - 32 Watt	1,212	7	1,205	1,205	123	0.011	123	0.011	100%	100%
CFL - 33 Watt	618	1	617	617	62	0.006	62	0.006	100%	100%
CFL - 36 Watt	45	-	45	45	3	0.000	4	0.000	171%	139%

Measure Type	Units Sold	Units Returned	Total Units Sold	Verified Units Sold	Gross Tracked Savings		Gross Revised Savings		Percent Difference	
					MWh	MW	MWh	MW	MWh	MW
CFL - 39 Watt	238	-	238	238	22	0.002	22	0.002	100%	100%
CFL - 40 Watt	1,080	-	1,080	1,080	101	0.009	101	0.009	100%	100%
CFL - 42 Watt	702	10	692	692	66	0.007	82	0.007	123%	100%
CFL - 54 Watt	16	-	16	16	1	0.000	3	0.000	187%	152%
CFL - 55 Watt	208	-	208	208	18	0.002	44	0.004	253%	205%
CFL - 68 Watt	161	9	152	152	11	0.001	39	0.004	348%	283%
Fixture - 13 Watt	78	7	71	71	4	0.000	4	0.000	100%	100%
Fixture - 54 Watt	28	2	26	26	2	0.000	4	0.000	187%	152%
LED Holiday Light-C7 [a]	155,475	-	155,475	155,475	549	-	112	-	20%	n/a
LED Holiday Light-C9 [a]	66,550	-	66,550	66,550	161	-	68	-	43%	n/a
LED Holiday Light-globe [a]	43,050	-	43,050	43,050	8	-	31	-	397%	n/a

Measure Type	Units Sold	Units Returned	Total Units Sold	Verified Units Sold	Gross Tracked Savings		Gross Revised Savings		Percent Difference	
					MWh	MW	MWh	MW	MWh	MW
LED Holiday Light-mini [a]	270,460	-	270,460	270,460	19	-	15	-	77%	n/a
LED - 0.25 Watt	640	2	638	638	12	-	12	-	100%	n/a
LED - 0.5 Watt	3,868	-	3,868	3,868	71	-	71	-	100%	n/a
LED - 8 Watt	160	9	151	151	9	0.000	5	0.000	57%	126%
LED - 9.6 Watt	13	-	13	13	1	0.000	0	0.000	45%	100%
LED - 10 Watt	74	1	73	73	6	0.000	2	0.000	42%	94%
LED - 11 Watt	221	20	201	201	17	0.001	6	0.001	37%	83%
LED - 12 Watt	5	11	(6)	(6)	(1)	(0.000)	(0)	(0.000)	33%	74%
LED - 13 Watt	470	-	470	470	47	0.002	24	0.002	51%	115%
LED - 15 Watt	612	15	597	597	69	0.003	29	0.003	42%	95%
LED - 16 Watt	24	1	23	23	3	0.000	1	0.000	39%	87%
LED - 17 Watt	123	15	108	108	14	0.001	7	0.001	48%	100%

Measure Type	Units Sold	Units Returned	Total Units Sold	Verified Units Sold	Gross Tracked Savings		Gross Revised Savings		Percent Difference	
					MWh	MW	MWh	MW	MWh	MW
LED - 18 Watt	1,082	2	1,080	1,080	151	0.006	67	0.006	45%	100%
LED - 20 Watt	53	5	48	48	7	0.000	3	0.000	39%	87%
LED - 24 Watt	179	-	179	179	33	0.001	10	0.001	30%	67%
Total	**2,655,260**	**1,219**	**2,654,041**	**2,654,041**	**112,552**	**10.18**	**111,915**	**10.19**	**99%**	**100%**

Note: Values appearing in () are negative.
[a] LED holiday lights are re-categorized per the recommendations appearing in Table 8

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Installation and Leakage Rate Methods

In PY2, we performed an in-store intercepts survey to measure the program Leakage Rate and Installation Rate. The survey included six participating retail locations, representing a variety of high-volume stores across the territory. A total of 228 purchasers of residential lighting were interviewed. Our methodology, analysis, and results for determining the Installation Rate and Program Leakage are described in the sections below.

Program Installation Rate

The program's tracked savings assumed an installation rate of 100%. However, many customers who purchase light bulbs typically install a portion of the bulbs shortly after purchase and store the rest for future use. Below we describe two alternative methods for estimating the PY2 installation rate. One is based on the results of the 2011 Baseline Study, and the other is based on the results of the 2012 in-store intercepts survey.

The SCE&G 2011 Baseline Study included in-home audits of the lighting installed in customers' homes. The study tallied the number of CFLs placed in storage versus the number of CFLs installed. We calculated the installation rate using the following equation.

PY1 In-Service Rate = # CFL bulbs in storage / (# CFLs in storage + # CFLs installed)

This calculation resulted in an in-service rate of 83%.[22]

For an installation rate for PY2 purchases, the evaluation team recommends that SCE&G use the PY1 Evaluation's baseline in-service rate of 83%. This estimate is comparable to other utility jurisdictions across the nation, though on the high-end. Installation rates in other parts of the country tend to be between 70-80%. This includes 71% in California[23], 70% in ComEd territory[24], and 82% in Colorado[25].

We make this recommendation because while the installation rate calculated through the intercepts survey may be accurate for bulbs installed within the next week, it may not accurately reflect the number of bulbs purchased that will be installed over the course of the next year. People cannot accurately predict the number of light bulbs they will need to replace in the coming year so we did not ask this question in the in-store survey. Future installation behavior is better predicted by looking to current or past behavior. A better estimate of a yearly installation rate is the number of bulbs in-service versus in-storage in the average home. This suggests that using the installation rate from the baseline study, which took an inventory of customers' current lighting practices, would be a good proxy for a program installation rate.

[22] SCE&G 2011 Baseline Study.

[23] KEMA; Final Evaluation Report: Upstream Lighting Program; February 8, 2010.

[24] Summit Blue Consulting, LLC., et al; Commonwealth Edison Company Energy Efficiency/Demand Response Plan, Plan Year 1, Evaluation Report: Residential Energy Star Lighting; December 10, 2009.

[25] The Cadmus Group, Inc.; Colorado Home Lighting Program Process and Impact Evaluation Report; January 22, 2010.

Other utility jurisdictions are also currently grappling with how to best estimate installation rates for upstream CFL programs. Because of program design, a record of program participation is not recorded and therefore it is not possible to follow participants over the course of the year and get an estimate of actual yearly installation. We will continue to monitor this issue as it develops and keep SCE&G updated on industry best practices.

Bulbs Purchased in PY2 but Installed in Future Years

Prior research shows that 98% of CFLs purchased are installed after three years.[26] Under this assumption, a first-year installation rate of 83% in PY2 means that 15% (98% - 83%) of the bulbs purchased in PY2 will be installed in PY3 and PY4. To account for the estimated 15% of bulbs not installed in PY2, we assume that 55% will be installed in PY3, and that the remaining 45% will be installed in PY4.[27] Table 65 below shows how to apply this by year.

Table 65. Installation Rates for Lighting Purchases

Year Purchased	PY2 Install Rate	PY3 Install Rate	PY4 Install Rate
PY2	83%	15% x 55% = 8.25%	15% x 45% = 6.75%

Verified gross MWh and MW savings from bulbs purchased in PY2 and installed in PY3 and PY4 will be added to PY3 and PY4 verified gross savings.

Program Leakage Rate

The program tracking assumed a leakage rate of 0%. In PY2, the evaluation team performed an in-store intercept survey to estimate program leakage. The Program Leakage Rate reflects the percentage of program bulbs purchased by non-SCE&G electric customers. SCE&G will not realize the savings from these purchases as these bulbs will not be installed in SCE&G territory and cannot be counted towards gross savings estimates. Below we discuss two different ways to calculate program leakage, the results, and our recommendation.

Program leakage can be calculated in two different ways. In one method, a GIS analysis is performed to determine the number of non-SCE&G electric customers living in the average participating stores' territory. In the second method, program leakage is calculated through conducting an intercepts survey in a sample of participating stores, and asking customers purchasing program bulbs if SCE&G provides electricity to their home.

The steps taken to calculate the leakage rate[28] for each method are described in the sections below.

Calculating Leakage through a GIS Analysis

[26] KEMA, Inc., The Cadmus Group Inc., Itron, Inc., PA Consulting Group, Jai J. Mitchell Analytics, Final Evaluation Report: Upstream Lighting Program. Prepared for the California Public Utilities Commission, Energy Division. February 8, 2010.

[27] Ibid.

[28] Note that stores in Aiken and North Augusta were assumed to have zero leakage in our calculations due to their proximity to Georgia, which also has CFL programs. For these areas, it is assumed that what savings goes out of the territory due to non-eligible shoppers comes back with SCE&G shoppers purchasing Georgia-discounted CFLs.

To calculate program leakage using GIS, we performed the following steps:

- Mapped PY2 participating store locations over an SCE&G electric territory shape file[29]
- Defined a store's territory as the area lying within a five mile radius[30]
- For each store, used U.S. Census block data to identify the proportion of households within that five mile radius that are in SCE&G territory
- Weighted the data by the program sales volume at each store location so that stores that sold more bulbs through the program had more weight

For the sales weighted average participating store, we found that 90% of households that are within a five mile radius are in SCE&G territory, resulting in a leakage rate of 10% (1.0 - .10).

Calculating Leakage through the Intercepts Survey

We also calculated program leakage using customer responses from the intercepts survey. First, we took steps to ensure that the sample of stores included in the intercepts survey was representative of the larger population of participating stores. This involved performing a separate GIS analysis, identical to the one described above, but just for the sample of stores so we could compare it to the result for all participating stores. We calculated that 91% of households are SCE&G electric customers within the five mile radius for samples stores, which is very similar to the result of 90% for all participating stores. Because the sample stores are located in areas that are similar to the overall population of participating stores, we have greater confidence that the leakage rate we calculate from the in-store interviews will be representative of the overall program and that the data does not need to be weighted based on the sample stores' locations within SCE&G territory.

In the survey, we asked each purchaser if they were an SCE&G electric customer and the number of program bulbs they were buying. We weighted customer responses by the number of bulbs purchased, and also by store sales volume. This ensured that, for example, someone purchasing 8 program bulbs would have more influence on the leakage rate than a person who bought just one program bulb, and stores with higher program sales were weighted more heavily than stores with lower program sales. This resulted in a leakage rate of 19%.

The two methodologies described above both have strengths and weaknesses. The GIS analysis allows SCE&G to include all participating stores, but does not account for customer purchasing behaviors which may lead them to buy lighting outside of the store territory in which they live. The intercepts survey incorporates information related to customer buying behaviors, as respondents are actual purchasers of program lighting who may or may not live in a particular store's territory, but the resulting leakage rate is based on a sample of stores. While we were able to determine that the samples of stores were similarly located within SCE&G electric territory compared to the larger population, we cannot determine whether the days and times during which we conducted the survey are representative of the rest of the year.

[29] GIS shape file of SCE&G electric territory from www.gis.sc.gov.

[30] A store's territory is likely to be influenced by a number of factors including the type of store, road network and population density of the area. It was not possible to consider all of these factors for this analysis. For the purposes of this analysis, using the same definition of each territory for each store is sufficient.

Given that both methods have strengths and weaknesses, we recommend taking the average of the two estimates. This results in a leakage rate of 14.5% ((10% + 19%)/2), and allows SCE&G to take advantage of the strengths of each methodology.

NTG Ratio Methodology

Below we discuss our methodology for calculating program free ridership through the intercepts survey and the resulting NTG ratio.

The program encourages customers to purchase CFLs through discounted pricing and customer education and outreach about the benefits of CFLs and LEDs. We asked questions about the influence of program marketing and price discounts in the intercept survey and developed a free ridership score for each element. For each respondent, the free ridership score ranges from 0 to 1. A score of 0 means the participant would not have purchased any of the bulbs without the program, while a score of 1 means the participant would have purchased all of the bulbs without the help of the program. The development of these separate scores is outlined below, followed by the methodology used to combine them into one overall free ridership estimate for the entire program and the results.

1. **Program Discount Influence.** This score reflects the impact that the program discount had on the quantity of lighting purchased.

   To determine the effect that the discount had on the quantity of bulbs purchased, we first asked customers if they would have bought the same number of bulbs, some of them, or none of them if the CFL(s) or LED(s) had cost more (dollar amount differs by standard CFLs, specialty CFLs, and LEDs). If a customer stated that they would have purchased some of them, we then asked how many they would have purchased. Table 66 further outlines this scoring method.

   Table 66. Program Discount Free Ridership Score

Question	Response	Program Discount Free Ridership Score
(1) If the CFL(s)/LED(s) had cost $X more per bulb, would you have still purchased all of these CFL(s)/LED(s), some of them, or none of them?	a) All	1.0
	b) Some	Go onto Question 2.
	c) None	0.0
	d) Don't Know	Assigned mean value.
(2) How many of the CFL(s)/LED(s) would you have purchased if they had not been discounted? *(Only for Respondents who answered "Some" to #1 above)*	Numeric Open End	Assign a value of 0 to the bulbs the customer would NOT have purchased, and a value of 1.0 to the bulbs they would have purchased. Take the average to come up with the Quantity Score.
	Don't Know	Assigned mean value.

   Using the methodology described above, the evaluation team calculated an average Program Discount Score of 0.32. This is based on the responses of 126 SCE&G customers purchasing program bulbs who could answer question one above.

2. **Program Information Influence.** To determine the influence of program education and outreach, we asked customers who recalled seeing in-store information or displays on the benefits of CFLs or LEDs about the influence of these materials on their purchase decision. Table 67 below shows how this question is scored.

Table 67. Program Information Free Ridership Score

Question	Response	Program Information Free Ridership Score
Using a scale of 0 to 10 where 0 means not at all influential and 10 means extremely influential, how influential was the in-store information in your decision to buy CFL(s)/LED(s)?	0 to 10	1 – (Response/10)
	Don't know	Assigned mean value.

Of the 126 SCE&G customers purchasing program bulbs, 43% said they saw information and materials in the store related to the program and were asked the question above. This resulted in an average Program Information Score of 0.10.

3. **Efficiency Score.** The efficiency score reflects the impact of the program on moving customers from a less efficient bulb purchase to a more efficient one. In the case of CFLs, we ask customers who would have purchased some or none of the bulbs on their own whether they would have purchased incandescent bulbs instead. In the case of LEDs, we ask if they would have purchased CFLs, incandescents, or a mix of CFLs and incandescents.[31] The responses and associated free ridership values are shown in Table 68. Respondents who would have bought all of the program bulbs without the discount are not asked the questions below, and are automatically assigned an Efficiency Score of 1.0.

Table 68. Efficiency Free Ridership Score

Question	Response	Efficiency Free Ridership Score
For CFLs:		
If the CFLs had not been discounted by $X per bulb, would you have purchased incandescent bulbs instead of CFLs?	Yes	0.0
	No	1.0
	Don't know	Assigned mean value.

Ninety-six customers were asked the question above. Of these, 10% would have purchased incandescent bulbs instead, while 65% would have just purchased fewer CFLs. The method described resulted in an average Efficiency Score of 0.85.

4. **Overall Free Ridership Score.** The overall free ridership score is based on two components. The first component is the Program Discount Score multiplied by the Efficiency Score. Multiplying the two scores together allows the program to receive additional credit if the customer would have

[31] Five LED purchasers were asked this question regarding LEDs, all of whom said "Don't know". Therefore, we did not include the LED portion of this question in our analysis.

purchased incandescent bulbs instead. The second component is simply the Program Information Score. The overall free ridership score is the lower of these two values. Taking the minimum of the values allows the program to receive equal credit whether the customer is influenced by price discounts or marketing. It does not matter how customers are influenced; it just matters whether that they are.

*Overall Free Ridership Score = Min [(Program Discount Score*Efficiency Score), (Program Information Score)]*

The algorithm above is calculated for each customer individually, as some customers may be more influenced by one component over the other. The Overall Free Ridership Score for the program is the average of the individual Overall Free Ridership Scores weighted by the number of program bulbs purchased. Using this methodology, we calculate an Overall Free Ridership Score for the program of 0.17, resulting in program net-to-gross factor of 0.83.

For a program beginning its third year of offering an upstream lighting program, a free ridership rate of 0.17 is quite good and on the low-end compared to other utility lighting programs. In other jurisdictions, free ridership rates have ranged from 0.15 for PPL Electric in Pennsylvania to 0.55 in Massachusetts.[32] SCE&G's free ridership rate may be lower at this time because it is a relatively new program in a jurisdiction that did not previously offer lighting programs. As a result, more opportunities may exist to influence the purchasing behaviors of customers who have not yet been heavily exposed to energy efficient lighting. These customers represent the "low-hanging fruit", and would naturally have lower free ridership scores. As the program matures and more customers become aware of the benefits of energy efficient lighting, there will be less low-hanging fruits to capture.

[32] The Cadmus Group, Inc.; Efficiency Maine Trust Residential Lighting Program Evaluation: Final Report; November 1, 2012.

Appendix B. HEATING & COOLING AND WATER HEATING DETAILED METHODS

Deemed Savings Values: Tracked versus Revised by Measure Type

Table 69. Summary of Gross Tracked and Revised Energy (MWh) and Demand (MW) Deemed Savings by HVAC Equipment Type

Measure Type	Tracked Quantity	Verified Quantity	Tracked Gross Savings		Revised Gross Savings		Percent Difference	
			kWh	kW	kWh	kW	kWh	kW
GSHP - EER 17	1	1	1,393	0.75	1,393	0.76	100%	100%
GSHP - EER 17 ASHP Base	2	2	796	1.25	1,686	1.03	212%	82%
GSHP - EER 19	2	2	3,590	1.96	3,590	1.97	100%	100%
GSHP - EER 19 ASHP Base	18	18	21,057	25.74	36,223	21.03	172%	82%
Packaged - ASHP - SEER 14	282	282	109,955	115.50	109,955	115.50	100%	100%
Packaged - ASHP - SEER 15	52	52	30,147	25.99	30,147	25.99	100%	100%
Packaged - ASHP - SEER 16	29	29	24,350	18.61	24,350	18.61	100%	100%
Packaged - ASHP - SEER 17	1	1	1,309	0.92	1,309	0.92	100%	100%
Packaged - ASHP - SEER 18	1	1	1,054	0.70	1,054	0.70	100%	100%
Packaged - DFHP - SEER 14	26	26	12,126	12.80	12,126	12.80	100%	100%
Packaged - DFHP - SEER 15	5	5	3,823	3.34	3,823	3.34	100%	100%
Packaged - Furnace/AC - SEER 14	509	509	156,962	130.44	156,948	129.70	100%	99%
Packaged - Furnace/AC - SEER 15	68	68	31,089	25.78	31,089	25.78	100%	100%

Measure Type	Tracked Quantity	Verified Quantity	Tracked Gross Savings		Revised Gross Savings		Percent Difference	
			kWh	kW	kWh	kW	kWh	kW
Packaged - Furnace/AC - SEER 16	26	26	15,707	13.05	15,707	13.05	100%	100%
Split - ASHP - SEER 14.5	133	133	60,463	56.92	60,463	56.92	100%	100%
Split - ASHP - SEER 15	1000	1,000	539,080	464.68	539,080	464.68	100%	100%
Split - ASHP - SEER 16	273	273	214,686	164.07	214,686	164.07	100%	100%
Split - ASHP - SEER 17	129	129	124,782	87.90	124,782	87.90	100%	100%
Split - ASHP - SEER 18	55	55	63,392	42.10	63,392	42.10	100%	100%
Split - ASHP - SEER 19	21	21	21,733	13.80	21,733	13.80	100%	100%
Split - ASHP - SEER 20	20	20	16,565	10.15	16,565	10.15	100%	100%
Split - ASHP - SEER 21	6	6	3,349	2.00	3,349	2.00	100%	100%
Split - ASHP - SEER 22	3	3	3,666	2.13	3,666	2.13	100%	100%
Split - ASHP - SEER 23	7	7	4,068	2.32	4,068	2.32	100%	100%
Split - ASHP - SEER 25	2	1	1,464	0.81	837	0.46	57%	57%
Split - ASHP - SEER 26	0	1	-	-	675	0.37	n/a	n/a
Split - DFHP - SEER 14.5	2	2	855	0.81	855	0.81	100%	100%
Split - DFHP - SEER 15	10	10	5,178	4.53	5,178	4.53	100%	100%
Split - DFHP - SEER 16	9	9	7,313	5.67	7,313	5.67	100%	100%
Split - DFHP - SEER 17	5	5	5,416	3.86	5,416	3.86	100%	100%
Split - DFHP - SEER 20	1	1	1,204	0.80	1,579	0.94	131%	117%

Measure Type	Tracked Quantity	Verified Quantity	Tracked Gross Savings		Revised Gross Savings		Percent Difference	
			kWh	kW	kWh	kW	kWh	kW
Split - Furnace/AC - SEER 14.5	87	87	34,929	28.97	34,923	28.92	100%	100%
Split - Furnace/AC - SEER 15	101	101	44,591	36.97	44,591	36.97	100%	100%
Split - Furnace/AC - SEER 16	225	225	110,181	91.53	110,181	91.53	100%	100%
Split - Furnace/AC - SEER 17	26	26	20,099	16.72	20,099	16.72	100%	100%
Split - Furnace/AC - SEER 18	7	7	5,980	4.98	5,980	4.98	100%	100%
Split - Furnace/AC - SEER 19	2	2	1,994	1.66	1,994	1.66	100%	100%
Total	**3,146**	**3,146**	**1,704,347**	**1,420**	**1,720,805**	**1,415**	**101%**	**100%**

Billing Analysis Methods and Results

The Evaluation Team conducted a pre-post comparison of the participant consumption data using a LFER model to determine average yearly energy savings. The LFER model derives yearly savings estimates by comparing monthly consumption before program participation, known as the pre-period, with monthly consumption after program participation, known as the post-period. The difference in monthly consumption from the pre- to post-period multiplied by 12 gives us an estimate of yearly energy savings that can be attributed to program participation.

In the LFER model, the average monthly consumption of energy by household *i* in time *t*, C_{it}, depends on three variables: the binary variable $Post_{it}$, the average monthly heating degree days (HDD) of household i at time t, HDD_{it}, and the average monthly cooling degree days (CDD) of household i at time t, CDD_{it}. The weather variables in this model are important because HVAC use is weather dependent. In this model, $Post_{it}$ captures the effect of changing or adding equipment/measures to participant households, or the change in consumption from the pre- to post-period. This coefficient, when calculated on an annual basis, gives us an estimate of savings that is not adjusted for the baseline efficiency (e.g. SEER rating) of the replaced heating and cooling equipment. This model is specified as follows:

Figure 3. LFER Post Model 1

$$C_{it} = \beta_0 + \beta_1 Post_{it} + \beta_2 HDD_{it} + \beta_3 CDD_{it} + \varepsilon_{it}$$

To increase the fit of the model, we also estimated an equation that interacted Post with HDD and CDD, which controls for weather, as does Model 1, but also estimates the increase in savings that occurs as the temperature becomes more extreme in the post period. This expanded model is as follows:

Figure 4. LFER Post Model 2

$$C_{it} = \beta_0 + \beta_1 Post_{it} + \beta_2 HDD_{it} + \beta_3 CDD_{it} + \beta_4 Post_{it} \cdot HDD_{it} + \beta_5 Post_{it} \cdot CDD_{it} + \varepsilon_{it}$$

Where:

$\beta_4 Post_{it} \cdot HDD_{it}$= the average monthly heating degree days (HDD) in the post-period of household i at time t

$\beta_5 Post_{it} \cdot CDD_{it}$ = the average monthly cooling degree days (CDD) in the post-period of household i at time t

In addition to the models specified in Figure 3 and Figure 4, we estimated an equation that controlled for measure-specific variables in order to estimate the change in consumption attributable to specific measures. Upon reviewing the measures installed through the program, we decided two construct two measure-specific variables: one variable representing heat pumps and one variable representing all other measures. We were limited in the number of measure-specific variables we could include in the model because increasing the number of predictor variables would reduce the model's degrees of freedom, which would affect the model's ability to make accurate point estimates. Table 70 below highlights which measures installed through the program we assigned to each measure-specific variable.

Table 70. Installed Measures by Measure-Specific Variable Grouping

Measure Catalog Name	Measure-Specific Variable	Count	Group Total
SF - GSHP - EER 19	Heat Pumps	4	569 (59.5%)
SF - Packaged - ASHP - SEER 14	Heat Pumps	19	
SF - Packaged - ASHP - SEER 15	Heat Pumps	7	
SF - Split - ASHP - SEER 14.5	Heat Pumps	18	
SF - Split - ASHP - SEER 15	Heat Pumps	366	
SF - Split - ASHP - SEER 16	Heat Pumps	97	
SF - Split - ASHP - SEER 17	Heat Pumps	27	
SF - Split - ASHP - SEER 18	Heat Pumps	31	
SF - Packaged - DFHP - SEER 14[33]	All Other Measures	60	387 (40.5%)
SF - Packaged - DFHP - SEER 15	All Other Measures	15	
SF - Packaged - Furnace/AC - SEER 14	All Other Measures	150	
SF - Packaged - Furnace/AC - SEER 15	All Other Measures	18	
SF - Split - DFHP - SEER 15	All Other Measures	8	
SF - Split - DFHP - SEER 16	All Other Measures	5	
SF - Split - DFHP - SEER 18	All Other Measures	1	
SF - Split - Furnace/AC - SEER 14.5	All Other Measures	18	
SF - Split - Furnace/AC - SEER 15	All Other Measures	29	
SF - Split - Furnace/AC - SEER 16	All Other Measures	62	
SF - Split - Furnace/AC - SEER 17	All Other Measures	18	
SF - Split - Furnace/AC - SEER 18	All Other Measures	3	
Total			**956**

[33] Note that we did not include Dual Fuel Heat Pumps (DFHP) in the heat pump category. This is because DFHP measures have two fuel sources, electricity and gas, making it difficult to determine electric savings through a billing analysis that only looks at electric savings.

In the LFER measure-specific model specified in Figure 5, the average monthly consumption by household i in time t, C_{it}, depends on four variables: the binary variable $Post_{it}$, the binary variable $Heat\ Pump_{it}$, the average monthly heating degree days (HDD) of household i at time t, HDD_{it}, and the average monthly cooling degree days (CDD) of household i at time t, CDD_{it}. In this model, $Post_{it}$ captures the effect of installing non-heat pump measures in the post-period, while $Heat\ Pump_{it}$ captures the effect of installing heat pump measures in the post-period. These two coefficients, when calculated on an annual basis, give us an estimate of savings for heat pump and non-heat pump measures that is not adjusted for the baseline efficiency of the replaced heating and cooling equipment.

Figure 5. LFER Measure-Specific Model

$$C_{it} = \beta_0 + \beta_1 Post_{it} + \beta_2 Heat\ Pump_{it} + \beta_3 HDD_{it} + \beta_4 CDD_{it} + \varepsilon_{it}$$

We ran both LFER post and measure-specific models on PY1 participants to determine the change in consumption from the pre- to post-period. The LFER post models provide us with savings estimates for all measures installed through the program. The LFER measure-specific model provides us with savings estimates for heat pump and non-heat pump measures installed through the program.

Note that these models do not account for what would have been installed without the program, given current code standards for efficiency-rated equipment. The models provide us with an estimate of gross savings caused by the installation of the equipment from the pre- to post-period. In order to account for what would have been installed without the program (according to federal minimum standards), we needed to make a post-estimation efficiency adjustment, by multiplying the savings estimates by a baseline adjustment factor. This post-estimation baseline adjustment gives us an estimate of ex-post gross savings that is comparable to the deemed savings values of the installed equipment.

We note that while we used one approach to adjust the gross savings estimates, there are two basic approaches to adjusting gross savings estimates by a baseline representing current code requirements. One approach uses a billing analysis of post-installation only. The other uses a pre-post billing analysis, which we used in this analysis. In both cases, there are potential biases in the estimate of program effect, taking into account the code baseline. One bias is potential take-back and the other is the quality of the installation. These biases work in opposite directions, and we are usually not able to measure them. Using take-back as an example, the post-only method of estimating savings would tend to under-adjust for baseline, while the pre-post method would tend to over-adjust.

When used in concert, these two approaches correct for biases inherent in both adjustment approaches. While the ideal situation is to do it both ways, we have used the pre-post method only because the post-only method requires more information than is available at this time. This means that we might have over-adjusted if there was substantial take-back. On the other hand, if the installation was less than optimal, we may have under-adjusted for baseline. If the biases of take-back and sub-optimal installation were equal, the net effect would be no bias. Were we able to complete a post-only approach, that, together with the pre-post approach, would produce estimates of program impact that would form the range or limits of these biases.

To calculate the baseline adjustment factor, we divided the difference of the code SEER rating and the SEER rating of the installed equipment by the difference of the SEER rating of the replaced equipment and the SEER rating of the newly installed equipment. This gives us a measure of what would have been installed without the program, given current code standards for efficiency-rated equipment. The equation for calculating the baseline adjustment factor is located in Figure 6.

Figure 6. Baseline Adjustment Factor

$$\frac{\eta_{Code} - \eta_{Installed\ Equipment}}{\eta_{Replaced\ Equipment} - \eta_{Installed\ Equipment}} = \textit{Baseline Adjustment Factor (BAF)}$$

Where:

η= SEER rating of equipment

ηCode= 13, which is the SEER rating we applied to all equipment. This is the federal minimum for cooling equipment[34]

ηInstalled Equipment= The SEER rating of the installed equipment, as indicated in the program database

ηReplaced Equipment= The SEER rating of the replaced equipment, as indicated in the program database

After calculating the baseline adjustment factor for each participant included in the billing analysis, we created a weighted adjustment factor for the entire group of analyzed participants, which could then be applied to the average gross savings from the installation of equipment through the program, giving us an estimate of ex-post gross savings. We developed the following three group-level adjustment factors:

1. **Overall baseline adjustment factor:** This is the weighted adjustment factor for all participants included in the billing analysis. We applied this factor to all participants to develop an estimate of ex-post gross savings from all measures installed through the program for analyzed participants.

2. **Heat pump baseline adjustment factor:** This is the weighted adjustment factor for all heat pump measures installed through the program for all participants included in the billing analysis. We applied this factor to the gross savings from heat pump measures to develop an estimate of ex-post gross savings from the installation of heat pump measures for analyzed participants.

3. **Non-heat pump baseline adjustment factor:** This is the weighted adjustment factor for all non-heat pump measures installed through the program for all participants included in the billing analysis. We applied this factor to the gross savings from non-heat pump measures to develop an estimate of ex-post gross savings from the installation of non-heat pump measures for analyzed participants.

We calculated each of the three baseline adjustment factors as specified in Figure 7:

Figure 7. Weighted Baseline Adjustment Factor

$$BAF_w = \sum_i (BAF_i * \left(\frac{kWh_i}{\sum_i kWh_i}\right))$$

Where:

BAF_w = Weighted baseline adjustment factor

[34] This is under 65 kBtu, which fits all program measures.

BAF = Unweigted baseline adjustment factor

i = each individual measure, which depending on which baseline adjustment factor is calculated, could represent all measures, heat pump measures, or non-heat pump measures

η = gross impact of each measure, in terms of evaluated deemed savings in kWh

After calculating the weighted adjustment factors, we applied the factors to the gross savings predicted by the billing analysis to arrive at an estimate of ex-post gross savings for all measures, heat pump measures, and non-heat pump measures. We then divided the ex-post gross billing analysis savings estimates by the evaluated deemed savings values to arrive at an evaluated savings adjustment factor (ESAF), which could be used to adjust the evaluated deemed savings values for all measures installed through the program. We calculated the ESAF as specific in Figure 8.

Figure 8. Evaluated Savings Adjustment Factor

$$\frac{Ex-Post\ Gross\ Billing\ Analysis\ Savings}{Evaluated\ Deemed\ Savings} = Evaluated\ Savings\ Adjustment\ Factor$$

Program and Billing Data Review

The Evaluation Team received program and billing data from SCE&G for all program participants in PY1. In reviewing the participant data, we identified the number of participants to be considered for analysis and, based on the dates of program participation, the periods of time on which to conduct the billing analysis on participant consumption. An overview of the participant population and the comparison period is located in Table 71.

Table 71. Participant Population and Comparison Period

Treatment Group	# of Potential Participants in Billing Analysis	Comparison Period
All PY1 participants	1,053	12 months pre-treatment, 12 months post-treatment

Data Preparation and Cleaning

Preparing the participant and billing data for the billing analysis involves matching the participant data to their billing data, cleaning the billing data, assigning billing records to pre- or post-participation status, and incorporating weather data in order to normalize the consumption data.

Cleaning the billing data resulted in a total of 863 participants for the PY1 analysis. A summary of the account drops made in the cleaning process is highlighted in Table 72.

Table 72. Steps Taken and Accounts Dropping Billing Data Cleaning Process

Cleaning Steps	Number of Participants
Total PY1 Participants	1,053
Number of Accounts Unable to Match to Billing Data	17 (2%)
Number of Accounts with Missing Consumption Values Removed	0
Number of Accounts with Negative Consumption Values Removed	0
Number of Accounts with Zero Values Removed	0
Number of Accounts with Durations of Zero Days Removed	0
Number of Accounts that Moved During Analysis Dropped	0
Number of Accounts with Insufficient Pre-Treatment Billing Data Removed (Less than 12 Months)	56 (5%)
Number of Accounts with Insufficient Post-Treatment Billing Data Removed (Less than 12 Months)	117 (11%)
Final Number of Accounts for Analysis	**863 (82%)**

Assigning Billing Records to Treatment Periods

An important part of billing analyses is defining a treatment period for each household, which is the period of time during which each household will experience the effects of program participation. Since the participants in the program installed the measures at one point in time, we defined the treatment period as the measure installation date. If a participant installed more than one measure at different points in time, we defined the earliest installation date as the beginning of the treatment period and the latest installation date as the end of the treatment period.

The billing data we received from SCE&G were in monthly intervals, with each bill having a bill read start date, which corresponds to the beginning of the bill period, and a bill read end date, which corresponds to the end of the bill period. For our analysis, we assigned billing data with a bill read end date that occurred before the beginning of the treatment period to the pre-treatment period, and assigned billing records with a bill read start date that occurred after the end of the treatment period to the post-treatment period. The period between the start and end dates is deadbanded so that none of the usage during that period is modeled. We do this because the deadband period is the period of installation, when no savings can be measured.

Incorporating Weather Data

We appended weather data to the billing data in order to use weather to normalize the billing data. The weather data we appended to the billing data were heating degree days (HDD) and cooling degree days (CDD). HDD and CDD are measurements that mirror the changes in energy needed to heat and cool a household. HDD is calculated as the difference between a base temperature of 65 degrees Fahrenheit and the daily average temperature for days with an average temperature less than 65 degrees Fahrenheit. CDD is calculated as the difference between the daily average temperature and a base temperature of 65 degrees Fahrenheit for days with an average temperature greater than 65 degrees Fahrenheit.

We obtained weather data for households through the website BizEE[35], which provides hourly weather data for weather stations throughout the United States based on National Oceanic and Atmospheric Administration (NOAA) weather data. We matched each household to the closest

[35] www.degreedays.net

weather station with adequate-quality data. In order to find the closest weather stations, we used ArcGIS[36] to find the geographic coordinates of each household, and then obtained the geographic coordinates for weather stations in South Carolina. Using these coordinates, we ran an algorithm to determine which weather stations are closest to households that completed projects through the program.

Once we determined which weather station was closest, we appended the weather data obtained from BizEE to each household. We merged daily weather data into the billing dataset so that each billing period captures the heating and cooling degrees for each day within that billing period (based on start and end dates). Since the billing data are organized by billing cycle, which approximates a month, we calculated HDD and CDD averages by dividing the sum of daily HDD and CDD values by the total number of days in each billing cycle.

Measure Composition

We analyzed the composition of measures installed through the program to gain an understanding of the types of measures installed through the program and the range of deemed savings assigned to the installed measures. We then compared the evaluated deemed savings values of the three measure groups (all measures, heat pump measures, and non-heat pump measures) with the ex-post gross savings for the three groups estimated by the billing analysis to develop a evaluated savings adjustment factor.

An overview of the measures installed through the program for all PY1 participants and analyzed participants is located in Table 73 and Table 74. For analyzed participants, we see that average evaluated deemed yearly savings is 552 kWh for all measures, 616 kWh for heat pump measures, and 457 kWh for non-heat pump measures. Most participants installed one measure through the program, although a small number of participants installed more than one measure.

Table 73. Overview of Installed Measures – All PY1 Participants

Number of Measures Installed	1,114
Average Number of Measures Installed	1
Max Measures Installed	3
Min Measures Installed	1
Sum of Evaluated Deemed Yearly Savings for All Measures (kWh)	612,434
Sum of Evaluated Deemed Yearly Savings for Heat Pump Measures (kWh)	407,202
Sum of Evaluated Deemed Yearly Savings for Non-Heat Pump Measures (kWh)	205,232
Average Evaluated Deemed Yearly Savings for All Measures (kWh)	**550**
Average Evaluated Deemed Yearly Savings for Heat Pump Measures (kWh)	**614**
Average Evaluated Deemed Yearly Savings for Non-Heat Pump Measures (kWh)	**455**

[36] ArcGIS is a geographic information system used for working with maps and geographic information.

Table 74. Overview of Installed Measures – Analyzed Participants

Number of Measures Installed	956
Average Number of Measures Installed	1
Min Measures Installed	1
Max Measures Installed	3
Sum of Evaluated Deemed Yearly Savings for All Measures (kWh)	527,960
Sum of Evaluated Deemed Yearly Savings for Heat Pump Measures (kWh)	350,839
Sum of Evaluated Deemed Yearly Savings for Non-Heat Pump Measures (kWh)	177,121
Average Evaluated Deemed Yearly Savings for All Measures (kWh)	**552**
Average Evaluated Deemed Yearly Savings for Heat Pump Measures (kWh)	**617**
Average Evaluated Deemed Yearly Savings for Non-Heat Pump Measures (kWh)	**458**

We also analyzed the mix of measures installed through the program in PY1 and PY2 to determine whether, based on the distribution of measures installed in each program year, it would be feasible to apply the evaluated savings adjustment factor developed through this billing analysis to the evaluated deemed savings values for PY2. As can be seen in Table 75, the mix of measures installed in PY1 and PY2 is very similar, barring some slight differences. The proportion of SEER 14 – 14.5 Air Source Heat Pumps installed increased in PY2, however, this increase was met with a small increase in higher-efficiency SEER 19+ Air Source Heat Pumps installed in PY2. Additionally, the proportion of SEER 14 – 14.5 Dual Fuel Heat Pumps decreased in PY2, which was met with an increase in SEER 14 – 14.5 Air Source Heat Pumps installed in PY2. Although Dual Fuel Heat Pumps tend to be slightly more efficient than Air Source Heat Pumps, the difference in the ratio between the installed equipment in PY1 and PY2 is not high enough to appreciably change the savings generated by the measures at the program level. Barring these minor differences, the proportion of measures installed in PY1 and PY2 is comparable, making it possible to apply the evaluated savings adjustment factor from PY1 to PY2 evaluated savings.

Table 75. PY1 and PY2 Measure Mix

Measure	SEER Rating	Proportion of PY1 Measures Installed	Proportion of PY1 Measures Installed (By Tonnage)	Proportion of PY2 Measures Installed	Proportion of PY2 Measures Installed (By Tonnage)	Measure Group
ASHP	14 - 14.5	4.76%	5.08%	13.19%	13.35%	Heat Pumps
	15	37.78%	34.54%	33.44%	32.23%	
	16 - 18	14.77%	15.74%	15.51%	16.24%	
	19 and Up	0.00%	0.00%	1.88%	1.06%	
GSHP	16 - 18 SEER	0.00%	0.00%	0.10%	0.06%	Heat Pumps
	19 and Up	0.50%	0.62%	0.64%	0.69%	
DFHP	14 - 14.5	7.39%	7.43%	0.89%	0.96%	Non-Heat Pumps
	15	2.56%	2.53%	0.48%	0.48%	
	16 - 18	0.64%	0.67%	0.45%	0.43%	
	19 and Up	0.00%	0.00%	0.03%	0.03%	
A/C only	14 - 14.5	18.18%	18.65%	18.94%	19.99%	Non-Heat Pumps
	15	5.82%	6.53%	5.37%	5.75%	
	16 - 18	7.60%	8.21%	9.03%	8.65%	
	19 and Up	0.00%	0.00%	0.06%	0.07%	
Totals		**100%**	**100%**	**100%**	**100%**	

Billing Analysis Results

The results of the billing analysis for all measures are located in Table 76. The outcome of the post model 1, which normalizes the billing data by average weather in the pre- and post-periods, shows average yearly gross savings of 1,745 kWh. The outcome of post model 2, which normalizes the billing data by average weather in the post-period, shows average yearly gross savings of 1,624 kWh. These estimates show the change in consumption from the pre- to post-period. Since we have two estimates for gross savings for all measures, one estimate needs to selected for comparison with evaluated deemed savings. Although both models are statistically significant at a 90% level of confidence, model 2 has a lower Akaike information criterion (AIC), which is a measure of the relative goodness of fit of a statistical model, suggesting that model 2 is slightly more accurate in its estimation.

Table 76. Billing Analysis Results for All Measures*

Model Type	Model 1 Controlling for Weather Only	Model 2 Interactions of Weather X Period
Average Monthly Consumption in Pre-Period	1,654.33	1,651.44
Monthly Change in Consumption in Post-Period	-145.43^	-135.35^
% Yearly Savings	**-8.79%**	**-8.20%**
Upper Bound % Yearly Savings @90%	-8.82%	-8.23%
Lower Bound % Yearly Savings @90%	-8.76%	-8.17%
Average yearly kWh Savings (Gross Savings)	**-1,745.17**	**-1,624.19**
Upper Bound yearly kWh Savings @90%	-1,751.06	-1,630.02
Lower Bound yearly kWh Savings @90%	-1,739.27	-1,618.36
Confidence Interval (CI) @90%	0.49	0.49
CI Upper Bound @90%	-145.92	-135.84
CI Lower Bound @90%	-144.94	-134.86
Relative Precision	0.34%	0.36%

^ Denotes statistical significance at a 90% level of confidence
* Note that negative values reflect savings, since they represent the change from the pre- to post-period.

The results of the LFER measure-specific model are located in Table 77. The outcome of measure-specific models shows average yearly gross savings of 2,178 kWh for heat pump measures and average yearly gross savings of 455 kWh for non-heat pump measures. The coefficients for both measure-specific variables are statistically significant at a 90% level of confidence.

Table 77. Billing Analysis Results for Heat Pumps and Non-Heat Pumps*

Measure Group	Heat Pumps	Non-Heat Pumps
Average Monthly Consumption in Pre-Period	1,654.66	1,654.66
Monthly Change in Consumption in Post-Period	-181.56^	-37.98^
% Yearly Savings	**-10.97%**	**-2.30%**
Upper Bound % Yearly Savings @90%	-11.05%	-2.35%
Lower Bound % Yearly Savings @90%	-10.90%	-2.24%
Average yearly kWh Savings (Gross Savings)	**-2,178.66**	**-455.8**
Upper Bound yearly kWh Savings @90%	-2,193.38	-466.17
Lower Bound yearly kWh Savings @90%	-2,163.94	-445.44
Confidence Interval (CI) @90%	1.23	0.86
CI Upper Bound @90%	-182.78	-38.85
CI Lower Bound @90%	-180.33	-37.12
Relative Precision	0.68%	2.28%

^ Denotes statistical significance at a 90% level of confidence
* Note that the average monthly consumption in the pre-period is the same for both heat pumps and non-heat pumps because the savings were estimated using the same model

Application of Baseline Adjustment Factors

The results of applying the baseline adjustment factors to the yearly gross savings, as detected by the billing analysis, from the equipment installed through the program are located in Table 78. The weighted adjustment factors range from 45.18% - 51.11% for all measures, heat pump measures, and non-heat pump measures. When separating the measures by heat pump measures and non-heat pump measures, it is clear that the savings from heat pump measures are driving the overall savings attributable to the program.

Table 78. Yearly Ex-Post Gross Savings

Measure Group	Average Yearly Billing Analysis Gross Savings (kWh)	Weighted Baseline Adjustment Factor	Average Yearly Ex-Post Billing Analysis Gross Savings (kWh)
All Measures	1,624	0.49	797
Heat Pump Measures	2,179	0.51	1,114
Non-Heat Pump Measures	456	0.45	206

Evaluated Savings Adjustment Factors

Table 79 below shows the evaluated savings adjustment factors for each of the three measure groups. We see that the adjustment factors range from .45 to 1.81, which suggests that the evaluated deemed savings values are over- and underestimated for certain measures. It is hard to identify which specific measures are over-and underestimated, since the measure-specific groups are broad, containing measures with a wide range of SEER ratings. For informational purposes, it is informative to learn that heat pump measures appear to be driving the savings generated by this program.

Table 79. Evaluated Savings Adjustment Factors

Measure Group	Average Yearly Ex-Post Billing Analysis Gross Savings (kWh)	Average Yearly Evaluated Deemed Savings (kWh)	Evaluated Savings Adjustment Factor
All Measures	797	552	1.44
Heat Pumps	1,114	617	1.81
Non-Heat Pumps	206	458	0.45

In terms of applying any of these evaluated savings adjustment factors to the savings claimed by the program in PY2, based on the mix of measures in PY2 compared to PY1 and the limitations of our current analysis to identify specifically which measures have evaluated deemed savings that are over- and underestimated, it would make sense to apply the evaluated savings adjustment factor to the evaluated deemed savings for all measures at the program level. Through this analysis we can say that the savings at the program-level are underestimated by 44%; however, determining the extent of over- and underestimation for specific measures would require more information derived from a more extensive research effort such as a metering study.

HVAC Equipment NTG Ratio Methodology

Gross impacts are defined as the change in energy consumption (or demand) that results directly from program-related actions taken by program participants, regardless of why those actions were taken. Net impacts are defined as the impacts, i.e., change in consumption that can be attributed to the program. Net impacts may be lower than total program gross impacts due to energy savings that would have occurred in the absence of the program (free riders). Conversely, the net impacts may be

higher than total program gross impacts due to energy impacts that occurred because of the program, but were not incented by the program (spillover).

Attribution is made up of these two concepts – free ridership (FR) and spillover (SO) – and is indicated as an Net-to Gross Ratio (NTG). The NTG is calculated as (1-FR + SO).

Free ridership

Free riders are program participants who would have implemented the program energy efficient measure(s) even without the program. These estimates are based on a series of questions in the telephone survey that explored the influence of the program in making the energy efficient improvements as well as likely actions had the program not been available. For each project included in the survey, we developed a free ridership factor (based solely on free riders) that consists of three scores:

- **Program influence**. This score is determined by whether the respondent heard about the program before or after they had their HVAC system and/or ducts serviced. Hearing about the program after performing work means the customer is a free rider.
- **Influence of program timing**. This score is developed based on two questions: 1) if the work would have been done at the same time without the program; and 2) if the work would have been done later, how much later. Later implementation without the program means a lower level of free ridership.
- **Influence of program components**. This score is developed based on three factors that might have influenced their decision to have their HVAC system and/or ducts serviced. The factors are: 1) availability of the rebate; 2) recommendation from the contractor; and 3) information from SCE&G. Greater influence of program components means a lower level of free ridership.

Each score can take on a value of 0 to 1, where a higher score means a higher level of free ridership. The overall free ridership factor for a project is the average of the three scores.

The NTG is 1-FR for each project and therefore ranges from 0 (100% free ridership) to 1 (no free ridership). To get further clarity, the NTG is weighted by the energy savings (of the survey respondents) get the final NTG ratio.

Spillover

Spillover energy and demand savings were calculated based on responses from participants who indicated installing energy efficient measures outside of the program, but were heavily influenced by the program. To determine the program-level spillover factor, we divided the estimated savings of the measures installed by survey respondents outside of the program (but influenced by the program) by the savings the survey respondents realized through the program.

Figure 9. Spillover Algorithm

$$\text{Spillover} = \frac{Respondent\ Energy\ Savings\ from\ Measures\ Installed\ Outside\ the\ Program}{Respondent\ Energy\ Savings\ from\ Measures\ Installed\ Through\ the\ Program}$$

The spillover energy and demand savings are added back to the program savings after adjusting for free ridership to determine the overall NTG ratio for the program.

Figure 10. Net to Gross Algorithm

$$\text{NTG} = (1 - \text{FR}) + \text{SO}$$

Precision

Our sampling plan allowed us to calculate the overall program Net to Gross with .04 precision at 90% confidence interval.

Table 80. HVAC NTG Precision

n	NTG Ratio	Relative Precision at 90% Confidence
196	84%	.04

Water Heating Equipment NTG Ratio Methodology

The NTG ratio for the water heating program was determined based on responses to our participant surveys of customers who converted to non-electric-resistance water heaters in existing homes and builders who installed non-electric-resistance water heaters in newly constructed homes. The NTG ratio is derived from two components: free ridership and spillover. Free ridership is the likelihood that a participant would have achieved the same level of savings even if the program had not existed. Free ridership is represented as a number between 0 and 1, with 1 being a 100% free rider. Spillover savings is credited to customers who report being influenced by the program to complete additional energy saving actions for which they did not receive an SCE&G rebate. Spillover is represented as a percentage of gross savings from the program. The NTG ratio is then calculated as *1 –free ridership + spillover*

Based on the total number of survey responses, we were able to extrapolate our overall NTG findings to the entire population. Table 81 below compares measures that are represented by surveyed participants to total measures installed through the program and shows the resulting precision level of the NTG ratio.

Table 81. Precision Level of Water Heater Incentives NTG Ratio

Incentive Type	Total Measures Represented by Survey Participants	Total PY2 Measures	Percent Surveyed	NTG Ratio		Precision Level at 90% Confidence
				kWh	kW	
Conversion Water Heaters	84	766	11%	0.65	0.66	.09
New Construction Water Heaters	577	2,094	28%	0.80	0.80	.03
Total Water Heater Incentives	661	2,860	23%	0.76	0.76	.03

Conversion Incentives NTG Methodology

Free ridership for conversion incentives is based upon three factors: Overall Program Likelihood (OPL), Program Timing (PT), and Program Component Influence (PC). Overall Program Likelihood is based upon the likelihood that participants would still have installed a new non-electric-resistance water heater even if rebates had not been available from SCE&G. Those who were more likely are bigger free riders than those who were not as likely. Program Timing is based on whether the program caused participants who were thinking of installing a new non-electric-resistance water heater to install one earlier than originally planned. Those who were not influenced by the program to change the timing of their planned installation are bigger free riders. Program Component Influence is based on the self-reported influence on participants' decision-making from the three main components of the program: (1) the rebate available from SCE&G, (2) recommendations from contractors, and (3) information or marketing materials provided by SCE&G. Those who were less influenced by the program components are bigger free riders. We then develop an overall program free ridership score by calculating the weighted average free ridership score by participant savings. We present the algorithm for calculating free ridership for conversion water heater incentives below.

Figure 11. Free ridership Calculation for Conversion Water Heater Incentives

$$\mathcal{F}ree\ ridership = Average(PI, PC)$$

Where:

$$Program\ Influence\ (PI) = Overall\ Program\ Liklihood\ (OPL) *\ Program\ Timing\ (PT)$$

$$Program\ Component\ Influence\ (PC) = 1 - MAX(PC_{rebate}, PC_{contractor}, PC_{info})$$

The resulting free ridership score was 0.35 for both kWh energy savings and kW demand savings. Only four participants were credited with spillover savings, constituting an overall spillover savings of 0.2% of gross energy savings and 0.7% of gross demand savings. Measures credited for spillover savings include installing attic insulation, wall insulation, new windows, or weather-stripping.

New Construction Incentives NTG Methodology

Free ridership for new construction incentives is based upon three factors: Program Timing, Program Likelihood, and Program Influence. Program Timing (PT) is based on whether or not builders had decided to install non-electric-resistance water heaters prior to learning about the program. Those who had are bigger free riders than those who had not. Program Likelihood (PL) is based on builders' self reported likelihood to have installed non-electric-resistance water heaters in the past year without the program and to continue doing so in the future even if rebates were no longer available. Those with high likelihood scores are bigger free riders than those with lower likelihood scores. Program Component Influence (PC) is based on the self-reported influence on builders' decision-making from the two main components of the program: the rebates available from SCE&G for gas appliances (from both the Gas and Electric Departments of SCE&G) and information or communication from SCE&G Gas. Those who report low levels of influence from these components are bigger free riders than those with high influence scores.

These three factors are averaged to give a free ridership score for each builder. We then develop an overall program free ridership score by calculating the weighted average free ridership score by the number of water heaters installed by each builder. We present our algorithm for calculating free ridership below:

Figure 12. Free ridership Calculation for New Construction Water Heater Incentives

$$Free\ ridership = Average(PI, PC)$$

Where:

$$Program\ Influence\ (PI) = Average(PT, PL_{past\ year}, PL_{future})$$

$$Program\ Component\ Influence\ (PC) = 1 - MAX(PC_{rebate}, PC_{info})$$

The resulting free ridership score was 0.80 for both kWh energy savings and kW demand savings. No builders were credited with spillover savings.

Overall Water heater Incentives NTG Methodology

After determining the NTG ratios for each of the two incentive types, we calculated an overall NTG ratio for water heater incentives by taking the weighted average of each NTG score based on savings from each incentive type. In Table 82 below, we present the free-ridership, spillover and NTG ratios for the individual program components and in total.

Table 82. NTG Ratio Calculation for Water Heater Incentives

Program Component	Free ridership (FR)		Spillover (SO)		NTG (1-FR+SO)	
	kWh	kW	kWh	kW	kWh	kW
Conversion incentives	0.35	0.35	0.002	0.007	0.65	0.66
New Construction incentives	0.20	0.20	0.00	0.00	0.80	0.80
Overall Water Heating incentives	0.24	0.24	0.001	0.002	0.76	0.76

Appendix C. HOME ENERGY REPORT DETAILED METHODS

In this Appendix, we detail the evaluation activities conducted for the PY2 Home Energy Report program, along with the methods that were used. The evaluation effort focuses on estimating PY2 impacts. Due to insufficient post program data for the PY2 program cycle, PY2 impacts are estimated by applying PY1 savings to PY2 participants. Demand savings are non-coincident, and as such are were not included in the billing analysis. As such, the estimated kW savings were calculated by applying the forecasted kWh to kW ratio to the forecasted kW savings.

The primary objective of this evaluation was to measure the energy savings impacts of the program, and to determine whether the program leads to additional participation in other energy efficiency rebate programs administered by SCE&G. To address this, we conducted two primary evaluation tasks:

- A billing analysis to determine net program energy impacts. This analysis also includes a comparison of customer response to the treatment by baseline usage and by season.
- A channeling analysis to determine whether the HER program treatment generates lift in other energy efficiency programs and to calculate a savings adjustment to determine what portion of net savings estimates, as measured through the billing analysis, is captured in other program databases. This analysis helps to adjust net savings to reflect only direct savings obtained outside of other programs.

Data Sources and Analytical Methods

Data sources for evaluating the HER Program include:

- Program tracking databases for all SCE&G programs
- Information on key program efforts and dates gathered through program staff interviews
- Electric billing usage data for treatment and comparison groups
- HER participant database for PY1 and PY2 through September 2012
- Weather data by address within SCE&G territory where participants and comparison group customers live

Table 83 provides a summary of the evaluation methods used for the PY2 program.

Table 83. Summary of Evaluation Methods for the Home Energy Report Program

Activity	Details
Program Materials Review	Reviewed materials to assess program design, implementation, and operations.
Participant Verification	Reviewed participant databases to identify total number of program participants and dates of enrollment.
Interviews with program managers	Interviewed program managers from SCE&G to discuss program theory and implementation.
Billing Analysis	Conducted a billing analysis to quantify the actions taken among the treatment and comparison group members. Given that there was insufficient data to conduct a PY2 billing analysis, a PY1 billing analysis was conducted and the estimates were applied to the PY2 participants.
Channeling Analysis	Conducted a channeling analysis to determine the effect of the program on other SCE&G program participation as well as to ensure that there is no double counting of savings from participation in other SCE&G programs.[37]

Discussion of Comparison Group

In June 2012, Direct Options (DO), implementers of the HER program, and Opinion Dynamics, the evaluation team, identified a comparison group in anticipation of an impact assessment (i.e., billing analysis). The comparison group was selected based on several demographic and housing attributes (such as usage, income, age, education etc). Using these attributes, a K-means clustering methodology was used to select 4,951 comparison group customers.

Modeling Approach

The evaluation team conducted a billing analysis to assess changes in energy consumption attributable to the HER Program. This analysis relied upon a statistical analysis of monthly electricity billing data for all SCE&G customers that received a HER (the treatment group) and a matched sample of customers that did not receive a HER (the comparison group). The analysis of program entrants during PY1 covers the first 12 months of their participation.

The evaluation team used linear fixed effects regression (LFER) analysis to estimate program effects. LFER analysis provides what is termed a Difference-in-Differences (DID) estimate of program savings, that compares the average change in energy consumption between pre- and post-periods among the treatment group to the average change in energy consumption between pre- and post-periods among the comparison group, to assess what participant consumption actually was after treatment compared to what it would have been in the absence of the program, i.e., program net savings.

The LFER/DID approach takes advantage of the presence of a comparison group that is similar to participants who received reports in the SCE&G territory, and of the fact that we have multiple measures of energy consumption both pre- and post-enrollment. The fixed-effects modeling approach allows for the time-invariant, household-level factors affecting energy use to be accounted for without measuring those factors and entering them explicitly in the models. These factors are contained in a household-specific intercept or constant term in the equation.

Because of the method used to select the comparison group, the treatment and comparison groups are assumed to have experienced similar events with similar effects on energy use. However, to

[37] Channeling refers to the analysis of participants in behavioral programs who have also participated in other SCE&G programs, either through behavioral program promotion or other drivers.

account for possible differences in weather that may exist, the model includes weather as an independent variable. Weather can be accounted for by entering heating and cooling degree days (HDD and CDD), using a base of 65 degrees Fahrenheit for HDD and 75 degrees for CDD. The model representing these factors in estimating average daily consumption (ADC) (and its change) would be:

Figure 13. Model for Estimating Average Daily Consumption for HER

$$ADC_{it} = \alpha_i + \beta_1 Post_t + \beta_2 Treatment_i \cdot Post_t + \beta_3 HDD + \beta_4 CDD + \varepsilon_{it}$$

Where:

ADC_{it}= Average daily consumption (kWh) for household i at time t

α_i= household-specific intercept

β_1= coefficient for the change in consumption between pre and post periods

β_2= coefficient for the change in consumption for the treatment group in the post period compared to the pre period and to the comparison group. This is the basis for the net savings estimate

β_3 and β_4 reflect the effects of weather (HDD and CDD) on energy consumption

Estimating Program Savings

The first step in calculating average program savings was accomplished by using the coefficients from the estimating equation to estimate average daily consumption (ADC) under two conditions: the treatment group in the treatment period and the comparison group in the treatment period. This is done by evaluating the first equation (shown above) with the Treatment variable set to 0 (to represent the comparison group), and the Post variable set to 1 to reflect the comparison group difference in consumption from pre- to post-periods. The equation was then evaluated with the Treatment variable set to 1 (to represent participation), and the Post variable remaining at 1, again to represent the post period. The difference between those two estimates constitutes the average daily savings per household.

Program savings as a percent reduction were calculated by dividing the average daily savings estimate described above by the estimate of ADC under the conditions of non-participation.[38] To calculate average household savings attributable to the program for the evaluated period, the average, raw, per-household daily savings was multiplied by the average number of days in the evaluated period; i.e., the average number of days between receiving the first report and the end point of the post-participation billing periods in the analysis The model evaluation used mean degree day values occurring during the treatment period. This allows a calculation of the percent savings per household under actual weather conditions.

Standard errors are required for calculating confidence intervals. They were based on standard errors that were generated from the procedure that estimated ADC for treatment and non-treatment conditions. The two separate estimates each had associated standard errors. Since the savings estimate was calculated from the difference between the two ADC estimates, we require a standard

[38] This includes usage by the treatment group prior to participation and usage by the comparison group during the entire period before and after the treatment group's participation.

error of the savings estimate. This was arrived at by propagating the two standard errors associated with the *ADC* estimates using the following equation:

Figure 14. Standard Error of Savings Calculation for HER

$$se_{sav} = \sqrt{se_T^2 + se_{NT}^2}$$

Where:

$se_{sav} = Standard\ error\ of\ saving\ estimate$

$se_T = Standard\ error\ of\ treatment\ estimate\ of\ ADC$

$se_{NT} = Standard\ error\ of\ non-\ treatment\ estimate\ of\ ADC$

Data Preparation

In this Appendix, we provide a summary of how we prepared the data for the billing analysis. The data used in the billing analysis comes from monthly billing data from January 2010 to September 2012 obtained directly from SCE&G.

The first HER reports were delivered to households over a period of about six months. The comparison group members were randomly assigned a first report date that is analogous to the first report dates of treatment group members, and were assigned in the same proportion found in the treatment group.[39] For the treatment group, this first report date marks the beginning of HER program treatment. For all customers in the analysis, the first billing period that begins after the first report date is the first billing period considered to be the "post" period in the billing analysis.

We eliminated some sample households in the statistical analysis to ensure adequacy of energy usage data during heating and cooling seasons. The number of households excluded from analysis represents approximately 9% of the treatment group and 2% of the comparison group accounts available for billing analysis. To develop the dataset used for the statistical analysis, the evaluation team conducted the following data processing steps:

- Removed observations and customers based on the following criteria (details can be found in Appendix B):
    - Energy Information Display (EID) program participants: Energy savings for these participants were evaluated through a separate billing so these participants were removed from this analysis to avoid double counting of savings.[40]
    - Insufficient post-treatment usage data: less than 12 months of post period data
    - Very low usage data: a daily average of less than 2 kWh of pre or post consumption

[39] The beginning of program treatment – and therefore dates of the first program year – varies by the first report date of the HER program, which varies by account. The first report dates fell between April 6, 2011 – September 21, 2011, with about 45% of the reports dated between July 5 and July 12. The comparison group members were assigned analogous first report dates to match the duration of the first program year for HER participants and the seasons covered pre and post participation.

[40] A total of 1,252 EID participants were excluded; 1,222 in PY1 and 30 in PY2.

- Gaps in usage data: more than 3 periods of zero usage

- Determined the average daily usage on for each customer based upon their billing cycles
- Matched weather data by customer to the geographically closest eight weather stations
- Linked energy usage with the customer-specific program start date

Given that the PY2 program cycle began in December 2012, and we received billing data ending September 2012, there was insufficient post program data to conduct a billing analysis for this cohort. Therefore, the evaluation team conducted a billing analysis for the PY1 program cycle (December 2011 – November 2012) and applied the average daily savings to the PY2 participants. Thus, impact estimates are expected to change when the full PY2 billing analysis is conducted.

Channeling Analysis

The HER program promotes other SCE&G energy efficiency programs—particularly rebate-based programs—in program materials, and directs customers to SCE&G resources to sign up for these programs. To determine whether the HER program effectively channels participants into other programs, we would assess whether there was a higher rate of participation among the treatment group, compared to the comparison group. Increased participation in other SCE&G energy efficiency programs among HER participants suggests that some portion of savings from other programs may potentially be counted by both the HER program (through the billing analysis savings estimates) and other SCE&G programs (through deemed savings in their tracking databases). The purpose of a channeling analysis is to answer the following two questions:

- Does the HER program treatment have an incremental effect on participation in other SCE&G energy efficiency programs? (Participation Lift)
- What portion of savings from HER program billing analysis is also counted by other SCE&G energy efficiency programs? (Savings Adjustment)

Participation Lift Analysis

To determine whether the HER program treatment generates lift in other energy efficiency programs, we calculated whether more treatment than comparison group members initiated participation in other SCE&G energy efficiency programs after the start of the HER program. We cross-referenced the databases of the HER behavioral program—both treatment and comparison groups—with the databases of other SCE&G residential energy efficiency programs available to the customer base targeted by the HER program.

Through this database crossing, we determined whether each program household (both treatment and comparison groups) participated in any program after the household received the first report through the HER Program. The difference in treatment and comparison participation rates is considered participation lift. Using a Difference-of-Differences (DoD) approach, the evaluation team calculated the participation lift (see table below). The lift values are then divided by each group's participation numbers to get the percent lift.

Table 84. Difference-of-Differences Estimator

	Pre	Post	Post-Pre Difference
Treatment	Y0t	Y1t	Y1t-Y0t
Comparison	Y0c	Y1c	Y1c-Y0c
T-C Difference	**Y0t-Y0c**	**Y1t-Y1c**	**(Y1t-Y1c) - (Y0t-Y0c)**

Savings Adjustment

HER participants can save energy directly—through conservation behaviors, or measures installed outside of an energy efficiency program—and indirectly, through measures installed as part of other SCE&G energy efficiency programs (channeling). Though indirect savings through other SCE&G energy efficiency programs may not have occurred in the absence of the behavioral program (e.g., if the HER induces participation), these savings will still be counted by other programs. The objective of the savings adjustment component of channeling analysis is to determine what portion of HER net savings, as measured through the billing analysis, are captured in other program databases, and then to adjust HER net savings to reflect only direct savings obtained outside of other energy efficiency programs.

The starting point of the savings adjustment analysis is HER program savings detected in billing analysis. Billing analysis models assume that treatment and comparison groups are equivalent on all dimensions except behavioral program treatment. However, because treatment and comparison rates of participation in other energy efficiency programs may not be equivalent (discussed above), it is possible that some portion of HER savings detected in the billing analysis is not unique to the HER program. To estimate HER Direct Savings, we first (1) estimated total HER net program savings from the billing analysis, and then (2) estimated net channeled savings as the difference between savings from other programs achieved by the treatment group, compared with the comparison group, to further refine the net savings estimates. We calculate channeled savings from other energy efficiency programs in PY2 using the following approach:

- Identify deemed net savings from all measures installed by accounts *prior to* each account's first report date within the programs
- Identify deemed net savings from all measures installed by accounts *after* each account's first report date within the programs
- Conduct difference-of-differences pre-post/treatment-comparison to estimate the resulting incremental channeled savings gained by the treatment group in excess of the comparison group from the pre-treatment period to the post-treatment period.

The result of this channeling analysis is a savings estimate, which can be subtracted from the estimate of total HER program savings. Note that these channeled savings could be attributed to both the HER and other utility programs, as they would not occur unless both programs were operating, but for accounting purposes, only one program can claim these savings.

Appendix D. HOME ENERGY CHECK-UP DETAILED METHODS

The installation rates and NTG ratios for the Home Energy Check-up program are based on responses to our participant telephone survey fielded in September 2012. We surveyed a total of 132 out of 2,670 participants. As can be seen in Table 85 below, our survey sample was large enough to be representative of the program population at a precision level of at least 90-10.

Table 85. Sampling Precision for Home Energy Check-up Participant Survey

	Full PY2 Program Population	Final Survey Responses	Precision at 90% Confidence Level
Overall Program	2,670	132	0.07

Installation Rate Methodology for Home Energy Check-up Program

Our participant survey included a battery of survey questions to verify that respondents received the leave behind measures tracked in the program database and to determine how many of the leave behind measures were actually installed. The installation rate was calculated as follows:

Figure 15. Home Energy Check-up Program Installation Rate Formula

$$Installation\ rate = \frac{Number\ of\ verified\ installed\ measures}{Number\ of\ measures\ tracked\ in\ program\ database}$$

Table 86 below presents the installation rates for leave behind measures and the relative precision of our findings.

Table 86. Home Energy Check-up Program Installation Rates for Leave Behind Measures

Leave behind Measure	Measures represented by the survey respondents	Total PY2 Program Measures	Installation Rate	Precision at the 90% Confidence Level
CFLs	1,290	2,670	0.55	0.02
Pipe Insulation	438	1,155	0.64	0.02
Water Heater Insulation blanket	63	881	0.57	0.03

NTG Methodology for Home Energy Check-up Program

The NTG ratios for the program are determined by two factors, free ridership and spillover. Free ridership is the likelihood that a participant would have achieved the same level of savings even if the program had not existed. Free ridership is represented as a number between 0 and 1, with 1 being a 100% free rider. Spillover savings is credited to customers who report being influenced by

the program to complete additional energy saving actions (not directly encouraged by the program) for which they did not receive an SCE&G rebate. Spillover is represented as a percentage of gross savings from the program. The NTG ratio is then calculated as *1 –free ridership + spillover*.

NTG ratios were calculated separately for gifted measures and recommended measures. The overall program NTG ratios were determined by weighting each program component NTG ratio by the size of savings that component represents.

Leave behind Measures Free ridership

Free ridership for leave behind measures is based upon two factors: Program Influence (PI) and Program Timing (PT). Program Influence is based upon the likelihood that participants would have purchased the measure even if they had not received them through the program. Those who were more likely are bigger free riders than those who were not as likely. For CFLs, we also asked respondents who were at least somewhat likely to purchase CFLs without the program approximately how many CFLs they would have purchased. Program Timing is based on whether the program caused participants who were thinking of installing these measures to install them earlier than originally planned. Those who were not influenced by the program to change the timing of their planned installation are bigger free riders. We then develop an overall free ridership score for each leave behind measures by calculating a weighted average free ridership score based on participant savings (which takes into account the verified number of measures installed by that participant). We present the algorithm for calculating free ridership for each type of leave behind measure below.

Figure 16. Free ridership Calculation for CFLs

$$\mathcal{F}ree\ ridership = Average(Program\ Influence, Program\ Timing)$$

Where:

$$Program\ Influence\ (PI) = PI\ (Likelihood\ to\ Install\ At\ All) * PI\ (Quantity\ Installed)$$

Figure 17. Free ridership Calculation for Pipe Insulation and Water Heater Insulation Blanket

$$\mathcal{F}ree\ ridership = Average(Program\ Influence, Program\ Timing)$$

We then weighted the free ridership score for each leave behind measure type by its gross verified savings to determine an overall free ridership score for leave behind measures. The resulting free ridership score for leave behind measures was 0.41 for kWh energy savings and 0.39 for kW demand savings. Table 87 below presents the free ridership scores for each type of leave behind measure.

Table 87. Home Energy Check-Up Program Free Ridership Scores for Leave Behind Measures.

Leave behind Measure Type	Total Measures Represented by Survey Participants	Free ridership	
		kWh	kW
CFLs	1,290	0.57	0.57
Pipe Insulation	438	0.23	0.23
Water Heater Insulation Blanket	63	0.16	0.16
Overall Leave behind Measures	**1,791**	**0.41**	**0.39**

Recommended Measures Free ridership

Free ridership for recommended measures is based on the self-reported influence of the program on respondents' decisions to take those measures. Any participant who reported an influence score of less than 8 (on a scale of 10) was considered a 100% free rider. We determined free ridership based on the proportion of total savings from recommended measures that are not attributable to the program (savings from participants with influence scores of less than 8). The resulting free ridership scores were 0.36 for kWh energy savings and 0.40 for kW demand savings.

Overall NTG Ratio for the Home Energy Check-up Program

Spillover savings was then applied to each program component to determine that component's NTG ratios. Spillover for the HEC program is energy and demand savings generated from actions taken since the program, but that were not included in the list of "11 Ways to Save Energy". We also verified that participants did not receive SCE&G rebates for these actions. Only actions taken by those participants who reported a high level of influence from the program are credited with spillover savings. Spillover savings in PY2 was 6% of gross kWh energy savings and 18% of gross kW demand savings.

The overall NTG ratios for the Home Energy Check-up program was then determined by taking the weighted average of each component NTG ratio based on gross verified savings from that component. The final NTG ratios for the HEC program are 0.68 for kWh energy savings and 0.78 for kW demand savings. Table 88 below provides an overview of our NTG calculation along with the relative precision of our findings.

Table 88. Overview of NTG Calculation for the Home Energy Check-Up Program

Component	Free ridership (FR)		Spillover (SO)		NTG (1-FR+SO)		Precision level at 90% Confidence (NTG)	
	kWh	kW	kWh	kW	kWh	kW	kWh	kW
Leave Behind Measures	0.41	0.39	0.06	0.18	0.65	0.79	0.02	0.02
Recommended Measures	0.36	0.40	0.06	0.18	0.71	0.77	0.06	0.06
Overall Program	**0.38**	**0.40**	**0.06**	**0.18**	**0.68**	**0.78**	**0.07**	**0.06**

Appendix E. HEATING & COOLING EFFICIENCY IMPROVEMENT DETAILED METHODS

The evaluation team conducted 101 surveys with PY2 participants. Part of this survey effort included a battery of net to gross questions with the intention of developing and applying a new net to gross ratio to EI measures savings.

Gross impacts are defined as the change in energy (consumption (or demand) that results directly from program-related actions taken by program participants, regardless of why those actions were taken. Net impacts are defined as the impacts, i.e., change in consumption that can be attributed to the program. Net impacts may be lower than total program gross impacts due to energy savings that would have occurred in the absence of the program (free riders). Conversely, the net impacts may be higher than total program gross impacts due to energy impacts that occurred because of the program, but were not incented by the program (spillover).

Attribution comprises these two concepts—free ridership (FR) and spillover (SO)—and is indicated as an NTG. The NTG is calculated as (1-FR + SO).

Free ridership

Free riders are program participants who would have implemented the program energy efficient measure(s) even without the program. These estimates are based on a series of questions in the telephone survey that explored the influence of the program in making the energy efficient improvements as well as likely actions had the program not been available. For each project included in the survey, we developed a free ridership factor (based solely on free riders) that consists of three scores:

- Program influence. This score is based on two survey questions. The first question asked respondents whether they heard about the program before or after they had their HVAC system and/or ducts serviced. Hearing about the program after performing work means the customer is a free rider. The second question asked respondents to rate the likelihood (on a 0-10 scale) that they would have had work done at all in the absence of the program. Greater likelihood of purchase in absence of the program means a higher level of free ridership.
- Influence of program timing. This score is developed based on two questions: 1) if the work would have been done at the same time without the program; and 2) if the work would have been done later, how much later. Later implementation without the program means a lower level of free ridership.
- Influence of program components. This score is developed based on three factors that might have influenced participants' decision to have their HVAC system and/or ducts serviced. The factors are: 1) availability of the rebate; 2) recommendation from the contractor; and 3) information from SCE&G. Greater influence of program components means a lower level of free ridership.

Each score can take on a value of 0 to 1, where a higher score means a higher level of free ridership. The overall free ridership factor for a project is the average of the three scores (four scores for the water heater respondents).

The NTG is 1-FR for each project and therefore ranges from 0 (100% free ridership) to 1 (no free ridership). To get further clarity, the NTG is weighted by the energy savings (of the survey respondents) to get the final NTG ratio.

Spillover

Spillover energy and demand savings were calculated based on responses from participants who indicated installing energy efficient measures outside of the program, but were heavily influenced by the program.

Figure 18. Spillover Algorithm

$$\text{Spillover} = \frac{Respondent\ Energy\ Savings\ from\ Measures\ Installed\ Outside\ the\ Program}{Respondent\ Energy\ Savings\ from\ Measures\ Installed\ Through\ the\ Program}$$

The spillover energy and demand savings are added back to the program savings after adjusting for free ridership to determine the overall NTG ratio for the program.

Figure 19. Net to Gross Algorithm

$$\text{NTG} = (1 - \text{FR}) + \text{SO}$$

Precision

Our sampling plan allowed us to calculate the overall program net to gross ratio with .08 precision at 90% confidence, as shown in Table 89.

Table 89. Net to Gross Ratio

	Free Ridership		Spillover		Net-to-Gross (1-FR+SO)		Relative Precision (90% Confidence Level)	
	kWh	kW	kWh	kW	kWh	kW	kWh	kW
Efficiency Improvement Program Overall (n=101)	.63	.62	.01	.03	.38	.40	.08	.08

Appendix F. HOME PERFORMANCE WITH ENERGY STAR® DETAILED METHODS

The evaluation team conducted a telephone survey with program participants in October 2012 and January 2013. We surveyed 62 out of a total of 258 program participants. All participants verified installing the measures in the tracking database. The survey also included a battery of net-to-gross questions from which we determined the program NTG ratios. Due to the high number of measures potentially installed by each participant, we chose to verify and perform our NTG analysis on the top four measures for each respondent based on energy savings. Overall, the measures included in our verification and NTG analyses represent 20% of program energy and demand savings.

As can be seen in Table 90 below, our survey sample was large enough to be representative of the program population at a precision level of at least 90-10.

Table 90. Sampling Precision for HPwES Participant Survey

Total Participants Surveyed	Total PY2 Program Population	Precision level at 90% Confidence
62	258	0.10

NTG Methodology

The NTG ratios for the program are determined by two factors, free ridership and spillover. Free ridership is the likelihood that a participant would have achieved the same level of savings even if the program had not existed. Free ridership is represented as a number between 0 and 1, with 1 being a 100% free rider. Spillover savings is credited to customers who report being influenced by the program to complete additional energy saving actions for which they did not receive an SCE&G rebate. Spillover is represented as a percentage of gross savings from the program. The NTG ratio is then calculated as *1 –free ridership + spillover*.

We divided our free ridership analysis into different subgroups based on measure type, including air conditioning, air sealing, duct sealing, insulation, and water heating subgroups. Free ridership for each participant (for each subgroup)[41] is based upon three factors: Program Likelihood (PL), Program Timing (PT), and Program Component Influence (PC). Program Likelihood is based upon the likelihood that participants would have made the same upgrades to their home even if rebates had not been available. Those who were more likely are bigger free riders than those who were not as likely. Program Timing is based on whether the program caused participants who were already thinking of making upgrades to make them earlier than originally planned. Those who were not influenced by the program to change the timing of their planned upgrades are bigger free riders. Program Component Influence is based on the self-reported influence on participants' decision-making from the four main components of the program: (1) the Home Energy Audit report, (2) the rebates available from SCE&G, (3) recommendations from contractors, and (4) information or marketing materials provided by SCE&G. Those who were less influenced by the program

[41] Participants may have installed measures in multiple measure subgroups and therefore may have multiple free ridership scores.

components are bigger free riders. We then develop an overall free ridership score for each subgroup by calculating a weighted average free ridership score based on participant savings. We present the algorithm for calculating free ridership for each subgroup below.

Figure 20. Free ridership Calculation for Measure Subgroup

$$Subgroup\ \mathcal{F}ree\ ridership = Weighted\ Average(Participant\ Subgroup\ Free\ ridership\ Scores)$$

Where:

$$Participant\ Subgroup\ \mathcal{F}ree\ ridership = \ Average(PC, OPL)$$

Where:

$$Overall\ Program\ Likelihood\ (OPL) = Program\ Likelihood\ (PL) * Program\ Timing\ (PT)$$

After calculating free ridership scores for each subgroup (participants were assigned to a subgroup or multiple subgroups depending on the types of measures they received through the program), we determined the overall free ridership score for the HPwES program by taking the weighted average of each subgroup score based on gross savings.

Table 91. Overall Free ridership Score for the HPwES Program

Measure Subgroup	Free ridership Score	
	kWh	kW
Air Conditioning	0.33	0.33
Air Sealing	0.20	0.19
Duct Insulation	0.22	0.23
Other Insulation	0.23	0.21
Water Heating	0.04	0.03
Overall Program	**0.21**	**0.22**

Spillover for the program was 0.33% of kWh energy savings and 0.02% of kW demand savings. The final NTG ratios for the program were 0.79 for kWh energy savings and 0.78 for kW demand savings. Table 92 provides an overview of our NTG calculation along with the relative precision levels of our findings.

Table 92. Overview of NTG Calculation for the HPwES Program

Free ridership (FR)		Spillover (SO)		NTG (1-FR+SO)		Precision level at 90% Confidence	
kWh	kW	kWh	kW	kWh	kW	kWh	kW
0.21	0.22	.0033	.0002	0.79	0.78	0.08	0.08

Appendix G. ENERGY INFORMATION DISPLAY DETAILED METHODS

In this Appendix, we detail the evaluation activities conducted for the PY2 Energy Information Display program, along with the methods that were used.

The evaluation effort focused on estimating PY2 impacts. The PY2 program cycle is from December 2011 to December 2012, although the bill analysis was conducted prior to the end of PY2 using data through October 2012. The overall PY2 program includes the second year of participation for the Device #1 customers and the first year of participation for the Device #2 customers. Additionally, the PY2 evaluation's primary focus is on the program's electric energy savings impacts. Demand savings are non-coincident, and as such are were not included in the billing analysis. As such, the estimated kW savings were calculated by applying the forecasted kWh to kW ratio to the forecasted kW savings.

The primary objective of this evaluation was to measure the net energy savings impacts of the program. To address this, we conducted two primary evaluation tasks:

- Selected a comparison group to conduct a billing analysis
- Conducted a billing analysis to determine net program energy impacts. This analysis also includes a comparison of customer response to the treatment by baseline usage and by season.

Data Sources and Analytical Methods

Data sources for evaluating the EID Program include:

- Information on key program efforts and dates gathered through interviews with program managers
- Electric billing usage data for all residential programs including EID participants
- EID participant database for PY1 and PY2 through October 2012
- Weather data by address within SCE&G territory where participants and comparison group customers live

Table 93 provides a summary of the evaluation methods used for the PY2 evaluation.

Table 93. Summary of Evaluation Methods for the EID Program

Activity	Details
Program Materials Review	Reviewed materials to assess program design, implementation, and operations.
Participant Verification	Reviewed participant databases to identify total number of program participants and dates of enrollment.
Interviews with program managers	Interviewed program managers from SCE&G to discuss program theory and implementation.
Comparison Group Selection	Identified a comparison group of equivalent customers to assess net program impacts for PY1 and PY2.
Billing Analysis	Conducted a billing analysis to quantify the actions taken among the participants. For the purpose of conducting a rigorous analysis, the evaluation team pulled an equivalent comparison group from the overall SCE&G residential customer database.

Comparison Group Selection

The evaluation team selected a comparison group for the impact analysis. Because comparison households are presumed to account for the energy use that participant households would have used in the absence of the program, differences between the energy consumption of participant households and the energy consumption of the comparison group during the program period provide an estimate of net program energy savings.

For evaluation, we best match each participating household with those non-participating households whose monthly energy consumption during the twelve months before enrollment in the program most closely match the participating household's consumption during the same twelve months. The underlying logic is that households with energy consumption closely matched over each of twelve months demonstrate that they respond the same way to the many exogenous factors – weather and economic conditions in particular – that drive energy consumption. This method is not a substitute for randomly assigning customers to treatment and control groups because two households that have the same consumption history may have used that amount of energy for different reasons. However, given that it is not always possible to employ an experimental design, no matching method will be perfect, and our method that gives priority to energy consumption over the period of a year is better and more relevant than most other methods of matching.

In addition to matching groups by household consumption, we wanted the comparison group to be as close as possible to participants in other factors that could affect energy usage as well as the decision to participate in programs so that differences in post-program period usage can be attributed to one group having participated and the other not. To the extent that the comparison group is different from participants in their propensity to participate in energy programs or in their habits and energy-related motivations, it would not provide a perfect counterfactual. We were, however, able to consider demographic and housing variables. With this in mind, we matched on the following criteria: household income, age, education and length of residence.

Selection Methodology

The matching method used to develop the comparison group is as follows:

- All billing data were "calendarized" and assigned to a billing month, based on the month in which the majority of billing days occurred.
- Customers were filtered on the following criterion:

- For program participants, electric consumption in the twelve months before program enrollment (November 2009 – October 2010) for the Device #1 participants and twenty-four months before program enrollment (November 2009 – October 2011) for the Device #2 participants was compared to *all* SCE&G residential with billing data over the same twelve or twenty-four months

- The sum of squared deviations (SSD) in monthly kWh was calculated for each potential comparison group member, and the ten non-program residential customer accounts with the lowest SSD were chosen as "finalists"

- For the purpose of examining monthly billing history at an aggregate level, we removed the monthly billing records of potential comparison group customers for each month that their matched participant was missing data

➢ Customers were then filtered: from the ten finalists, three households were chosen to be included in the analysis. Typically these three were best matches based on lowest SSD, household income, age, education and length of residence

Modeling Approach

The evaluation team conducted a billing analysis to assess changes in energy consumption attributable to the EID program. This analysis relied upon a statistical analysis of monthly electricity billing data for all SCE&G customers that received an EID (the treatment group) and a matched sample of customers that did not receive an EID.

The evaluation team used linear fixed effects regression (LFER) analysis to estimate program effects. We describe this analysis approach below. LFER analysis provides what is termed a Difference-in-Differences (DID) estimate of program savings, that essentially compares the average change in energy consumption between pre- and post-periods among the participant group to the average change in energy consumption between pre- and post-periods among the comparison group, to assess what participant consumption would have been in the absence of the program, i.e., program net savings.

The LFER/DID approach takes advantage of the presence of a comparison group for each of the cohorts (i.e. Device #1 and Device #2 recipients) who received the energy information display in the SCE&G territory, and of the fact that we have multiple measures of energy consumption (i.e. monthly billing data) both pre- and post-participation. The fixed-effects modeling approach allows for the time-invariant, household-level factors affecting energy use to be accounted for without measuring those factors and entering them explicitly in the models. These factors are contained in a household-specific intercept or constant term in the equation.

Because of the method used to pull the comparison group, the treatment (i.e. program participants) and comparison groups can be assumed to have experienced similar events with similar effects on energy use. However, to account for any differences in weather that may exist, the model includes weather as an independent variable. Weather can be accounted for by entering heating and cooling degree days (HDD and CDD), using a base of 65 degrees Fahrenheit for HDD and 75 degrees for CDD. The model representing these factors in estimating average daily consumption (ADC) (and its change) is:

Figure 21. Model for Estimating Average Daily Consumption for EID

$$ADC_{it} = \alpha_i + \beta_1 Post_t + \beta_2 Treatment_i \cdot Post_t + \beta_3 HDD + \beta_4 CDD + \varepsilon_{it}$$

Where:

ADC_{it}= Average daily consumption (kWh) for household i at time t

α_i= household-specific intercept

β_1= coefficient for the change in consumption between pre and post periods

β_2= coefficient for the change in consumption for the treatment group in the post period compared to the pre period and to the comparison group in the post period. This is the basis for the net savings estimate

β_3 and β_4 reflect the effects of weather (HDD and CDD) on energy consumption

The evaluation team also estimated a seasonal model to determine how customer response to the treatment varied by season, and a baseline consumption model to determine the effect of baseline consumption level on treatment impacts.

Estimating Program Savings

The first step in calculating average program savings was accomplished by using the coefficients from the estimating equation to estimate average daily consumption (ADC) under two conditions: the treatment group in the treatment period and the comparison group in the treatment period. This is done by evaluating the above equation with the Treatment variable set to 0 (to represent the comparison group), and the Post variable set to 1 to reflect the comparison group difference in consumption from pre- to post-periods. The equation was then evaluated with the Treatment variable set to 1 (to represent participation), and the Post variable remaining at 1, again to represent the post period. The difference between those two estimates constitutes the average daily savings per household.

Program savings as a percent reduction were calculated by dividing the average daily savings estimate described above by the estimate of ADC under the conditions of non-participation.[42] To calculate average household savings attributable to the program for the evaluated period, the average, raw, per-household daily savings was multiplied by the average number of days in the evaluated period; i.e., the average number of days between receiving the energy information display and the end point of the post-participation billing periods. Similar calculations were done for the baseline usage model and the seasonal model. The model evaluation used mean heating and cooling degree day values occurring during the treatment period. This allows a calculation of the percent savings per household under actual weather conditions.

Standard errors are required for calculating confidence intervals. They were based on standard errors that were generated from the procedure that estimated ADC for treatment and comparison groups. The two separate estimates each had associated standard errors. Since the savings estimate was calculated from the difference between the two ADC estimates, we require a standard

[42] This includes usage by the treatment group prior to participation and usage by the comparison group during the entire period before and after the treatment group's participation.

error of the savings estimate. This was arrived at by propagating the two standard errors associated with the ADC estimates using the following equation:

Figure 22. Standard Error of Savings Calculation for EID

$$se_{sav} = \sqrt{se_T^2 + se_{NT}^2}$$

Where:

$se_{sav} = Standard\ eror\ of\ saving\ estimate$

$se_T = Standard\ error\ of\ treatment\ estimate\ of\ ADC$

$se_{NT} = Standard\ error\ of\ non-\ treatment\ estimate\ of\ ADC$

Data Preparation

In this Appendix, we provide a summary of how the data was prepared for the billing analysis. The data used in the billing analysis comes from monthly billing data from January 2010 to September 2012, obtained directly from SCE&G.

To develop the dataset used for the statistical analysis, the evaluation team conducted the following data processing steps:

- Removed observations and customers with insufficient post-treatment usage data and or lack of usage data and/or more than 3 periods of zero usage
- Determined the usage on a calendar month basis for each customer based upon their meter read cycle
- The selected comparison group members were randomly assigned an installation date analogous to the installation dates of the treatment group, and in equal proportion to treatment installation dates. This installation date marks the beginning of EID program treatment. The first billing period after the installation date is the first billing period considered as the post-treatment period in billing analysis.
- Matched weather data by zip code to seven weather stations
- Linked usage data with the customer-specific program start date

The beginning of program treatment – and therefore dates of the first program year – varies by the installation date of the energy information display, which varies by account. The installation dates for the Device #1 participants fell between November 1, 2010 – November 11, 2010 and the installation dates for the Device #2 participants fell between November 1, 2011 – October 30, 2011. The comparison group customers were randomly assigned analogous installation dates to match the EID participants.

Device #1 customers that had an installation date of November 2011 were included in the evaluation (234 participants). Remaining Device #2 customers (1,022 participants) were not included due to insufficient post installation usage data. However, savings were estimated for these customers based on the savings calculated for the 234 participants with sufficient data.

Given the two phases within the EID program and the insufficient data available for the second year of Device #1 participants and the Device #2 participants, the evaluation team conducted three separate analyses to estimate the energy saving impacts for the PY2 period. The descriptions of these analyses are described below.

Device #1 PY2 Impacts (235 participants)

The 244 Device #1 participants received the energy information display. Of these nine customers had a final bill date in PY1 and as such there were 235 participants with Device #1. These participants were in their second year of participation during the PY2 program cycle. Thus, the evaluation focuses on the second year of participation to estimate the Device #1 participants' impacts. Notably, we also estimated PY1 impacts for these participants to identify trends in energy savings over time.

Device #2 PY2 Impacts (234 participants)

There were a total of 1,286 customers who enrolled for the Device #2 portion of the EID program. Of these 1,286 participants, 21 returned the device, 10 had a final bill date in PY1 and 9 were existing Device #1 participants. As such there were 1,255 participants with Device #2. Of these participants. 234 participants received the energy information display between November 1, 2011, and November 29, 2011. As such, these participants were in their first year of participation during the PY2 program cycle and had sufficient post program data to estimate savings through a billing analysis. Thus, the evaluation focuses on the first year of participation to estimate the 234 Device #2 participants' impacts.

Device #2 PY2 Impacts (1,022 participants)

The remaining 1,022 Device #2 participants received the energy information display between April 19, 2011 and October 30, 2011. As such, these participants were in their first year of participation during the PY2 program cycle, but did not have sufficient post program data to estimate savings through a billing analysis. Thus, the impacts are estimated by applying first-year impact results from the 234 Device #2 participants with sufficient billing data to the 1,022 Device #2 participants with insufficient billing data on a pro-rated basis based on when participants began treatment.

Appendix H. C&I CUSTOM AND PRESCRIPTIVE DETAILED METHODS

Table 94 summarizes the data collection activities that were conducted through the course of this evaluation. A description of each activity follows.

Table 94. C&I Evaluation Data Collection Activities

Data Collection Type	Targeted Population	Sample Size
Onsite visits	Program participants	37
Project Desk Reviews	Program participants	39
Customer Survey	Program participants	91
Database Review	Program participants	1

Onsite Visits: The evaluation team conducted site inspections at 37 participating sites. Many sites completed multiple energy efficiency measures and therefore 37 sites represented 99 measures in the program tracking database. Each of the 37 sites, and the associated 99 measures, were inspected and reviewed by a field engineer. During the onsite inspection the reported equipment, installation quantities, and efficiency levels of all measures were visually confirmed to ensure the equipment installed matched what was rebated by the program. Engineers also gathered information on the equipment that was in place prior to the retrofit to establish an accurate baseline for savings calculations.

Project Desk Reviews: The evaluation team conducted engineering desk reviews of 39 measures reported in PY2. These measures were completed by 22 distinct program participants. For projects analyzed using desk review only, several sources of information were reviewed to inform savings calculations. All invoices, equipment specifications, and energy savings calculations included in project files were reviewed. Phone interviews with equipment operators were conducted to verify equipment installation and increase understanding of annual equipment usage patterns, hours of operation, and loading conditions. Additional equipment data was collected from manufacturers as necessary.

Customer Survey: In addition to the surveys that were conducted onsite the evaluation team also conducted 66 surveys in order to increase the size of the sample of participants asked about program processes and the influence of the program over customer decision-making. These surveys combined with the surveys done on site yielded 91 completed surveys.

Database Review: The evaluation team also reviewed the program tracking database in order to verify that the correct savings values were applied and that the measure quantities matched the project savings.

Sampling

Onsite Visit and Desk Review Sample

Sampling was conducted at the project level for the verified savings analysis. For purposes of the evaluation, a project is defined as a record, or row, in the program tracking database. The sampling

strategy did not differentiate projects by technology category (lighting or HVAC for example). Strata breakpoints were determined by applying the Dalenius Hodges approach to stratification and the sample sizes for each stratum were calculated using a Neyman allocation. The upper and lower bounds of each stratum are presented in Table 95 along with the contribution to ex-ante programs savings and number of projects evaluated. Notice that the high impact projects in stratum 3 are sampled at a much higher frequency than projects from stratum 2 or stratum 1.

Table 95. C&I Verification Sample Frame

Stratum	kWh Boundaries	Number of Measures in PY2 Population	Percent of tracked kWh savings	Number of projects receiving site visits	Number of projects receiving desk reviews	Percent of projects evaluated
1 (Small)	0 to 30,000	750	16.26%	65	11	10%
2 (Medium)	30,000 to 150,000	176	36.56%	25	18	24%
3 (Large)	Greater than 150,000	47	47.18%	9	10	42%

A small group of participating sites, such as military bases, were excluded from the sample frame for security reasons. A random sample of projects was selected from each stratum according to the sample design. If a project from a participating site was selected in the sample, the evaluation team opted to also verify all of the other measures implemented at the site. This 'value of information' approach allowed the team to gather information on additional projects at low incremental cost. The 99 measures which received site visits were selected from 37 distinct facilities and the 39 projects which received desk reviews represented 22 distinct facilities.

While onsite, the evaluation team installed data loggers at 31 of the 37 visited sites in order to verify the operating schedules of the efficient equipment installed as part of the program. Lighting loggers were the primary type of instrumentation used in the evaluation because installation is less invasive to the customer than metering the electric load of lighting fixtures. This approach is consistent with IPMVP Option A – Partially Measured Retrofit Isolation protocols[43]. Option A is an ideal approach for lighting retrofit projects because accurate stipulated wattage values are available for most fixture types. The uncertainty in a lighting retrofit project comes from the hours of operation, and this parameter was measured with lighting loggers or calculated based on the building operating schedule. Load shapes were developed from the lighting logger data and used to determine equipment consumption during the weekday afternoon, 2 pm to 6 pm, peak demand window. This technique allowed the evaluation team to measure a specific coincidence factor (CF) for each measure in the evaluation sample.

Customer Survey Sample

The customer survey was conducted in two waves. In the first wave the evaluators used tablets to survey customers while onsite. The survey was only conducted in this manner if the customer representative onsite was determined to be the most knowledgeable about the project. There were a number of occasions where the engineer was not escorted by someone with knowledge of the project. The second wave of surveys was conducted via Computer Assisted Telephone Interview

[43] *International Performance Measurement & Verification Protocol Concepts and Options for Determining Energy and Water Savings* Volume I, March 2002. http://www.nrel.gov/docs/fy02osti/31505.pdf

(CATI). Participants that did not receive an onsite visit were included in the phone survey sample. A census of the remaining participants was attempted and an additional sixty-six interviews were completed in this manner. In total the surveys represented almost 20% of the overall program tracked savings. Table 96 shows the number of surveys that were conducted both onsite and over the phone and the gross savings they represent.

Table 96. C&I Survey Response Rate

	Number of surveys completed	Population	Response Rate	Percent of Gross Verified MWh
Onsite Surveys	25	37 (onsite visits conducted)	68%	8%
Phone Surveys	66	266[44]	25%	11%
Total	91	303[45]	NA	19%

Gross impacts are defined as the change in energy (or demand) consumption that results directly from program-related actions taken by program participants, regardless of why those actions were taken. Net impacts are defined as the impacts, i.e., change in consumption that can be attributed to the program. Net impacts may be lower than total program gross impacts due to energy savings that would have occurred in the absence of the program (free riders). Conversely, the net impacts may be higher than total program gross impacts due to energy impacts that occurred because of the program, but were not incented by the program (spillover).

Attribution is made up of these two concepts – free ridership (FR) and spillover (SO) – and is indicated as an Net-to Gross Ratio (NTG). The NTG is calculated as (1-FR + SO).

Free ridership

Free riders are program participants who would have implemented the program energy efficient measure(s) even without the program. These estimates are based on a series of questions in the telephone survey that explored the influence of the program in making the energy efficient improvements as well as likely actions had the program not been available. For each project included in the survey, we developed a free ridership factor (based solely on free riders) that consists of three scores:

- **Program influence**. This score is determined by whether the respondent heard about the program before or after they had completed their energy efficiency project. Hearing about the program after completing the project means the customer is a free rider.
- **Influence of program timing**. This score is developed based on two questions: 1) if the work would have been done at the same time without the program; and 2) if the work would have been done later, how much later. Later implementation without the program means a lower level of free ridership.

[44] The population of 266 only includes customers that did not receive site visits as anyone that would have been interviewed by the engineer onsite was removed from the sample.

[45] The total number of potential interview candidates does not equal the total number of customers that participated in the program for several reasons. There were several cases where an individual was listed as the contact for more than one project (especially common in national chain accounts and school districts).

- **Influence of program components**. This score is developed based on factors that might have influenced their decision to complete the energy efficiency project. The factors are: 1) availability of the incentive; 2) recommendation from EnergyWise program staff; 3) Information from program marketing materials and 4) endorsement from their SCE&G account manager. Greater influence of program components means a lower level of free ridership.

Each score can take on a value of 0 to 1, where a higher score means a higher level of free ridership. The overall free ridership factor for a project is the average of the three scores.

Spillover

Spillover savings were calculated based on responses from participants who indicated installing energy efficient measures outside of the program, but were heavily influenced by the program. When a customer was identified as a potential spillover candidate a follow-up call was scheduled with engineering staff so that information could be gathered in order to estimate the energy savings of the project. Additionally evaluation staff cross-checked the database to ensure that the customer did not receive a rebate for the project.

The spillover energy and demand savings are added back to the program savings after adjusting for free ridership to determine the overall NTG ratio for the program.

Figure 23. Net to Gross Algorithm

$$\mathrm{NTG} = (1 - \mathrm{FR}) + \mathrm{SO}$$

Evaluation efforts attempted to capture any program spillover but no spillover was found. As a result, the NTG score for PY2 is based solely on free ridership.

Precision

Our sampling size allowed us to calculate the overall program Net to Gross with within the industry accepted precision of +/- 10% at 90% confidence level.

Table 97. C&I NTG Ratio Relative Precision

	n	NTG Ratio	Relative Precision (90% Confidence Level)
MWh	87	.75	.07
MW	87	.76	.07