STATE OF SOUTH CAROLINA

BEFORE THE
PUBLIC SERVICE COMMISSION
OF SOUTH CAROLINA

Application of South Carolina Electric & Gas Company for Approval to Continue Demand Side Management Programs and Included Rate Rider, and for Approval of Revised Portfolio of Energy Efficiency Programs

COVER SHEET

DOCKET NUMBER: 2013 - 208 - 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

SCANA
POWER FOR LIVING

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May 30, 2014

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
Application of South Carolina Electric & Gas Company for Approval to Continue Demand Side Management Programs and Included Rate Rider, and for Approval of Revised Portfolio of Energy Efficiency Programs; Docket No. 2013-208-E

Dear Ms. Boyd:

In accordance with Order No. 2013-826 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 3, which consists of the time period December 1, 2012, to November 30, 2013.

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 other parties in the above-referenced docket with a courtesy copy of the report.

If you have any questions, please advise.

Very truly yours,

Matthew W. Gissendanner

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MWG/kms
Enclosure

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BEFORE

THE PUBLIC SERVICE COMMISSION OF

SOUTH CAROLINA

DOCKET NO. 2013-208-E

IN RE:

Application of South Carolina Electric & Electric & Gas Company for Approval to Continue Demand Side Management Programs and Included Rate Rider, and for Approval of Revised Portfolio of Energy Efficiency Programs	)	**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 30th day of May 2014

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Opinion Dynamics

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South Carolina Electric and Gas EnergyWise Program Year 3:

Evaluation, Measurement, and Verification Report

Megan Campbell
Project Director

May 2014

Opinion Dynamics

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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 1, 2012 through November 30, 2013 constituted their third program year (PY3). Over this period, SCE&G implemented nine programs for their residential electric customers and two programs for their commercial and industrial (C&I) electric customers. The purpose of this report is to provide verified PY3 gross and net program energy and demand saving estimates as compared to the company's forecasted savings.

Based on SCE&G's forecasting model for the PY3 portfolio, the programs were expected to achieve net savings of 142,284 MWH and 25 MW in PY3, including the newly introduced Neighborhood Energy Efficiency Program in PY3. While the programs continued to grow in terms of participation numbers compared to the first year, the savings fell slightly short of forecast, achieving 105,378 MWH and 18.2 MW, or 74% of energy and 72% of demand forecasts. In PY3, SCE&G spent just over $19M dollars implementing this portfolio of programs,[1] 74% of forecast. Table 1, on page 2, presents net savings, costs, and participation for each program, comparing each item to PY3 forecasts.

The original PY3 forecasts were set prior to PY1. In terms of energy savings, the Residential ENERGY STAR® Lighting Program, Home Energy Check-Up Program, and Home Energy Report Program (together representing close to two-thirds of the portfolio's energy savings) performed far better than forecasted, mainly due to larger-than-expected participation numbers. Other programs, such as the Heating & Cooling Efficiency Improvement and Home Performance with ENERGY STAR Programs (together representing 1% of the energy savings), underperformed mainly due to fewer participants than forecasted. While participation is a large factor in program performance, some programs received fewer energy savings per participant or measure than anticipated. For example, the C&I Program was able to exceed its participation forecast but greatly missed its energy savings forecast, largely due to industrial customers opting-out of the rate rider, after the forecast had been set. This resulted in smaller energy savings per customer than anticipated.

After implementing the programs in the first two years, SCE&G realized that it overestimated the participation potential for some programs, especially the Efficiency Improvement and Home Performance with ENERGY STAR Programs. However, other programs were performing better than expected. In response to market conditions, SCE&G placed more of an emphasis on its high-performing programs and reduced implementation dollars for low-performing programs.

This report dedicates a chapter to each program, wherein 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

Program Name	Net Savings				Program Costs		Participation		
	MWH Actual	% of Forecast	MW Actual	% of Forecast	Actual	% of Forecast	Actual	% of Forecast	Definition
ENERGY STAR Lighting	54,311	184%	4.95	130%	$4,541,570	114%	1,944,133	214%	Bulbs/Fixtures
Home Energy Report	12,350	146%	4.47	144%	$585,090	134%	36,918	144%	Customers
Heating & Cooling and Water Heating	4,660	43%	2.28	85%	$2,946,732	65%	7,401	83%	Measures
Home Energy Check-up	2,423	240%	0.51	253%	$683,411	84%	2,949	105%	Customers
Heating & Cooling Efficiency Improvement	832	7%	0.29	5%	$695,719	18%	1,179	6%	Customers
Neighborhood Energy Efficiency Program	449	106%	0.08	133%	$236,126	134%	510	102%	Customers
Energy Information Display	356	16%	0.06	16%	$565,269	59%	980	17%	Customers
ENERGY STAR New Homes	344	55%	0.18	82%	$323,635	67%	192	25%	Homes
Home Performance with ENERGY STAR	285	8%	0.11	14%	$1,191,644	35%	213	15%	Customers
C&I Prescriptive and Custom	29,368	40%	5.2	61%	$7,767,129	122%	963	150%	Customers
Total	**105,378**	**74%**	**18.12**	**72%**	**$19,536,325**	**74%**	**n/a**	**n/a**	**n/a**

Notes: We compare actuals to PY3 forecasts in the PY1-PY3 Evaluation Plan; program costs presented in the report do not account for amortization or interest (carrying costs).

As shown in Table 2, most of the PY3 energy savings came from lighting sales through the ENERGY STAR Lighting Program. The C&I programs also contributed a significant amount. The Home Energy Report Program is the third largest in terms of energy savings; it has more than 36,000 residential electric customers, the most of any program.

Table 2. Program Contribution to Overall Portfolio MWH Savings

Program	PY3
ENERGY STAR® Lighting	52%
C&I Prescriptive and Custom	28%
Home Energy Report	12%
Heating & Cooling and Water Heating	4%
Home Energy Check-Up	2%
Heating & Cooling Efficiency Improvement	0.8%
Neighborhood Energy Efficiency (NEEP)	0.4%
Energy Information Display	0.3%
ENERGY STAR New Homes	0.3%
Home Performance with ENERGY STAR	0.3%

The PY3 impact evaluation effort was two-fold for most programs: (1) reviewing the program-tracking databases to verify that they 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.

Table 3 below shows the gross realization rates (RRs) that the Evaluation Team found in PY3 and the main reason for differences. Gross realization rates show the difference between tracked (deemed savings per participant or measure) and verified gross savings per program and are a valuable metric for comparing actual savings to expected (or deemed) savings. The Home Energy Check-Up and Heating & Cooling Programs have the largest gross realization rates, indicating that these programs produced more savings (per measure or per participant) than SCE&G predicted through its planning model. The C&I gross realization rates were very close to one with demand being slightly higher due to adjustments in the coincidence factors. Many of the LED lighting projects were 24/7 operations meaning they contributed to more demand savings than originally assumed.

Alternatively, the ENERGY STAR Lighting, ENERGY STAR New Homes, Heating and Cooling Efficiency Improvement, and Home Performance with ENERGY STAR Programs have the lowest gross realization rates. The latter two programs' realization rates are driven by a billing analysis of customers, which found fewer actual savings than anticipated. 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.

[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 future program years. The 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 PY3 that were not reviewed in the PY1 or PY2 evaluation.

Table 3. PY3 Gross Realization Rates

Program Name	Gross Realization Rates		
	KWH RR	KW RR	Reasons for Difference
Home Energy Check-Up	2.37	2.27	Made database corrections/removed duplicate entries, applied installation rates, deemed savings for leave-behind measures, and per-participant savings for recommended measures
Heating & Cooling Equipment	1.41	1.41	Applied billing analysis adjustment factor and adjusted deemed savings values for new PY3 measures
Home Energy Report*	1.01	1.00	Adjusted based on billing analysis (ex-post net savings)
Water Heating Equipment	1.00	1.00	Made database corrections/removed minor duplicate entries that had little impact on the overall RR
Neighborhood Energy Efficiency (NEEP)	1.00	1.00	Reviewed Data-Tracking Systems against Deemed Savings; program will undergo full evaluation in PY4 or PY5
C&I Prescriptive and Custom	0.91	1.12	Adjusted based on metering data, desk reviews, and database corrections
Energy Information Display*	0.91	1.00	Adjusted based on application of PY2 billing analysis (ex-post net savings)
Home Performance with ENERGY STAR	0.75	0.75	Applied billing analysis adjustment factor
Heating & Cooling Efficiency Improvement	0.71	0.73	Applied billing analysis adjustment factor for complete duct replacement projects
ENERGY STAR New Homes	1.00	1.00	PY3 savings already accounted for .67 realization rate against past program modeled estimates, no database corrections needed
ENERGY STAR Lighting	0.64	0.64	Adjusted deemed savings for one new measure, applied new PY3 installation rate and the PY2 leakage rate

*Evaluation methods for these behavioral programs only allows for a net realization rate instead of gross.

Net-to-gross-ratios (NTGRs) help to determine how much of the energy savings are attributed to program intervention in the marketplace, and can vary year-over-year. As such, evaluated NTGRs for PY2 and PY3 are compared in Table 4 below. Most program NTGRs were only slightly higher or lower compared to PY2, with some exceptions. Overall, the NTGRs show that the majority of the PY3 savings would not have occurred absent the program. However, the NTGR for the Water Heating Program greatly decreased to a level that is concerning for the program, specifically for new construction. The Water Heating Program gives incentives to residential electric customers who convert to non-electric resistance water heaters and to builders who install them in new construction. The Water Heating Program NTGR was largely dominated by new construction builders who predominately said that they would have installed the water heaters in newly constructed buildings without the program incentives. Note that NTGRs may also improve over time for some programs. In PY2, the Heating & Cooling Efficiency Improvement Program had a very low NTGR of 0.38, which greatly increased to 0.57 in PY3, indicating that the program is starting to motivate more customers to make duct improvements than would have otherwise. The C&I Prescriptive and Custom Program's NTGR ratio also increased.

Table 4. PY2 to PY3 NTGR Comparison

Program Name	Evaluated PY2 KWH NTGR	Evaluated PY3 KWH NTGR	Difference
Heating & Cooling Equipment	0.84	0.78	Slightly decreased
C&I Prescriptive and Custom	0.67	0.77	Slightly increased
Home Performance with ENERGY STAR®	0.79	0.69	Slightly decreased
Heating & Cooling Efficiency Improvement	0.38	0.57	Greatly increased
Water Heating Equipment	0.76	0.16	Greatly decreased

Note: Table includes only the programs where evaluation efforts calculated a NTGR in both PY2 and PY3.

The original forecast for net savings was based upon a best estimate of NTGRs for SCE&G's jurisdiction. Most of the programs in PY1-PY3 underwent research to determine a NTGR based on the decision-making process of actual program participants. In the first 3-year cycle, it was prudent to adjust net savings claimed each year based on evaluated NTGRs because the original estimates were not based on SCE&G's market conditions. This method is consistent with the recommendation from testimony on behalf of the South Carolina Office of Regulatory Staff regarding the Application of South Carolina Electric & Gas Company for the Establishment and Approval of DSM Programs and Rate Rider[3]. Given that SCE&G now has a better sense of the true NTGRs for existing programs and their market conditions, we recommend that SCE&G use the evaluated NTGRs from PY3 in its planning assumptions for PY4-PY6 and that these same PY3 NTGRs be held static across the next program cycle (i.e. PY4-PY6) for each program. If SCE&G chooses to field a new program, we recommend that the Evaluation Team perform secondary research to inform what the most appropriate NTGR should be for the new program during the PY4-PY6 cycle. During the PY4-PY6 period, the Evaluation Team will continue to monitor market conditions and update NTGRs at least once for each program. These data can be used as inputs into future planning beyond PY6. This prospective application of evaluated NTGRs is employed in several jurisdictions across the country where the utilities have implemented programs for several years. It allows utilities to have the certainty they need to plan for lost revenue and cost recovery while continuing to assure that research occurs on market conditions.

[3] The Office of Regulatory Staff, Direct Testimony of Randy Gunn, January 7, 2010. DOCKET NO: 2009-261-E

2. Evaluation Methods

The purpose of this PY3 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. We provide a high-level description of each evaluation method below.

Database Review Verification: The Evaluation Team reviewed program-tracking databases to ensure that there were no duplicates or database errors and that all agreed-upon deemed savings for PY3 were applied accurately for each measure.

On-Site Measure & Project Desk Review Verification: The Evaluation Team conducted site inspections at a sample of participating C&I customer sites. During the on-site inspection, the reported equipment, installation quantities, and efficiency levels of all measures were visually confirmed to ensure that the equipment installed matched what was rebated. Engineers gathered information on the equipment that was in place prior to the retrofit, in order 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.

On-Site Residential Home Survey: The Evaluation Team completed home surveys on a representative sample of 201 homes in the Fall of 2013. The in-home survey collected detailed lighting and measure data. The study calculated the number in storage to determine the installation rate for program bulbs sold in PY3.

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 PY3 participants. In cases where program populations were relatively small, a census attempt was used to capture as many participant responses as possible. In cases where a sampling approach was used, samples were drawn to ensure that results meet the industry-standard 90/10 sampling error criteria. We designed the telephone surveys to verify installation and operation of measures, and to explore program attribution.

Engineering Modeling and Linear Regression: Specifically for the ENERGY STAR New Homes Program, in PY1 and PY2 ex-ante energy savings per home were determined by the implementer's predictive savings tool. To reduce program costs in PY3, the Evaluation Team developed another approach, a deemed savings algorithm, to estimate savings per home based on statistical analysis of historical program data. This new deemed savings algorithm was applied to PY3 program data to estimate the savings per home.

Engineering Desk Review Verification: The Evaluation Team conducted a full engineering desk review of measures in PY1. As a result, the evaluation recommended the application of new deemed savings estimates for some measures prospectively in future program years (including PY3). The team conducted this activity again in PY3, but only for new measures that we did not review in PY1 or PY2. This activity consisted of an engineer reviewing written documentation from the program concerning impacts and assessing whether the inputs are reasonable and in line with standard practice.

Net Savings Verification Analysis: The Evaluation Team often calculated verified net savings 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 (please refer to Appendix B for detailed methods). For most programs, we derive net program impacts by applying a net-to-gross ratio (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. We base free ridership estimates 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, which refers to the installation of energy efficiency measures or the adoption of energy-efficient practices by a program participant due to program influences but without financial or technical assistance through an SCE&G program. An example of participant spillover is a customer who installed a new heat pump through an 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.

Application of PY2 Evaluated Inputs: The Evaluation Team and SCE&G determined where to focus evaluation funds in PY3 based on implementation costs, specific needs for each program, and how the program was evaluated in PY2. As such, some of the PY2 evaluation findings were prospectively applied to PY3 savings. For example, evaluation funds were allocated to the Home Energy Check-Up Program in PY2 to determine both the average annual gross savings per participant and the program NTGR. These values were then applied prospectively to PY3 participation numbers.

Table 5 below shows the data collection and analytical methods the Evaluation Team applied in this impact evaluation report for each program. We provide detailed data collection and analytical methods for each program in its program chapter and in the Appendices.

Table 5. Portfolio Evaluation Methods

Evaluation Method	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	Neighborhood Energy Efficiency (NEEP)
Reviewed Data-Tracking Systems against Deemed Savings & Corrected Tracking Errors	Yes for All Programs									
On-Site Visits and Project Desk Reviews	Yes									
Engineering Modeling and Linear Regression							Yes			
On-Site Residential Home Survey		Yes								
Billing Analysis			Yes	Yes		Yes		Yes		
Participant Telephone Surveys*	Yes		Yes	Yes	Yes*	Yes				
Engineering Desk Review	Yes	Yes	Yes							
NTGR Adjustments Based on Self-Report	Yes		Yes	Yes		Yes				
Application of PY2 Evaluated Findings (NTGR, Installation, Leakage Rates, Savings per Participant)		Yes, used PY2 NTGR and leakage rates			Yes, used installation rates & NTGR				Yes, used savings per participant	

* Phone surveys conducted with participants to ensure that they received tracked measures and that the measures are 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. PY2 phone surveys calculated the actual installation rate per measure and adjusted the energy savings accordingly per participant. The per-participant savings value estimates what is saved per participant within a given program year. Additional phone surveys were conducted in PY3 with past PY2 and PY3 Home Energy Check-Up Program participants to determine if they installed any additional measures that were not installed within the respective program years.

3. Program-Specific Findings

3.1 ENERGY STAR Lighting Program

3.1.1 Program Description

SCE&G's Residential ENERGY STAR Lighting Program launched in 2011 with the goal of increasing the awareness and purchase of ENERGY STAR qualified lighting products. The program targets residential electric customers within SCE&G's electric service territory. The program limits sales to a maximum of 15 bulbs per customer.

The program is designed to overcome the most common barriers to 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

To overcome these barriers, the program works with retailers and manufacturers to offer energy-efficient lighting products such as CFLs, LEDs, and ENERGY STAR qualified fixtures at reduced prices. The program operates in an upstream fashion by providing automatic product markdowns at participating retailers. The discounts encourage customers who are reluctant to pay full price for ENERGY STAR lighting to choose energy-efficient lighting products rather than standard alternatives. To increase awareness of energy-efficient lighting and its benefits, the program also performs education, marketing, and outreach efforts, including in-store marketing materials and events, mass media (TV, radio, print) advertising, bill inserts, and trade shows.

Similar to PY1 and PY2, in PY3 the program discounted standard and specialty CFL bulbs and fixtures, as well as omni-directional LED bulbs. Incentive levels varied by product, manufacturer, and retailer, and changed throughout the year to assist the program in meeting its goals. Generally, incentives were set to cover 25% to 75% of the incremental cost of the measure. In PY3, average incentive levels were $1.36 per bulb for standard CFLs, $1.78 for specialty CFLs, $5.90 for screw-based LEDs, $10.00 for fixtures, $1.00 for LED nightlights, and $5.00 per LED holiday string.

Third-party implementers ICF International (ICF) and Applied Proactive Technologies (APT) implement the program. ICF manages the rebate processing and data tracking, while APT focuses on enrolling retailers and managing relationships with them.

3.1.2 Program Performance Summary

This program made up 52% of SCE&G's portfolio energy savings in PY3. The program was very successful in its third year of implementation, exceeding the PY3 savings forecast (184% of energy savings and 130% of demand savings). SCE&G forecasted that it would sell 908,158 bulbs and fixtures through the program in PY3. At the end of the program year, SCE&G provided incentives on 1,944,133 products, more than doubling the forecasted number. The budget expended through November 2013 reached 114% of the forecasted budget. Table 6 below summarizes the forecasts and overall performance for the program.

Table 6. Residential ENERGY STAR Lighting Program Forecasts and Results

Metric	Forecasts	Actuals	% of Forecast Accomplished
Cost	$3,989,835	$4,541,570	114%
Participants (number of bulbs/fixtures)	908,158	1,944,133	214%
Net MWH Savings	29,529	54,311	184%
Net MW Savings	3.82	4.95	130%

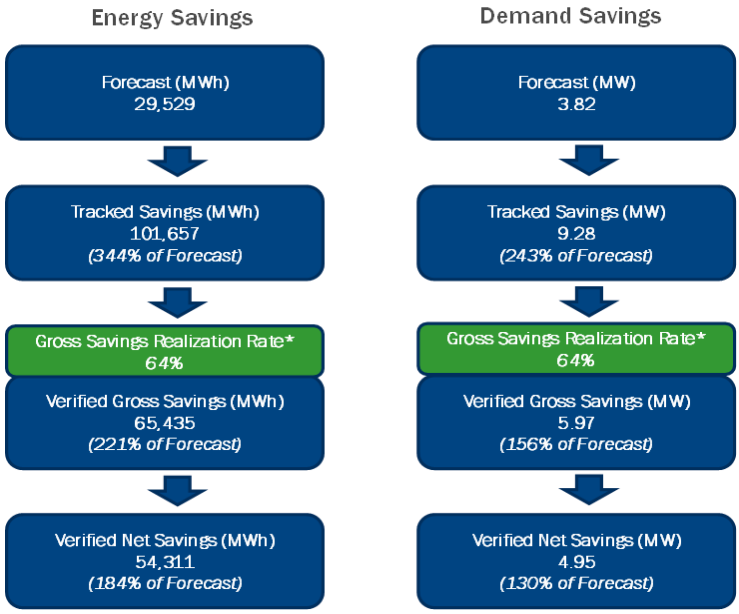
3.1.3 Impact & Data Tracking Findings

Figure 1 below provides a summary of the ENERGY STAR Lighting Program's gross and net impacts, and compares them to the savings forecast. Tracked program savings represent energy savings in the program-tracking databases. Verified gross savings are savings adjusted for installation rate, leakage rate, carryover savings rate, and any adjustments to quantities or savings assumptions revealed through the program-tracking database review and engineering review. Finally, verified net savings incorporate the net-to-gross ratio (NTGR) for the program. Detailed descriptions of how the savings adjustments were derived and applied are provided in the sections below and in the Appendices of this report.

As can be seen in Figure 1, the program realized 64% of its tracked gross energy and demand savings. The verified net savings of 54,311 MWH and 4.95 MW represent 184% of its energy savings forecast and 130% of its demand savings forecast.

As further described in the sections below, a first-year installation rate of 66% for CFLs, an in-service rate of 85.5%, and a NTGR of 83% are the core contributors to reductions in verified gross and net savings. However, the program gained 8.25% in carryover savings from the bulbs that were purchased in PY2 but not installed until PY3.

Figure 1. Summary of PY3 Residential ENERGY STAR Lighting Program Impacts



* The realization rate is calculated by dividing the verified gross savings by the tracked savings.

CFLs continued to be the core contributor to the ENERGY STAR Lighting Program's savings. Almost 2 million CFLs and fixtures were sold, accounting for more than 99% of savings from bulbs sold in PY3. The program also sold 15,490 LEDs of varying types, including 10,523 omni-directional LED bulbs, 4,020 LED night-lights, 928 LED holiday strings, and 19 LED reflector bulbs.

As can be seen in Table 7 below, realization rates are much higher for LEDs than for CFLs, primarily because the installation rate of 66% is applied to CFL tracked gross savings. An installation rate of 100% is applied to the CFL fixture and LED savings.

Table 7. Verified Gross and Net Savings for the Residential ENERGY STAR Lighting Program by Lighting Product

Bulb Type	Verified Units Sold	Tracked Gross Savings		Verified Gross Savings		Gross Savings Realization Rate*		Verified Net Savings	
		MWH	MW	MWH	MW	MWH	MW	MWH	MW
CFLs	1,927,637	101,008	9.22	56,996	5.20	56%	56%	47,306	4.32
CFL Fixtures	1,006	62	0.01	53	0.00	86%	86%	44	0.004
LEDs	15,490	587	0.05	492	0.04	84%	84%	408	0.03
Sold in PY3	**1,944,133**	**101,657**	**9.28**	**57,541**	**5.25**	**57%**	**57%**	**47,759**	**4.36**
Carryover Savings from PY2				7,894	0.72	N/A	N/A	6,552	0.60
Total PY3 Savings				**65,435**	**5.97**	**64%**	**64%**	**54,311**	**4.95**

* The realization rate is calculated by dividing the verified ex-post gross savings by the tracked ex-ante savings.

The sections below provide greater detail around the calculation of tracked gross, verified gross, and verified net savings.

Tracking Database and Engineering Desk Review

The Evaluation Team reviewed program-tracking data and conducted an engineering review of the newly added measures to determine verified gross savings. More specifically, this analysis included the following steps:

- Review of measure counts
- Engineering analysis of deemed measure savings
- Application of the installation and leakage rates
- Application of carryover savings (from lighting products purchased in PY2 but not installed until PY3)

Review of the program-tracking data revealed that, for the most part, the program accurately and comprehensively documents and tracks measures and energy savings. The number of cases where the Evaluation Team found discrepancies was fairly small and had mostly to do with miscoded bulb wattages.

Aside from one new measure (13.5-watt LED) added to the PY3 product offering, savings values applied to the discounted lighting products matched the recommended savings assumptions[4] in 100% of cases. For the newly added measure, we completed an engineering review to determine energy and demand savings. Table 8 below provides the per-unit savings values used by the program for this measure, and the revised savings values as determined by an engineering review. As can be seen in the table, the engineering review resulted in higher savings values than what were used by the Program. A more detailed write-up of the engineering review is included in Appendix A of this report.

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

Measure	Program-Tracked Savings Assumptions		Revised Energy Savings Assumptions	
	Energy (KWH/bulb)	Demand (KW/bulb)	Energy (KWH/bulb)	Demand (KW/bulb)
LED - 13.5 Watt	46.8200	0.00430	50.9175	0.00465

Verified Gross Savings Adjustment

After reviewing the program-tracking data and verifying savings assumptions, the Evaluation Team developed revised savings estimates. We then applied the in-service rate and first-year installation rate to the revised savings estimates to determine verified gross savings. We also credited the program with carryover savings from the bulbs purchased in PY2 but not installed until PY3.

Final verified gross savings were determined using the following algorithm:

Verified Gross Savings = Revised Gross Savings[5] * Installation Rate * (1 – Program Leakage Rate) + PY2 Carryover Savings

Table 9 below shows the resulting verified gross savings after making adjustments for the leakage rate and installation rate. A total of 65,435 MWH and 5.97 MW were saved at the verified gross savings level, resulting in a gross savings realization rate of 64%.

[4] These represent savings values determined through the engineering review in PY1 and PY2, and recommended for program use.

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

Table 9. Verified Gross Savings for Residential ENERGY STAR Lighting Program

Residential ENERGY STAR Lighting Program	CFLs		CFL Fixtures		LEDs		All Bulbs	
	MWH	MW	MWH	MW	MWH	MW	MWH	MW
Tracked Gross Savings	101,008	9.22	62	0.01	587	0.05	101,657	9.28
Revised Gross Savings	100,993	9.22	62	0.01	592	0.05	101,647	9.28
In-Service Territory Rate (1–program leakage, or 1–.145)	85.5%	85.5%	85.5%	85.5%	85.5%	85.5%	85.5%	85.5%
PY3 Installation Rate	66%	66%	100%	100%	100%	100%	Variable	
PY3 Verified Gross Savings	56,996	5.20	53	0.005	492	0.04	57,541	5.25
PY3 Gross Savings Realization Rate	56%	56%	85%	85%	84%	84%	57%	57%
PY2 Carryover Savings							7,894	0.72
Total Verified Gross Savings							65,435	5.97
Total Verified Gross Savings Realization Rate							64%	64%

Net Impacts

In PY2, the Evaluation Team estimated a program NTGR of 0.83 using in-store interviews conducted with customers purchasing lighting at participating retailers. We did not update this value in PY3, but rather relied on the PY2 estimate. This free ridership rate is low relative to other utility jurisdictions, which may be because SCE&G's Residential ENERGY STAR Lighting Program is still relatively new in a utility territory that did not previously offer lighting-specific energy efficiency programs. The Evaluation Team recommends reassessing this value in the next couple of years.

Table 10 below displays PY3 verified net savings and carryover verified net savings from PY2 after applying the NTGR of 0.83. PY3 verified net savings are 47,759 MWH and 4.36 MW. Total verified net savings with the carryover savings from PY2 are 54,311 MWH and 4.95 MW.

Table 10. Verified Net Savings for Residential ENERGY STAR Lighting Program

Residential ENERGY STAR Lighting Program	Verified Gross Savings		NTGR		Verified Net Savings	
	MWH	MW	MWH	MW	MWH	MW
PY3 Savings	57,541	5.25	0.83	0.83	47,759	4.36
Carryover Savings from PY2	7,894	0.72	0.83	0.83	6,552	0.60
Total Verified Net Savings	65,435	5.97	0.83	0.83	54,311	4.95

3.2 Home Energy Report Program

3.2.1 Program Description

The Home Energy Report (HER) Program offers free monthly or bimonthly reports to customers, comparing their energy usage to that of a peer group and to their own energy usage 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. The Home Energy Reports are customized reports that provide participants with a summary of their household energy use and are focused on whole-

house electricity usage. After the introductory four-page report, subsequent monthly/bimonthly Home Energy Updates were issued to customers, focusing on comparing their usage to that of a peer group and promoting a variety of customized energy efficiency tips and information about other SCE&G EnergyWise programs.

The HER Program is an opt-in program. It 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 an electronic copy that is emailed to the customer in combination with an online portal. Customers using the online portal have the option to create a Home Energy Plan wherein they can develop personalized energy efficiency forecasts and plans.

3.2.2 Program Performance Summary

The HER Program made up 12% of SCE&G's portfolio energy savings in PY3. As can be seen in Table 11 below, the program achieved its forecasted goals for participation and energy savings. The program reached 36,918 customers,[6] exceeding its forecasted number of participants by 44%. The program exceeded its implementation budget by 34%, while exceeding its net MWH and MW goals by 46% and 44%, respectively. Notably, the program's 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.[7] The program-verified annual net adjusted energy savings estimates are 335 KWH per household. Savings estimates incorporate a deduction of savings from customers participating in other SCE&G residential energy efficiency programs.[8]

Table 11. HER Program Forecasts and Results

Metric	Forecast	Actual	% of Forecast
Cost	$438,254	$585,090	134%
Participants (Treatment Households)	25,629	36,918	144%
Net MWH	8,458	12,350	146%
Net MW	3.10	4.47	144%

3.2.3 Impact & Data Tracking Findings

The Evaluation Team reviewed the program participant database and found no duplicate accounts or data entry errors. We estimated net savings for this program in PY3 using a billing analysis, which by its nature estimates net program savings. As such, we do not report estimated gross energy savings. The Evaluation Team then removed any savings counted in other SCE&G residential energy efficiency programs from the net billing analysis estimates. For detailed impact estimation methods, see Appendix B.

In PY3, the program provided a Home Energy Report to 36,918 participants at a total cost of $585,090. The program achieved 2.11% net savings per household, as estimated from the billing analysis. After applying the channeling analysis savings adjustment, the program had net adjusted savings of 2.08% per household. The

[6] Excludes customers who had a final bill or opted-out. A total of 2,902 participants either had a final bill or opted-out of the program in PY1 and PY2.

[7] 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.

[8] 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.

PY3 program cycle produced estimated savings of 12,350 MWH. Table 12 below shows net adjusted program savings.

Table 12. PY3 Net Adjusted Program Savings

HER Program	Forecast	Actual	% of Forecast Accomplished
Total Treatment Households*	25,629	36,918	144%
Net Savings			
% Savings per Household	2.00%	2.11%	106%
Average Annual Savings per Household (KWH)	330.00	334.61	101%
Average Annual Savings per Household (KW)**	0.12	0.12	100%
Net Adjusted Savings (After Channeling Adjustments)			
Adjusted % Savings per Household	2.00%	2.08%	104%
Average Adjusted Annual Savings per Household (KWH)	330.00	334.52	101%
Total Program Savings			
Program Savings, All Households (MWH)***	8,458	12,350	146%
Program Savings, All Households (MW)***	3.10	4.47	144%

* The participant counts are all participants who received reports at any time during PY3.
** We applied 100% KW savings given that the program achieved over 100% of its KWH impacts.
*** A total of 1,543 customers participated in both the HER and EID Programs. In PY4, the EID Program will transition out of the DSM portfolio. As such, we applied the HER adjusted percent savings per household to these 1,543 customers (see EID Program report for more details).

3.3 Heating & Cooling and Water Heating Program

3.3.1 Program Description

The Residential Heating & Cooling and Water Heating Program offers rebates to SCE&G residential electric service customers who purchase and install high-efficiency HVAC equipment. The program's major goal is 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 HVAC 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 rebates 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, or solar). The program also incents builders to install non-electric resistance water heaters in newly constructed homes.

There were no major changes to program design in PY3. However, in PY3 the duct improvement measures were merged into the Heating & Cooling and Water Heating Program.

As shown in Table 13 below, there are four rebate levels for HVAC equipment, dependent on the type and efficiency of the unit. All water heaters receive the same rebate.

Table 13. Eligible Program Measures for Heating & Cooling and Water Heating Program

Equipment Type	Efficiency	Rebate Amounts
Package Central A/C and Air Source Heat Pumps	≥ 14 SEER and ≥ 11 EER (and ≥8 HSPF for Heat Pumps)	$200
	≥ 15 SEER and ≥ 12 EER (and ≥8 HSPF for Heat Pumps)	$300
Split Central A/C and Air Source Heat Pumps	≥ 14.5 SEER and ≥ 12 EER (and ≥8.2 HSPF for Heat Pumps)	$200
	≥ 16 SEER and ≥ 12.5 EER (and ≥8.5 HSPF for Heat Pumps)	$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

In the past year, customers and contractors installed close to 8,000 measures in homes in the SCE&G electric service territory (see Table 14 below), relatively evenly split between HVAC and water heating equipment. The majority (85%) of water heaters that came through the program went into newly constructed homes.

Table 14. Number of Measures in PY3 Program

Measure Type	Total PY3 Measures
New Construction Water Heaters	3,221
Conversion Water Heaters	580
Total Water Heater	**3,801**
Air Source Heat Pumps	2,775
Central A/C	1,146
Dual-Fuel Heat Pumps	44
Ground Source Heat Pumps	21
Total HVAC	**3,986**
Total Program Measures	**7,787**

3.3.2 Program Performance Summary

The Heating & Cooling and Water Heating Program made up 4% of SCE&G's portfolio energy savings in PY3. Table 15 below summarizes the PY3 forecasts and overall results for the program in terms of costs, participation, and net energy and demand savings. The program achieved a lower percentage of the energy savings goals as compared to the participation and demand savings goals. This is mainly due to the low NTGR score for the Water Heating side of the program. In comparison to heating and cooling equipment, the water heating measures contributed a greater share of the energy savings than the demand savings, and therefore the NTGR for water heating measures had a proportionally higher effect on the energy savings than the demand savings. [9]

[9] Prior to applying the NTGR, the ex-post gross program savings represented 158% of the forecasted energy savings and 181% of the forecasted demand savings, which illustrates the impact the NTGR had on the program's realized net savings.

Table 15. Heating & Cooling and Water Heating Program Forecasts and Results

Metric	Forecast	Actual	% of Forecast
Cost	$4,564,078	$2,946,732	65%
Participants	8,868	7,401	83%
Net MWH	10,746	4,660	43%
Net MW	2.69	2.28	85%

The program had 3,657 customers participate in the Heating & Cooling (HVAC) incentives and 3,744 homes participate in the Water Heating side of the program. Table 16 below shows the participation values and the total number of measures installed.

Table 16. Heating & Cooling and Water Heating Program Participation

Equipment	Number of Participants (Homes)	Number of Measures
HVAC	3,657	3,986
Water Heating	3,744	3,801
Total	**7,401**	**7,787**

3.3.3 Impact & Data Tracking Findings: Heating & Cooling

In PY3, Heating & Cooling achieved verified net savings of 2,453 MWH and 1.91 MW. Table 17 below shows the savings adjustments by equipment type. The majority of the HVAC measures installed in PY3 were air source heat pumps, which represented 75% of ex-ante gross heating and cooling savings, followed by central air conditioners, which represented 22% of ex-ante gross savings. The table shows the distribution of HVAC installations for PY3 by the type of system installed.

Table 17. Verified Gross and Net Savings for HVAC Equipment

Measure Type	Quantity	Ex-ante Gross Savings		Ex-post Gross Savings		Gross Realization Rate		Verified Net Savings	
		MWH	MW	MWH	MW	MWH	MW	MWH	MW
Air Source Heat Pump	2,775	1,673	1.36	2,778	2.26	1.66	1.66	2,167	1.70
Central A/C	1,146	479	.40	283	.23	0.59	0.59	220	.17
Ground Source Heat Pump	21	38	.02	63	.04	1.66	1.66	49	.03
Dual Fuel Heat Pump	44	36	.03	21	.02	0.59	0.59	17	.01
Total	**3,986**	**2,226**	**1.81**	**3,145**	**2.55**	**1.41**	**1.41**	**2,453**	**1.91**

Verified Gross Savings Adjustments

We adjusted the PY3 ex-ante gross savings using the results of an engineering desk review and a billing analysis. In Table 18, the verified gross savings account for the results of the engineering desk review, while the ex-post gross savings include both the engineering review and the billing analysis adjustment factor. The program realized 141% of its tracked KWH savings and 141% of its tracked KW savings.

Table 18. HVAC Gross Savings Adjustments

Measure Type	Ex-ante Gross Savings		Verified Gross Savings		Billing Analysis RR	Ex-post Gross Savings		Gross Realization Rate	
	KWH	KW	KWH	KW		KWH	KW	KWH	KW
Air Source Heat Pump	1,673,240	1,364.11	1,673,574	1,364.27	1.66	2,777,579	2,264.43	1.66	1.66
Furnace/AC	478,943	396.09	478,943	396.09	0.59	282,576	233.69	0.59	0.59
Dual-Fuel Heat Pump	35,907	29.45	36,641	29.77	0.59	21,185	17.37	0.59	0.59
Ground Source Heat Pump	38,096	22.46	38,096	22.46	1.66	63,239	37.28	1.66	1.66
Total	**2,226,186**	**1,812.11**	**2,227,254**	**1,812.58**		**3,144,579**	**2,552.77**	**1.41**	**1.41**

Engineering Desk Review

The database for PY3 included three additional HVAC measures (10 units) than those found in the previous two years (PY1 and PY2). These were high-efficiency dual-fuel heat pumps (DFHPs) and air source heat pump (ASHP) mini-split units, as shown in Table 19 below.

Table 19. Additional HVAC Measures for PY3 Evaluation

Measure	Number of Units
Split Dual-Fuel Heat Pump (DFHP) – SEER 21	2
Split Dual-Fuel Heat Pump (DFHP) – SEER 23	1
Split Air Source Heat Pump (ASHP) – SEER 27	7

To maintain consistency with previous assessments, the Evaluation Team calculated the deemed per-unit savings for these additional measures similarly to how they were evaluated in PY1. Within that analysis, the energy and demand savings versus efficiency (SEER) were plotted using PY1 tracked per-unit savings values. Evaluated energy and demand savings were calculated using derived linear correlations to represent the evaluated savings for new HVAC systems with varying efficiencies.

The plots shown in Figure 2 and Figure 3 are a result of weighted curves used to generate a single representative curve for homes with and without basements located in Charleston and Columbia, South Carolina. The linear equations shown in Table 20 below were used to calculate energy and demand savings using the actual efficiency (SEER) value for each HVAC system requiring a deemed evaluated savings value for PY3.

Figure 2. Weighted Energy Savings Versus SEER for HVAC Systems (KWH/ton)

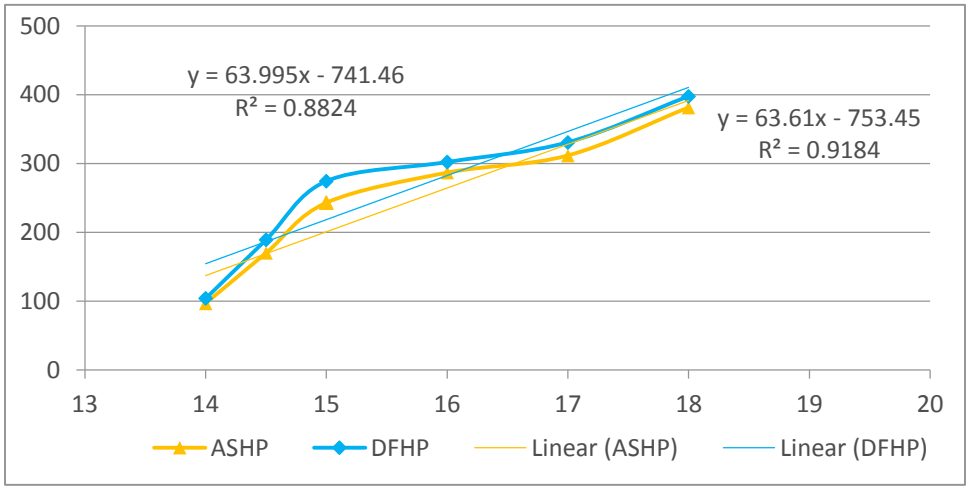


Figure 3. Weighted Demand Savings Versus SEER for HVAC Systems (KW/ton)

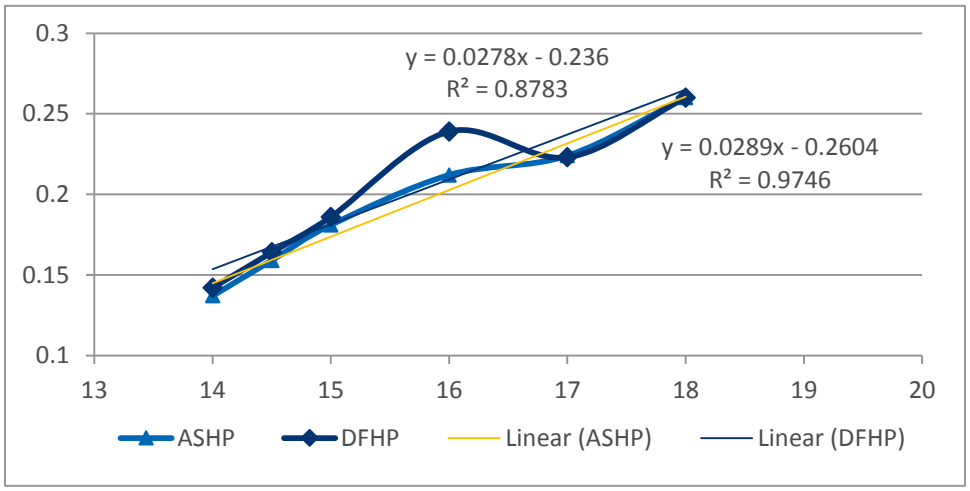


Table 20. Equations for Calculating Energy and Demand Savings for Heat Pumps

Measure	Energy Savings	Demand Savings
ASHP	KWH/ton = 63.610 x SEER – 753.45	KW/ton = 0.0289 x SEER – 0.2604
DFHP	KWH/ton = 63.995 x SEER – 741.46	KW/ton = 0.0278 x SEER – 0.2360

We chose to continue with this analytical approach because there are few of these units in the program (i.e., 10 units installed out of approximately 4,000 units installed in the PY3 program). However, in the future we may want to revisit the analysis using the linear regressions, especially as the efficiency of the units continues to go up further outside of the boundary of the initial analysis.

Table 21 below compares the tracked and evaluated per-unit energy and demand savings for the three additional HVAC measures to be included in the PY3 evaluation. The program assigned savings for the one air source heat pump unit based on SEER 26. Similarly, we assigned the two dual-fuel heat pumps savings based on SEER 20. We calculated the evaluated savings for these units using the actual SEER efficiencies, and therefore the engineering review yields higher energy and demand savings than are shown in the tracking database.

Table 21. Comparison of Tracked and Evaluated Per-Unit Values for Additional Heat Pump Measures

Measure	Tracked Energy Savings (KWH/ton)	Evaluated Energy Savings (KWH/ton)	KWH RR	Tracked Demand Savings (KW/ton)	Evaluated Demand Savings (KW/ton)	KW RR
Split Air Source Heat Pump (ASHP) – SEER 27	900.41	964.02	1.07	0.490	0.520	1.06
Split Dual-Fuel Heat Pump (DFHP) – SEER 21	538.40	602.44	1.12	0.320	0.348	1.09
Split Dual-Fuel Heat Pump (DFHP) – SEER 23	538.40	730.43	1.36	0.320	0.403	1.26

Billing Analysis

We calculated gross savings derived from HVAC equipment through a billing analysis of PY2 participants, because these participants had enough billing data to conduct a rigorous pre/post billing analysis using at least 12 months of both 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[10] with the evaluated deemed savings estimates to develop a realization rate, which we used to adjust the savings claimed by the program for PY3.[11]

Overall, we found that the deemed gross savings for HVAC equipment appear to be over- or underestimated for certain measure categories. Consistent with last year's report, the results of the billing analysis suggest that evaluated deemed savings are underestimated (by 66%) for heat pumps and overestimated (by 41%) for non-heat pump measures installed through the program. Detailed methods and analysis can be found in Appendix C.

We calculated gross realization rates from the adjusted gross savings from the billing analysis divided by the average yearly tracked gross savings.

[10] We adjusted estimates for federal code standards that form the appropriate baseline. This is described in detail in Appendix C.

[11] The evaluation team carefully compared the PY2 and PY3 participants to be sure that this was an appropriate use of the billing analysis. This is described in Appendix C.

Table 22. Summary of Program and Measure-Group Savings

Measure Group	Average Yearly Tracked Gross Savings (KWH)	Average Yearly Billing Analysis Gross Savings (KWH)	Baseline Adjustment Factor	Average Yearly Adjusted Gross Savings (KWH)	Gross Realization Rate
All Measures	553	1,656	0.456	755	137%
Heat Pumps	625	2,201	0.472	1,039	166%
Non-Heat Pumps	404	585	0.406	238	59%

Note: Dual-fuel heat pumps are included in the Non-Heat Pump category because of the likelihood that their backup heating turned on in the winter. This is consistent with the PY2 billing analysis methodology.

Net Impacts

The overall NTGR for this program is 0.78 for energy savings and 0.75 for demand savings. There is little variation among the individual NTGR scores for each service offered through the program. Although we used a methodology that allowed us to adjust for effects that the program was having on contractors' likelihood to recommend efficient HVAC equipment that would otherwise not be captured in the participant survey, this adjustment did not significantly change the program's NTGR.

Table 23. Net-to-Gross Ratio

Program	Free Ridership		Spillover		Net-to-Gross (1-FR+SO)		Relative Precision (90% Confidence Level)	
	KWH	KW	KWH	KW	KWH	KW	KWH	KW
Heating & Cooling NTGR (n=220)	0.26	0.26	0.04	0.01	0.78	0.75	±0.05	±0.05

3.3.4 Impact & Data Tracking Findings: Water Heating

In PY3, Water Heating achieved verified net savings of 2,207 MWH and 0.37 MW. Table 24 below shows the savings adjustments by equipment type. Overall, the program realized 100% of its tracked gross energy and demand savings.

Table 24. 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
Natural gas tankless	10,479	1.77	10,457	1.77	1.00	1.00	1,665	0.28
Natural gas storage	2,749	0.46	2,763	0.47	1.00	1.00	440	0.07
Propane tankless	589	0.10	549	0.09	0.96	0.96	87	0.01
Heat pump	74	0.01	74	0.01	1.00	1.00	12	0.00
Solar	22	0.00	18	0.00	1.00	1.00	3	0.00
Total	**13,913**	**2.35**	**13,862**	**2.34**	**1.00**	**1.00**	**2,207**	**0.37**

In PY3, the program incented the installation of 3,801 non-electric resistance water heaters. Three-quarters of these measures (75%) were natural gas tankless water heaters, followed by natural gas storage water heaters (20%). Non-electric resistance water heaters installed by builders in newly constructed homes

represented the vast majority (85%) of measures incented by the program. Table 25 below shows a detailed breakdown of the number of installations by water heater type.

Table 25. Water Heating Systems Installed by Measure and Participant Type

Measure Type	New Construction	Existing Homes	Total Measures	% of Total Measures
Natural gas tankless	2,483	374	2,857	75%
Natural gas storage	738	17	755	20%
Propane tankless	0	150	150	4%
Heat pump	0	34	34	1%
Solar	0	5	5	0%
Total	**3,221**	**580**	**3,801**	**100%**

Tracking Database Review

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 tracked savings for future program years. We found minimal issues with the database, eventually removing 12 water heaters from the Water Heating side of the program (2%) based on data-tracking errors identified in the database review.

Table 26. Data Tracking Errors Identified

Case	Number of Water Heaters Removed from Tracking Database
Duplicate entries	5
Savings credited to non-rebated water heater*	7
Total Removed	**12**

*Cases in which an additional water heater was installed but no additional electric water heater was removed (thus no rebate issued).

Verified Gross Savings Adjustments

We then applied all appropriate PY2 deemed savings values, resulting in a gross savings realization rate of approximately 1.00. Table 27 below presents tracked and verified gross savings for the program by measure type.

Table 27. 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
Natural gas tankless	2,862	2,857	10,479	1.77	10,457	1.77	1.00	1.00
Gas storage	751	755	2,749	0.46	2,763	0.47	1.00	1.00
Propane tankless	157	150	589	0.10	549	0.09	0.96	0.96
Heat pump	34	34	74	0.01	74	0.01	1.00	1.00
Solar	5	5	22	0.00	18	0.00	1.00	1.00
Total	**3,809**	**3,801**	**13,913**	**2.35**	**13,862**	**2.34**	**1.00**	**1.00**

Net Impacts

Based on the team's findings in PY2, the forecasted NTGR for PY3 was 0.76. In PY3, the Evaluation Team calculated a new NTGR through a telephone survey of PY3 participants. We found a lower NTGR of 0.16 for PY3. This is a very low NTGR primarily driven by the new construction side, and SCE&G should consider discontinuing the new construction water heating portion of the program. Table 28 displays PY3 verified net savings after applying the NTGR.

Table 28. Summary of Verified Net Savings for Water Heating Equipment

Measure Type	Verified Gross Savings		NTGR		Verified Net Savings	
	MWH	MW	MWH	MW	MWH	MW
Natural gas tankless	10,457	1.77	0.16	0.16	1,665	0.28
Natural gas storage	2,763	0.47			440	0.07
Propane tankless	549	0.09			87	0.01
Heat pump	74	0.01			12	0.00
Solar	18	0.00			3	0.00

3.4 Home Energy Check-Up Program

3.4.1 Program Description

The Residential Home Energy Check-Up (HEC) Program provides electric customers in SCE&G's electric 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, and discusses energy-saving behaviors with the customer (e.g., thermostat settings, water heater settings, etc.).

During the check-up, participants receive 10 CFLs, and, if applicable, free hot water pipe insulation and an insulating external blanket for their electric water heater. Customers also receive a list of "10 Ways to Save Energy," 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 29. 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 30. 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 the 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

3.4.2 Program Performance Summary

This program accounts for 2% of the total savings from SCE&G's portfolio in PY3. Table 31 below summarizes the forecast and actual results in terms of costs, participation, and energy and demand savings. While actual program costs were lower than predicted and the number of participants was close to target capacity, the total energy and demand savings were more than double the original forecasts. The program performance was better than expected, given that the evaluation found more savings per participant than what was originally assumed. Further, the PY3 savings account for savings from participants in PY3, but also account for additional savings from PY1 and PY2 participants. Past participants did not install all measures received in those program years. Evaluation efforts in PY3 focused on follow-up with past participants to determine whether uninstalled measures such as CFLs were installed in later years.

Total participation in the program exceeded the forecast originally set for the program by 5%. Net savings for the program were more than double SCE&G's forecasts because, 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. Furthermore, total savings claimed in PY3 include additional savings from PY1 and PY2 that result from program measures that were installed after the PY1 and PY2 program years.

Table 31. HEC Program Forecasts and Results

Metric	Forecast	Actual	% of Forecast Accomplished
Costs	$812,786	$683,411	84%
Participants	2,803	2,949	105%
Net MWH	1,009	2,423	240%
Net MW	0.20	0.51	253%

The program performed check-ups for 2,949 residential customers during PY3, from December 2012 through November 2013. Table 32 provides the list of leave-behind measures given to participants.

Table 32. HEC Program Participation by Leave-Behind Measures

Measure	Number of Participants Who Received Measure	% of Total Participants (n= 2,949)	Total Measures Given in PY3
CFL 13-Watt Bulbs (10-pack)	2,938	99.6%	29,380 bulbs
Pipe Insulation (6 feet)	1,262	43%	7,572 feet
Water Heater Insulating Blanket	984	33%	984 blankets
No Measures (Audit only)	8	0.3%	0

3.4.3 Impact and Data Tracking Findings

PY3 Participant Tracking Database Review

The Evaluation Team reviewed the program-tracking database for accuracy and to ensure that deemed savings values were applied. We found minimal database issues, removing a total of eight (8) duplicate entries. We detail the data cleaning steps and measures removed in Table 33 below.

Table 33. HEC Program Data Cleaning Steps

Data Cleaning Step	Entries Removed	Number of Measures		
		CFL 13W (bulbs)	Pipe Insulation (feet)	WH Insulating Blanket (blankets)
Counts Before Cleaning	2,957	29,460	7,602	987
Removed Duplicate Account Numbers	-1	-10	0	0
Removed Duplicates by Customer Name and Address	-7	-70	-30	-3
Total Removed	8	80	30	3
Measure Counts After Cleaning	**2,949**	**29,380**	**7,572**	**984**

PY3 Participant Gross Verified Savings Adjustments

After database adjustments, we determined verified measure counts by applying the installation rates determined by PY2 evaluation efforts. We then multiplied the deemed savings values by the verified measure

counts to determine total verified gross savings for leave-behind measures. Lastly, we applied a per-participant savings value from recommended measures, also determined by PY2 evaluation efforts. In Table 34 below, we present gross verified savings for the PY3 participants in the HEC Program.

Table 34. PY3 Participant Gross Verified Savings

Program Component	Tracked Measures Given in PY3	Installation Rate	Verified Measures Installed in PY3	Savings per Measure		Total Gross Verified Savings	
				KWH	KW	MWH	MW
Recommended Measures List Provided During Home Energy Audits	2,949 customers	n/a	2,949	566	0.15	1,668	0.46
CFL 13-Watt Bulbs	29,380 bulbs	55%	16,079	51.5	0.0047	828	0.08
Pipe Insulation	7,572 feet	64%	4,875	85.6	0.01	417	0.05
Water Heater Insulating Blanket	984 blankets	57%	562	360.8	0.041	203	0.02
Total	**n/a**					**3,117**	**0.60**

Below we summarize the adjustments made to each leave-behind measure type as well as the application of recommended measure savings.

Compact Fluorescent Lighting (CFL)

During PY3, nearly 100% of participants (2,938 of 2,949) received a 10-pack of low-wattage CFL bulbs to install in their homes. We assigned each CFL a deemed savings of 51.5 KWH and .0047 KW. The validated quantity of CFLs distributed was 29,380 bulbs. The program-tracking database overstated the quantity of CFLs distributed by 80 bulbs, as eight projects were entered twice each.

The PY2 participant survey verified the number of CFLs each respondent installed in their home. It was found that customers installed 55% of the CFLs they received through the program, or 5.5 out of every 10 CFLs, in their homes. These numbers are reflected in the verified quantity, thus reducing the actual energy and demand impacts by these installation rates.

Hot Water Pipe Insulation

During PY3, approximately 43% of program participants received six (6) feet of hot water pipe insulation. These participants have electric water heaters and uninsulated hot water pipes. To calculate tracked energy and demand savings, we applied deemed savings values of 85.6 KWH and 0.010 KW per foot. The validated quantity of pipe insulation distributed was 7,572 feet. The program-tracking database overstated the quantity of pipe insulation distributed by 30 feet, as three projects were entered twice each. Since each participant who received the hot water pipe insulation was supposed to install the insulation on their own (it was not installed by program staff), the PY2 participant survey obtained an installation rate to accurately quantify the proportion of participants who did install the measure. As a result of the survey, we applied an installation rate of 64% to the 1,262 participants who received hot water pipe insulation.

Water Heater Insulation Blanket

During PY3, approximately 33% of program participants received water heater insulation blankets. The program only provided this measure to customers with electric water heaters installed in their home. The deemed savings values that we 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 984. Similar to the pipe insulation, participants were supposed to install the water heater insulation blankets on their own. The program-tracking database overstated the quantity of insulation blankets distributed by three blankets, as three projects appeared to have been entered twice. From PY2 participant surveys, it was found that 57% of respondents had installed the insulation blanket around their water heater tanks. We applied this installation to the 984 participants who received insulation blankets, which is reflected in the verified quantity, resulting in reduced energy and demand savings when compared to the tracked savings.

Recommended Measure Savings

In addition to savings from leave-behind measures offered to participants, the Evaluation Team also counted savings from measures recommended to participants during the home visits toward total savings. In PY2, we conducted an engineering analysis that indicated that seven of the 10[12] measures included in the list of "11 Ways to Save Energy" could be counted toward recommended measure savings for the Home Energy Check-Up Program at this time.[13]

Based on the results of the PY2 participant survey, we determined per-participant gross savings from recommended measures by averaging total savings from recommended measures across the survey population. The resulting per-participant savings values from recommended measures were 566 KWH and 0.15 KW. This per-participant savings estimate was then extrapolated to the entire PY3 program population to determine verified gross savings from recommended measures.

PY3 Participant Net Impacts

After making the adjustments to gross savings, the team applied the NTGRs we derived from PY2 evaluation efforts to determine net savings for the program from PY3 participants. As shown in Table 35 below, PY3 participants produced a total net savings of 2,115 MWH and 0.47 MW.

We based the NTGR for recommended measures on the PY2 survey participant self-reported influence of the program in their decision to take actions recommended during the check-up. PY2 telephone survey efforts verified the installation of leave-behind measures and incidence of additional actions taken. We then applied these values prospectively to PY3 participants, given that the program implementation and design did not change between years.

[12] Ten (10) specific actions/measures are listed in a handout to all participants. The 11th way to save energy listed is to call SCE&G or visit the EnergyWise website.

[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 if 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 Verified Net Savings

Component	Total Participants	Verified Gross Savings		NTGR		Verified Net Savings	
		MWH	MW	MWH	MW	MWH	MW
Leave-Behind Measures	2,949	1,448	0.15	0.65	0.79	938	0.12
Recommended Measures		1,668	0.46	0.71	0.77	1,177	0.35
Total PY3 Program		**3,117**	**0.60**	**0.68**	**0.78**	**2,115**	**0.47**

Table 36 below compares verified and tracked PY3 program savings. While the verified NTGRs were lower than the tracked NTGR of 0.90, verified net savings were nearly double the tracked estimates due to the addition of savings from recommended measures.

Table 36. Tracked vs. Verified PY3 Participant Savings

Description	Number of Participants	Gross Verified Savings		NTGR	Net Savings	
		MWH	MW		MWH	MW
Tracked Total*	2,957	1,313	0.27	0.90	1,182	0.24
Verified Total	2,949	3,117	0.60	0.68 (KWH) 0.78 (KW)	2,115	0.47
% of Tracked	99.7%	237%	227%	75%-78%	179%	196%

*The tracked total applies the gross savings per participant from the planning model (444 KWH and 0.09 KW) to the participant counts in PY3.

Total Net Impacts Claimed in PY3

In addition to savings from PY3 participants, the total savings claimed in PY3 include additional savings that were not claimed in PY1 and PY2. Some PY1 and PY2 participants did not install all measures within their respective program years, but did install them afterward. To verify the number of measures installed outside of a given program year, Opinion Dynamics conducted a telephone survey with the same Home Energy Check-Up Program customers who participated in previous evaluation surveys but had not installed all measures in previous years.

Based on survey results, an installation rate was calculated for each program measure and was subsequently applied to the number of measures that were not installed within the program year. Please refer to Appendix D for a more detailed description of the methodology used to calculate additional savings. This allowed for an additional savings of 307 MWH and 0.03 MW to be claimed in PY3. Therefore, the total claimed savings in PY3 are 2,423 MWH and 0.51 MW, as shown in Table 37 below.

Table 37. Total Savings Claimed in PY3

HEC Program	Net Savings	
	MWH	MW
PY1 Savings	109	0.01
PY2 Savings	198	0.02
PY3 Savings	2,115	0.47
Total Savings Claimed in PY3	**2,423**	**0.51**

3.5 Heating & Cooling Efficiency Improvement Program

3.5.1 Program Description

The Residential Heating and Cooling Efficiency Improvement Program (the Efficiency Improvement Program or EI 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 airflow correction), duct sealing, duct insulation, and complete duct replacement. To participate in this Program, the customer must receive residential electric service from SCE&G in an existing separately metered residence.

Table 38. Planning Incentives by Measure

Measure	Incentive
System Optimizer of Existing Central AC or Heat Pump	$60
Duct Insulation in Existing Home	$150
Duct Sealing in Existing Home	$150
Complete Duct Replacement	$300

In PY4, SCE&G plans to shift this Program from a stand-alone offering and merge it with the Heating & Cooling and Water Heating Program. In PY3, SCE&G eliminated the incentive for system optimization and will only offer duct sealing, duct insulation, and complete duct replacement measures going forward.

3.5.2 Program Performance Summary

This program made up 0.8% of SCE&G's portfolio energy savings in PY3. Table 39 below summarizes the forecasts and overall results for the program in terms of costs, participation, and energy and demand savings. The program did not hit its savings forecasts for PY3, largely because it did not hit its participation target. SCE&G set the forecast during the PY1-PY3 planning stages, and may have been too aggressive in its original participation assumptions.

Table 39. EI Program Forecasts and Results

Metric	Forecasts	Actuals	% of Forecast Accomplished
Cost	$3,847,343	$695,719	18%
Participants	20,225	1,179	6%
Net MWH	11,549	832	7%
Net MW	5.29	0.29	5%

In PY3, the Efficiency Improvement Program had 1,179 unique participating customers (note that individual participants may have received more than one service).[14] Table 40 below shows the total measures installed in customer homes and the savings associated with each measure. The most commonly installed measure is

[14] Participant count is based on the total number of unique account numbers across measure categories presented in the program-tracking database. Measure counts presented in Table 40 are based on the total number of measures installed.

complete duct replacement (representing 87% of the program's ex-ante gross savings), followed by system optimization (representing 11% of savings).

Table 40. Efficiency Improvement Program Measure Counts

Measure Type	Measure Counts	Ex-ante Gross KWH	Ex-ante Gross KW	% of Ex-ante Gross KWH Savings
Complete Duct Replacement	889	1,771,975	552.92	87%
System Optimizer	446	221,492	63.64	11%
Duct Sealing	30	44,662	15.10	2%
Duct Insulation	10	5,052	1.69	0%
Total	**1,375**	**2,043,181**	**633.34**	**100%**

3.5.3 Impact & Data Tracking Findings

Tracking Database Review

Program-tracked savings values were reviewed for errors and duplicates. No errors were found in the quantity of tracked measures or the application of deemed savings.

Verified Gross Savings Adjustment

To verify gross savings for this program in PY3, we adjusted the complete duct replacement ex-ante gross savings via a billing analysis. To obtain the most reliable results, the billing analysis focused on customers who only performed complete duct replacement. After comparing our evaluated savings with the deemed savings, we found lower savings than what had been deemed in the program-tracking database. On average, complete duct replacement in homes with air conditioners realized 74% of its savings, and complete duct replacement in homes with heat pumps realized 63% of its savings (See Appendix E for details). We apply the billing analysis adjustment factor for demand savings in homes with air conditioners (74%) to the demand savings for homes with heat pumps because, during the summer months when demand savings are critical, the heat pump functions essentially as an air conditioner.

Table 41. Complete Duct Replacement Verified Ex-Post KWH Savings Summary

Heating Type	Ex-ante Deemed Savings (KWH/Ton)	Ex-post (KWH/Ton)	Realization Rate KWH	Realization Rate KW
AC	464	342	74%	74%
HP	965	612	63%	74%

After applying the billing analysis adjustment factor to the verified savings, the ex-post gross savings are shown in Table 42.

Table 42. Verified EI Program Gross Savings Summary

Measure Type	Ex-ante Gross Savings		Billing Analysis Adjustment Factor		Ex-post Gross Savings	
	KWH	KW	KWH	KW	KWH	KW
Complete Duct Replacement - AC	658,562	304.87	74%	74%	487,336	225.60
Complete Duct Replacement - HP	1,113,413	248.05	63%	74%	701,450	183.56
System Optimizer - AC	60,196	27.80	n/a	n/a	60,196	27.80
System Optimizer - Heat Pump	161,296	35.84	n/a	n/a	161,296	35.84
Duct Sealing - AC	21,414	9.92	n/a	n/a	21,414	9.92
Duct Sealing - HP	23,249	5.18	n/a	n/a	23,249	5.18
Duct Insulation - AC	2,282	1.06	n/a	n/a	2,282	1.06
Duct Insulation - HP	2,771	0.62	n/a	n/a	2,771	0.62
Total	**2,043,181**	**633.34**	**71%**	**77%**	**1,459,994**	**489.58**

Net Impacts

The overall net-to-gross ratio (NTGR) for this program is 0.57 for energy savings and 0.59 for demand savings. There is little variation among the individual net-to-gross scores for each service offered through the program. The PY3 NTGRs are much lower than the 0.80 that was assumed in the PY1-PY3 planning model.

Removing the participants who only received system optimization from the NTGR analysis did not significantly change the result. Therefore, we found no reason to expect that removing this measure from the program in PY4 will significantly affect the NTGR.

Table 43. Net-to-Gross Ratio

Efficiency Improvement Program	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=102)	0.50	0.50	0.07	0.09	0.57	0.59	±0.08	±0.08
Duct Replacement, Duct Sealing, and Duct Insulation (n=67)	0.52	0.52	0.09	0.10	0.61	0.62	±0.10	±0.10

In PY3, the program achieved verified net savings of 832.20 MWH and 0.29 MW. Table 44 shows the total gross and net savings. The Evaluation Team found no errors in the program-tracking database or the application of deemed savings. However, billing analysis findings reduced the gross savings realization rate to 0.71 for energy savings and 0.73 for demand savings.

Table 44. Efficiency Improvement Program Verified Gross and Net Savings

EI Program	Ex-ante Gross Savings		Ex-post Gross Savings		Gross Savings Realization Rate		Verified Net Savings	
	MWH	MW	MWH	MW	MWH	MW	MWH	MW
Total	2,043.18	.63	1,459.99	0.49	0.71	0.73	832.20	0.29

3.6 Neighborhood Energy Efficiency Program

3.6.1 Program Description

Newly introduced in PY3, the Residential Neighborhood Energy Efficiency Program (NEEP) provides qualifying customers with energy education, an on-site energy survey of their home, and direct installation of energy-saving measures at no additional cost to the customer. The program is delivered in a neighborhood door-to-door sweep approach and offers a variety of direct installation energy efficiency measures to customers who are eligible and wish to participate. The program approaches neighborhoods that have a significant number of households with income levels equal to or less than 150% of the poverty line, as defined by the federal government.

Table 45. 2012 Federal Poverty Guidelines

Size of Family Unit	Threshold	Income Level (150%)
1	$11,170	$16,755
2	$15,130	$22,695
3	$19,090	$28,635
4	$23,050	$34,575
5	$27,010	$40,515
6	$30,970	$46,455
7	$34,930	$52,395
8	$38,890	$58,335
For each additional person, add	$3,960	$5,940

3.6.2 Program Performance Summary

This program made up 0.4% of SCE&G's portfolio of energy savings in PY3. The program performed better than forecasted. A total of 510 customers participated and the program achieved savings of 449 MWH and 0.08 MW.

Table 46. NEEP Program Forecasts and Results

Metric	Forecast	Actuals	% of Forecast Accomplished
Cost	$175,872	$236,126	134%
Participants	500	510	102%
Net MWH	422	449	106%
Net MW	0.06	0.08	133%

3.6.3 Impact & Data Tracking Findings

Given that this program is new in PY3 and contributes less than 1% to the overall savings, the PY4 evaluation efforts were limited to a review of the program database and an application of agreed-upon deemed savings estimates.

Tracking Database Review

Table 47 below outlines the savings by measure. Overall, CFLs contributed the greatest share of energy savings to the program (50%), while winterization contributed the greatest share of demand savings (33%).

Table 47. NEEP Savings by Measure

Measure Description	Unit Quantity	Ex-ante KWH per Unit	Ex-ante KWH Total	Ex-ante KW per unit	Ex-ante KW Total
CFL 9W spiral	584	51.5	30,076	0.0047	2.74
CFL 13W spiral	3,390	51.5	174,585	0.0047	15.93
CFL 20W spiral	383	51.5	19,725	0.0047	1.80
CFL 23W spiral	37	51.5	1,906	0.0047	0.17
Filter 12x20x1	48	64	3,072	0.015	0.72
Filter 14x20x1	600	64	38,400	0.015	9.00
Filter 14x25x1	48	64	3,072	0.015	0.72
Filter 16x20x1	300	64	19,200	0.015	4.50
Filter 16x25x1	72	64	4,608	0.015	1.08
Filter 20x20x1	228	64	14,592	0.015	3.42
Filter 20x25x1	84	64	5,376	0.015	1.26
Specialty Filter - hand cut	154	64	9,856	0.015	2.31
Misc Filter size	36	64	2,304	0.015	0.54
Pipe Wrap 1 foot	210	85.6	17,976	0.01	2.10
Smart-strip	24	102.8	2,467	0.012	0.29
Water Heater Blanket	92	360.8	33,194	0.041	3.77
Winterization kit- large	93	164	15,252	0.060	5.58
Winterization kit - medium	121	164	19,844	0.060	7.26
Winterization kit - small	203	164	33,292	0.060	12.18
Total	**6,707**		**448,796**		**75.38**

3.7 Energy Information Display Program

3.7.1 Program Description

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

Over the course of the Program, a total of 2,557 customers received an EID device. The program used two different devices (Device #1 and Device #2) and is now in its third year of implementation (PY3). While 1,555 participants enrolled in both the EID and Home Energy Report Programs, 1,543 participants received credit in

the HER Program. Therefore, 980 customers are claiming savings for the EID Program in PY3. For additional participation count details, see Appendix J. The focus of this evaluation is to calculate energy and demand savings for all participants in PY3. This includes those who enrolled in PY3 as well as those who remained in the program from PY1 and PY2. The Evaluation Team calculated program impacts via applying net savings estimated in PY2 through a billing analysis.

In PY4, SCE&G will no longer offer the EID Program to new customers.

3.7.2 Program Performance Summary

This EID program accounted for 0.3% of the energy savings of the SCE&G's portfolio in PY3. The program forecasted 5,652 customers participating in the program and reached 17% of its forecasted number of participants. The performance summary excludes any savings realized by customers who were enrolled in both the EID and HER Programs. These savings are incorporated into the HER Program. The program achieved 16% of its MWH and MW savings forecast to date. The program annual net energy savings estimates are 363 KWH and 0.06 KW per household. Importantly, the program realized lower savings primarily due to lower participation rates than forecasted, as well as removing overlapping HER Program participants, rather than lower-than-expected per-participant savings. Overall, the program achieved 91% of the savings estimate per household.

Table 48 summarizes the forecasted participation and savings, as compared to the actual participation and applied savings in PY3.

Table 48. EID Program Forecast and Results

EID Program	Forecasts	Actuals*	% of Forecast Accomplished
Cost	$961,749	$565,269	59%
Participants	5,652	980	17%
Net MWH	2,261	356	16%
Net MW	0.36	0.06	16%
Net MWH Savings / Participant	400	363	91%
Net MW Savings / Participant	0.064	0.058	91%

Forecasts are calculated based on assumed energy and demand savings per participant, multiplied by participation forecast and assumed NTGR.
*PY3 impact findings are based on the PY2 billing analysis results and for participants not overlapping with the HER Program. See Appendix F for more details regarding the savings estimation.

3.7.3 Impact & Data Tracking Findings

For PY3, the total net savings for this program are estimated to be 356 MWH and 0.06 MW. Table 49 below shows the energy and demand savings that were estimated in PY3.

Notably, PY3 impact findings are based on PY2 billing analysis results and are likely underestimated, as the PY2 estimates were calculated on less than a full year of program participation data, and these estimates do not take into account a ramping-up effect as the participants have an additional year in the program. See Appendix F for more details regarding the savings estimation.

Table 49. Application of Estimated Savings per EID Program Participant

Description	Number of Units	Assumed Net KWH Savings per Participant	Assumed KW Savings per Participant	Net Savings	
				KWH	KW
Forecast Total	5,652	400 [a]	0.064	2,260,800	360
Estimated Total	980	363 [b]	0.058	355,596	57
% of forecast	0.17	0.91	0.91	0.16	0.16

[a] The forecast-assumed net KWH and KW per participant are calculated using gross deemed savings of 500 KWH and 0.064 KW, respectively, and a NTGR of 0.8.
[b] The estimated assumed net KWH and KW savings per participant are the net savings per participant as calculated through the PY2 billing analysis, which directly yielded net impacts, and no NTGR was involved in determining net impacts.

3.8 ENERGY STAR New Homes Program

3.8.1 Program Description

Overall, the Residential ENERGY STAR New Homes Program is a small component of the SCE&G portfolio, 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 PY3 were built to ENERGY STAR Version 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. 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 V3.0 ENERGY STAR criteria. The HERS rater inspects the home in two different phases: mid-construction and final completion. 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.

In PY1 and PY2, program staff modeled all characteristics for each home in implementer's predictive savings tool to generate the expected savings per home. To reduce program implementation costs, program staff continued to collect similar home characteristics in PY3, but did not model savings for each home. Program staff instead used an algorithm developed by the Evaluation Team to generate the expected savings for each home.

3.8.2 Program Performance Summary

This program made up 0.3% of SCE&G's portfolio energy savings in PY3. The program provided incentives to 192 homes in PY3, which is 25% of the forecasted participation. The actual number of participating homes was less than forecasted, but the ongoing changes to the ENERGY STAR version requirements may have been part of the reason, in addition to potentially aggressive original forecasts. While the program provided incentives to fewer homes than forecasted, the savings per home is more than twice the amount anticipated because the program forecasting was based on ENERGY STAR V2.0, while the program operated under V3.0 requirements in PY3.

Table 50. ENERGY STAR New Homes Program Forecasts and Results

ENERGY STAR NEW HOMES PROGRAM	Forecast	Actual	% of Forecast Accomplished
Cost	$483,268	$323,635	67%
Homes	769	192	25%
Net MWH	623	344	55%
Net MW	0.22	0.18	82%

The number of active participating builders decreased from 16 in PY2 to five in PY3. However, more builders are moving to V3.0 in PY3 compared to PY2. In PY2, 16% of homes built were to V3.0 standards, while almost all of the PY3 homes (98%) are V3.0 compliant. As shown in Table 51 below, participating builders built between two and 105 homes to ENERGY STAR standards in PY3.

Table 51. ENERGY STAR New Homes Program Participation by Builder

Builder	Homes Built to V2.5	Homes Built to V3	Total Homes Built
Builder 1	3	102	105
Builder 2	0	75	75
Builder 3	0	7	7
Builder 4	0	3	3
Builder 5	0	2	2
Grand Total	**3**	**189**	**192**

In PY3, the number of active HERS raters decreased from six (PY2) to four (PY3). However, this drop has not caused difficulty because, as in PY2, two raters did only one home each.[15] Additionally, similar to PY2, where two raters performed 85% of the ratings, two raters make up the majority of participation (94%) in PY3.

[15] Additionally, there were four raters in PY1.

Table 52. ENERGY STAR New Homes Program Participation by HERS Rater

HERS Rater	Total Homes
Rater 1	105
Rater 2	75
Rater 3	10
Rater 4	2
Grand Total	**192**

As shown in Table 53 below, the greatest proportion of PY3 homes (31%) received HERS ratings between 66 and 70. Similar to PY2, the HERS ratings ranged from 51 to 75. However, across the PY3 population more homes have lower HERS scores than previously. For example, in PY2 13% of all homes built were in the most efficient tier (51-55 Index). As shown in Table 53, this percentage doubled to 26% in PY3.

Table 53. ENERGY STAR New Homes Program HERS Scores

HERS Index Score	Homes Built to ES V2.5	Homes Built to ES V3	Total Homes Built	% of Total
51 – 55	0	50	50	26%
56 – 60	1	26	27	14%
61 – 65	1	30	31	16%
66 – 70	1	58	59	31%
71 – 75	0	25	25	13%
Total	**3**	**189**	**192**	**100%**

The planning model for this program was based on ENERGY STAR V2.0 (which is 15% more efficient than a home built to International Energy Conservation Code (IECC) 2006 standards, which was the code within South Carolina at the time of planning for the program[16]). However, the more efficient ENERGY STAR V2.5 and V3.0 were actually in effect during PY3 and, as shown in Table 53 above, all program builders did build to those higher efficiency levels. Therefore, the program garnered more savings per home than it originally expected.

3.8.3 Method

In PY1 and PY2, ex-ante energy savings per home were determined by the rater's engineering modeling in REM/Rate and EnergyGauge software. To reduce program costs in PY3, the Evaluation Team developed another approach, a deemed savings algorithm, to estimate savings per home based on statistical analysis of historical program data, which replaced the REM/Rate and EnergyGauge estimates. Ultimately, the Evaluation Team conducted a two-stage approach to verifying the PY3 impacts. First, the Evaluation Team conducted a standard engineering approach, which uses the REM/Rate files obtained from a sample of PY2 participants and determines a realization rate between the ex-ante (i.e., program-tracking) value and evaluated findings. This produced a realization rate of 67% and thus reduced the modeling software estimates by 33% for KWH savings.

[16] South Carolina adopted the IECC 2009 for residential homes January 1, 2013.

After reducing each of the PY2 saving estimates by 33%, we then developed a linear regression model using inputs from the program-tracking database to determine what home characteristics predicted savings. The statistical analysis uses the multiple parameters known for each home (such as the square footage, HVAC system type, etc.) as well as the engineering-derived per-home savings and determines a statistical model that SCE&G can easily apply to PY3 homes. Because the effort folded-in our evaluation findings (a realization rate of 67% for all KWH savings estimates produced by REM/Rate or EnergyGauge), the output from the model results in impacts for the program. SCE&G used our statistical model to calculate savings for their PY3 program. Because SCE&G used the method based on our analysis, we deployed the same method to calculate ex-post savings as SCE&G had used to calculate their PY3 ex-ante savings. As such, there is no adjustment between the two values unless there are issues found through a review of the program-tracking data. We provide further detail in Appendix G.

3.8.4 Impact & Data Tracking 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
- All home characteristics needed for dependent variables in linear model were complete with no missing data

Net Impacts

Given that we found no database errors, the verified and tracked savings for this program are identical for PY3. After reviewing the database, the PY3 net savings for this program are estimated to be 344 MWH and 0.18 MW. Overall, the program achieved 55% of its forecasted energy savings and 82% of its forecasted demand savings. Table 54 below compares the program's forecasted energy savings to actual energy savings.

Table 54. Forecast Versus Actual Energy and Demand Savings Summary for the ENERGY STAR New Homes Program

Description	Number of Homes	Gross Savings		NTGR	Net Savings	
		MWH	MW		MWH	MW
Forecast Total	769	692	0.24	0.9	623	0.22
Actual Total	192	383	0.20	0.9	344	0.18
% of Forecast	25%	55%	83%	n/a	55%	82%

Note: The NTGR is from the PY1 deemed value and has not been updated by Opinion Dynamics.

Overall, the program realized 222% of its forecasted per-home average energy savings and 334% of its forecasted per-home average demand savings. Table 55 below compares the program-forecasted savings per home to its actual tracked energy savings.

Table 55. Summary of Average Energy (KWH) and Demand (KW) Savings per Home

Description	Number of Homes	Gross Savings / Home	
		KWH	KW
Forecast Total	769	900	0.31
Actual Total	192	1,995	1.04
% of Forecast	25%	222%	334%

3.9 Home Performance with ENERGY STAR Program

3.9.1 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 helps customers recognize energy solutions for their home by taking a "whole-house" approach to energy efficiency. Contractors provide participants with a comprehensive report using the BEACON Home Energy Advisor™ (BEACON) software, 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 the customer installs and receives a rebate for at least one eligible measure through the program, he or she can receive a $200 rebate to offset the cost of the audit. Table 56 below includes a complete list of measures that are eligible for rebates through the HPwES Program.

Table 56. HPwES Program Eligible Rebated Measures

Eligible Measure	Rebate
Home performance assessment (requires completion of a minimum of one of the 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	$150
Programmable thermostat (requires ramp-up technology for heat pumps)	$50
Split system or packaged central AC/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
Comfort Home Package bonus incentive: install at least one measure from four categories (Envelope Improvements, Heating and Cooling Performance Improvements, Heating and Cooling Equipment, and/or Water Heating Equipment)	$400

To be eligible to receive rebates, up to $2,500 per home, for the home assessment and qualified measures installed, a participating BPI-certified HPwES Program contractor must complete the inspection and installations of the project. The program implementer recruits and trains participating contractors on both the program and the BEACON audit assessment tool. The SCE&G website lists a directory of participating contractors who have BPI Building Analysts certification. SCE&G currently lists 19 BPI-certified contractors on the program website, along with information on the counties these contractors serve. Further, multiple

contractors are available in each county within SCE&G's electric service territory, suggesting that the program has the ability to reach all customers interested in participating.

3.9.2 Program Performance Summary

The HPwES Program made up less than 0.3% of SCE&G's portfolio energy savings in PY3. It achieved 8% of net energy (MWH) savings and 14% of net demand (MW) savings forecasted. The program did not achieve the savings levels it forecasted because the program achieved less than one-quarter of participation forecasted. Further, the adjustment to BEACON software savings estimates based on a billing analysis of PY2 participants also contributed to a lower percentage of net savings realized by the program. Table 57 below summarizes the forecasted and actual results in terms of costs, participation, and net energy and demand savings.

Table 57. HPwES Program Forecasts and Results

Metric	Forecasts	Actuals	% of Forecast Accomplished
Costs	$3,363,253	$1,191,644	35%
Participants	1,401	213	15%
Net MWH	3,605	285	8%
Net MW	0.78	0.11	14%

The HPwES Program had 213 participants during PY3. These participants received a Home Energy Audit and a rebate for one or more of the recommended energy efficiency measures. Table 58 below shows the types of rebated measures that participants installed.

Table 58. HPwES Program Participation by Measure

Rebated Measures	Number of Participants	Percentage of Participants (n=213)
Home Energy Audit	213	100%
Air Sealing and Insulation Measures		
Air Sealing Package	200	94%
Insulation – Attic	133	62%
Seal/Insulate Attic Access Hatches	113	53%
Treat Major Attic Bypasses	100	47%
Insulation - Kneewalls/Vertical Attic Wall	44	21%
Seal/Insulate Recessed Lights	58	27%
Insulation - Rim Joist	35	16%
Insulation - Basement/Enclosed Crawlspace	27	13%
Insulation - Exterior Wall	3	1%
Duct System Measures		
Duct System Sealing	123	58%
Duct System Insulation	71	33%
Air Conditioning System Measures		
Programmable Thermostat	80	38%
Heat Pump	34	16%
Central AC	26	12%
SF - Central AC Tune-Up	1	0.5%
Water System Measures		
Water Heater	23	11%

3.9.3 Impact & Data Tracking Findings

The savings per participant from the program vary widely depending on the measures installed and whether the customer has electric or non-electric heat. 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.[17] The estimates derived from this software determine tracked gross savings for the program.

Tracking Database Review

The Evaluation Team reviewed the program-tracking database for duplicates and accuracy and fielded a participant survey to verify measures included in the database. We found no database errors, and all survey respondents verified the installation of their tracked measures. Therefore, the team did not adjust tracked savings.

Verified Gross Savings Adjustment

The Evaluation Team derived verified gross savings through a billing analysis of PY2 participants. This analysis compared the actual energy savings realized by customers after participating in the program to the estimates produced by the BEACON software, resulting in an evaluated savings adjustment factor. We provide a detailed billing analysis methodology in Appendix H. Table 59 below summarizes the adjustment to tracked gross savings to determine verified gross savings.

Table 59. Verified Gross Savings Adjustment for the HPwES Program

Total Participants	Tracked Gross Savings		Billing Analysis Adjustment Factor	Verified Gross Savings		Gross Realization Rate	
	KWH	KW		KWH	KW	KWH	KW
213	549,231	208	0.75	412,918	156	75%	75%

Net Savings

The team explored net savings in PY3 by fielding a telephone survey to participants and asking a battery of net-to-gross questions. The NTGRs determined for PY3 were 0.69 and 0.71 for KWH and KW, respectively. Please refer to Appendix I for detailed methods on how we derived the NTGR for this program. Table 60 below summarizes the verified gross and net savings.

Table 60. Verified Gross and Net Savings for the HPwES Program

Total Participants	Verified Gross Savings		NTGR		Verified Net Savings	
	KWH	KW	KWH	KW	KWH	KW
213	412,918	156	0.69	0.71	285,090	110

[17] 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 South Carolina Measures Database (SCMDB), so it is not possible to estimate savings on a measure-by-measure level using a deemed savings value from this specific source.

3.10 Commercial and Industrial Prescriptive and Custom Program

3.10.1 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 program offers incentives to businesses to encourage installation of high-efficiency equipment and building improvements that reduce energy costs. They are available to all eligible commercial and industrial (C&I) customers in the SCE&G electric 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 program falls short of the original planning assumptions, which were developed with the understanding that large customers would participate.

3.10.2 Program Performance Summary

The EnergyWise for Your Business Program made up 28% of SCE&G's portfolio energy savings in PY3. Table 61 below shows the program's PY3 performance in comparison to the original forecast. Although the number of participants was higher than forecast, the overall savings is lower. It should be noted that the original forecast was developed before the large industrial customer opt-out was enacted. About 70% of those very large customers did choose to opt-out, and as a result the forecast is not necessarily a valid point of comparison for actual program performance.

Table 61. Program Performance Compared to Forecast

Metric	Forecasts	Actuals	% of Forecast Accomplished
Program Cost	$6,376,481	$7,767,129	122%
Participation	640	963	151%
Net MWH	74,013	29,368	40%
Net MW	8.48	5.20	61%

Tracking Database Review

The gross reported energy savings were calculated by reviewing the program-tracking database supplied by the program implementer and summing the stipulated savings for each completed project. The gross reported savings for the EnergyWise for Your Business Program were 41,732 MWH of annual energy savings and 6.3 MW of peak demand savings.

Table 62. Reported Gross Savings and Performance by Measure Type

Rebate Type	Measure Type	Gross Reported Savings	
		KWH	KW
Prescriptive Lighting	LED Interior & Exterior	11,002,954	1,018
	High Bay Lighting	4,385,402	588
	Standard Linear Fluorescent Lighting	4,368,384	884
Prescriptive Lighting (cont'd) KWH: 23,511,205 KW: 3,111	Sensors & Controls	3,184,830	505
	Exterior Fixtures	318,662	60
	CFL Fixtures or Screw-In	187,467	51
	LED Exit Signs	63,505	6
Custom KWH: 13,312,936 KW: 2,355	Custom	13,312,936	2,355
Prescriptive HVAC KWH: 2,576,049 KW: 310	VFD	2,060,785	152
	Chillers	515,264	158
	Split/Unitary Systems	156,010	101
Prescriptive Refrigeration and Food Service KWH: 1,194,164 KW: 157	Cooler/Freezer Lights & Controls	505,158	79
	Cooking Equipment and Reach-ins	316,308	69
	Vending/Ice	183,330	2
	Coolers/Freezers, Anti-Sweat Heater Controls	110,186	0
	Cooler/Freezer ECMs	79,182	7
New Construction KWH: 981,802 KW: 232	Whole Building Lighting	981,802	232
Total		**41,732,165**	**6,266**

* Sum of the "Quantity" field in the program-tracking data. Units vary by measure type.

Prescriptive lighting measures continue to be the leading contributor of savings in PY3, with a shift in focus from linear and compact linear fluorescents to LED and controls measures. The majority of the savings associated with custom projects also continues to be generated through lighting projects.

Generally, the program database accurately reflected the appropriate application of stipulated savings, with only a few minor discrepancies in the prescriptive LED measure category. Table 63 below shows the adjustments made as a result of the database review.

Table 63. Database Review Adjustments

Application Type	Tracked		Revised		Tracking Accuracy	
	MWH	MW	MWH	MW	MWH	MW
Custom Incentives	13,313	2.4	13,313	2.4	100%	100%
Refrigeration and High Efficiency Food Service Equipment	1,194	0.16	1,194	0.16	100%	100%
HVAC	2,732	0.41	2,732	0.41	100%	100%
New Construction Lighting	982	0.23	982	0.23	100%	100%
Prescriptive LED Lighting	11,003	1.0	10,209	0.98	93%	98%
Prescriptive Lighting	12,580	2.1	12,509	2.1	100%	100%
Total	41,732	6.3	40,939	6.28	98.1%	99.7%

Verified Gross Savings Adjustment

The gross verified savings include adjustments made to the tracked savings based on engineering findings discovered through the site visits, metering, desk reviews, and phone interviews. This primary research can help verify the assumptions that go into savings estimates in future program years.

The evaluated savings for PY3 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.

Table 64. Tracked and Verified Results

Savings	Tracked Savings	Gross Verified Savings	Gross Realization Rate	90% Confidence Level	
				Relative Precision	Error Bound
MWH	41,732	38,140	0.91	10.82%	4,126
MW	6.3	7.0	1.12	15.25%	1.07

The evaluated energy savings estimate for the program is 38,140 MWH per year, so we can say with 90% confidence that the true impact of the PY3 measures is between 34,014 MWH and 42,266 MWH per year (i.e., the verified savings value ± the error bound value).

Evaluated Results

The energy realization rates for Stratum 1 and Stratum 2 (medium and large measures) were both less than 100% and showed good correlation between reported and verified savings (error ratio < 0.5). Measures in Stratum 3 exhibited more variability and a higher realization rate, with verified gross savings estimates 3.6% higher than reported savings estimates, on average. It is important to note that the program realization rate is most closely aligned with the value observed for Stratum 1, because it contributed almost 60% of the savings to the program and is weighted more heavily in the final realization rate.

Table 65. Sample Project Stratum KWH Savings and Error Ratios

Stratum	MWH Boundaries	Tracked MWH Savings	Verified MWH Savings	Realization Rate MWH*	Error Ratio
1 (Large)	> 220,131	24,655	22,532	0.938	0.41
2 (Medium)	> 40,131 and ≤ 220,131	11,119	10,162	0.809	0.44
3 (Small)	≤ 40,131	5,959	5,446	1.036	0.74
Total	**N/A**	**41,732**	**38,140**	**0.914**	**0.48**

* 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 strata realization rates do not equal the verified KWH divided by the total reported KWH for the stratum.

Table 66. Sample Project Stratum KW Savings and Error Ratios

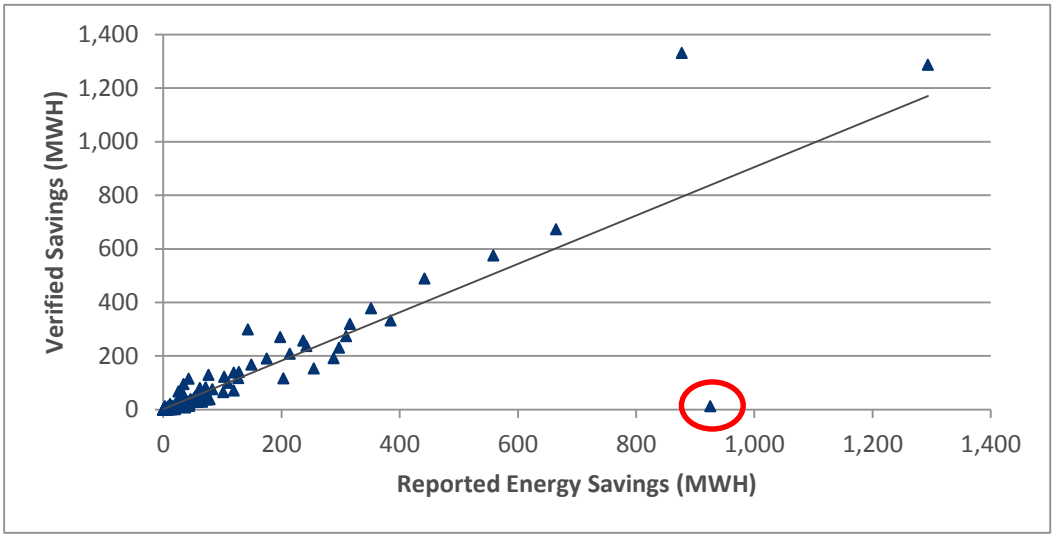
Stratum	KWH Boundaries	Tracked KW Savings	Verified KW Savings	Realization Rate KW*	Error Ratio
1 (Large)	> 220,131	3,579.0	4,014.8	0.932	0.98
2 (Medium)	> 40,131 and ≤ 220,131	1,636.3	1,835.5	1.202	1.58
3 (Small)	≤ 40,131	1,050.4	1,178.2	1.954	1.29
Total	**NA**	**6,265.7**	**7,028.5**	**1.122**	**1.21**

* The clarification regarding realization rate calculations also applies to peak demand

There is uncertainty associated with the program savings estimates because a sample of projects (rather than a census) was evaluated and used to calculate the realization rate for the program. It is possible that the sampled projects realized savings at a lower or higher rate than the program as a whole. The amount of uncertainty associated with the realization rate and the resulting evaluated savings estimates for the program is a function of the sample size and the degree of correlation between the tracked and evaluated savings estimates.

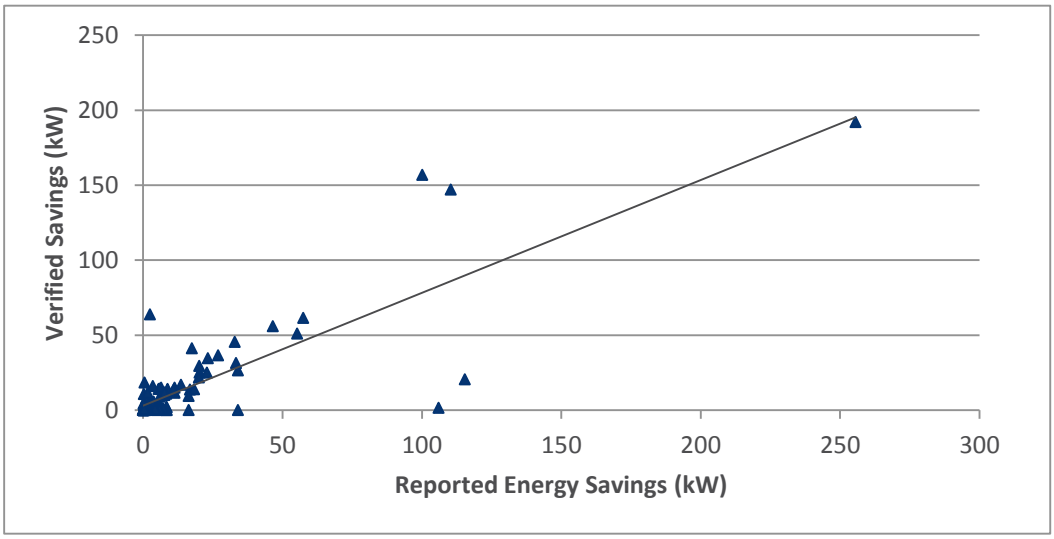
In this evaluation, the relationship between tracked savings and evaluated savings was more stable for energy savings values than peak demand savings. The degree of correlation between tracked and evaluated savings is quantified by the error ratios shown in Table 65 and Table 66 above, and those relationships are also presented graphically in Figure 4 and Figure 5 below. The realization rate for the program can be thought of as the slope of the line shown in Figure 4. Overall, the evaluated KWH savings estimates were slightly lower than the tracked KWH savings for measures in the sample, which led to a program realization rate of less than 1.0 and an evaluated savings estimate for the program that was smaller than the tracked savings total.

Figure 4. Relationship Between Tracked and Verified MWH Savings Estimates



The project circled in red shows extremely high reported savings (925,719 KWH) and significantly lower verified savings (12,656 KWH). This poor realization rate is due to an error in the reported savings where the per-unit savings were multiplied by the installed quantity of 87 twice to produce a drastic overestimation of savings. This project is discussed in more detail in the Database Review section presented in Appendix J.

Figure 5. Relationship Between Tracked and Verified KW Savings Estimates



Although the sample was not designed to produce statistically significant results by rebate type, the Evaluation Team decided to compare evaluated results between the prescriptive and custom projects in the sample. In PY2 there was a large difference noted in the realization rates between custom and prescriptive measures. Table 67 below compares the energy and peak demand realization rates observed amongst the two rebate types for PY3. The energy realization rates were much more consistent across the two program types, but the demand realization rates still vary. This is due in part to the inordinately high demand realization rates found to be associated with prescriptive LED measures and the very low realization rates from two custom projects in the evaluation sample.

Table 67. Realization Comparison – Custom and Prescriptive Rebates

Rebate Type	Measures Evaluated	Gross Realization Rate KWH	Gross Realization Rate KW
Custom	10	0.93	0.71
Prescriptive	103	0.92	1.17

Twenty-five (25) of the prescriptive measures in the sample were LED projects. Analysis of the sampled prescriptive LED projects revealed that the verified gross energy savings estimates were consistently well aligned with the reported impacts, but the verified gross peak demand savings were consistently higher than the reported KW impacts. The effects of this are detailed in Table 68 below. The main reason behind this poor correlation between reported and verified impacts for LED measures is the applied coincidence factor (CF). In the case of screw-in lamps, the CF was found to be too low in almost all sites that received on-site verifications. For exterior lamps, as discussed previously, CFs were found to be applied when lighting was assumed to operate 8,760 hours. In general, all LED measures had inappropriately low CF applied.

Table 68. Realization Comparison – LED and Non-LED Rebates

Rebate Type	Measures Evaluated	Gross Realization Rate KWH	Gross Realization Rate KW
LED	25	0.95	2.74
Non-LED	88	0.92	0.85

Customer-reported data regarding baseline equipment types was found to be reliable when compared to primary data collected by the evaluation team, with issues primarily arising in HVAC and LED lighting measures. The team's site inspections and phone interviews revealed very few discrepancies between the reported quantities and equipment types contained in the program-tracking database and supporting documentation, which are detailed further in Appendix A. The primary sources of variation between tracked and verified savings impacts for lighting measures were the annual hours of use (HOU) and CF values used in the reported savings calculations. For LED measures, the differences were significant enough that the Evaluation Team recommends modifying assumptions for future program years. Specifically, we believe it will be necessary to distinguish between dusk-to-dawn and 24/7 operation when reporting savings for exterior fixtures.

Net Impacts

Table 69 below shows the free ridership scores that were calculated for the program by applying the free ridership and spillover rates that were found through the customer survey and in-depth engineering interviews.

Table 69. Free Ridership Scores

Savings Type	Free Ridership Scores (A)	Spillover Scores (B)	Net to Gross (1-(A) +(B))
Energy Savings (MWH)	0.24	0.01	0.77
Demand Savings (MW)	0.26	0.00	0.74

Table 70 below shows the net savings that the program achieved in PY3, in comparison to the forecast net savings that were planned for the program.

Table 70. Net Results

Savings Type	Forecast Net Savings	Verified Gross Savings	NTGR	Verified Net Savings	Percent of Net Forecast
Energy Savings (MWH)	74,013	38,140	0.77	29,368	40%
Demand Savings (MW)	8.48	7.03	0.74	5.20	61%

Appendix A. ENERGY STAR Lighting Program Detailed Methods

Table 71. Deemed Savings Values: Tracked Versus Revised by Bulb Type

Measure Type	Tracked Units Sold	Verified Units Sold	Gross Tracked Savings		Gross Revised Savings		Percent Difference	
			MWH	MW	MWH	MW	MWH	MW
CFL - 9 Watt	39,457	39,351	1,339	0.122	1,336	0.122	100%	100%
CFL - 10 Watt	38,177	38,177	1,254	0.115	1,254	0.115	100%	100%
CFL - 11 Watt	7,967	7,989	253	0.023	254	0.023	100%	100%
CFL - 12 Watt	5,538	5,538	170	0.016	170	0.016	100%	100%
CFL - 13 Watt	1,107,246	1,104,547	56,984	5.204	56,846	5.191	100%	100%
CFL - 14 Watt	303,912	304,686	15,317	1.398	15,347	1.402	100%	100%
CFL - 15 Watt	62,032	62,032	3,057	0.279	3,057	0.279	100%	100%
CFL - 16 Watt	1,737	1,737	84	0.008	84	0.008	100%	100%
CFL - 18 Watt	77,560	77,560	4,841	0.442	4,841	0.442	100%	100%
CFL - 19 Watt	35,419	35,419	2,172	0.198	2,172	0.198	100%	100%
CFL - 20 Watt	23,703	23,703	1,428	0.130	1,428	0.13	100%	100%
CFL - 23 Watt	175,658	174,207	10,002	0.913	9,919	0.906	99%	99%
CFL - 24 Watt	5,352	5,352	299	0.027	299	0.027	100%	100%
CFL - 25 Watt	28	28	2	0.000	2	0.000	100%	100%
CFL - 26 Watt	43,059	43,059	3,489	0.319	3,489	0.319	100%	100%
CFL - 27 Watt	2	2	0.16	0.000	0.16	0.000	100%	100%
CFL - 32 Watt	1,776	1,776	181	0.017	181	0.017	100%	100%
CFL - 40 Watt	1,253	1,253	117	0.011	117	0.011	100%	100%
CFL - 42 Watt	748	748	88	0.008	88	0.008	100%	100%
CFL - 55 Watt	227	227	48	0.004	48	0.004	100%	100%
CFL - 68 Watt	246	246	62	0.006	62	0.006	100%	100%
LED - 8 Watt	319	319	11	0.001	11	0.001	100%	100%
LED - 11 Watt	845	929	27	0.002	30	0.003	110%	110%
LED - 12 Watt	313	313	10	0.001	10	0.001	100%	100%
LED - 13 Watt	6,068	6,068	312	0.029	312	0.029	100%	100%
LED - 13.5 Watt	325	2,759	15	0.001	140	0.013	923%	918%

Measure Type	Tracked Units Sold	Verified Units Sold	Gross Tracked Savings		Gross Revised Savings		Percent Difference	
			MWH	MW	MWH	MW	MWH	MW
LED - 17 Watt	154	154	10	0.001	10	0.001	100%	100%
LED Nightlight - 0.25 Watts	576	576	11	0.000	11	0.000	100%	100%
LED Nightlight - 0.5 Watts	3,444	3,444	63	0.000	63	0.002	100%	100%
Lighting Fixture - 13 Watt	0	265	0	0.000	14	0.001	N/A	N/A
Lighting Fixture - 23 Watt	0	677	0	0.000	39	0.004	N/A	N/A
Lighting Fixture - 54 Watt	64	64	10	0.001	10	0.001	100%	100%
Mini Lights	928	928	0.05	0.000	5	0.002	10000%	N/A
Total	**1,944,133**	**1,944,133**	**101,657**	**9.28**	**101,647**	**9.28**	**100%**	**100%**

Note: Hand calculations in this table may not add due to rounding.

Engineering Review of New Measures

As previously mentioned, the only new product added to the product lineup discounted through the Residential ENERGY STAR Lighting Program in PY3 was 13.5-watt LEDs. We reviewed this measure and developed program savings estimates using the algorithm below. This algorithm is consistent with how energy savings for other LED products discounted through the program were estimated.

$$kWh\ savings = annual\ hours\ of\ use\ x\ (W_{baseline} - W_{LED})\ x\ WHFe/1000$$

$$kW\ savings = (W_{baseline} - W_{LED}) x\ WHFd\ x\ Coincidence\ Factor/1000$$

Where:

Annual hours of use = Daily hours of use x 365

$W_{baseline}$ = The wattage of the bulb being replaced with an LED

W_{LED} = The wattage of the replacement LED

WHFe = Waste heat factor of energy use, a value that depends on climate and HVAC system type

WHFd = Waste heat factor of demand, a value that depends on climate and the presence of a cooling system

Coincidence Factor = A number less than 1 indicating how many LEDs are expected to be in use and saving energy during the peak summer demand period

Baseline Wattage

The baseline wattage for 13.5-watt LEDs is based on the equivalent lumen output of the incandescent bulb to the replacement LED. Table 72 below compares the tracked baseline incandescent wattage to the recommended equivalent incandescent for this new LED measure.

Table 72. Deemed and Recommended Baseline Incandescent Wattages Based on Lumen Output

Measure Type	Ex-ante Incandescent Baseline Wattage	Ex-post Incandescent Baseline Wattage	Differences in Baseline Incandescent Wattages
LED – 13.5 Watt	Unknown	60	No

*Ex-post incandescent-equivalent baseline wattage based on research using lumen average from ENERGY STAR Qualified Bulbs and Lighting Calculator. Also agrees with information presented to SCE&G for PY1 and PY2 Residential ENERGY STAR Lighting Program.

LED Hours of Use

In PY2, the Evaluation Team recommended using 3.0 hours as the daily hours of use (HOU) for LEDs when calculating energy savings. We used the same hours of use estimate in PY3 evaluation.

LED Waste Heat Factors

Efficient lighting technologies emit less waste heat than incandescent bulbs. Waste heat factors account for the impact of efficient lighting, such as LEDs, on the heating and cooling of homes. Replacing incandescents

with LEDs can reduce the energy a house uses to stay cool in summer, but this can also increase the amount of energy used to heat a home in winter. When LEDs were introduced to the program in PY2, we recommended setting both waste heat factors, WHFe and WHFd, to 1.0. Similarly, we ignored any interactive contributions to energy or demand savings from heating and cooling energy use for CFLs and LEDs in the PY1 and PY2 evaluation. We followed the same approach in the case of 13.5-watt LEDs.

LED Coincidence Factor

SCE&G uses a coincidence factor of 0.10 to calculate the demand savings during the peak summer period. As noted in the PY2 Residential ENERGY STAR Lighting Guidance Report, this value compares well to what is used in other programs. We retained the coincidence factor (CF) at 0.10 for the 13.5-watt LEDs.

LED Savings Summary

Table 73 below summarizes the current deemed savings assumptions used to calculate energy and demand savings for the new LED measure discounted through the program for PY3, along with our recommended assumptions.

Table 73. LED Energy and Demand Savings Assumptions for New Measure (13.5-Watt LED)

Variable	Current Assumption	Recommended Assumption
Daily Hours of Use	Unknown	3.0
Incandescent Equivalent	Unknown	60W Incandescent
WHFe	Unknown	1.0
WHFd	Unknown	1.0
Coincidence Factor	Unknown	0.10

Table 74 below lists how the tracked and evaluated energy and demand savings of each LED in the program change as a result of the engineering review. These changes resulted in a slight increase in both KWH savings (9%) and KW savings (8%).

Table 74. Deemed and Evaluated Per-Unit Energy and Demand Savings and Realization Rates

Measure Type	Units	Recommended Incandescent-Equivalent Wattage	Tracked KWH Savings	Tracked KW Savings	Evaluated KWH Savings	Evaluated KW Savings	RR KWH	RR KW
LED – 13.5-Watt	Per bulb	60	46.8	0.004	50.9	0.005	1.09	1.08

Carryover Savings Estimation

Though customers put some CFLs purchased in storage for later use, research in other jurisdictions shows that 98% of all CFLs purchased are installed within three years. In PY2, we used a first-year installation rate of 83%, meaning that 15% of bulbs purchased in PY2 would be installed in PY3 and PY4. We assumed that 55% of stored PY2 bulbs were installed in PY3, and 45% of stored PY2 bulbs will be installed in PY4. Based on these assumptions, the program can claim 8.25% of the savings from bulbs sold in PY2 and installed in PY3. In PY4, the program can claim 6.75% of PY2 sales.

Table 75. PY2 Carryover Savings

Year Purchased	First Year Installation Rate (PY2)	Second Year Installation Rate (PY3)	Third Year Installation Rate (PY4)
PY2	83%	15% x 55% = 8.25%	15% x 45% = 6.75%

We estimated the carryover savings from PY2 using the following formula:

PY2 Carryover Savings = PY2 Revised Gross Savings * In-Service Territory Rate * PY2 Second-Year Installation Rate

We added carryover savings to the PY3 verified gross savings and verified net savings.

Similar to estimating carryover savings from measures purchased but not installed in PY2, we calculate the percentage of PY3 CFL sales that the program will be able to claim in PY4 and PY5, when these bulbs are assumed to be installed. Using a first-year installation rate of 66%, the program can claim 17.6% of PY3 sales in PY4 and 14.4% in PY5.

Table 76. PY3 Carryover Savings

Year Purchased	First Year Installation Rate (PY3)	Second Year Installation Rate (PY4)	Third Year Installation Rate (PY5)
PY3	66%	32% x 55% = 17.6%	32% x 45% = 14.4%

Program First-Year Installation Rate

The program's tracked savings assumed an installation rate of 100%. However, many customers typically install a portion of the bulbs shortly after purchase and store the rest for future use. In PY3, we estimated the revised first-year installation rate for CFLs using the results of the PY3 Residential In-Home Tracker Study. The study included in-home audits of the lighting found in customers' homes and tallied the number of CFLs installed in sockets as well as the number placed in storage.

We calculated the first-year installation rate using the following equation:

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

This calculation resulted in a first-year installation rate of 66%, which is lower than the 83% rate calculated from the 2011 Baseline Study and used in the PY2 evaluation. This rate is lower than the installation rate in several other jurisdictions (see Table 77 below). This lower installation rate may be due to the increased prevalence and lower cost of CFLs, as well as deep discounts offered by the program on multi-packs of CFLs.

Table 77. Installation Rates in Other Jurisdictions

Study Name	First Year Installation Rate
SCE&G (2013)	66%
New Hampshire (2010)	68%
Commonwealth Edison (2009)	70%
California (SCE, PG&E, and SDG&E) 2010	71%
Detroit Edison (2010)	72%

For LEDs and fixtures, we assumed a first-year installation rate of 100%. The PY3 Residential In-Home Tracker Study did not contain enough homes with LEDs to develop a reliable estimate for LEDs. Because of the higher

costs of LEDs and fixtures, we believe that customers purchase the bulbs and install them. They also tend to be sold as single bulbs and fixtures. Furthermore, Technical Resource Manuals (TRMs) across the country currently recommend using the installation rate of 100% for those measures.[18,19] As LEDs saturate the market and become a bigger part of the program, further research to determine the installation rate might be warranted.

Program Leakage Rate and Net-To-Gross Ratio Estimation

In PY3, the Evaluation Team relied on the program leakage rate of 0.145, determined as part of the PY2 evaluation. 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 electric service territory and cannot be counted toward gross savings estimates. In PY2, two methods were used to calculate program leakage—GIS analysis and in-store intercept surveys. The PY2 report contains greater detail on the methodology and the estimation process.

The Evaluation Team relied on the net-to-gross ratio (NTGR) ratio developed as part of the PY2 evaluation. We used customer in-store intercept interviews to estimate free ridership and the resulting NTGR. The study resulted in a NTGR of 0.83. This ratio includes free ridership and does not include spillover. The PY2 evaluation report contains greater detail on the study and the methodology used to estimate the free ridership rate.

[18] Mid-Atlantic TRM, Version 2.0 http://www.neep.org/Assets/uploads/files/emv/emv-products/A5_Mid_Atlantic_TRM_V2_FINAL.pdf

[19] Massachusetts TRM http://www.ma-eeac.org/Docs/8.3_TRMs/1MATRM_2013-15%20PLAN_FINAL.pdf

Appendix B. Home Energy Report Program Detailed Methods

In this Appendix, we detail the evaluation activities conducted for the PY3 Home Energy Report (HER) Program, along with the methods that were used. The evaluation effort focuses on estimating PY3 impacts. For this evaluation, we applied 100% KW impacts, given that the program achieved over 100% of its KWH impacts. Because we do not have insight into the interactive effects of the energy savings that affect demand, we believe this is the best approach.

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 three primary evaluation tasks:

- Equivalency assessment between participants and assigned comparison group
- A billing analysis to determine net program energy impacts; this analysis also includes an examination of customer reactions 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 residential programs
- Information on key program efforts and dates gathered through program staff interviews
- Electric billing usage data for treatment and comparison groups
- HER Program participant database for PY1 through PY3
- Weather data by address within SCE&G electric territory where participants and comparison group customers live

Table 78 provides a summary of the evaluation methods used for the PY3 program.

Table 78. Summary of Evaluation Methods

Activity	Details
Interview with Program Manager	Interviewed program manager from SCE&G to discuss program theory and implementation
Participant Verification	Reviewed participant databases to identify total number of program participants and dates of enrollment
Equivalency Assessment	Conducted an equivalency assessment of treatment and comparison group customers based on baseline usage, demographic, and household characteristics
Billing Analysis	Conducted a billing analysis to quantify the actions taken among the treatment and comparison group members
Channeling Analysis	Conducted a channeling analysis to determine the effect of the program on other SCE&G program participation, and to ensure that there is no double-counting of savings from participation in other SCE&G programs[20]

Data Preparation

In this section, 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 November 2013 obtained directly from SCE&G.

We eliminated some 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 4% of the treatment group and <1% 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:
  - Missing billing reads, duplicative, has negative consumption values, had billing duration of zero days, or had very long billing periods
  - No cohort (treatment or comparison) assignment
  - Missing first report dates
  - Participants who opted-out of the program in the post-period
  - Energy Information Display (EID) Program participants: the EID Program, as designed, delivered the HER as a part of the program to customers who received an in-home display[21]
  - Very low usage data: a daily average of less than 2 KWH of pre- or post-consumption

[20] 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.
[22] A total of 1,543 EID Program participants were excluded: 1,375 in PY1, 44 in PY2, and 124 in PY3. These customers were removed from the billing analysis, as they participated in both the HER and EID Programs. However, these customers received savings as estimated for the HER-only customers.

  - Very high usage data: a daily average of more than 300 KWH of pre- or post-consumption
- Determined the average daily usage for each customer based upon their billing cycles
- Matched weather data by customer to the geographically closest weather station
- Linked energy usage with the customer-specific program start date

Discussion of Comparison Group

In June 2012, Direct Options (DO), implementer 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. As participants enrolled in the program, Direct Options continued to match comparison group customers for PY2 and PY3 customers using the same process.

The Evaluation Team conducted an equivalency check during the PY3 analysis, in which it was determined that the treatment and comparison groups for all program Cohorts were equivalent based on demographic and housing attributes.

The Evaluation Team also performed a comparison of usage between the treatment and comparison groups for all of the Cohorts. We examined the average daily energy consumption for the 12-month period prior to when the first reports were received for treatment and comparison group customers. We found no effects on comparison group equivalency from customers moving or opting-out.

Table 79 below shows that there were significant differences in PY2 and PY3, based on the average daily consumption in the pre-period. However, the Original Cohort was well matched on baseline average daily consumption.

Table 79. Pre-Program KWH Average Daily Consumption

Cohort	Pre-Program Average Daily KWH Consumption Treatment (with Standard Deviation)	
	Treatment	Comparison
Original Cohort	46 (12)	47 (12)
Expansion 1 Cohort	48 (12)	45 (12)
Expansion 2 Cohort	40 (10)	44 (10)

For each of the three Cohorts, Direct Options selected a comparison group. The customers in the comparison group were not assigned a first report date at the time of selection. As such, Opinion Dynamics used the actual first report dates from the treatment group to randomly assign a first report date to each customer in the comparison group, so the comparison group's first report dates were proportional to the treatment group's distribution.[22] For each Cohort, we took the entire list of first report dates for all of the treated customers and

[22] The beginning of program treatment—and therefore the exact 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, and November 30, 2013, with about 70% of

randomly selected without replacement, assigning the selected first report date to the first comparison group customer. We then selected dates from the list until all of the comparison group customers for the Cohort were assigned first report dates.

For the treatment group, this first report date marked the beginning of HER Program treatment. For all customers in the analysis, the first billing period that begins after the first report date is considered to be the first "post" period in the billing analysis.

Modeling Program Impacts

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 Home Energy Report (HER) (the treatment group) and a matched sample of customers that did not receive a HER (the comparison group).

The Evaluation Team used a two-way linear fixed-effects regression (LFER) analysis to estimate program effects. We describe this analysis approach below. LFER analysis provides what is termed an "average treatment effect on the treated" (ATT) estimate of program savings, which 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 under the counterfactual, where the counterfactual is, "What would the treatment group's change between pre- and post-period energy consumption have been without the HER Program?" This analysis assesses 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/ATT approach takes advantage of the presence of a comparison group that is similar to participants who received reports in the SCE&G territory, and on which we have multiple measures of energy consumption both pre- and post-enrollment. The two-way fixed-effects modeling approach allows for the time-invariant household-level factors and month-year-invariant across household factors affecting energy use to be accounted for without measuring those factors and entering them explicitly in the models. These factors are contained in household-specific intercepts and month-year-specific intercepts in the equation. These intercepts are not reported because they are absorbed by the model as a way to significantly reduce the computation required to estimate the model parameters.

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 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 degree-days (HDD) and cooling degree-days (CDD), using a base of 65 degrees Fahrenheit for HDD and 75 degrees Fahrenheit for CDD. The model representing these factors in estimating average daily consumption (ADC) and its change would be:

Equation 1. Energy Savings Model

$$ADC_{it} = \alpha + \alpha_i + \alpha_m + \beta_1 Treatment_i \cdot Post\ Year_{it} + \beta_2 HDD_{it} + \beta_3 CDD_{it} + \beta_4 HDD_{it} \cdot Post_{it} + \beta_5 CDD_{it} \cdot Post_{it} + \beta_6 PreADC_i \cdot Post_{it} + \varepsilon_{it}$$

the first reports dated in 2011. The comparison group members were assigned first report dates randomly to match the duration of each cohort program year for HER Program participants, and the seasons covered pre- and post-participation.

Where:

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

α= Overall intercept

α_i= Household-specific intercept (absorbed)

α_m= Month intercept for each month-year combination (absorbed)

$Treatment_i$= Indicator variable for inclusion in the treatment group

$PostYear_{it}$= Indicators for years of participation after the first report date

HDD_{it}= Sum of heating degree-days (base 65)

CDD_{it}= Sum of cooling degree-days (base 75)

$Post_{it}$= Indicator for post-period

$PreADC_i$= Mean pre-period ADC for household i

β_{1-6}= Model coefficients

ε_{it} = Error

This model has several terms that were not included in the savings model for PY2: PreADC, Post*PreADC, Post*CDD, and Post*HDD. We added these terms to avoid omitted variable bias. Omitted variable bias occurs when there is a variable that is correlated with the outcome (ADC) and one or more of the independent variables, but is not included in the model. This can lead to biased estimates of the parameters for those independent variables that are correlated with the omitted variable. We added the variables to control for issues we found in comparison group equivalency in pre-period baseline consumption for PY2 and PY3.

There was much milder weather in the winters of 2012 and 2013, which can be seen in lower consumption for both the comparison and treatment groups during those winters. Because this occurred in only the post-period for PY1 and PY2 participants, we added the Post*HDD and Post*CDD terms to help control for the differences in weather between the pre- and post-periods.

Finally, we added a vector of month-year intercept term to help control for any differences between months that affected all participants (comparison and treatment) similarly.

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 (Equation 1 above) to estimate average daily consumption (ADC) under two conditions: 1) the comparison group in the treatment period, and 2) the treatment group in the treatment period. The first estimate was made by evaluating Equation 1 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 second estimate was made by evaluating Equation 1 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 KWH 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.[23] 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 endpoint of the post-participation billing periods). The Evaluation Team estimated savings using this model for each season covered by the pre- and post-periods for all Cohorts.

We applied savings for final bill customers up to the date that they moved, and for opt-out customers until the date that they decided to opt-out of the program.

Channeling Analysis

The HER Program promotes other SCE&G energy efficiency programs in program materials, and directs customers to SCE&G resources to sign up for these additional programs.

The purpose of a channeling analysis is to answer the following questions:

- Does the program treatment have an incremental effect on participation in other SCE&G residential energy efficiency programs (participation lift)?
- What portion of savings from the program treatment is double-counted by other SCE&G residential energy efficiency programs (savings adjustment)?

The savings tips provided in the reports could lead to additional program participation. If program materials were effective, we would expect to see a lift in participation in other SCE&G residential energy efficiency programs among program participants, or a higher rate of participation among the treatment group compared to the comparison group. Increased participation in other SCE&G energy efficiency programs among the treatment participants would mean that some portion of savings from other programs may be counted by both the HER Program (through the billing analysis savings estimate) and other SCE&G programs (through deemed savings in their tracking databases).

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 in PY3 compared to the pre-period (i.e., prior to receiving Home Energy Reports). 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. Programs under evaluation include:[24]

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[23] 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.

[24] This analysis does not include the ENERGY STAR™ Lighting Program. (Energy-efficient lighting sold through stores was not captured in our analysis, as the upstream lighting program component does not collect customer information.) This analysis also does not include the ENERGY STAR™ New Homes Program. (Rebates for this program were given to builders of new homes. Customers at the new home,

- Home Performance with ENERGY STAR™
- Home Energy Check-Up
- Heating & Cooling and Water Heating
- Efficiency Improvement

Through this database crossing, we determined whether each program household (both treatment and comparison groups) participated in any program in the pre-period and in PY3. The difference in treatment and comparison participation rates is considered participation lift (see Table 80 below).

Savings Adjustment Based on Participation Lift

The HER Program participants can save energy in three ways: 1) through conservation behaviors; 2) through measures installed outside of an energy efficiency program; and 3) through measures installed as part of other SCE&G energy efficiency programs.

Although savings through other energy efficiency programs may not have occurred in the absence of the HER Program (i.e., if the HER Program induces participation), these savings will still be counted by the other programs. The objective of the savings adjustment is to remove savings already captured in other program evaluations.

To determine the net savings component of the participation lift, the following steps were conducted:

- Step 1: Determine Overlap in Accounts: As with the participation lift analysis, the Evaluation Team cross-referenced the database of the HER Program, both treatment and comparison groups, with the databases of other SCE&G residential programs.
- Step 2: Evaluate Savings of Overlapping Accounts: Once the overlapping accounts were established, the per-measure (per-program) evaluated net deemed savings were applied to the installed measures to get the KWH savings for both the pre- and post-program period for the treatment and comparison groups.
- Step 3: Difference-of-Differences (DoD) Approach: Using the DoD approach, the Evaluation Team calculated the savings adjustments (see Table 80 below).

Table 80. Difference-of-Differences Estimator

HER Program	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)**

- Step 4: Calculate per-Household Adjustment: The savings adjustment values calculated were then divided by the modeled baseline consumption to get the household-level adjustment value.

if part of the treatment group, received reports after they occupied their home; thus, their decision to move into an energy efficiency home was not likely influenced by the HER Program).

The result of this database crossing and calculation is an adjusted net savings estimate, which is subtracted from the estimate of total program savings. Note that these channeled savings could be attributed to both the HER Program and other residential SCE&G programs, as they would not have occurred unless both programs were operating; however, for accounting purposes, only one program can claim these savings.

Appendix C. Detailed Heating & Cooling Billing Analysis Findings

One of the most robust approaches to determine savings from HVAC equipment is to use actual usage (KWH) billed to the customer. Similar to last year, the Evaluation Team calculated savings for the HVAC equipment through conducting a pre-post comparison of the participant consumption data. Specifically, we used a Longitudinal Fixed Effects Regression (LFER) model to determine average yearly energy savings. The LFER model derives yearly savings estimates by comparing average daily consumption across billing periods before program participation, known as the pre-period, with average daily consumption across billing periods after program participation, known as the post-period. Evaluating the model estimates the change in average daily consumption (ADC) between the pre- and post-periods. That estimate was multiplied by 30.4 to provide monthly figures, and by 365 to provide annual figures.

Billing analysis requires a full year of data both before and after an installation. Therefore, the participant group under analysis is comprised of customers from last year's program. However, prior to moving forward with this analysis we compared customers between last year and this year to ensure equivalency so the results would be applicable to PY3 participants.

We derived a number of possible models and selected the one with the most robust coefficients and best goodness of fit. Our LFER model of the average daily consumption of energy by household i in time t, ADC_{it}, depends on three variables: the binary variable $Post_{it}$, the average daily heating degree-days (HDD) of household i at time t, HDD_{it}, and the average daily 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. To increase the fit of the model, we estimated an equation that interacted Post with HDD and CDD, which estimates the effect of weather on usage (i.e., it estimates the increase in savings that occurs as the temperature becomes more extreme in the post-period).[25]

This model is as follows:

Equation 1. LFER Overall Model

$$ADC_{it} = \beta_0 + \beta_1 Post_{it} + \beta_2 HDD_{it} + \beta_3 CDD_{it} + \beta_4 Post_{it} \cdot HDD_{it} + \beta_5 Post_{it} \cdot CDD_{it} + \varepsilon_{it} \quad (1)$$

Where:

β_1 = Average change in usage in the post-period compared to the pre-period, controlling for other variables in the model

β_2 = Average effect of cold weather on usage

β_3 = Average effect of warm weather on usage

β_4= Average daily rate of change in usage that occurs with each increment of heating degree-days (HDD) in the post-period of household i at time t

[25] We compared the results from this model to a baseline model that included the weather variables but had no interactions. We found that our weather interactions model had improved goodness of fit statistics, as evidenced by higher R^2 and a lower Akaike information criterion score.

β_5= Average daily rate of change in usage that occurs for each increment of cooling degree-days (CDD) in the post-period of household i at time t

In this model, the effect of changing or adding equipment/measures to participant households, or the change in consumption from the pre- to post-period, is captured by our three variables that include Post. The overall treatment effect, when calculated on an annual basis, gives us an estimate of unadjusted gross savings (i.e., gross savings that is not adjusted for the baseline efficiency (e.g., SEER rating) of the replaced heating and cooling equipment).

In addition to the model specified in Equation 1, we also estimated an equation that included measure category variables in order to assess the change in consumption attributable to specific measure categories. Consistent with last year's report, we constructed a measure category variable with two values: one value (set to 1 for those installing heat pumps) representing heat pumps, and one value (set to 0 for other measures—air conditioners and furnaces) representing all other measures. We included this binary measure variable rather than all individual measures because increasing the number of predictor variables by using specific measures would reduce the model's degrees of freedom, which would affect the model's ability to make accurate point estimates, especially for the specific measures. Table 81 below highlights which measures installed through the program we assigned to each measure category.

Table 81. Installed Measures by Measure-Specific Variable Grouping

Measure	Binary Value	Count	Group Total
MH - Packaged - ASHP - SEER 14	Heat pumps	2	Group 1 "Heat Pump" 67%
MH - Packaged - ASHP - SEER 15	Heat pumps	1	
SF - GSHP - EER 19 ASHP Base	Heat pumps	8	
SF - Packaged - ASHP - SEER 14	Heat pumps	197	
SF - Packaged - ASHP - SEER 15	Heat pumps	38	
SF - Packaged - ASHP - SEER 16	Heat pumps	16	
SF - Packaged - ASHP - SEER 18	Heat pumps	1	
SF - Split - ASHP - SEER 14.5	Heat pumps	98	
SF - Split - ASHP - SEER 15	Heat pumps	723	
SF - Split - ASHP - SEER 16	Heat pumps	209	
SF - Split - ASHP - SEER 17	Heat pumps	93	
SF - Split - ASHP - SEER 18	Heat pumps	41	
SF - Split - ASHP - SEER 19	Heat pumps	13	
SF - Split - ASHP - SEER 20	Heat pumps	14	
SF - Split - ASHP - SEER 21	Heat pumps	5	
SF - Split - ASHP - SEER 22	Heat pumps	3	
SF - Split - ASHP - SEER 23	Heat pumps	6	
SF - Split - ASHP - SEER 25	Heat pumps	2	
SF - Packaged - DFHP - SEER 14[26]	All other measures	3	
MH - Packaged - Furnace/AC - SEER 14	All other measures	2	
SF - Packaged - Furnace/AC - SEER 14	All other measures	342	

[26] Note that we did not include dual-fuel heat pumps (DFHPs) 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.

Measure	Binary Value	Count	Group Total
SF - Packaged - Furnace/AC - SEER 15	All other measures	43	
SF - Packaged - Furnace/AC - SEER 16	All other measures	16	
SF - Split - DFHP - SEER 14.5	All other measures	1	Group 2
SF - Split - DFHP - SEER 15	All other measures	9	"Non-HP"
SF - Split - DFHP - SEER 16	All other measures	5	33%
SF - Split - DFHP - SEER 17	All other measures	5	
SF - Split - DFHP - SEER 20	All other measures	1	
SF - Split - Furnace/AC - SEER 14.5	All other measures	58	
SF - Split - Furnace/AC - SEER 15	All other measures	73	
SF - Split - Furnace/AC - SEER 16	All other measures	150	
SF - Split - Furnace/AC - SEER 17	All other measures	21	
SF - Split - Furnace/AC - SEER 18	All other measures	5	
SF - Split - Furnace/AC - SEER 19	All other measures	1	
Total			2,205

In the LFER model, including measure category, and specified in Equation 2 below, the average daily consumption by household i in time t, ADC_{it}, depends on four variables: the binary variable $Post_{it}$, the binary measure variable $Heat\ Pump_{it}$, the average daily heating degree-days (HDD) of household i at time t, HDD_{it}, and the average daily cooling degree-days (CDD) of household i at time t, CDD_{it}. To increase model fit, we derived an equation where we interacted Post both with our weather variables (HDD and CDD) and with heat pump. For the remainder of this report, we refer to this model as the measure-specific model.

Equation 2. LFER Measure-Specific Model

$$ADC_{it} = \beta_0 + \beta_1 Post_{it} + \beta_2 HDD_{it} + \beta_3 CDD_{it} + \beta_4 Post_{it} \cdot HDD_{it} + \beta_5 Post_{it} \cdot CDD_{it} + \beta_6 Post_{it} \cdot Heat\ Pump_{it} + \varepsilon_{it}$$

The additional interaction term in this model, with the coefficient β_6, captures the effect of installing heat pump measures on change in usage in the post-period (controlling for weather). Evaluating this model at the means of the weather variables, and sequentially setting the Heat Pump by Post value to 1 for participants installing heat pumps and to 0 for those installing other measures, allows us to estimate the effect of installing heat pump and non-heat pump measures in the post-period (controlling for weather). Specifically, estimating the pre-post difference in usage under each condition gives us estimates of savings for heat pump and non-heat pump measures. These values are not yet adjusted for the baseline efficiency of the replaced heating and cooling equipment.

We ran both LFER overall and measure-specific models on PY2 participants to determine the change in consumption from the pre- to post-period. The LFER overall model provides 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.

When doing a pre-post billing analysis after installing energy-rated equipment, the implicit model baseline is the replaced equipment. However, this does not yield the correct estimate of gross savings. Any equipment installed in 2013 would have been more efficient than the old, replaced equipment, regardless of the program. Therefore, it is necessary to adjust the billing analysis-based estimate by a factor based on current code standards. Specifically, we made a post-estimation 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 source of 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. If 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 between 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. As stated here, we needed the SEER rating of the replaced equipment to calculate a baseline adjustment factor. However, this information was available for PY1 and PY3 participants only, not PY2. Therefore, we used the mean SEER rating (SEER=10) of the replaced equipment in PY1 and PY3 and assigned it to the replaced equipment for all PY2 participants.[27] The current code minimum is SEER=13, and this was used for that term in the equation. The equation for calculating the baseline adjustment factor is located in Equation 3 below.

Equation 3. Baseline Adjustment Factor[28]

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

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[29]

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

[27] We chose to assign a SEER rating of 10 for all replaced equipment in PY2 based on analysis of SEER ratings for replaced equipment in both PY1 and PY3. In both program years, the mean SEER rating of replaced equipment was 10. Thus, we assume that the replaced equipment SEER rating in PY2 is no different from PY1 and PY3.

[28] Based on Agnew & Goldberg (2009). *Getting to the Right Delta: Adjustment and Decomposition of Billing Analysis Results*. 2009 Energy Program Evaluation Conference, Portland. 607-618.

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

ηReplaced Equipment= 10, which is the mean SEER rating of replaced equipment in PY3. We applied this to all replaced equipment in PY2.

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 deemed savings from the installation of equipment through the program, giving us an adjusted estimate of ex-post gross savings. To summarize, we developed the following three group-level adjustment factors:

1. **Overall baseline adjustment factor:** This is the weighted baseline 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 baseline 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 baseline 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 Equation 4 below.

Equation 4. 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

BAF = Unweighted 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

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 deemed savings values to arrive at a realization rate (RR), which could be used to adjust the deemed savings values in PY3 for all measures installed through the program. We calculated the realization rate as specified in Equation 5 below.

Equation 5. Realization Rate

$$\frac{Ex-Post\ Adjusted\ Gross\ Billing\ Analysis\ Savings}{Evaluated\ Deemed\ Savings} = RR$$

Program and Billing Data Review

The Evaluation Team received program and billing data from SCE&G for all program participants in PY2. 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 pre- and post-participation periods is located in Table 82 below.

Table 82. Participant Population and Comparison Period

Treatment Group	# of Potential Participants in Billing Analysis	Comparison Period
All PY2 participants	2,873	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 each participant's 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 2,029 participants for the PY2 analysis. A summary of the account drops made in the cleaning process is highlighted below.

Clean Program-Tracking Data

In cleaning the participant database for PY2, we encountered several minor data issues and took careful actions to address and correct each one to ensure that the billing analysis was not biased by these issues. The breakdown of the drops and counts is detailed in Table 83 below.

Table 83. Participant Database Cleaning Results

Participant Database	Unique Accounts
Initial #	2,873
Dropped if DSMAC status was not approved	200
# After Adjustment	2,673
Dropped if participated in *both* HVAC & EI	164
Dropped if participated in *both* HVAC & EID	26
Dropped if participated in *both* HVAC & HEC	47
Dropped if participated in *both* HVAC & HPWES	2
Dropped if participated in *both* HVAC & WH	16
# After Adjustment	2,418
Dropped if used in analysis of PY1	1
# After Adjustment	2,417
Unable to merge with billing data	10

Participant Database	Unique Accounts
# accounts remaining	2,407
# After Adjustment	2,407

Clean Participant Billing Data

The participant billing data used in the billing analysis comes from monthly billing data from October 2009 to December 2013, obtained directly from SCE&G. To develop the dataset used for the statistical analysis, the Evaluation Team conducted the following data-processing steps:

- Removed customers based on the following criteria:
  - Customer not found in the program-tracking database (and therefore had no PY2 participation flag)
  - All usage data fields missing
  - Extremely high or low KWH average daily usage (<2 KWH or >300 KWH)
- Checked for data issues such as negative usage, billing dates out of range, duplicate billing periods, overlapping billing periods, and long billing durations (greater than three months). We found no issues on these grounds.
- Assigned seasonal dummy variable to each of the monthly observations:
  - Summer: June, July, August
  - Non-Summer: All other months
- Using the pre-period, post-period, and seasonal indicators, we removed additional customers based on the following criteria:
  - No pre-period billing data
  - Less than two months of pre-period data in the summer period
  - Less than two months of post-period data in the summer period
  - Less than 12 billing periods in the pre-period
  - Less than 12 billing periods in the post-period

Table 84 below provides the results of the data cleaning effort for the billing analysis.

Table 84. Steps Taken and Accounts Dropping Billing Data Cleaning Process

Data Cleaning	#	%
Unique Accounts	**2,407**	
No Usage Data	0	0%
# accounts remaining	2,407	100%

Data Cleaning	#	%
Negative Usage	0	0%
# accounts remaining	2,407	100%
Billing Dates Out of Range	0	0%
# accounts remaining	2,407	100%
Duplicative Billing Dates	0	0%
# accounts remaining	2,407	100%
Overlapping Billing Periods	0	0%
# accounts remaining	2,407	100%
High ADC Overall (Overall ADC for account >300)	0	0%
High ADC in the Pre-Period Only	0	0%
High ADC in the Post-Period Only	0	0%
# accounts remaining	2,407	100%
Low ADC Overall (Overall ADC for account <2)	0	0%
Low ADC in the Pre-Period Only	1	0%
Low ADC in the Post-Period Only	0	0%
# accounts remaining	2,406	100%
Extremely long duration	0	0%
# accounts remaining	2,406	100%
No pre-program billing data	0	0%
# accounts remaining	2,406	100%
Insufficient pre-program billing data (less than 12 months)	125	5%
# accounts remaining (using 12 months)	2,281	95%
Insufficient post-program billing data (less than 12 months)	160	7%
# accounts remaining (using 12 months)	2,121	88%
Insufficient pre-program summer months (using two-month cutoff)	0	0%
# accounts remaining	2,121	88%
Insufficient post-program summer months (using two-month cutoff)	0	0%

Data Cleaning	#	%
# accounts remaining	2,121	88%
Low monthly pre-program ADC (more than 25% of months with ADC<2)	88	4%
# accounts remaining	2,033	84%
Low monthly post program ADC (more than 25% of months with ADC<2)	4	0%
# accounts remaining	2,029	84%
# After Adjustment	**2,029**	

In summary, we retained approximately 71% of PY2 participants, as shown in Table 85 below.

Table 85. Summary of Participants Used in Billing Analysis

Sample for Analysis	#
Initial Participant Count (from participation database)	2,873
Total Drops	844
Final N	2,029
% Remaining	71%

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 installation period, and the latest installation date as the end of the installation period.

The billing data we received from SCE&G were in approximately 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 installation period to the pre-treatment period, and assigned billing records with a bill read start date that occurred after the end of the installation period to the post-treatment period. The period between the start and end dates (the installation period) is deadbanded so that none of the usage during that period is modeled. We do this because the deadband period is a period of partial installation, when there may be partial savings that cannot be separated from normal usage (i.e., in cases where a participant received multiple installations, the period between the first and last installation was excluded from the analysis).

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 75 degrees Fahrenheit for days with an average temperature greater than 75 degrees Fahrenheit.

We obtained weather data for households through the website BizEE,[30] 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 weather station with adequate-quality data. In order to find the closest weather stations, we used ArcGIS[31] 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 each billing period captures the heating and cooling degrees for each day within that billing period (based on start and end dates). Because 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 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 adjusted gross savings for the three groups produced by the billing analysis, and adjusted post-estimation, to develop a realization rate.

An overview of the measures installed through the program for all PY2 participants and analyzed participants is located in

Table 86 below. For analyzed participants, we see that average evaluated deemed yearly savings is 553 KWH for all measures, 625 KWH for heat pump measures, and 404 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 86. Overview of Installed Measures – All PY2 Participants

Number of Measures Installed	3,146
Average Number of Measures Installed	1
Min Measures Installed	1
Max Measures Installed	3
Sum of Evaluated Deemed Yearly Savings for All Measures (KWH)	1,704,347
Sum of Evaluated Deemed Yearly Savings for Heat Pump Measures (KWH)	1,281,422
Sum of Evaluated Deemed Yearly Savings for Non-Heat Pump Measures (KWH)	422,925
Average Evaluated Deemed Yearly Savings for All Measures (KWH)	**550**
Average Evaluated Deemed Yearly Savings for Heat Pump Measures (KWH)	**624**
Average Evaluated Deemed Yearly Savings for Non-Heat Pump Measures (KWH)	**403**

[30] www.degreedays.net.

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

Table 87. Overview of Installed Measures – Analyzed Participants

Number of Measures Installed	2,205
Average Number of Measures Installed	1
Min Measures Installed	1
Max Measures Installed	3
Sum of Evaluated Deemed Yearly Savings for All Measures (KWH)	1,203,487
Sum of Evaluated Deemed Yearly Savings for Heat Pump Measures (KWH)	916,466
Sum of Evaluated Deemed Yearly Savings for Non-Heat Pump Measures (KWH)	287,021
Average Evaluated Deemed Yearly Savings for All Measures (KWH)	**553**
Average Evaluated Deemed Yearly Savings for Heat Pump Measures (KWH)	**625**
Average Evaluated Deemed Yearly Savings for Non-Heat Pump Measures (KWH)	**404**

We also analyzed the mix of measures installed through the program in PY2 and PY3 to determine whether, based on the distribution of measures installed in each program year, it would be feasible to apply the realization rate developed through this billing analysis to the evaluated deemed savings values for PY3. As can be seen in Table 88 below, the mix of measures installed in PY2 and PY3 is very similar, barring some slight differences.

Table 88. PY2 and PY3 Measure Mix

Measure	SEER Rating	Proportion of PY2 Measures Installed	Proportion of PY2 Measures Installed (by Tonnage)	Proportion of PY3 Measures Installed	Proportion of PY3 Measures Installed (by Tonnage)	Measure Group
ASHP	14-14.5	13.19%	13.35%	14.10%	14.04%	Heat Pumps
	15	33.44%	32.23%	38.06%	36.24%	
	16-18	15.51%	16.24%	14.83%	15.40%	
	19 and up	1.88%	1.06%	2.63%	1.63%	
GSHP	16-18	0.10%	0.06%	0.05%	0.03%	Heat Pumps
	19 and up	0.64%	0.69%	0.48%	0.51%	
DFHP	14-14.5	0.89%	0.96%	0.38%	0.46%	Non-Heat Pumps
	15	0.48%	0.48%	0.18%	0.25%	
	16-18	0.45%	0.43%	0.48%	0.52%	
	19 and up	0.03%	0.03%	0.08%	0.07%	
A/C Only	14-14.5	18.94%	19.99%	17.06%	17.97%	Non-Heat Pumps
	15	5.37%	5.75%	5.07%	5.47%	
	16-18	9.03%	8.65%	6.47%	7.24%	
	19 and up	0.06%	0.07%	0.15%	0.17%	
Total		100%	100%	100%	100%	

The proportion of SEER 14-14.5 and SEER 15 air source heat pumps installed increased in PY3. However, this increase was met with a small increase in higher-efficiency SEER 19+ air source heat pumps installed in PY3. Additionally, the proportion of AC-only (across all SEER levels) saw a small decrease. Barring these minor

differences, the proportion of measures installed in PY2 and PY3 is comparable, making it possible to apply the evaluated savings adjustment factor from PY2 to PY3 evaluated savings.

Billing Analysis Results

The results of the billing analysis for all measures are located in Table 89 below. The outcome of the LFER overall model, which normalizes the billing data by average weather in the post-period, shows average yearly gross savings of 1,656 KWH. These estimates show the change in consumption from the pre- to post-period.

Table 89. Billing Analysis Results for All Measures

Model Type	Model 1 Interactions of Weather X Period
Average Monthly Consumption in Pre-Period	1,467.63
Monthly Change in Consumption in Post-Period	137.94
% Yearly Savings	**9.40%**
Upper Bound % Yearly Savings @90%	10.06%
Lower Bound % Yearly Savings @90%	8.74%
Average yearly KWH Savings (Gross Savings)	**1,656.21**
Upper Bound Yearly KWH Savings @90%	1,771.99
Lower Bound Yearly KWH Savings @90%	1,540.43
Confidence Interval (CI) @90%	9.64
CI Upper Bound @90%	147.59
CI Lower Bound @90%	128.30
Relative Precision	7.0%

^ Denotes statistical significance at a 90% level of confidence.

The results of the LFER measure-specific model are located in Table 90 below. The outcome of measure-specific models shows average yearly gross savings of 2,221 KWH for heat pump measures, and average yearly gross savings of 585 KWH for non-heat pump measures. The coefficients for both measure-specific variables are statistically significant at a 90% level of confidence.

Table 90. Billing Analysis Results for Heat Pumps and Non-Heat Pumps*

Measure Group	Heat Pumps	Non-Heat Pumps
Average Monthly Consumption in Pre-Period	1,467.22	1,467.22
Monthly Change in Consumption in Post-Period	183.30	48.73
% Yearly Savings	**12.49%**	**3.32%**
Upper Bound % Yearly Savings @90%	13.42%	4.30%
Lower Bound % Yearly Savings @90%	11.57%	2.34%
Average yearly KWH Savings (Gross Savings)	**2,200.81**	**585.12**
Upper Bound Yearly KWH Savings @90%	2,363.72	758.00
Lower Bound Yearly KWH Savings @90%	2,037.90	412.24
Confidence Interval (CI) @90%	13.57	14.40
CI Upper Bound @90%	196.87	63.13
CI Lower Bound @90%	169.73	34.33
Relative Precision	7.4%	29.5%

^ 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 91 below. The weighted adjustment factors range from 40.56% to 47.20% for all measures, heat pump measures, and non-heat pump measures. When separating the measures by heat pump 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 91. Yearly Ex-post Gross Savings

Measure Group	Average Yearly Billing Analysis Gross Savings (KWH)	Weighted Baseline Adjustment Factor	Average Yearly Ex-post Billing Analysis Adjusted Gross Savings (KWH)
All Measures	1,656	0.456	755
Heat Pump Measures	2,201	0.472	1,039
Non-Heat Pump Measures	585	0.406	238

Realization Rates

Table 92 below shows the realization rates for each of the three measure groups. We see that the realization rates range from 59% to 166%, which suggests that the evaluated deemed savings values are over- or underestimated for certain measures. It is hard to identify which specific measures are over- and underestimated, because the measure-specific groups are broad, containing measures with a wide range of SEER ratings. For informational purposes, it may be of interest to learn that heat pump measures, in addition to apparently driving program savings, are also producing more savings than anticipated by the ex-ante estimates.

Table 92. Realization Rates

Measure Group	Average Yearly Ex-post Billing Analysis Gross Savings (KWH)	Average Yearly Evaluated Deemed Savings (KWH)	Realization Rate
All Measures	755	553	137%
Heat Pumps Measures	1,039	625	166%
Non-Heat Pump Measures	238	404	59%

Our analysis of measures installed in PY2 and PY3 allows us to apply the realization rates that come from the PY2 participants to the PY3 participants. In addition, this year we were able to model the different impacts of heat pump and non-heat pump measures. This makes it possible to apply different realization rates depending on the measure type. Thus, it is most appropriate to apply the realization rates by heat pump and non-heat pump installations.

Appendix D. HEC Program Methods for Capturing Savings from Previous Years

Opinion Dynamics conducted a telephone survey to follow up with PY1 and PY2 Home Energy Check-Up (HEC) Program customers who were surveyed in February and September of 2012. The primary purpose of this survey was the calculation of a rolling installation rate to understand whether participants who did not install the measures received in PY1 or PY2 had done so after the surveys were conducted. A secondary purpose of this survey was to capture persistence of already installed measures in order to help inform or adjust installation rates.

The sample frame consisted of 156 HEC Program participants who stated in previous surveys that they had not installed all measures received through the program. This applied to 67 of 101 PY1 participants who were surveyed in 2011, and 89 of 132 PY2 participants who were surveyed in 2012. The follow-up survey was fielded from September 25 to October 1, 2013, through the Opinion Dynamics Call Center. We called each of the HEC Program participants from the sample frame and completed interviews with 70 HEC Program participants (36 from PY1, 34 from PY2) with a response rate of 50%.[32]

Table 93 Sample

HEC Program	PY1 Participants	PY2 Participants	Total Participants
2012 Survey respondents	101	132	233
2013 Sample frame (2012 Survey respondents who had not installed all measures)	67	89	156
2013 Completed interviews	36	34	70

Installation Rates

To determine installation rates for outstanding measures not installed within a program year, survey respondents were asked how many program measures they had installed since they were last surveyed. The installation rate was calculated as follows:

$$Installation\ Rate = \frac{Number\ of\ outstanding\ measures\ installed}{Number\ of\ uninstalled\ measures}$$

Table 94 below presents the number of installed measures at two points in time. T1 represents survey results from 2011 (for PY1 participants) and 2012 (for PY2 participants). T2 results represent results based on findings in our recent survey. To calculate the number of installed measures, we applied the 2013 installation rates from Table 94 (Row E) to the number of measures that were not installed as per previous surveys. The total number of installed measures is the sum of measures installed in T1 and T2. The current rate of installed measures (in T2) is calculated as the verified installed measures in T2 over the number of tracked measures in T1.

[32] AAPOR Response Rate 3.

Table 94. Rolling Installation Rates for Leave-Behind Measures After T1 and T2

Step		CFL		Pipe Insulation		Water Heater Insulation Blanket		Total	
		PY1	PY2	PY1	PY2	PY1	PY2	PY1	PY2
2011/2012 Survey Results (T1)									
A	Total Measures Given in T1	20,300	26,720	870	1,155	723	881	21,893	28,756
B	Measures Installed within PY	13,189	14,613	653	744	492	503	14,334	15,860
C *(A- B)*	Number Not Installed within PY	7,111	12,107	218	411	231	378	7,560	12,896
2013 Survey Results (T2)									
D	Verified Number Installed in T2	2,571	3,915	65	206	84	236	2,720	4,356
Installation Rate of Measures Not Installed in T1									
E (D/C)		**36%**	**32%**	**30%**	**50%**	**36%**	**63%**	**36%**	**34%**

Additional Savings

The deemed savings assigned to the measures were 51.5 KWH and 0.0047 KW for each CFL bulb, 85.6 and 0.01 KW per foot for the hot water pipe insulation, and 360.8 KWH and 0.041 KW for water heater insulation blankets. Gross savings were calculated as the product of verified number of measures installed in T2 and respective deemed savings. The total net savings were estimated as product of total gross savings and the net-to-gross ratio (NTGR). The NTGR was 0.65 for KWH, and 0.79 for KW.

Table 95. Additional KWH Savings for Leave-Behind Measures in PY1 and PY2

HEC Program	Gross Savings (KWH)				Total Net Savings (KWH)
	CFLs	Pipe Insulation	Water Heater Insulation Blanket	Total	
Additional Savings from PY1 Participants	132,401	5,585	30,307	168,294	109,391
Additional Savings from PY2 participants	201,602	17,591	85,239	304,432	197,881
Total	**334,003**	**23,176**	**115,546**	**472,726**	**307,273**

Table 96. Additional KW Savings for Leave-Behind Measures in PY1 and PY2

HEC Program	Gross Savings (KW)				Total Net Savings (KW)
	CFLs	Pipe Insulation	Water Heater Insulation Blanket	Total	
Additional Savings from PY1 Participants	12.1	0.7	3.4	16.2	12.8
Additional Savings from PY2 Participants	18.4	2.1	9.7	30.1	23.8
Total	**30.5**	**2.7**	**13.1**	**46.3**	**36.6**

Appendix E. Detailed Efficiency Improvement Program Billing Analysis Findings

Program Data Review

The Evaluation Team received program and billing data from SCE&G for all Efficiency Improvement (EI) Program participants in PY1, PY2, and PY3. In reviewing the participant data, we identified the initial number of participants considered for analysis and based on the date of the duct replacement (November 1, 2011, through October 31, 2013). An overview of the participant population and summary of savings is located in Table 97 below.

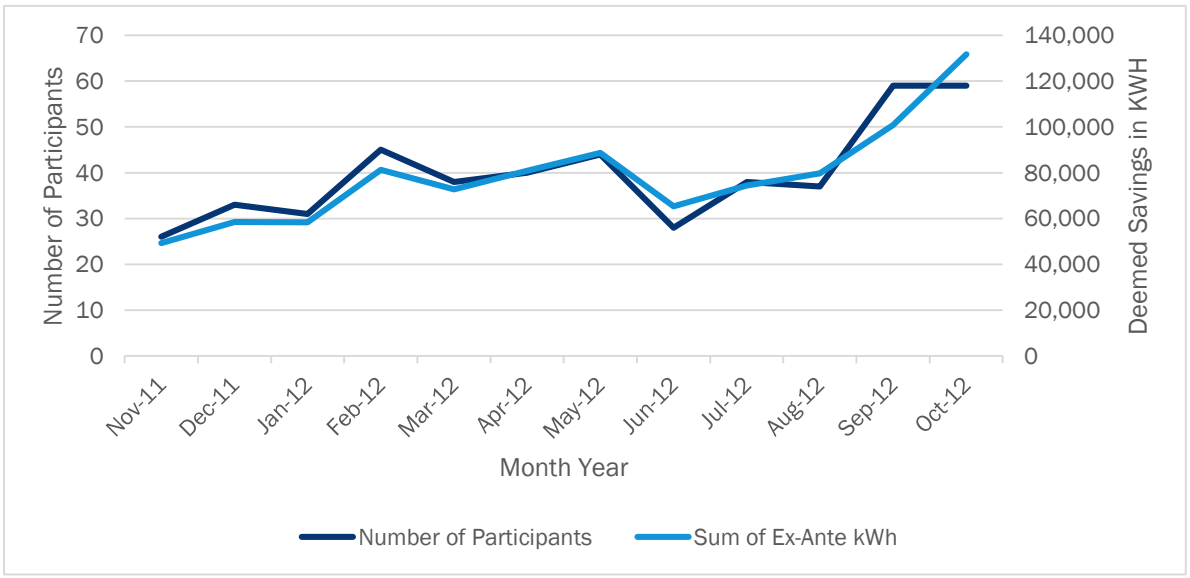
Table 97. Ex-ante Savings Summary for Duct Replacement

HP/AC	Accounts	Sum of KWH Savings	Sum of KW Savings	Average KWH Savings	Average KW Savings
AC	292	402,289	186.23	1,378	0.64
HP	184	532,386	118.60	2,893	0.64
HP&AC	2	6,629	2.26	3,314	1.13
Overall	478	941,304	307.10	1,969	0.64

Table 98. Ex-ante Deemed Savings per Ton

Heating Type	Savings (KWH/Ton)	Savings (KW/Ton)
AC	464.43	0.2150
HP	965.08	0.2150

Figure 6. Duct Replacement Participation by Month in PY2



Billing Analysis Methods and Model Specifications

The Evaluation Team compared pre-post consumption data using a fixed-effects regression on participant billing data. We determined the interactions by the fact that homes with heat pumps both heat and cool the home, whereas homes with AC's only cool.

Equation 1. LFER Model

$$\boldsymbol{ADC_{it} = \beta_0 + \beta_1 Post_{it} + \beta_2 Post_{it} \cdot HP_i + \beta_3 HDD_{it} + \beta_4 CDD_{it} + \beta_5 HDD_{it} \cdot HP_i + \beta_6 CDD_{it} \cdot HP_i + \varepsilon_{it}} \quad (1)$$

Where:

β_1 = Average change in usage in the post-period compared to the pre-period, controlling for other variables in the model

β_2 = Average difference in effect between homes with a heat pump versus an AC in the post-period

β_3 = Average effect of cold weather on usage

β_4 = Average effect of warm weather on usage

β_5 = Average difference in effects that cold weather has on usage between homes with a heat pump and homes with just an AC

β_6 = Average difference in effects that warm weather has on usage between homes with a heat pump and homes with just an AC

For individual regressions, we interacted Post with HDD and CDD. This further controls for changes in weather patterns during the pre-period and the post-period.

Equation 2. Individual Regression Model

$$C_{it} = \beta_0 + \beta_1 Post_{it} + \beta_2 HDD_{it} + \beta_3 CDD_{it} + \beta_4 Post_{it} \cdot HDD_t + \beta_5 Post_{it} \cdot CDD_t + \varepsilon_{it} \quad (2)$$

Where:

$\beta_4 Post_{it} \cdot HDD_t$= Average daily heating degree-days (HDD) by month in the post-period of household i at time t

$\beta_5 Post_{it} \cdot CDD_t$ = Average daily cooling degree-days (CDD) by month in the post-period of household i at time t

Data Preparation and Cleaning

Preparing the participant and billing data 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. A description of the process involved in preparing and cleaning the data for the billing analysis is as follows.

Participant Data

From the EI Program data, we isolated all individuals who received a duct replacement.

Table 99. Participation Summary

Participation	Number of Accounts	
	PY2	PY3
Total Unique Customers	1,026	1,179
Has Duct Replacement	424	841
Duct Replacement in PY2	374	104
Customers with Duct Replacement Installation Date in PY2	478	

The Evaluation Team needed to isolate participants who only had duct replacements. We searched for duct replacement participants within datasets from other SCE&G programs.

Table 100. Customers with Other Measure Installations Before and After Duct Replacement

Program Overlap	Customers with Other Measure Installations During or Before Duct Replacement	Customers with Other Measure Installations After Duct Replacement	Duct Replacement Only	Total
No Other Program Overlap	-	-	236	236
EI	4	4	-	8
HEC	17	2	-	19
HVAC	177	25	-	202
WH	8	5	-	13
Total	206	36	236	478

Billing Data

Because we want to include as much data as possible, we did not want to eliminate those participants who have other measures installed, if those measures were installed long enough before or after duct replacement. Rather than dropping the entire participant, the Evaluation Team instead deadbanded the periods. These deadbanded periods actually resulted in insufficient data in the pre- or post-period, and dropped anyways.

In order to clean the billing data, we performed the following steps:

- Removed duplicative and fixed overlapping billing records
- Removed billing records with negative consumption values
- Removed billing records with bill period durations of zero days
- Removed accounts with no billing data
- Removed accounts with insufficient pre-treatment billing data (defined as less than nine months overall or less than two months in summer with at least 30 days in each period)
- Removed accounts with insufficient post-treatment billing data (defined as less than nine months overall or less than two months in summer with at least 30 days in each period)

- Removed accounts with periods of unusually low or high usage

These drops are shown in Table 101 below.

Table 101. Summary of Billing Data Drops

Drop Reason	Overall		Other Measures Installed During or Before		Other Measures Installed After		Duct Replacement Only Measure Installed	
	# of Account	% of Account	# of Account	% of Account	# of Account	% of Account	# of Account	% of Account
Total Unique Accounts	478	0%	206	0%	36	0%	236	0%
No Billing Data	3	1%	1	0%	1	3%	1	0%
# of accounts remaining	475	99%	205	100%	35	97%	235	100%
All Billing Data Dead-banded	1	0%	0	0%	1	3%	0	0%
# of accounts remaining	474	99%	205	100%	34	94%	235	100%
Less than 9 Pre-Billing Periods	209	44%	192	93%	2	6%	15	6%
# of accounts remaining	265	55%	13	6%	32	89%	220	93%
Less than 9 Post-Billing Periods	31	6%	0	0%	24	67%	7	3%
# of accounts remaining	234	49%	13	6%	8	22%	213	90%
High Overall ADC > 300 KWH	0	0%	0	0%	0	0%	0	0%
High Pre ADC > 300 KWH	0	0%	0	0%	0	0%	0	0%
High Post ADC > 300 KWH	0	0%	0	0%	0	0%	0	0%
# of accounts remaining	234	49%	13	6%	8	22%	213	90%
Low Overall ADC < 2 KWH	0	0%	0	0%	0	0%	0	0%
Low Pre ADC < 2 KWH	0	0%	0	0%	0	0%	0	0%
Low Post ADC < 2 KWH	0	0%	0	0%	0	0%	0	0%
# of accounts remaining	234	49%	13	6%	8	22%	213	90%

Drop Reason	Overall		Other Measures Installed During or Before		Other Measures Installed After		Duct Replacement Only Measure Installed	
	# of Account	% of Account	# of Account	% of Account	# of Account	% of Account	# of Account	% of Account
Less than 2 Summer Billing Pre-Period	1	0%	1	0%	0	0%	0	0%
# of accounts remaining	233	49%	12	6%	8	22%	213	90%
Less than 2 Summer Billing Post-Period	1	0%	0	0%	1	3%	0	0%
# of accounts remaining	232	49%	12	6%	7	19%	213	90%
Less than 9 Months in Pre-Period Days	0	0%	0	0%	0	0%	0	0%
# of accounts remaining	232	49%	12	6%	7	19%	213	90%
Less than 9 Months in Post-Period Days	0	0%	0	0%	0	0%	0	0%
# of accounts remaining	232	49%	12	6%	7	19%	213	90%

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. We calculated HDD using 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. We calculated CDD using the difference between the daily average temperature and a base temperature of 75 degrees Fahrenheit for days with an average temperature greater than 75 degrees Fahrenheit. Prospectively, the Evaluation Team will work with SCE&G staff to adjust weather variables as appropriate.

We obtained weather data for households through the website BizEE,[33] 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 weather station with adequate-quality data. In order to find the closest weather stations, we used ArcGIS[34] to find the geographic coordinates of each

[33] www.degreedays.net.

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

household and then obtained the geographic coordinates for weather stations in South Carolina. Addresses that did not map well were assigned a weather station based on ZIP code.

LFER Results

We obtained annual savings (in KWH/ton) from the LFER model. We multiplied these values by the average tonnage per home to obtain estimates of annual savings per home.

Table 102. Complete Duct Replacement Ex-post KWH Savings Confidence Intervals

Heating Type	Number of Participants	Annual Savings (KWH/Ton)	Standard Error	95% Confidence Interval	
AC	152	342	78	188	495
HP	80	612	180	257	967

Table 103. Ex-post Annual Savings Estimate per Home

Heating Type	Average Tons per Household	Savings (KWH/Ton)	Annual Savings per Home (KWH)
AC	2.87	342	981
HP	2.84	612	1,737

Appendix F. Energy Information Display Program Detailed Methods

In this Appendix, we detail the evaluation activities conducted for the PY3 Energy Information Display (EID) Program.

Over the course of the program, 2,557 customers received an energy information display through the program. The program used two different devices and is now in its third year of implementation. During PY1 (December 1, 2010 – November 30, 2011), 507 residential customers received an energy information display device (Device #1 and Device #2). During PY2 (December 1, 2011 – November 30, 2012), Device #2 was mailed to 1,048 customers. In PY3 (December 1, 2012 – November 20, 2013), additional devices (Device #2) were mailed to 1,002 customers. While 1,555 participants enrolled in both the EID and Home Energy Report (HER) Programs, 1,543 participants received credit in the HER Program, as 12 participants had duplicate devices (see Table 105 below). Thus, of these 2,557 customers, 980 are claiming savings for the EID Program in PY3.

The evaluation effort focused on estimating PY3 impacts. The impacts were estimated by applying the results of the PY2 program cycle billing analysis.[35] Notably, not all participants receive full savings credit, as some had their final bill during the program year, returned their devices, or had more than one device in their home. Table 104 below details program participation and the total number of participants producing savings in PY3.

Table 104. EID Program Participants

EID Program	PY1 Enrollees (December 2010 – November 2011)	PY2 Enrollees (December 2011 – November 2012)	PY3 Enrollees (December 2012 – November 2013)	Total Devices in PY3	Notes
Total Enrolled Participants	**507**	**1,048**	**1,002**	**2,557**	
Receiving credit in the HER Program	411	902	242	1,555	Includes 12 duplicate devices
Full Savings Credit in PY3	77	133	736	946	
Partial Savings Credit in PY3	7	6	21	34	
No Savings Credit in PY3	12	7	3	22	
Total Producing Savings in PY3	**84**	**139**	**757**	**980**	Includes 7 returned devices for partial savings

A summary of the billing analysis results and application of those results for PY3 participants is detailed below.

- **Device #1 Impacts:** During the time of the PY2 analysis, Device #1 participants were in their second year of participation. The per-household savings estimated through the PY2 billing analysis was 471 KWH. These participants did not have a full year of post-program data in PY2, so the estimate of 471 KWH was calculated based on a period of 300 billing days. To apply this estimate to the PY3

[35] South Carolina Electric and Gas Residential Energy Information Display Program, Program Guidance Report, Year 2, June 2013. Prepared by Opinion Dynamics Corporation.

participants, the Evaluation Team extrapolated the savings to 365 days. This extrapolated savings of 573 KWH was then applied to the Device #1 participants still in the program in PY3.

- **Device #2 Impacts:** During the time of the PY2 analysis, Device #2 participants were in their first year of participation. Of these participants, a subset of participants received the device between November 1, 2011, and November 29, 2011, and had sufficient data to calculate savings through a partial year bill analysis. The per-household savings estimated through the PY2 billing analysis was 288 KWH. These participants did not have a full year of post-program data in PY2, so the estimate of 288 KWH was calculated based on a period of 300 billing days. To apply this estimate to the PY3 participants, the Evaluation Team extrapolated the savings to 365 days. This extrapolated savings of 349 KWH was then applied to the Device #2 participants still in the program in PY3.

Table 105 below details application of the billing analysis results to PY3 program participants. In PY3, there were seven participants who returned the energy information display. Given that these participants were in the program for part of the PY3 program cycle, the savings were estimated on a pro-rated basis based on when they returned the device, and depending on the device they received through the program.

Table 105. EID Program Savings Estimates

Device	Year of Participation in PY3	PY3 Participation Producing Savings	Available Billing Analysis Estimates	Partial Per-Participant Annual Net KWH Savings	Days in Post-Period Used to Estimate Partial KWH Savings	Extrapolated Per-Participant Annual Net KWH Savings
Device #2 PY3 Enrollees	First Year	757	First Year Partial Device #2 Savings	288	301	349
Device #2 PY2 Enrollees	Second Year	139	First Year Partial Device #2 Savings	288	301	349
Device #2 PY1 Enrollees	Second Year	0	First Year Partial Device #2 Savings	288	301	349
Device #1 PY1 Enrollees	Third Year	84	Second Year Partial Device #1 Savings	471	300	573
Total		**980**				

Appendix G. ENERGY STAR New Homes Ex-Post Program Evaluation Methodology

The ENERGY STAR New Homes Program evaluation for PY3 included the derivation of a linear regression model using ex-post savings data from 353 PY2 participants. The linear regression model is applied to all PY3 participants to calculate the ex-post gross savings. The following steps were taken to derive the linear regression model:

- **Step 1 – Develop PY2 Ex-post Energy Savings Using an Engineering Approach:** We obtained energy and demand savings for a sample of 70 PY2 participants, and calculated realization rates by running the existing building files against an IECC 2006 baseline using the REM/Rate or EnergyGauge modeling software. We applied the realization rates to the entire PY2 population, and included all 353 PY2 homes within the development of the linear model.
- **Step 2 – Develop Linear Regression Model Using a Statistical Approach:** We used a linear regression model to calculate savings from the program. Using inputs from the program-tracking database and results from Step 1, the statistical result is expressed as a formula that SCE&G could easily use to calculate PY3 savings as the homes were brought into the program.

Step 1 – Engineering Approach: Calculate PY2 Ex-post Energy Savings

The first step to developing the linear model was to create the dependent variable (i.e., the savings per home). Continuing with the standard approach we have used in the past for SCE&G and in other jurisdictions for residential new construction, we calculated a realization rate of ex-post (evaluated) savings to ex-ante (program-tracking) savings. To be cost-effective, we calculated the realization rate from a random sample of 70 PY2 participants. Once determined, we applied this realization rate to the PY2 population (a total of 353 participants) resulting in ex-post gross savings for PY2. The five-step process we deployed to determine the engineering-based realization rates is described below:

- Step 1a – Define the Appropriate Reference Home
- Step 1b – Request a Sample of REM/Rate and EnergyGauge Files from SCE&G
- Step 1c – Create Baseline Reference Home
- Step 1d –Energy and Demand Savings from Modeling Software
- Step 1e – Calculate Realization Rate and Extrapolate to the PY2 Population

Step 1a – Define the Appropriate Reference Home

The Evaluation Team determined that the 2006 International Energy Conservation Code (IECC 2006) current low-rise building code standards were in effect for the state of South Carolina at the time of the newly constructed homes.

As the market moves toward adopting more rigorous building energy codes, builders are challenged to meet code compliance, especially at the point of a new code being put in place. An ACEEE report indicates that code

compliance rates vary by state and range anywhere from 16% to 90%[36] for new construction buildings (Misuriello et al. 2012). We believe that homes built in South Carolina most likely do not exactly meet code. Obviously, the ACEEE report indicates the fact that there is a wide range of the number of homes meeting code. However, that report is silent on the degree to which code is not met (i.e., 16% of homes are 4% less efficient than code). Therefore, we performed additional research to see if we could find secondary data showing empirical data that represents the percentage below (or above) current code compliance for builders.

We scoured all our resources to look for this secondary data and found seven documents that had the potential for helping us with this issue. Table 106 below is a list of the resources we found.

Table 106. Resources Reviewed to Determine Compliance with Energy Building Codes

Title	Author	Year Published
Assessment of Energy Efficiency Achievable from Improved Compliance with U.S. Building Energy Codes: 2013 - 2030	Stellberg, Sarah	2013
Energy Efficiency Policies, Programs, and Practices in the Midwest	Midwest Energy Efficiency Alliance, Cullather, Kevin, et al.	2012
Impacts of the 2009 IECC for Residential Buildings at State Level	Pacific Northwest National Laboratory	2009
Indiana Commercial Energy Code Baseline Study	International Code Council, Meyers, Darren. Britt/Makela Group, Makela, Eric. Britt, Michelle.	2005
Measuring State Energy Code Compliance	Pacific Northwest National Laboratory	2010
Midwest Energy Codes Needs Analysis Report	Elnecave, Isaac	2010
Notes on Midwest Energy Efficiency Alliance Regional Building Energy Codes Conference	Midwest Energy Efficiency Alliance	2010

We found no existing data within these documents that helps us assign a specific value for code non-compliance and appropriately adjust the baseline. Lacking any specific research, we chose to keep baseline as the specific code (IECC 2006) and did not adjust our analysis to account for builders who do not build to code within the state of South Carolina.

Step 1b – Request a Sample of REM/Rate and EnergyGauge Files from SCE&G:

The Evaluation Team requested a random sample of PY2 participants from SCE&G and received a total of 70 building files (44 REM/Rate files and 26 EnergyGauge files) from which to build the analysis and evaluate energy and demand savings.

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[36] Original sources: Elnecave I., C. Baker, Carolyn Sarno, and Puja Vohra. 2012. "Enhancing Energy Code Compliance through Partnerships with Utilities." In *Proceedings of the 2012 ACEEE Summer Study on Energy Efficiency in Building.* Washington, DC: American Council for an Energy-Efficient Economy.

Stellberg,S., A. Cooper, Carolyn Sarno, and David Lis. 2012. "Role for Utilities in Enhancing Building Energy Code Compliance." *In Proceedings of the 2012 ACEEE Summer Study on Energy Efficiency in Buildings.* Washington, DC: American Council for an Energy-Efficient Economy.

Step 1c – Create the Baseline Reference Home

The program required that the home inspectors or raters input the characteristics of the home into HERS-accredited modeling software (REM/Rate or EnergyGauge) to generate a HERS score that verified compliance with SCE&G's ESNH program. Each software has its own limited capabilities for changing the baseline model, so we built baseline models using a different approach for each software.

The User-Defined Reference Home (UDRH) – For REM/Rate Files Only

The REM/Rate software includes embedded reference homes against which to run simulated homes; however, the Evaluation Team did not use this option due to a number of issues. The most significant issue is due to an auto-sizing feature in the software. The HVAC equipment is automatically sized as a variable of the infiltration rate and resulted in a non-comparable analysis between the baseline home (i.e., the one at the IECC 2006 standards) and the as-built home. Additionally, the embedded reference homes automatically reassign the window areas by assuming an equal percentage of glazing for each wall (25% of the total window area modeled for each wall). The actual window inputs in the as-built files are overwritten, and no longer result in a comparable analysis. Thus, for this evaluation, the User Defined Reference Home (UDRH) option in REM/Rate was used. The UDRH option allows the user to customize building inputs and compare them to the rated (as-built) homes. The UDRH was created using IECC 2006 code requirements (see Table 107 below).

Create Individual Baseline Files – For EnergyGauge Files Only

The EnergyGauge software has more limited capabilities, as it does not calculate energy savings against a reference home, but generates energy consumption for the modeled home only. Because of this, the Evaluation Team created a baseline file for each modeled home and compared the energy consumption to the as-built file to calculate the energy savings between the two homes. The newly created baseline file used the original inputs from the as-built file. The only changes made to the baseline file were those that are requirements to comply with the IECC 2006 code (see Table 107). Home characteristics such as window orientation, area distribution, square footage, and HVAC equipment capacity are the original assignments from the as-built files, and are unique to each participant.

IECC 2006 Reference Home Characteristics

South Carolina's minimum building code requirement for PY2 residential homes was the IECC 2006. This changed to IECC 2009 as of January, 2013 however many of the PY3 homes could have been permitted under the 2006 code. The Evaluation Team obtained the IECC 2006 manual to create and define the reference home used to determine the energy savings for the ENERGY STAR New Homes Program. In some cases, the Evaluation Team needed to source references outside of the manual. Table 107 below outlines the inputs used to create the reference homes for both REM/Rate and EnergyGauge modeled homes.

Table 107. IECC 2006 (Climate Zone 3) Baseline Home Characteristics

Measure	IECC 2006	Reference
Attic Insulation	U_o-value 0.035 (R-30)	IECC 2006 Table 402.1.3 for Uo-value IECC 2006 Table 402.1.1 for R-value
Exterior Wall Insulation	U_o-value 0.082 (R-13)	IECC 2006 Table 402.1.3 for Uo-value IECC 2006 Table 402.1.1 for R-value
Conditioned Basement Wall Insulation	U_o-value 0.36 (R-0)	IECC 2006 Table 402.1.3 for Uo-value IECC 2006 Table 402.1.1 for R-value
Unconditioned Basement Wall Insulation	U_o-value 0.36 (R-0)	IECC 2006 Table 402.1.3 for Uo-value IECC 2006 Table 402.1.1 for R-value

Measure	IECC 2006	Reference
Unvented Crawlspace Insulation	U_o-value 0.136 (R-5 continuous or R-13 framing cavity)	IECC 2006 Table 402.1.3 for U_o-value IECC 2006 Table 402.1.1 for R-value
Rim Joist Insulation	U_o-value 0.36 (Cond to ambient) Uo-value 0.36 (Uncond or Cond Basement to ambient) Uo-value 0.136 (Enclosed/unvented Crawlspace to ambient) Uo-value 0.36 (uncond/vented crawlspace to ambient)	IECC 2006 Table 402.1.3
Floor Insulation (over ambient)	U_o-value 0.047 (R-19)	IECC 2006 Table 402.1.3 for Uo-value IECC 2006 Table 402.1.1 for R-value
Slab Insulation	Uninsulated (R-0)	IECC 2006 Table 402.1.1 for R-value
Infiltration	0.00036 SLA	IECC 2006 Table 404.5.2(1)
Duct Leakage (supply/return)	12 cfm /100 sf of conditioned floor area Zero leakage if located in conditioned space	Howard, Eli P. III. SMACNA. "HVAC Air Duct Leakage". http://www.sheetmetalpartners.org/files/HVACDuctLeakage-Firestopping%5B1%5D.pdf
Duct Insulation	Supply/Return Ducts R-8 Ducts in Floor Trusses R-6	IECC 2006 Section 403.2.1
Windows	U-value 0.65 SHGC 0.40	IECC 2006 Table 402.1.1
Skylights	U_o-value 0.65	IECC 2006 Table 402.1.3
Interior Shade Factor	Summer 0.70 Winter 0.85	IECC 2006 Table 404.5.2(1)
Window Area/Orientation	Project-specific (same as as-built file)	No reference
Gas Furnace	78% AFUE	DOE Standards for Residential Furnace and Boilers; Table 1. http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/72
Air Source Heat Pump	13 SEER / 7.7 HSPF	DOE Standards for Residential Central Air Conditioners and Heat Pumps; Table 2. http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/75
Air Conditioner	13 SEER	DOE Standards for Residential Central Air Conditioners and Heat Pumps; Table 2. http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/75
Gas Water Heater	Calculated per participant using: EF = 0.67 – (0.0019*volume) Used same volume tank size as specified in as-built	Department of Energy Standards for Residential Water Heaters; Table 1 http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/27

Measure	IECC 2006	Reference
	If as-built is instantaneous water heater we used 50 gallon storage tank for baseline (same fuel as indicated in as-built file)	
Electric Water Heater	Calculated per participant using: EF = 0.97 – (0.00132*volume) Used same volume tank size as specified in as-built If as-built is instantaneous water heater we used 50 gallon storage tank for baseline (same fuel as indicated in as-built file)	Department of Energy Standards for Residential Water Heaters; Table 1 http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/27
Thermostat Settings	Cooling set point 75˚F Heating set point 68˚F	IECC 2006 Amendments. Jan 2009. Table 404.5.2(1)

The IECC 2006 building code requires duct sealing for residential homes to comply with Section M1601.3.1[37] of the International Residential Code (IRC). The IRC states:

> "M1601.3.1 Joints and Seams: Joints of duct systems shall be made substantially airtight by means of tapes, mastics, gasketing or other approved closure systems… Duct connections to flanges of air distribution system equipment or sheet metal fittings shall be mechanically fastened. Crimp joints for round ducts shall have a contact lap of at least 1.5 inches (38 mm) and shall be mechanically fastened by means of at least three sheet metal screws or rivets equally spaced around the joint."

The IRC does not specify minimum duct leakage in terms of airflow. A visual inspection of ducts is required to ensure that ducts are properly sealed. We relied on additional research from Sheet Metal and Air Conditioning Contractors National Association[38] (SMACNA) to quantify duct leakage in units of cubic feet per minute as a function of conditioned floor area.

We assume 1-inch water gauge pressure, as this is typical for residential applications. Using Table 108 below, we found the seal class to be C based on the 1-inch water gauge pressure assumption. We also assumed, because these are newly constructed homes, that the installed ducts are round metal type ducts, as this is most typical in residential homes. Using Table 108 we found the leakage class to be 12.

[37] International Residential Code (IRC). 2003. Section M1601 "Duct Construction". http://www2.iccsafe.org/states/Seattle/seattle_residential/PDFs_residential/Chapter%2016.pdf

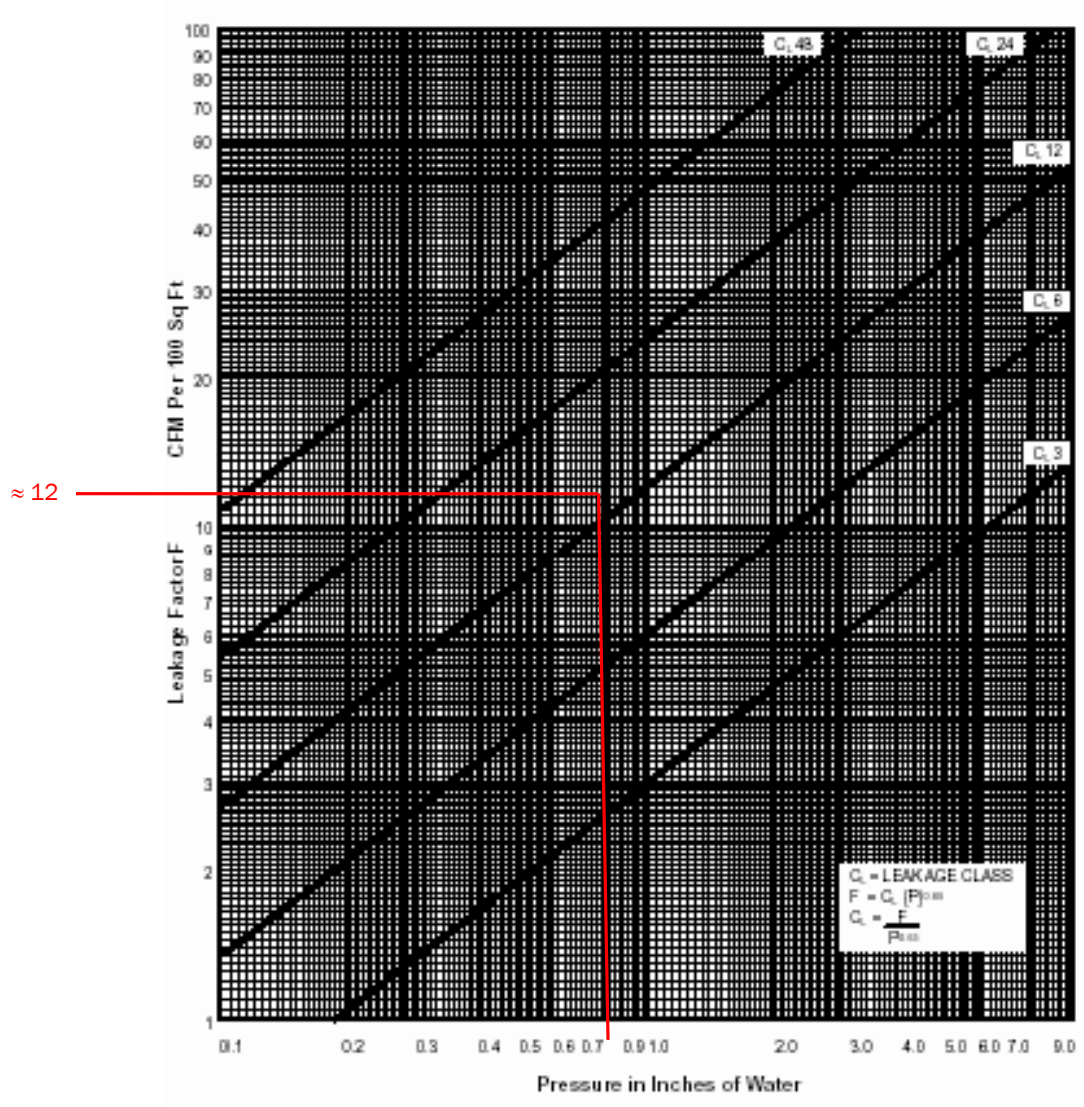
[38] Howard, Eli. Sheet Metal and Air Conditioning Contractors National Association. "HVAC Air Duct Leakage". http://www.sheetmetalpartners.org/files/HVACDuctLeakage-Firestopping%5B1%5D.pdf

Table 108. Leakage Classes from SMACNA

Duct Class	½", 1", 2" w.g.	3" w.g.	4", 6", 10" w.g.
Seal Class	C	B	A
Sealing Applicable	Transverse Joints Only	Transverse Joints & Seams	Joints, Seams & All Wall Penetrations
Leakage Class			
Rectangular Metal	24	12	6
Round Metal	12	6	3

Using Figure 7 below, we found the baseline duct leakage to be 12 cfm per 100 square feet of conditioned space. This value is what was used as duct leakage for the reference home, and is aligned with the duct leakage requirements for IECC 2009.

Figure 7. Duct Leakage Classification from SMACNA



Step 1d –Energy and Demand Savings from Modeling Software

Using the provided REM/Rate and EnergyGauge output files for the sample of 70 participants, the Evaluation Team recorded the total electric energy end-use consumption and total demand for the UDRH case (for REM/Rate files), baseline home (for EnergyGauge files); and the as-built case. The savings for each home is the difference between the UDRH or baseline home and as-built home's total energy and demand consumption at each site.

Step 1e –Calculate Realization Rate and Extrapolate to the PY2 Population

The Evaluation Team determined realization rates for participants whose home was modeled using REM/Rate and a separate realization rate for homes modeled using EnergyGauge. We calculated the realization rates by dividing the total evaluated savings in the sample by the total program-tracked savings for the same homes in the sample. The overall realization rate for the program, which was applied to all participants (353 participants) within PY2, is 0.67±0.03 (see Table 109 below).

Table 109. Leakage Classes from SMACNA

ENERGY STAR New Homes Program	REM/Rate	EnergyGauge
Gross Realization Rate	0.65	0.69
Standard Error	0.02	0.03
Error Bound	0.04	0.04
Low Realization Rate	0.61	0.65
High Realization Rate	0.69	0.73
Relative Precision	0.06	0.06
PY2 Population Ex-ante KWH	554,459	456,374
Ex-post Population KWH (Ex-ante * Gross RR)	358,461	314,153
Overall Program Realization Rate		0.67±0.03

The total PY2 ex-post savings for program participants are inputs into Step 2, developing the linear regression model. SCE&G used the linear regression equation to calculate the PY3 ex-post energy and demand savings.

Step 2 - Statistical Approach - Develop Linear Regression Model

Opinion Dynamics built the linear regression model to estimate savings for each participant based on the individual home information and the savings from the 353 SCE&G PY2 participants. Specifically, we built the linear regression model using the elastic-net regression method, which uses data from the PY2 participants to predict savings for PY3 participants. We chose the elastic-net method because it reduces savings prediction variance compared to the ordinary least-squares regression without substantially increasing bias, while still yielding simple-to-apply linear regression models. This method balances subset selection and coefficient shrinkage. Subset selection selects only the covariates that yield the smallest residual sum of squared error, yet prediction error is not usually substantially reduced. Shrinkage reduces the size of the regression coefficients while keeping all the covariates and typically reduces the prediction error substantially. Using both of these methods simultaneously yields relatively simple models (i.e., fewer covariates) that still have reasonably low prediction variance.

We developed the following linear regression equations, which we then applied for each participant in PY3 to obtain the ex-post gross energy and demand savings.

Equation 3. Ex-Post Gross KWH Energy Savings Linear Regression

$$KWH\ Savings = [((HERs\ Score * C_{HERs\ Score}) + (Slab\ Foundation * C_{Slab\ Foundation}) + (Total\ Square\ Footage * C_{Square\ Footage}) + (Number\ of\ Stories * C_{Stories}) + (Infiltration\ rate * C_{CFM50}) + (Ceiling\ Insulation\ R\text{-}value * C_{Ceiling\ R\text{-}value}) + (Window\ U\text{-}value * C_{Window\ U\text{-}value}) + (Electric\ Tankless\ WH * C_{E\text{-}Tankless\ WH}) + (Gas\ Storage\ WH * C_{G\text{-}Storage\ WH}) + (Dual\ Fuel\ Heat\ Pump * C_{DFHP}) + (Gas\ Furnace * C_{G\text{-}Furnace}) + (Cooling\ Output * C_{clg\ Output}) + (Number\ of\ Returns * C_{Returns})) + Intercept) * Realization\ Rate]$$

Equation 4. Annual Ex-post Gross KW Demand Savings Linear Regression

$$KW\ Savings = [((House\ Type * C_{House\ Type}) + (Vented\ Crawlspace\ Foundation * C_{Crawl}) + (Total\ Square\ Footage * C_{Square\ Footage}) + (Number\ of\ Stories * C_{Stories}) + (Ceiling\ Insulation\ R\text{-}value * C_{Ceiling\ R\text{-}value}) + (Wall\ Insulation\ R\text{-}value * C_{Wall\ R\text{-}value}) + (Window\ SHFC * C_{SHGC}) + (Electric\ Tankless\ WH * C_{E\text{-}Tankless\ WH}) + (Gas\ Storage\ WH * C_{G\text{-}Storage\ WH}) + (Dual\ Fuel\ Heat\ Pump * C_{DFHP}) + (Cooling\ Output * C_{clg\ Output}) + (Heating\ Output * C_{Htg\ Output}) + (Cooling\ SEER * C_{SEER})) + Intercept) * Realization\ Rate]$$

Where:

Intercept = Intercept from regression model

Realization Rate = Realization Rate extrapolated to the PY2 population; calculated using PY2 data from sample of 70 participants

HERs Score = Home Energy Rating System score for the home; generated using accredited software (i.e. REM/Rate, EnergyGauge)

House Type = Identifier indicating the house type is an attached-inside unit (1 = yes, 0 = no)

Slab Foundation = Identifier indicating the foundation of the house is slab (1 = yes, 0 = no)

Vented Crawlspace Foundation = Identifier indicating the foundation of the house is a vented crawlspace (1 = yes, 0 = no)

Total Square Footage = Total conditioned floor area of the home

Number of Stories = Total number of stories, or floors, per household that are conditioned

Infiltration Rate = Measured infiltration of the home in units of cubic feet per minute pressurized at 50 pascal

Ceiling Insulation R-value = Total attic or ceiling insulation R-value

Wall Insulation R-value = Total wall insulation R-value

Window U-value = U-value of the windows

Window SHGC = Solar Heat Gain Coefficient of the windows

Electric Tankless Water Heater = Identifier indicating whether the water heating equipment is an electric tankless unit (1 = yes, 0 = no)

Gas Storage Water Heater = Identifier indicating whether the water heating equipment is a gas storage unit (1 = yes, 0 = no)

Dual-Fuel Heat Pump = Identifier indicating whether the space heating equipment is a dual-fuel heat pump (1 = yes, 0 = no)

Gas Furnace = Identifier indicating whether the space heating equipment is a gas furnace (1 = yes, 0 = no)

Cooling Output = Capacity of the cooling equipment given in units of BTUh

Heating Output = Capacity of heating equipment given in units of BTUh

Number of Returns = Number of conditioned air return grilles in the home

Cooling Efficiency = Efficiency of the cooling equipment given in units of SEER

Table 110 below shows the specific coefficients within the KWH and KW models.

Table 110. ENERGY STAR New Homes Regression Model Coefficients

Independent Variables	Variable Name	KWH Coefficient	KW Coefficient
Intercept	Intercept	1,104.37	-0.2944
Realization Rate	Realization Rate	0.67	1.0000
HERs Score	$C_{HERs\ Score}$	-0.558	n/a
House Type	$C_{House\ Type}$	0.000	-0.0541
Slab Foundation	$C_{Slab\ Foundation}$	-102.45	n/a
Vented Crawlspace Foundation	C_{Crawl}	0.000	-0.0028
Total Square Footage	$C_{Square\ Footage}$	1.07	0.0004
Number of Stories	$C_{Stories}$	97.28	0.0266
Infiltration Rate (CFM50)	C_{CFM50}	0.037	n/a
Ceiling Insulation R-value	$C_{ceiling\ R\text{-}value}$	29.43	0.0013
Wall Insulation R-value	$C_{Wall\ R\text{-}value}$	0.000	-0.0054
Window U-value	$C_{Window\ U\text{-}value}$	-3,317.18	n/a
Window SHGC	C_{SHGC}	0.000	-1.5051
Electric Tankless Water Heater	$C_{E\text{-}Tankless\ WH}$	-572.37	-0.1518
Gas Storage Water Heater	$C_{G\text{-}Storage\ WH}$	136.90	-0.1125
Dual Fuel Heat Pump (DFHP)	C_{DFHP}	597.86	0.5547
Gas Furnace	$C_{G\text{-}Furnace}$	-1,114.57	n/a
Cooling Output (kBTUh)	$C_{Clg\ Output}$	-0.11	-0.0006
Heating Output (kBTUh)	$C_{clg\ Output}$	0.000	0.0005
Number of Returns	$C_{Returns}$	57.21	n/a
Cooling Efficiency (SEER)	C_{SEER}	0.000	0.0587

Appendix H. Home Performance with ENERGY STAR Billing Analysis Methods and Results

For the Home Performance with ENERGY STAR (HPwES) Program, the Evaluation Team conducted a pre-post comparison of the participant consumption data using a linear fixed-effects regression (LFER) model to determine average yearly energy savings. The LFER model derives yearly savings estimates by comparing the average daily consumption (ADC) by month before program participation, known as the pre-period, with average daily consumption by month after program participation, known as the post-period. The difference in average daily consumption from the pre- to post-period multiplied by 12 gives us an estimate yearly energy savings that can be attributed to program participation.

In the LFER model, the average daily consumption by month of energy by household *i* in time *t*, C_{it}, depends on three variables: the binary variable $Post_{it}$, the average daily heating degree-days (HDD) by month of household i at time t, HDD_{it}, and the average daily cooling degree-days (CDD) by month of household i at time t, CDD_{it}. 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 code standards for heating and cooling equipment. This model is specified as follows:

Equation 5. LFER Post Model 1

$$C_{it} = \beta_0 + \beta_1 Post_{it} + \beta_2 HDD_{it} + \beta_3 CDD_{it} + \varepsilon_{it} \quad (1)$$

To increase the fit of the model, we also estimated an additional equation. It 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. It also interacted Post with the average daily consumption of energy by month by household *i* in time *t*, C_{it}, which controls for the potential increase in savings as a product of the baseline energy use in the pre-period. This expanded model is as follows:

Equation 6. LFER Post Model 2

$$C_{it} = \beta_0 + \beta_1 Post_{it} + \beta_2 HDD_{it} + \beta_3 CDD_{it} + \beta_4 Post_{it} \cdot HDD_t + \beta_5 Post_{it} \cdot CDD_t + \beta_6 Post_{it} \cdot C_{it} + \varepsilon_{it} \quad (2)$$

Where:

$\beta_4 Post_{it} \cdot HDD_t$= Average daily heating degree-days (HDD) by month in the post-period of household i at time t

$\beta_5 Post_{it} \cdot CDD_t$ = Average daily cooling degree-days (CDD) by month in the post-period of household i at time t

$\beta_6 Post_{it} \cdot C_{it}$ = Average of average daily consumption by month in the post-period of household i at time t

We ran both pooled and individual LFER models on PY2 participants to determine the change in consumption from the pre- to post-period. The pooled models provide us with savings estimates at the group level for PY2 participants. The individual models provide us with savings estimates at the individual or household level for all PY2 participants. The results of the pooled model tell us, in aggregate, what the average change in consumption is that is associated with program participation for PY2 participants in their first year after installation.

The individual models provide us with individual estimates for average changes in consumption for each PY2 participant. The pooled models give us overall savings for each program year, while the individual models give us an idea of the range of savings achieved across program participants.

We then compared the LFER results with the engineering savings estimates produced by the BEACON software to determine the range of observed changes in consumption, in relation to the BEACON estimates, in both the pooled and individual models to get a rough idea of how close the two types of estimates are. We conducted this comparison by identifying:

- The percent of BEACON savings detected by the billing analysis for the pooled models[39]
- The percent of PY2 participants that saved more or less than the BEACON savings estimates, as detected by the individual models

The estimates cannot be precise because the BEACON estimates were adjusted for code baseline effects, while the billing analysis estimates were not. In addition, a more thorough modeling effort would include more participants, more time after participation, and economic factors that may influence energy consumption.

Program and Billing Data Review

The Evaluation Team received program and billing data from SCE&G for all HPwES Program participants in PY2. 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 periods of analysis is located in Table 111 below.

Table 111. Participant Population and Periods of Analysis

Treatment Group	# of Participants by Program Year	# of Potential Participants in Billing Analysis	Treatment Date Range	Comparison Period
PY2 participants with a July 2011 - Nov. 2012 install date	258	258	July 2011 - Nov. 2012	1 year pre-treatment, 1 year post-treatment

The program-tracking data shows that 258 households participated in the HPwES Program in PY2. The period of analysis for PY2 is 12 months before and after installation within the HPwES Program.

Data Preparation and Cleaning

Preparing the participant and billing data 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. A description of the process involved in preparing and cleaning the data for the billing analysis follows.

Cleaning Billing Data

In order to clean the billing data, we performed the following steps:

[39] This can be thought of as the realization rate, or the percent of BEACON savings detected by the billing analysis.

- Removed billing records with missing, negative, or zero consumption values
- Removed billing records with bill period durations of zero days
- Removed accounts with insufficient pre-treatment billing data (defined as less than nine months for the PY2 analysis)
- Removed accounts with insufficient post-treatment billing data (defined as less than nine months for the PY2 analysis)
- Removed duplicate participant and billing records
- Flagged accounts with periods of unusually low or high usage, and investigated reasons
- Identified accounts where billing periods overlap, and took appropriate actions to resolve the contradictions

Billing data was available for 228 (88%) of the 258 PY2 participants. Cleaning the billing data resulted in a total of 192 participants for the PY2 analysis. A summary of the account drops made in the cleaning process is highlighted in Table 112 below.

Table 112. Steps Taken and Accounts Dropped in Billing Data Cleaning Process

Billing Data Cleaning	Number of Accounts	% of Accounts
Total Unique Accounts	228	100%
Less than 9 Pre-Billing Periods	28	12%
# of accounts remaining	200	88%
Less than 9 Post-Billing Periods	5	2%
# of accounts remaining	195	86%
Low Pre ADC < 2 KWH	0	0%
High Pre ADC > 300 KWH	1	0%
Low Post ADC < 2 KWH	0	0%
# of accounts remaining	195	86%
High Post ADC > 300 KWH	0	0%
# of accounts remaining	194	85%
Less than 2 Summer Billing Pre-Period	1	0%
# of accounts remaining	193	85%

Billing Data Cleaning	Number of Accounts	% of Accounts
Less than 2 Summer Billing Post-Period	0	0%
# of accounts remaining	193	85%
Less than 9 Months in Pre-Period Days	1	0%
# of accounts remaining	192	84%
Less than 9 Months in Post-Period Days	0	0%
# of accounts remaining	192	84%

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 HPwES Program participation. In a program like this one, part of the post-treatment period can show only partial program effects because equipment is installed over a period of weeks or months. Because we cannot know the exact dates of each installation, it would not be possible to determine the effects of each separately or even in combinations. For this reason, we define a period that we call the "treatment period," where savings cannot be estimated. Therefore, that period is removed from analysis, leaving only the pre-treatment period and the post-treatment period. We used the month of the install date, the date by which all measures had been installed, as 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 with the treatment date is deadbanded, so none of the usage during that period is modeled.

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 75 degrees Fahrenheit for days with an average temperature greater than 75 degrees Fahrenheit.

We obtained weather data for households through the website BizEE,[40] which provides hourly weather data for weather stations throughout the United States based on National Oceanic and Atmospheric Administration

[40] www.degreedays.net.

(NOAA) weather data. We matched each household to the closest weather station with adequate-quality data. In order to find the closest weather stations, we used ArcGIS[41] 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 HPwES projects.

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 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.

LFER Pooled and Individual Results

The results from the pooled LFER analysis are located in Table 113 below.[42] The outcome of the post model 2, which normalizes the billing data by average weather in the pre- and post-periods and includes interaction terms for weather and pre-period consumption, shows average yearly savings of 10% for PY2. This estimate shows the change in consumption from the pre- to post-period. The savings estimates detected by the post model 2 results in average yearly KWH savings of 1,952 for PY2.

Table 113. Pooled LFER Results

Model Type	Model Interactions of Weather X Period, Average Consumption X Period
Average Daily Consumption in Pre-Period	53.45
Daily Change in Consumption in Post-Period	-5.35^
% Yearly Savings	**-10.0%**
Upper Bound % Yearly Savings @90%	-10.1%
Lower Bound % Yearly Savings @90%	-9.9%
Average Yearly KWH Savings	-1,952
Upper Bound Yearly KWH Savings @90%	-1,977
Lower Bound Yearly KWH Savings @90%	-1,927
Confidence Interval (CI) @90%	0.07
CI Upper Bound RR @90%	-5.42
CI Lower Bound RR @90%	-5.28
Relative Precision	1%

^ Denotes statistical significance at a 90% level of confidence.

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

[42] Note that negative values reflect savings, since they represent the change from the pre- to post-period.

The results from the individual LFER analysis are located in Table 114 below. We only used Model 1 to conduct the individual LFER analysis. The purpose of the individual LFER analysis is to gain an understanding of the range of savings that individual households achieved in the post-treatment period. The individual models tend to be less stable than the pooled models, because individual models have a significantly lower number of observations that can be used to make point estimates. Because of this, we decided to run the individual analysis using Model 1, which has fewer predictor variables, and as a result, a greater number of degrees of freedom.

The results from the individual LFER analysis show a very wide range of average yearly savings across households. The average was 7.18% for PY2. The maximum savings achieved by individual households was 47.01% in PY2. The individual models also show that usage actually increased for some participants in the post-treatment period. The highest increase in usage for individual households was 81% in PY2. The reasons for these increases can only be speculated, because we have no interviews on which to base an interpretation. It could be that these participants made the energy efficiency upgrades as part of a renovation that added conditioned square footage.

Table 114. PY2 Individual LFER Results

Model Type	Model 1 Controlling for Weather
Mean	-7.18%
Std. Dev.	14.3%
Max	-47.01%
Min	81.0 %
n	192

We divided the individual participants into the following three groups depending on how their consumption changed in the post-period: Positive Savers, Neutral Savers, and Negative Savers. Positive Savers saw decreased consumption in the post-treatment period, Neutral Savers saw a relatively flat level of consumption across the periods, and Negative Savers saw increased consumption in the post-period. The results of this analysis show, as highlighted in Table 115 below, that 73% of PY2 participants are Positive Savers and 19% are Negative Savers.

Table 115. Change in Individual Household Consumption

Group	n	%
Positive <= -1%	140	73%
Neutral < 1% & > -1%	15	8%
Negative >= 1%	37	19%
Totals	192	100%

Comparison with BEACON Estimates

After developing the savings estimates from the LFER pooled and individual models, we compared the results with the engineering estimates produced by the BEACON software. We conducted this comparison in two ways:

- Identifying the percent of BEACON savings detected by the billing analysis for the pooled models

- Using the results from the individual models to determine the percent of PY2 participants that saved more or less than the BEACON savings estimates

In comparing the BEACON estimates with the results of the pooled models, we divided the sum of the BEACON annual savings (KWH) for the measures installed for all analyzed program participants for each program year by the number of analyzed program participants for each program year. This gave us the total and average BEACON engineering savings estimates for each program year. An overview of the BEACON savings estimates for analyzed program participants is located in Table 116 below.

Table 116. Overview of BEACON Savings Estimates

BEACON Savings Estimates	PY2
Number of Participants in Final Billing Analysis	192
Number of Measures Installed	1,992
Average Number of Measures Installed	10.4
Min Measures Installed	4
Max Measures Installed	35
Sum of KWH Impact	498,501.9
Sum of KW Impact	190.05
Average KWH Impact	2596.364
Average KW Impact	0.99

Our comparison of BEACON estimates with the pooled model result is found in Table 117 below. Through the billing analysis we were able to verify 75% of BEACON savings for PY2.

Table 117. Pooled Model Comparison of BEACON and Billing Analysis Savings

BEACON and Billing Analysis Savings	PY2
Total BEACON Savings	498,501.90
Total Post Model 2 Savings	**374,779.78^**
Upper Bound Total Post Model 2 Savings	379,667.51
Lower Bound Total Post Model 2 Savings	369,892.06
Post Model 2 Realization Rate (RR)	**0.75**
Lower Bound Post Model 1 RR	0.76
Upper Bound Post Model 1 RR	0.74

^ Denotes statistical significance at a 90% level of confidence.

In comparing the BEACON estimates with the results of the individual models, we compared the estimated annual savings produced by the billing analysis with the annual BEACON savings located in the program-tracking data. The results of this analysis are located in Table 118 below, which shows that almost all analyzed PY2 participants saved less than the BEACON estimates.

Table 118. Individual Model Comparison of BEACON and Billing Analysis Savings

Savings	PY2	
Group	**n**	**%**
Saved More than BEACON	1	0.5%
Saved Less than BEACON	191	99.5%
Totals	192	100%

Measure Mix Analysis

We conducted an analysis of the mix of measures installed in each program year to get a sense for how differences in the types of measures installed affect savings. We compared the mix of measures installed by all PY2 participants to the measure mix of PY3 to get a sense for how the measure mix of this population compares to PY2 participants.

Table 119 below highlights the comparison of some measure mix data points. We find that PY3 participants have a slightly higher average number of measures installed, which corresponds to a slightly higher KWH impact of all measures installed for PY3 participants.

Table 119. Measure Mix Data Points by Program Year

Measure Mix Data Points	PY2	PY3
Number of Participants	192*	213
Number of Measures Installed	1,426	1,683
Average Number of Measures Installed	7	8
Min Measures Installed	1	1
Max Measures Installed	32	31
Sum of Yearly KWH Impact (est by BEACON)	498,502	549,231
Sum of Yearly KW Impact (est by BEACON)	190.05	207.91
Average Yearly KWH Impact (est by BEACON)	2,596	2,579
Average Yearly KW Impact (est by BEACON)	0.99	0.98

*Only includes those PY2 participants used for the billing analysis

Appendix I. Home Performance with ENERGY STAR Detailed Net-to-Gross Methods

The net-to-gross ratios (NTGRs) for the Home Performance with ENERGY STAR (HPwES) 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 are credited to customers who report being influenced by the program to complete additional energy-saving actions for which they did not receive a rebate from SCE&G. Spillover is represented as a percentage of gross savings from the program. The NTGR 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)[43] 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 to upgrade 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 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 8. 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.

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

Table 120. Overall Free Ridership Score for the HPwES Program

Measure Subgroup	Free Ridership Score	
	KWH	KW
Air Conditioning (n=25)	0.37	0.35
Air Sealing (n=49)	0.21	0.20
Duct System (incl. duct insulation) (n=43)	0.26	0.26
Insulation (excl. duct insulation) (n=47)	0.29	0.28
Water Heating (n=6)	0.40	0.40
CFLs (n=6)	0.41	0.41
Overall Program	**0.31**	**0.29**

Based on responses to the PY3 participant survey, the team did find evidence for small percentages of spillover among PY3 survey respondents (0.6% and 0.9% for KWH and KW, respectively). Potential spillover measures included installing a 17 SEER air source heat pump, 13-watt CFLs, and weather stripping/sealing on windows and doors. However, the billing analysis adjustment factor applied to gross savings in PY3 takes into account savings that the program may have indirectly influenced, including spillover. Therefore, the team did not credit these savings to the NTGR.

The NTGRs calculated for the program in PY3 were 0.69 for KWH energy savings and 0.71 for KW demand savings. Table 121 below provides an overview of our NTGR calculation.

Table 121. Overview of PY3 NTGR Calculation for the HPwES Program

Free Ridership (FR)		Spillover (SO)		NTG: (1-FR)+SO	
KWH	KW	KWH	KW	KWH	KW
0.31	0.29	Not Applicable		0.69	0.71

Appendix J. Detailed Methods for the C&I Prescriptive and Custom Program

Database Review

Overall, the program database accurately reflected the appropriate application of stipulated savings, with only three discrepancies within the sample:

- On one project, the Evaluation Team found that the data input as the per-unit impact was actually the total savings and not the per-unit savings. This resulted in the already-totaled savings then being multiplied by the measure quantity a second time, inflating the calculated savings by a factor of 87.
- Another participant received incentives for two different interior LED measures. While both measures were actually found to be installed in exterior applications, they were categorized as one each of "recessed, surface, pendant, or track downlight fixtures" and "PAR38 and PAR30 screw-in integral replacement lamps." The realization rates on these two projects both exceeded 100% for both energy and demand due to the difference in deemed load shapes for the evaluated interior LED measures and the more appropriate exterior LED measure.
- The third discrepancy came from one of the largest projects contributing to both the selected sample and the total program. When a measure is turned on all year (24/7), peak demand is simply calculated by spreading the energy savings out equally over the 8,760 hours in a year. For this site, that calculation produces a peak demand savings of 78.4 KW. However, the reported demand savings were only 3.5 KW, leading to a very high demand realization rate. When any measure specifies 8,760 hours of operation, the coincidence factor (CF) should be set equal to 1.0 for the peak demand reduction calculation. Including the coincidence factor as a field in the program-tracking database would help make this type of error more apparent and likely to be noticed by program staff.

On-Site Visits and Data Logging

The Evaluation Team installed data loggers at 16 of the 40 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 participant than metering the electric load of lighting fixtures. This approach is consistent with IPMVP Option A – Partially Measured Retrofit Isolation Protocols.[44] 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's operating schedule. Load shapes were developed from the lighting logger data, and were used to determine equipment consumption during the weekday afternoon peak demand window, 2 p.m. to 6 p.m. This technique allowed the Evaluation Team to measure a specific CF for each measure in the evaluation sample. Figure 9 below shows a lighting intensity logger installed to track the operating hours of an LED spotlight.

[44] *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.

Figure 9. Lighting Logger Installed to Measure the Operating Hours of LED Spotlights

Logging equipment was deployed for 10 to 12 weeks at each site between October 2013 and January 2014, and was extrapolated to calculate annual hours of use (HOU) for retrofitted fixtures. Adjustments were made to the logger data to account for the fact that the logging period contained a disproportionate number of holidays (including Thanksgiving, Christmas, and New Year's Day) compared to the rest of the year. Facility staff interviews were conducted and logger data was reviewed to understand facility closures on these weekdays. The operational schedule was adjusted to ensure that the holiday hours were only removed where applicable. Additional adjustments were necessary for several elementary schools in the evaluation sample to reflect the building schedules during summer vacation. In cases where logging equipment was not installed, the staff gathered typical operating schedules from facility staff for each affected space so annual HOU and CF could be calculated.

Project Desk Reviews

For HVAC projects, including chiller replacements and VFD retrofits, project-specific energy savings calculations were generated by incorporating information from interviews with facility staff, equipment specifications, and other sources of manufacturer's data, along with site-specific weather data. A load profile for each site was created and applied to site-specific TMY3 weather data.[45] Energy savings were calculated as the difference between the energy needed to meet the site's load using the installed efficient equipment and that of the appropriate baseline equipment. For retrofit projects like VFD installations, the baseline condition was defined as the pre-retrofit constant speed operation of the equipment. For "replace on burnout" measures such as chillers and unitary AC, it is assumed that the participant would have replaced the old equipment in the absence of the program, but that program incentives caused participants to select higher-efficiency models than would have otherwise been installed. In this scenario, baseline equipment efficiencies were assigned based on minimum code requirements in the state of South Carolina (IECC 2009). Peak demand savings were calculated by averaging the demand savings that occurred during the identified peak window (June through September non-holiday weekdays between 2 p.m. and 6 p.m.).

[45] TMY3 weather data is "Typical Meteorological Year" weather data maintained by the National Renewable Energy Laboratory. More information is available here: http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/.

For measures with energy savings independent of weather conditions, such as food service equipment, appropriate engineering equations for energy consumption were identified. Site-specific inputs like equipment KW, efficiency, and hours of operation were used as inputs to the engineering equations wherever possible. In the absence of site-specific data, industry literature, including Technical Reference Manuals (TRMs), was reviewed to guide assumptions. Energy savings were calculated as the difference between energy consumed by the installed equipment and the baseline equipment. These measures often exhibited uniform demand savings throughout the year, so the peak demand savings could be calculated as the average annual demand savings.

Evaluated Results

The gross impact evaluation used stratified ratio estimation[46] to develop estimates of program savings based on the results observed in the evaluation sample. Ratio estimation relies on the ratio of the evaluated savings to verified savings estimates to assess the rate at which reported savings are being realized. This ratio of evaluated savings to tracked savings in the evaluation sample is referred to as the realization rate of the program and is calculated as follows:

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

Energy and demand savings estimates were developed for each evaluated measure within the sample, based on metered data from the site as well as 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 are presented in Table 122 and Table 123 below. Approximately 28% of the reported energy and demand savings from the program were included in the evaluation sample.

Table 122. Sample Project Stratum KWH Savings and Error Ratios

Stratum	MWH Boundaries	Tracked MWH Savings	Verified MWH Savings	Realization Rate MWH*	Error Ratio
1 (Large)	> 220,131	24,655	22,532	0.938	0.41
2 (Medium)	> 40,131 and ≤ 220,131	11,119	10,162	0.809	0.44
3 (Small)	≤ 40,131	5,959	5,446	1.036	0.74
Total	**N/A**	**41,732**	**38,140**	**0.914**	**0.48**

* 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 strata realization rates do not equal the verified KWH divided by the total reported KWH for the stratum.

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

Table 123. Sample Project Stratum KW Savings and Error Ratios

Stratum	KWH Boundaries	Tracked KW Savings	Verified KW Savings	Realization Rate KW*	Error Ratio
1 (Large)	> 220,131	3,579.0	4,014.8	0.932	0.98
2 (Medium)	> 40,131 and ≤ 220,131	1,636.3	1,835.5	1.202	1.58
3 (Small)	≤ 40,131	1,050.4	1,178.2	1.954	1.29
Total	**NA**	**6,265.7**	**7,028.5**	**1.122**	**1.21**

*The clarification regarding realization rate calculations also applies to peak demand.

Net Savings

The net energy savings were determined by applying a net-to-gross ratio (NTGR) to the evaluated savings. The NTGR was calculated using data captured during participant interviews. As mentioned earlier, 91 interviews were conducted with participants, with 66 completed over the phone and 25 conducted during on-site visits. The NTGR is generated using the following algorithm:

NTGR = 1 - Free Riders + Spillover

Free Ridership

Free ridership occurs when participants receive incentives for projects that they would have done if the program did not exist. An example of a free rider would be a customer that learns about the incentive after they have purchased the new equipment. The Evaluation Team used survey data and information from in-depth interviews to calculate free ridership including questions related to when the customer learned about the incentive, how both program and non-program factors contributed to their decision-making process, and how important the incentive was to completing the project. The scores calculated for a survey respondent were applied to all of the projects that individual completed. The scores were then weighted based on project size to develop a program-level average.

Spillover

Spillover was calculated to include SCE&G customers participating in the EnergyWise for Your Business Program. Spillover savings are based on the installation of additional energy-efficient measures that are influenced by the program. Customers who reported that the program had an influence of 8 or greater on a 10-point scale are included in the spillover savings total. Additionally, customers who were found to have received rebates through the program for the indicated measures were excluded from this analysis.

Three participants out of the 99 who completed the survey specified that the program influenced them to install energy-efficient measures outside of the program without receiving a rebate. The Evaluation Team was unable to contact one participant, and therefore no spillover savings were calculated. One participant identified measures as spillover measures in the survey, but these measures were in place at the time when the rebates were calculated. Additionally, these measures were not approved to receive rebates through the program, so they are not eligible for spillover savings.

Table 124 below shows the equation used to calculate the energy savings for the one participant.

Table 124. Algorithm Used to Calculate Per-Unit Spillover Savings

Measure	KWH Savings Equation	KW Savings Equation[1]	Source[2]
Lighting Controls - Timers	KWH = ((Watts/1000)*WHFe*ΔHOU*# Fixtures)	n/a	NY TRM

[1] No KW savings, as this measure is dependent on the reduction in lighting hours.

[2] Equation was modified using lighting algorithms from the NY TRM to account for hours of reduction opposed to wattage reduction.

The total spillover savings for the SCE&G PY3 C&I Program are shown in Table 125 below.

Table 125. Total Spillover Savings for SCE&G PY3 EnergyWise for Your Business Program

Measure	KWH	KW
Lighting Controls - Timers	624	0.00
Total	624	0.00
Total Verified Savings for Surveyed Sample	8,585,261	1,447
% Spillover	0.01%	0%

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