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MEMORANDUM

December 21, 2012

To: Chris Ann Dickerson, Jim Flanagan

Re: Verification of Hawaii Energy 2011 Programs

Evergreen Economics is currently under contract with the Hawaii Public Utilities Commission (Commission) to conduct a comprehensive multi-year evaluation of the Hawaii Energy Conservation and Efficiency (Hawaii Energy) Program¹. The program is implemented by an independent third-party, SAIC, serving as the “Public Benefits Fee Administrator (PBFA)” under contract to the Commission. This memorandum provides the results of validation and verification activities that the Evergreen team conducted as part of the evaluation on energy efficiency programs implemented by Hawaii Energy for Program Year 2011.

1. Introduction

One component of the Program Year 2011 evaluation was to estimate energy savings by measuring and verifying the program’s energy savings claims. Our research to estimate the energy savings included:

- Technical Reference Manual (TRM) review;
- Savings database validation; and
- Measure installation verification.

This memorandum presents the results of the last two activities to estimate energy savings: the savings database validation and the measure verification. These two activities are typically performed as one component of a larger program impact evaluation. They are generally referred to as “verification” activities. They are intended to:

- Validate that the summary of program accomplishments matches the program tracking database;
- Confirm that the program is claiming savings based on the most recently approved values in the Program Year 2011 TRM dated August 14, 2012;

¹ www.hawaiienergy.com



- Verify that the program installed the measures for which savings were claimed;
- Determine that the installed measures are program-qualifying; and
- Verify savings for custom measures using engineering analyses.

These verification activities are distinguished from “measurement” activities that are intended to measure the energy savings from the program such as through equipment metering or analysis of changes in electricity bills and from analyzing the savings values approved for use in the TRM. These evaluation efforts are conducted on different schedules, apart from the verification activities described herein.

The combination of the results from these two verification activities, the **savings database validation** and the **measure verification**, comprises the **overall verification results** that are presented in this memorandum.

1.1 Background

The Hawaii Energy Program is operated by SAIC, the independent third-party contractor serving as the PBFA under contract to the Hawaii Public Utilities Commission. The Program Year 2011 Hawaii Energy portfolio, which ran from July 1, 2011 through June 30, 2012, consisted of seven programs, with four programs targeting the business sector and three targeting the residential sector.²

- **Business Energy Efficiency Measures (BEEM).** Provided prescriptive incentives to business customers who purchased and installed energy efficiency measures. The program paid incentive rebates for lighting, air conditioning, water heating, water pumping, motors, building envelope improvements, energy awareness, measurement and control systems, and ENERGY STAR business equipment.
- **Custom Business Energy Efficiency Measures (CBEEM).** Provided custom financial incentives based on calculated savings to commercial, institutional, governmental, and industrial sector customers.
- **Business Service and Maintenance (BESM).** Provided incentives and direct installation of measures to business in addition to business design, audits, and commissioning.
- **Business Hard to Reach (BHTR).** Provided equipment grants in addition to building owner, tenant and apartment/condo complex measures.
- **Residential Energy Efficiency Measures (REEM).** The program provided prescriptive incentives to residential customers who purchased and installed

² Hawaii Energy Conservation and Efficiency Programs. *Annual Plan Program Year 2011*. Submitted by Hawaii Energy on July 5, 2011.



energy efficiency measures. The program paid incentive rebates for prescriptive measures, including water heating, lighting, air conditioning, appliances, and awareness, measurement and control systems.

- **Residential Energy Services and Maintenance (RESM).** Provided incentives to direct installations, design and audits, and system tune-ups.
- **Residential Hard to Reach (RHTR).** Provided equipment grants in addition to landlord, tenant and apartment/condo complex measures.

SAIC also conducted various market transformation activities in Program Year 2011 designed to increase and further support projects that achieve energy reductions, demonstrate energy reduction capabilities, and/or provide on the job training for individuals within energy efficiency and energy conservation fields. No direct energy savings are claimed for these activities, and as such they are not included in the tables showing verified program savings throughout this memo. However, these market transformation activities were reviewed as part of the validation task as discussed in Section 3.1.

1.2 Overall Validation and Verification Results

The overall validation and verification results indicate that the program realized 101 percent of the energy savings claimed in the SAIC *Hawaii Energy Annual Report Program Year 2011* (Annual Report)³. There were cases where the program realized less savings than it claimed due to a variety of issues, but there were also cases where the program realized more savings than it claimed. The net effect was that the program realized slightly more savings than it claimed in the Annual Report. The results are presented in more detail in Section 3, including explanations for discrepancies between claimed and verified savings. Table 1 presents the overall verification results by program. The values shown in the table by column are:

- **Sector and Program**, which indicate the sector (residential or non-residential) and the Hawaii Energy program;
- **Claimed First-Year Net⁴ Savings** (kWh), which summarize the first-year energy savings claims from the Annual Report in kilowatt hours by program;
- **Verified First-Year Net Savings** (kWh), which summarize the overall verified energy savings by program, based on the combination of the savings validation and measure installation verification results; and

³ Submitted to Hawaii Public Utilities Commission, October 8, 2012. Net savings reported at the measure level in Attachment B of the Annual Report.

⁴ Net savings refer to the program-level savings reported by SAIC in their Annual Report and tracking data, which use a net-to-gross ratio of 0.73 across all programs and measures.



- **Percent Verified of Claimed Savings**, which presents the overall verified savings ratios by program, also reflecting the combination of the savings validation and measure installation verification results.

Table 1. Program Year 2011 Claimed and Verified First-Year Energy Savings, by Sector and Program

Sector	Program	First-Year Net Savings (kWh)		Percent Verified of Claimed Savings
		Claimed	Verified	
Non-Residential				
	Business Energy Efficiency Measures	34,929,190	35,267,460	101%
	Business Energy Service and Maintenance	2,045,013	2,057,135	101%
	Business Hard to Reach	1,657,404	1,675,686	101%
	Custom Business Energy Efficiency Measures	22,519,610	22,115,468	98%
	Non-Residential Total	61,151,217	61,115,749	100%
Residential				
	Residential Energy Efficiency Measures	65,511,035	66,877,382	102%
	Residential Energy Services and Maintenance	91,481	91,481	100%
	Residential Hard to Reach	2,032,234	2,021,151	99%
	Residential Total	67,634,750	68,990,014	102%
Program Overall		128,785,968	130,108,676	101%

Note: Claimed program-level net savings reported by SAIC in *Hawaii Energy Annual Report Program Year 2011*.

2. Research Methods

2.1 Overview

As described above, this memorandum presents results from three research tasks that were intended to evaluate the program's energy savings claims:

1. **Savings database validation.** We obtained a database from SAIC including program participants and energy savings values for Program Year 2011 and summarized the savings claims by program (e.g., REEM) and energy efficiency measure (e.g., ceiling fans) and compared that to SAIC's program and measure-level summary of its savings claims in the Annual Report. We also compared per unit savings values against the approved ("deemed") values in the approved Program Year 2011 TRM.
2. **Measure verification.** We conducted telephone and site surveys with statistically representative samples of participants by program. We also conducted site surveys of large non-residential customer projects to verify that measures contained in the program tracking database were actually installed, program-qualifying, operational, and the correct savings inputs and calculations were being used. For non-residential custom measures, we



conducted engineering analyses based on on-site surveys to confirm claimed savings.

3. **Hard-to-Reach Verification.** As part of our overall program savings verification, we conducted additional verification on the compact fluorescent lamps (CFLs) distributed under the RHTR program and Advanced Power Strips (APS) distributed through the BEEM, REEM, and RHTR programs. For Program Year 2011 this Hard-to-Reach verification was a streamlined review to ensure that tracking information is being recorded correctly and that equipment is being distributed in line with protocols established by the Commission's contract manager. In the next evaluation cycle for Program Year 2012, we will conduct a more extensive verification.

The combination of the results from these activities comprises the overall verification results that are presented below. The **savings database validation** provides a set of ratios by program and energy efficiency measure category that reflects the proportion of energy savings we verified in the program tracking database relative to the savings reported in Annual Report. The **measure verification** provides a second set of ratios, also by program and measure, that reflect the proportion of measures and their associated savings that we verified to be installed, program qualifying and with appropriate savings claims.

We multiplied the two sets of ratios to yield a final set of **overall verification and validation ratios** that are applied by program and measure to the values found in the Annual Report. The resulting savings are our independent assessment of the verified energy savings associated with Program Year 2011 operations.

2.2 Savings Database Validation

SAIC provided the evaluation team with the final data from its tracking system for the entire Program Year 2011. We used the data to generate an independent estimate of claimed savings and compared our estimate to that reported in the Hawaii Energy 2011 Annual Report.

The validation exercise included summarizing the measure installation counts and total savings in the tracking database and comparison to the Annual Report. There were multiple iterations of the database through early October 2012.

Similarly, the per unit savings values used in the Annual Report were also checked in the tracking data (for those measures included in the TRM) to ensure that the appropriate values from the TRM were being used for each measure and program. Finally, we attempted to replicate the net savings, and Total Resource Benefit (TRB) Ratio results from the Annual Report by conducting our own calculations for these parameters using the final tracking system data. We developed validation ratios based on the fraction of the claimed savings from the Annual Report that we



validated in the program tracking data based on approved savings values from the latest TRM.

kWh Savings for REEM Residential Peer Group Comparison

The basis for the Program Year 2011 Residential Peer Group Comparison savings from the TRM is expressed as a 1.73 percent reduction in a customer's annual kWh usage. Using the value approved in the TRM is consistent with the approach used in this verification to derive savings for prescriptive measures. The savings values in the TRM are assessed by the evaluation team as a separate evaluation task that precedes the verification effort. In order to validate the savings claims, we requested from the program the number of participating customers per month and the average monthly usage of participants. We then calculated the total validated savings as follows:

$$\text{Validated Savings for Residential Peer Group Comparison} = \sum_i \text{Participants}_i * \text{Usage}_i * 0.0173$$

Where:

Participants = Number of participants receiving home energy reports in month *i*

Usage = Average household baseline electricity usage (kWh) in month *i*

i = Index for month of participation

In the Annual Report, SAIC claimed savings based on calculations performed by Opower, the implementer of the Residential Peer Group Comparison, based on their own estimates of realized savings based on the difference in participant and control group billing data. The approach used in the Annual Report yielded a more conservative estimate of savings than the approved TRM value. However, in consultation with the Commission's contract manager for the Hawaii Energy program, the approved Program Year 2011 TRM value was used in this validation analysis to re-calculate savings for the Residential Peer Group Comparison program. The approved Program Year 2011 TRM value estimating a 1.73 percent reduction in annual energy use is consistent with the current evaluation literature.

We calculated a validation ratio for the Residential Peer Group Comparison program equivalent to the ratio of the validated savings using the TRM value to the savings claimed by the program in the Annual Report.

Note that as a separate task for the Program Year 2011 evaluation, we are conducting an independent measurement study of this program. We are also reviewing the program's savings calculations as part of our broader evaluation effort, and the results of this review will be provided in a separate memo. We may use those results to update the approved TRM value for subsequent program years if we find that measured savings are significantly different than the current TRM



value. This evaluation approach is consistent with the overall evaluation approach for deemed measures.

2.3 Measure Verification

The measure verification research methods included fielding telephone and site surveys, reviewing program participation records, confirming savings inputs and calculations and conducting engineering analyses. Below we provide an overview of the approach to sampling, data collection, and analysis.

2.3.1 Sample Design

We used program tracking data from the first three quarters of the 2011 program year as the basis for the first stage of the sample frame, from which we drew samples for the measure verification for all but the CBEEM program and large BEEM projects. We used this subset of the full-year program tracking database because the verification results were due in the fall of 2012, requiring us to pull the majority of our research samples before the close of the program year. Our intent was that the samples drawn from the first three quarters and the subsequent research results would be representative of the full-year program, since the program design did not change in the fourth quarter.

SAIC provided Evergreen an extract of the program tracking database covering the first three quarters on April 25, 2012. Additional participant-level information specific to the BEEM program was downloaded from the Salesforce database on May 14, 2012. We used this dataset to develop samples for phone and on-site surveys, which we used to verify the REEM, BEEM and CBEEM programs.

For the non-residential program, we supplemented the Q1-Q3 sample frame with large projects in the BEEM program and all projects in the CBEEM program recorded in the tracking database in Q4 of the Program Year 2011. We worked closely with SAIC over the summer to collect additional detailed information to support the sampling approach. We conducted on-site surveys of those projects, to ensure our sample included significant projects not included in the sample frame based on the first three quarters.

Table 2 below compares the first-year net energy savings covered by the sample to the total savings claimed by the program. The first two columns indicate the sector and program, the third column the first-year net energy savings claims represented by the sample, the fourth column the first-year net energy savings claims represented by the full-year participation database, and the fifth and final column the fraction full-year energy savings that is represented by the sample.

The sample represents 27 percent of the full-year program savings. Appendix B provides more detail on our sampling approach.



Table 2. Program Year 2011 Net Energy Savings for Measure Verification Sample as a Fraction of the Participant Population, by Sector and Program

Sector	Program	First-Year Net Savings (kWh)		Sample as a % of Total Program Savings
		Sample	Total Program Savings	
Non-Residential				
	Business Energy Efficiency Measures ¹	16,145,558	34,929,190	46%
	Business Energy Service and Maintenance ²	0	966,110	0%
	Business Hard to Reach	0	1,657,404	0%
	Custom Business Energy Efficiency Measures ³	² 9,441,581	⁶ 23,598,513	40%
	Non-Residential Total	25,587,139	61,151,217	42%
Residential				
	Residential Energy Efficiency Measures ⁵	9,431,288	65,511,035	14%
	Residential Energy Services and Maintenance ⁴	923	91,481	1%
	Residential Hard to Reach ³	380,692	2,032,234	19%
	Residential Total	9,812,903	67,634,750	15%
Total		35,400,042	128,785,967	27%

Notes:

¹ Sample pulled from Q1-Q3 data for small projects and from full-year data for large projects.

² The CBEEM sample included one project that was selected from the frame whose savings accrued to the BESM program, because its measure description indicated "CBEEM."

³ Sample pulled from the full-year data.

⁴ Sample pulled from Q1-Q3 data only.

⁵ Sample pulled from Q1-Q3 data for downstream customers and from full-year data for upstream CFLs.

⁶ The CBEEM sample frame included two BESM sites where their measure descriptions indicated "CBEEM."

2.3.2 Data Collection

The evaluation team implemented a variety of research methods to verify program measure installations and program qualifications. The research approach varied based on the type of customer.

Most of the program participants were "downstream" customers that resided in a residential home or operated a commercial, industrial, or government facility and received a rebate for program-qualifying equipment. Typically they mailed in a rebate application and were later mailed a check. The program also paid rebates directly to lighting manufacturers and distributors ("upstream" or "mid-stream" market actors) for compact fluorescent lamps (CFLs). The manufacturers and distributors then sold discounted product to lighting retailers. The retailers pass on that discount directly to customers who buy CFLs and receive their discount via a point-of-sale rebate that is redeemed instantly at the time of purchase.

Research methods used for the downstream customers included telephone surveys to confirm that customers received a rebate, bought program-qualifying equipment, and presently had the equipment installed and operational. Evergreen also conducted on-site surveys and reviewed project files to confirm savings for large and custom non-residential projects. For Program Year 2011 the Hard-to-Reach



verification was conducted as a spot check to ensure that tracking information was recorded correctly and that equipment was distributed in line with protocols established by the Commission's contract manager. For upstream CFLs, we performed a streamlined validation of invoices and measure descriptions to ensure that the quantities claimed matched the database and the Annual Report and that a sample of measures were found to be program-qualifying.

The following is a brief description of the methods we used to verify measure installations and program qualifications.

- **Telephone surveys.** SMS, a Hawaii-based telephone survey research firm, conducted computer-assisted telephone interview (CATI) surveys for both residential and non-residential customers in Summer 2012. The surveys included questions to verify that the customer had received a rebate for a program measure, installed the measure, and that the measure was still operable.

The telephone surveys were conducted with a sample of participants from REEM, RESM and small and medium projects from BEEM. For residential customers, to determine the allocation, we first constructed a proportional allocation of 350 sample points based on the percentage of energy savings of each measure/island combination. We then adjusted the target sample to ensure a minimum number of sample points by strata (geography and measure category) to arrive at the sample allocation. We increased the sample allocation for certain measure categories and Hawaii and Maui Counties to ensure adequate sample for islands other than Oahu.

The survey targeted 350 customers, addressing up to two measures per customer. For non-residential customers, due to the small number of participants across all islands, no sample allocation was made. Instead, a census of all retained participants was pursued in an effort to complete the target number of 50 surveys. Since the survey addressed up to two measures for participants who installed more than one measure, the number of completed surveys at the measure level was expected to exceed 50. SMS completed 380 residential surveys covering 401 measures and 50 non-residential surveys covering 59 measures.⁵

⁵ Note that for Program Year 2009 and Program Year 2010, we conducted a nested sample of on-site verification surveys for residential programs and small/medium projects within the BEEM program. We found very high verification rates. For Program Year 2011, we conducted only telephone verification surveys for this subsample of the participant population, reserving on-site surveys for the custom and large commercial projects. This freed up evaluation budget to be used for other purposes, notably a baseline study to assess appliance and equipment saturation, and building characteristics throughout the state.

- **Customer on-site surveys and document reviews.** We conducted a sample of on-site surveys of measures installed in non-residential locations for CBEEM and large BEEM projects. Michaels Energy based in Wisconsin conducted the on-site surveys to verify that the measures were installed, that they qualified for the program, and were operational.

The BEEM on-site sample was generated by taking a random stratified sample based on energy savings of projects from the 36 projects (representing 27 percent of total BEEM savings) with the highest savings from Q1-Q4.⁶ Five BEEM sites had on-site and document reviews, and five had document reviews only.

The commercial on-site surveys also supported the engineering analyses performed on all custom measures. During the on-site visits, the quantity of installed equipment was verified by inspection, and equipment nameplate information was recorded. These two pieces of information were used to ensure the installed equipment was consistent with the information presented in the application, and to determine if it was program qualifying. Additionally, we collected operational characteristics such as temperature set points, operating schedules, typical loading characteristics, baseline system equipment, and baseline system operational details. This information was used to verify the accuracy of any original calculations, and to determine if customer's actual operation was consistent with program assumptions.

For the CBEEM program, a random stratified sampling approach utilized four different strata based on energy savings that included all projects. Of the 278 custom projects, ten had both on-sites and document reviews, and five had document reviews only.

- **Upstream CFL verification.** We reviewed a random stratified sample of invoices representing the top 95 percent of savings included in the program tracking data to ensure that they matched invoice detail from the Salesforce database. For this sample of invoices we compared CFL quantities and savings against the invoice detail in Salesforce and confirmed that products are program-qualifying (e.g., matching the unique retail product number with the ENERGY STAR website.)⁷

⁶ The sample frame of the top 36 sites was pulled in two stages. First, the top 22 sites from the Q1-Q3 program tracking data were pulled, and then another 14 sites were pulled from the Q4 data. The cutoff point for both iterations was based on projects claiming more than 150,000 kWh savings.

⁷ This review was streamlined from our approach the prior two years, where we undertook a third stage where we requested actual invoices and did a more detailed review of a sample of invoices. We found both years that 100 percent of the invoices were validated against the program tracking data.



2.4 Hard-to-Reach Verification

As part of our overall program savings verification, we conducted additional verification work on the CFLs distributed under the RHTR program and Advanced Power Strips (APS) distributed through the BEEM, REEM, and RHTR programs. For Program Year 2011 this Hard-to-Reach verification was conducted to ensure that tracking information is being recorded correctly and that equipment is being distributed in line with protocols established by the EM&V contract manager. In the next evaluation cycle for Program Year 2012, we will conduct a more extensive verification of upstream equipment and will request upstream tracking information and documentation as part of our year-end data request.

The CFL and APS verification for Program Year 2011 was conducted in three parts:

1. Checking compliance with the documentation requirements set forth by the Commission's contract manager in a memorandum dated October 5, 2011;
2. Verifying quantities of equipment between tracking spreadsheets, final program data, and the Hawaii Energy Program Year 2011 Annual Report; and
3. Reviewing a sample of distribution logs from giveaway and exchange events and comparing quantities to the tracking spreadsheets.

To conduct the Hard-to-Reach CFL and APS equipment review, Hawaii Energy provided us with tracking spreadsheets with purchase and distribution information for both CFLs and APS along with documentation in PDF form of distribution logs from giveaway or exchange events in the community. Tracking spreadsheets for the full program year were provided, while only a sample of distribution logs were sent at our request.

To check compliance with the documentation requirements, Evergreen reviewed the tracking spreadsheets and distribution logs for information such as receipts for equipment purchases, number and description of units given to third parties, number and description of units distributed to end users, and dates and nature of distribution events.

After our review of documentation, we compared the quantities shown in the CFL and APS tracking spreadsheets to the quantities reflected in the Annual Report and the final program data. Finally, we reviewed the sample of distribution logs from community events and compared the quantities logged on paper to the quantities reflected in the tracking spreadsheets.

2.5 Analysis

We used the data collected from the surveys, project reviews, and invoice audits to develop verification ratios by program and measure category, which are the fraction



of energy savings that was verified to be installed and program-qualifying. Where samples were used, we developed sample weights so that results are reflective of the population of participating customers.

For **end-use customers**, a measure was counted as verified if:

- The respondent recalled receiving a rebate or we confirmed the respondent received a rebate check based on SAIC's database check fields;
- The measure was program-qualifying based on confirming the model number against program qualifications;
- The savings inputs and calculations were appropriate and accurate; and
- The equipment was still operable and in use.

For telephone surveys, we relied on customers to provide this information. We developed an initial verification ratio equal to the fraction of measures verified by telephone for each stratum.

For **large and custom commercial facilities** that were reviewed by engineers based on electronic project files and customer site surveys, we attempted to confirm the energy savings claims in the database. We reviewed vendor records, observed equipment size and specifications on-site and interviewed customers. We developed verification ratios for each project based on the energy savings that we could confirm. Where we could not confirm the energy savings, we relied on at least two sources of information (e.g., a site survey combined with a project file review).

We applied the verification ratios by program and measure that we developed based on the process described above to the final program tracking database, which covered the entire year. For upstream CFLs and RHTR measures, where we conducted a streamlined verification this year, we used the average over the residential sector savings (99 percent), which is very close to the 100 percent ratio that was used in the prior two years when we did more robust verification efforts.

3. Overall Verification Results

This section presents the overall verification results, which is the combined effect of applying the savings database validation research and the installed verification to the claimed savings numbers. As described previously, the overall verification results reflect our independent assessment of the verified energy savings associated with Hawaii Energy's Program Year 2011.

The results of the two steps of the verification, the savings database validation (step one) and the installation verification (step two), are discussed separately below.



3.1 Savings Database Validation – Step One (of Two)

The savings validation exercise was intended to provide an independent verification of the savings accomplishments from the Annual Report based on the final program tracking database extract provided by SAIC. We compared the results to the Hawaii Energy 2011 Annual Report by program and measure category.

Hawaii Energy reported first-year energy savings of 128,785,968 kWh in the Annual Report and the evaluation team validated 101 percent of first-year energy savings from the tracking database. We validated 100 percent of all measures with the exception of the REEM Residential Peer Group Comparison, which was validated at over 100 percent due to our calculation of savings using the deemed value in the TRM. Hawaii Energy claimed savings for the Residential Peer Group Comparison based on the estimated savings provided by Opower rather than the deemed value in the TRM. The savings claimed by Hawaii Energy for this measure is a total of 1,704,648 kWh based on savings estimated by Opower. When savings are calculated using the approved Program Year 2011 TRM value of 1.73 percent of baseline usage, program savings increases to 3,420,993 kWh. This difference in savings values is reflected in the 201 percent validation rate for this measure.

The validation task also included comparing kW savings and TRB values between the program tracking data and the Program Year 2011 Annual Report. All kW and TRB values were reviewed at the program and measure level and were validated at 100 percent of claimed values.

An additional validation task that we conducted was to review market transformation activities. SAIC provided a list of market transformation activities undertaken during Program Year 2011 for our review. Upon review of this list and consulting with the PBFA contract manager, we confirmed that Hawaii Energy has met the goal for Market Transformation.

3.2 Installation Verification – Step Two (of Two)

The verification surveys and engineering analyses resulted in a set of verification ratios that were used to adjust the savings claimed by SAIC in the Annual Report. The verification ratio represents the percentage of savings associated with the measures that we verified to be installed, program qualifying, and operational. We developed verification ratios for business sector programs at the project level, not the measure level. Results are shown at the program and measure levels. For the residential sector, we developed verification ratios at the measure level, and we provide results at the measure level.

We verified a total of 99 percent of residential and 100 percent of non-residential energy savings to be installed, program qualifying, operational, and with accurate savings claims based on the methods described above. A total of 100 percent of the



overall program savings were verified (a weighted average of results from the two sectors).

For the non-residential sector, we verified a total of 101 percent of BEEM, BESM and BHTR savings and 89 percent of CBEEM savings.

- For the CBEEM program, we sampled at the project level. We developed a verification ratio for the program based on weighting the sample results from the on-site surveys and engineering analyses, which represented 40 percent of the total claimed CBEEM savings.
- For BEEM, we combined the telephone and on-site survey results with engineering analyses to produce a verification ratio at the program-level by weighting the sample results, which represented 46 percent of the total claimed BEEM savings.
- We included one custom measure from the BESM (3 percent of total business program savings claims for all of BESM) program in the CBEEM sample, as mentioned previously, because the measure name included “CBEEM”. Otherwise, we did not sample from among the remaining BESM and BHTR (also 3 percent of total business program savings claims) programs. The telephone surveys are focused on simple prescriptive measures (BEEM and residential program), and the on-site surveys and engineering analyses focused on the largest projects. These programs combined also accounted for a very insignificant portion of program savings when we drew the Q1-Q3 sample frame. For BESM, we assigned the verification ratio from CBEEM for the custom lighting measure (98 percent), the BEEM chiller verification ratio (100 percent) for chillers and the overall BEEM verification ratio (101 percent) for the other measures. For BHTR, we assigned the verification ratio from CBEEM for the custom lighting measure (98 percent) and the overall BEEM verification ratio (101 percent) for the other measures.

As mentioned above, 100 percent of nonresidential program claimed savings were verified. This is a weighted average of project-level results, with a wide range of realization rates. For CBEEM, there were fifteen projects that we sampled (representing 40 percent of the sample, as stated above). For BEEM, we did on-sites and technical reviews for ten projects and phone surveys for 50 sites, (representing 46 percent of the sample, as stated above). Discrepancies between claimed and realized savings were due to the following reasons:

- A data entry error for a large custom site where an extra zero was added
- Lighting wattage entered as double the actual wattage for a large prescriptive site
- Incorrect operating hour look-up values applied to a multifamily building



- Comparing a high load baseline condition to a low load proposed condition for two cooling tower projects
- Incorrect lighting operating hours used for two custom lighting projects
- Incorrect fixture wattages used for two custom lighting projects
- A difference in the installed quantity of lamps for a large prescriptive lighting project
- Using the average building type instead of the applicable building type for prescriptive projects
- Using inappropriate project specific values for prescriptive projects

Evaluators typically find and correct a few errors of this type when conducting verification activities of the type described in this memorandum. Despite having identified and corrected the discrepancies mentioned above, we find that on the whole, program tracking was done properly and the correct values were applied.

The amount of variation in project level verification rates for the CBEEM program is common for this type of program. The two most common adjustments, differences in operating conditions or inappropriate baselines, are typical adjustments for custom projects. Due to the complexity of the projects and calculations, adjustments to projects will almost always lead to wide ranging realization rates.

The amount of variation seen in claimed versus verified savings with regards to the prescriptive BEEM projects was also typical. Prescriptive projects can and typically do have similar amounts of variation as custom projects. However, the adjustments are generally the same across building types or technologies. Due to several of the projects using “customized” inputs in the prescriptive calculations, the variability seen at the measure level was slightly higher than what is typically seen.

For the residential sector, we verified a total of 99 percent of REEM and RHTR and 100 percent of RESM program savings. There were three measures that were not verified based on the telephone surveys (3 sampled measures of a total of 380 surveyed customers and 401 sampled measures). These were either not installed, no longer operational or had been removed.

- For REEM, we included downstream customer rebate measures in the telephone survey sample. CFLs were delivered upstream and were verified by reviewing tracking data and invoice documentation. The peer group comparison program was verified by analyzing tracking data and additional information provided by SAIC. The smart strip event promotion (less than 0.5 percent of residential sector savings claims) was not verified, but documentation was reviewed as part of the RHTR verification. We developed measure-level verification ratios for the downstream customer rebate measures. For all other measures, we applied the overall residential sector program verification ratio (99 percent). This ratio is very close to the 100



- percent ratio for upstream CFLs that was developed for Program Year 2010 based on a more thorough verification of upstream invoice documentation.
- For RESM, we included downstream customer rebate measures in the telephone survey sample like we did for REEM. The efficiency home design measures that were given to builders (less than 0.5 percent of residential sector savings claims) were not verified. We applied the overall RESM verification ratio (100 percent) for this measure category.
 - For RHTR that distributed measures at events, we conducted a streamlined verification of SAIC's program documentation. We applied the overall residential sector program verification ratio (99 percent). This ratio is very close to the 100 percent ratio for RLI (the previous name of the program) that was developed for Program Year 2010 based on a more thorough verification of RLI invoice documentation.

Hard-to-Reach Verification Results

In our review of the CFL and APS documentation we found that, in general, the required tracking criteria were met either in the tracking spreadsheets or in the third-party distribution logs. The CFL documentation included all of the required information such as equipment purchase invoices, units distributed to third parties, and units distributed to end-users. The APS documentation contained most of the required information, but was lacking only in the area of number of units not yet distributed to end users, which was not clearly shown. Tracking documentation for both APS and CFLs included information on the original equipment purchase by Hawaii Energy; description of third-party events including location, date, and equipment distributed at each; and event logs showing individual end users and number of units received by each. Review of the sample of distribution logs from third parties indicated that equipment is being distributed according to policy rules.

Our comparison between the tracking spreadsheets, final program data, and Annual Report revealed that all CFLs and APS appear to be appropriately accounted for in each source. For the sample of event documentation that was reviewed we found that the quantities shown in the distribution logs matched the quantities reported in the tracking spreadsheets for events for which we had complete documentation.

Upon completion of our review of Hard-to-Reach tracking and documentation, we feel confident that CFLs and APS are being tracked properly and distributed in accordance with policy rules. For Program Year 2012, we will use these findings to inform a more robust verification effort.

3.3 Overall Verification Results

Table 3 shows the final verification results for the non-residential program, which are the combination of the savings database validation and the measure installation verification. The first two columns indicate the sector and program, and the third



column indicates the name of the measure (as reported in the tracking database). The fourth column shows the claimed first-year net energy savings. The fifth column is the energy savings as validated and verified by Evergreen, which was calculated by multiplying the validated savings (fourth column) by the verification ratio (fifth column). The sixth column shows the final ratio of verified and validated savings relative to the savings reported by SAIC in the Annual Report. To calculate the final ratio, we divided the verified and validated energy savings in this table by the claimed savings in the Annual Report. The last column shows each measure's percent of total validated and verified savings in the non-residential program.

Table 4 presents the verification ratio results for the residential programs. It also shows the overall ratio for both the non-residential and residential programs. The final column shows each measure's percent of total validated and verified savings in the residential program. Overall, the non-residential program accounts for 47 percent and the residential program accounts for 53 percent of total validated and verified savings.

The overall verification results are 102 percent of residential and 100 percent of non-residential savings were validated and verified based on the combination of research activities described in this document. The overall verification ratios shown here were applied to kW savings and net TRB by program and measure to arrive at the verified and validated kW and TRB values shown in Appendix A.

Table 3. Program Year 2011 Overall Verification Results by Program and Measure, Non-Residential Programs

Sector	Program	Measure	Claimed	Verified and	Verified and	Verified
			First-Year Net Energy Savings (kWh)	Validated Net First-Year Savings (kWh)	Validated % of Claimed Net First- Year Savings	Savings as % of Total Non- Residential Savings
Non-Residential (continued on next page)	Business Energy Efficiency Measures	CEE Listed Premium Efficiency Motors	67,116	67,839	101%	0%
		Ceiling Fan	20,594	20,594	100%	0%
		CFL	12,879,268	13,024,131	101%	21%
		Chillers	2,013,062	2,017,669	100%	3%
		Clothes Washer	48,686	48,915	100%	0%
		Commercial Kitchen Equipment	226,264	229,312	101%	0%
		Cool Roof Technologies	96,285	96,457	100%	0%
		Delamp/Reflector	926,038	933,329	101%	2%
		Delamping	201,165	202,413	101%	0%
		Dishwasher	7,920	7,975	101%	0%
		HID Pulse Start	442,675	446,642	101%	1%
		High Efficiency Water Heaters - Electric Resistance	130	131	101%	0%
		HVAC - Packaged/Split	2,157,062	2,178,004	101%	4%
		Induction	73,598	73,598	100%	0%
		LED	4,749,757	4,803,554	101%	8%
		Refrigerator	70,104	70,816	101%	0%
		Refrigerator with Recycling	205,893	205,911	100%	0%
		Sensors	93,121	93,864	101%	0%
		Smart Strip - Event Promotion	9,052	9,140	101%	0%
		Submetering	52,064	52,569	101%	0%
		T5 / T8HO	181,521	184,075	101%	0%
		T8 /T8LW	6,618,558	6,683,578	101%	11%
		VFD Applications	1,919,991	1,938,522	101%	3%
		VRF Split Systems	816,139	817,460	100%	1%
		Window AC	105,585	106,702	101%	0%
		Window Tinting	947,544	954,261	101%	2%
		Subtotal	34,929,190	35,267,460	101%	58%
	Businesses Service and Maintenance	Air Cooled Chiller	157,271	157,631	100%	0%
		CFL	11,816	11,949	101%	0%
		Chiller Plant Retrofits	921,632	923,742	100%	2%
		Custom Lighting	7,201	7,072	98%	0%
		FB40 to F17	18,954	19,141	101%	0%
		LED	229,936	232,541	101%	0%
		T8 /T8LW	698,202	705,061	101%	1%
		Subtotal	2,045,013	2,057,135	101%	3%

Sector	Program	Measure	Claimed	Verified and	Verified and	Verified
			First-Year	Validated Net	Validated %	Savings as % of
			Net Energy	First-Year	of Claimed	Total Non-
			Savings	Savings (kWh)	Net First-	Residential
			(kWh)		Year	Savings
Non-Residential (continued)	Business Hard to Reach	CFL	1,655	1,674	101%	0%
		Custom Lighting	7,386	7,254	98%	0%
		FB40 to F17	18,512	18,694	101%	0%
		LED	1,465,743	1,482,344	101%	2%
		T8 /T8LW	164,108	165,720	101%	0%
		Subtotal	1,657,404	1,675,686	101%	3%
	Custom Business Energy Efficiency Measures	Air Cooled Chiller	410,656	403,286	98%	1%
		Bi-Level Stairwell And Parking Garage Lighting	151,272	148,557	98%	0%
		Central Plant Optimization	164,356	161,406	98%	0%
		Chiller Plant Retrofits	295,210	289,912	98%	0%
		CO Garage Exhaust Control	5,902,799	5,796,866	98%	9%
		Commercial Lighting	381,186	374,345	98%	1%
		Customized Project Measures	279,944	274,920	98%	0%
		EC Motors and Controllers	241,744	237,406	98%	0%
		EMCS Linked Thermostats	139,737	137,229	98%	0%
		Fresh Water Pumping Motors	485,850	477,131	98%	1%
		Heat Pumps	60,254	59,173	98%	0%
		HID Pulse Start	12,034	11,818	98%	0%
		Hotel Guestroom HVAC Control	586,723	576,194	98%	1%
		HVAC Controls	2,671,083	2,623,147	98%	4%
		LED	4,042,531	3,969,983	98%	6%
		Low E Glass w/ Wall Insulation	2,643,692	2,596,248	98%	4%
		MR16	4,765	4,679	98%	0%
		PC Power Management	348,519	342,264	98%	1%
		Refrigeration	450,229	442,149	98%	1%
		Solar Thermal Dehumidification	249,960	245,474	98%	0%
		Solar Thermal Water Heating	152,441	149,705	98%	0%
		Submetering	53,837	52,871	98%	0%
		T5 / T8HO	385,293	378,379	98%	1%
		T8 /T8LW	878,957	863,183	98%	1%
		Vending Miser	3,989	3,918	98%	0%
		VFD Applications	1,522,548	1,495,224	98%	2%
		Subtotal	22,519,610	22,115,468	98%	36%
	Business Sector Total		61,151,217	61,115,749	100%	100%

Table 4. Program Year 2011 Overall Verification Results by Program and Measure, Residential Programs

					Verified and Validated % of Claimed Net First-Year Savings	Verified Savings as % of Total Residential Savings
Sector	Program	Measure	Claimed First-Year Net Energy Savings (kWh)	Verified and Validated Net First-Year Savings (kWh)		
Residential	Residential Energy Efficiency Measures	Refrigerator Trade-In and Refrigerator/Freezer Recycling - Bounty	3,569,799			
		Ceiling Fan	712,373	4,282,173	100%	6%
		CFL	398,218	398,218	100%	1%
		Clothes Washer	53,153,208	52,876,482	99%	77%
		Dishwasher	1,212,557	1,212,557	100%	2%
		Heat Pumps	48,770	48,770	100%	0%
		High Efficiency Water Heaters - Electric Resistance	295,144	295,144	100%	0%
		LED	10,847	10,847	100%	0%
		Refrigerator (Legacy & < \$600)	159,490	158,660	99%	0%
		Residential Peer Group Comparison	342,630	329,758	96%	0%
		Smart Strip - Event Promotion	1,704,648	3,403,183	200%	5%
		Solar Attic Fans	78,619	78,209	99%	0%
		Solar Thermal Water Heating	60,148	60,148	100%	0%
		Split System AC	3,278,371	3,244,558	99%	5%
		VRF AC Systems	205,435	205,435	100%	0%
		Whole House Energy Metering	88,842	88,842	100%	0%
		Whole House Fan	4,021	4,021	100%	0%
		Window AC	148,075	148,075	100%	0%
		Subtotal	39,841	32,303	81%	0%
		Subtotal	65,511,035	66,877,382	102%	97%
	Residential Energy Services and Maintenance	AC Annual Tune Up	3,399	3,399	100%	0%
		Efficiency Inside Home Design	24,517	24,517	100%	0%
		Solar Water Heater Tune Up	63,565	63,565	100%	0%
		Subtotal	91,481	91,481	100%	0%
	Residential Hard to Reach	CFL	1,683,615	1,674,849	99%	2%
		Smart Strip - Event Promotion	250,087	248,785	99%	0%
		Solar Water Heater- Direct Install and Solar Water Heating Inspections - WAP	87,128			
Subtotal		11,405	97,517	99%	0%	
Residential-Total	2,032,234	2,021,151	99%	3%		
Program Overall			67,634,750	68,990,014	102%	100%



Appendix A-Detailed Validation Tables

This appendix provides detailed data of Evergreen’s savings database validation and verification and calculation of Net TRB. The overall verification ratio for kWh savings is 101 percent, for kW savings is 100 percent, and for net TRB is 105 percent due to an upward adjustment for LED measure life as described below. SAIC’s claims in the Program Year 2011 Annual Report for net kWh, net kW, and net TRB were 128,785,968 kWh, 17,260 kW, and \$127,957,545 respectively.

A. 1 Non-Residential Programs

Table A-1 shows Evergreen’s independent estimate of measure installation counts and savings for the non-residential programs. The evaluation team used the final data from SAIC’s tracking system for entire Program Year 2011 to generate the data in the table. The table shows the following data:

- The first two columns indicate the program and measure. Measures without claimed kWh or kW savings are excluded from the table.
- The third column (labeled A) shows the number of measures installed—the subtotal and total lines show the summed number of measures.
- The fourth column (labeled B) shows the number of participants, in this case, the number of businesses that received rebates—the subtotal and total lines show the summed number of measures.
- The fifth and sixth columns (labeled C and D) show the net kWh savings per unit and net kW savings per unit, respectively.
- The seventh column (labeled E) shows the overall verification ratio, as reported in Table 3 of this memorandum. It represents the portion of savings for each measure that Evergreen verified to be installed and program qualifying.
- The eighth and ninth columns (labeled F and G) show verified and validated net savings, in kWh and kW, respectively. The figures are the product of the number of measures and the net kWh per-unit savings (or the net kW per-unit savings) and the verification ratio—the subtotal and total lines show the summed number of savings.
- The tenth column (labeled H) shows the effective useful life (EUL) for each measure, as specified in the TRM—the subtotal and total rows show the EUL for that category.
- The final column (labeled I) shows the verified and validated net Total Resource Benefit (TRB).



Table A-1 also reflects one adjustment made based on an engineering review of the TRM:

- LED useful life: The measure life for LEDs is listed at five years in the Program Year 2011 TRM. However, review by Michaels Energy indicated that this was not an appropriate measure life and LEDs are generally known to have a lifetime much longer than this. Based on a review of measure life used for LEDs in other jurisdictions, we assumed a measure life of 15 years for LEDs in the BEEM, BESM, and BHTR programs for the purposes of our verification. This is a relatively conservative assumption and a more formal recommendation will be made for an adjustment to the TRM for subsequent program years at a later time. This measure life of 15 years was used only to recalculate the average EUL and net TRB values presented in Appendix A, since measure life does not affect first year savings but does affect the TRB. This adjustment to TRB for LEDs resulted in an overall verification ratio for net TRB of 105 percent, slightly higher than the overall verification ratio for kWh and kW savings of 101 percent.

A. 2 Residential Programs

Table A-2 shows Evergreen’s independent estimate of measure installation counts and savings for the residential programs. The evaluation team used the final data from SAIC’s tracking system for entire Program Year 2011 to generate the data in the table. The table shows the following data:

- The first two columns indicate the program and measure. Measures without kWh and kW savings are excluded from this table.
- The third column (labeled A) shows the number of measures installed—the subtotal and total lines show the summed number of measures.
- The fourth column (labeled B) shows the number of participants, in this case, the number of households that received rebates—the subtotal and total lines show the summed number of measures.
- The fifth and sixth columns (labeled C and D) show the net kWh savings per unit and net kW savings per unit, respectively.
- The seventh column (labeled E) shows the verification ratio, as reported in Table 4 of this memorandum. It represents the portion of savings for each measure that Evergreen verified to be installed and program qualifying.
- The eighth and ninth columns (labeled F and G) show verified and validated net savings, in kWh and kW, respectively. The figures are the product of the number of measures and the net kWh per-unit savings (or the net kW per-unit savings) and the verification ratio—the subtotal and total lines show the summed number of savings.



- The tenth column (labeled H) shows the effective useful life (EUL) for each measure, as specified in the TRM—the subtotal and total rows show the EUL for that category.
- The final column (labeled I) shows the verified and validated net Total Resource Benefit (TRB).

Table A-2 also reflects two adjustments made based on an engineering review of the TRM:

- **LED useful life:** The measure life for LEDs is listed at five years in the Program Year 2011 TRM. However, review by Michaels Energy indicated that this was not an appropriate measure life and LEDs are generally known to have a lifetime much longer than this. Based on a review of measure life used for LEDs in other jurisdictions, we assumed a measure life of 15 years for LEDs in REEM program for the purposes of our verification. This is a relatively conservative assumption and a more formal recommendation will be made for an adjustment to the TRM for subsequent program years at a later time. This measure life of 15 years was used only to recalculate the average EUL and net TRB values presented in Appendix A, since measure life does not affect first year savings but does affect the TRB. This adjustment to TRB for LEDs resulted in an overall verification ratio for net TRB of 105 percent, slightly higher than the overall verification ratio for kWh and kW savings of 101 percent.
- **kW savings for REEM Heat Pumps:** The Program Year 2011 TRM was updated to correct the customer-level kW savings for heat pumps from 0.28 kW to 0.21 kW per unit, but the change was not carried over into the final program data. Evergreen was going to make an adjustment for this in the verification, but since only program-level (net) as opposed to customer-level kW savings are used for verification no change was made. SAIC will be asked to ensure that the program tracking data are corrected for subsequent program years.



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Table A-1. Program Year 2011 Validated and Verified Participation and Savings by Program and Measure, Non-Residential Programs

Program	Measure	Number of Measures Installed (A)	Number of Participants (B)	Net kWh Savings Per Unit (C)	Net kW Savings Per Unit (D)	Overall Verification Ratio (E)	Verified & Validated Net kWh Savings (F = A x C x E)	Verified & Validated Net kW Savings (G = A x C x E)	EUL (H)	Verified & Validated Net TRB (I)
Business Energy Efficiency Measures	CEE Listed Premium Efficiency Motors	200	52	336	0	101%	67,839	41	15.0	\$ 234,651.93
	Ceiling Fan	153	111	135	0.02	100%	20,594	2	5.0	\$ 13,374.00
	CFL	81,142	116	159	0.02	101%	13,024,131	1,679	3.3	\$ 5,428,350.43
	Chiller Plant Retrofits	25	17	80,522	16.63	100%	2,017,669	417	20.0	\$ 4,706,193.67
	Clothes Washer	292	292	167	0.02	100%	48,915	7	11.4	\$ 67,080.43
	Commercial Kitchen Equipment	32	9	7,071	1.21	101%	229,312	39	15.0	\$ 413,300.74
	Cool Roof Technologies	18	18	5,349	2.43	100%	96,457	44	15.0	\$ 278,775.05
	Delamp/Reflector	5,789	68	160	0.02	101%	933,329	121	13.9	\$ 1,462,505.60
	Delamping	1,291	18	156	0.01	101%	202,413	17	13.8	\$ 280,998.60
	Dishwasher	146	146	54	0.01	101%	7,975	2	12.0	\$ 13,785.68
	HID Pulse Start and	19	17	22,856	2.14					
	HID Pulse Start	18	2	467	0.08	101%	446,642	41	14.0	\$ 628,763.68
	High Efficiency Water Heaters - Electric									
	Resistance	1	1	130	0.03	101%	131	0	9.0	\$ 178.71
	HVAC - Packaged/Split	1,271	133	1,697	0.28	101%	2,178,004	359	15.0	\$ 3,875,264.12
	Induction	11	11	6,691	0.53	100%	73,598	6	2.0	\$ 18,298.00
	LED	31,155	178	152	0.02	101%	4,803,554	656	15.5	\$ 8,047,970.78
	Refrigerator	824	264	85	0.01	101%	70,816	11	14.0	\$ 119,485.41
	Refrigerator with Recycling	310	310	664	0.03	100%	205,911	9	14.0	\$ 255,892.32
	Sensors	955	106	98	0.02	101%	93,864	21	8.0	\$ 116,195.94
	Smart Strip - Event Promotion	143	3	63	-	101%	9,140	-	5.0	\$ 4,306.58
	Submetering	235	4	222	0.05	101%	52,569	11	12.0	\$ 87,478.05
	T5 / T8HO	839	9	216	0.03	101%	184,075	28	13.6	\$ 296,430.56
	T8 /T8LW	54,893	286	121	0.02	101%	6,683,578	979	13.6	\$ 10,246,608.30
	VFD Applications	180	75	10,667	2.42	101%	1,938,522	441	12.7	\$ 3,363,628.12
	VRF AC Systems	338	138	2,415	0.26	100%	817,460	88	14.9	\$ 1,273,054.19
	Window AC	237	209	446	0.17	101%	106,702	40	12.0	\$ 235,326.56
	Window Tinting	52	52	18,222	4.83	101%	954,261	253	10.0	\$ 1,534,512.66
	Subtotal	180,569	2,645	-	-	101%	35,267,460	5,311	-	\$ 43,002,410.11



Table A-1 (continued). Program Year 2011 Validated and Verified Participation and Savings by Program and Measure, Non-Residential Programs

Program	Measure	Number of Measures Installed (A)	Number of Participants (B)	Net kWh Savings Per Unit (C)	Net kW Savings Per Unit (D)	Overall Verification Ratio (E)	Verified & Validated Net kWh Savings (F = A x C x E)	Verified & Validated Net kW Savings (G = A x D x E)	EUL (H)	Verified & Validated Net TRB (I)
Business Service and Maintenance	Air Cooled Chiller	1	1	157,271	19.72	100%	157,631	20	15.0	\$ 256,503.73
	CFL	82	27	144	0.01	101%	11,949	1	14.0	\$ 17,042.56
	Chiller Plant Retrofits	1	1	921,632	105.18	100%	923,742	105	15.0	\$ 1,463,093.00
	Custom Lighting	75	5	96	-	98%	7,072	-	8.6	\$ 5,139.09
	FB40 to F17	101	11	188	0.03	101%	19,141	3	14.0	\$ 32,504.21
	LED	1,558	113	148	0.03	101%	232,541	43	15.0	\$ 430,180.78
	T8 /T8LW	4,585	414	152	0.01	101%	705,061	66	14.0	\$ 1,011,020.43
	Subtotal	6,403	572	-	-	101%	2,057,135	238	-	\$ 3,215,483.80
Business Hard to Reach	CFL	11	4	150	0.00	101%	1,674	0	14.0	\$ 2,033.62
	Custom Lighting	42	6	176	-	98%	7,254	-	14.0	\$ 7,925.17
	FB40 to F17	84	6	220	0.01	101%	18,694	1	14.0	\$ 24,190.33
	LED	9,963	230	147	0.02	101%	1,482,344	177	15.0	\$ 2,380,322.28
	T8 /T8LW	1,026	91	160	0.02	101%	165,720	24	14.0	\$ 268,815.09
	Subtotal	11,126	337	-	-	101%	1,675,686	202	-	\$ 2,683,286.50



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Table A-1 (continued). Program Year 2011 Validated and Verified Participation and Savings by Program and Measure, Non-Residential Programs

Program	Measure	Number of Measures Installed (A)	Number of Participants (B)	Net kWh Savings Per Unit (C)	Net kW Savings Per Unit (D)	Overall Verification Ratio (E)	Verified & Validated Net kWh Savings (F = A x C x E)	Verified & Validated Net kW Savings (G = A x D x E)	EUL (H)	Verified & Validated Net TRB (I)
Custom Business Energy Efficiency Measures	Air Cooled Chiller	8	8	51,332	12.81	98%	403,286	101	17.5	\$ 965,057.35
	Lighting.	4	4	37,818	3.24	98%	148,557	13	12.3	\$ 196,111.22
	Central Plant Optimization	1	1	164,356	22.56	98%	161,406	22	15.0	\$ 270,021.57
	Chiller Plant Retrofits	6	6	49,202	5.99	98%	289,912	35	15.8	\$ 489,052.95
	CO Garage Exhaust Control	17	17	347,223	27.63	98%	5,796,866	461	15.6	\$ 8,568,953.25
	Commercial Lighting	11	11	34,653	5.45	98%	374,345	59	6.4	\$ 309,609.14
	Customized Project Measures	1	1	279,944	37.33	98%	274,920	37	15.0	\$ 455,761.33
	EC Motors and Controllers	7	7	34,535	3.95	98%	237,406	27	15.0	\$ 376,235.60
	EMCS Linked Thermostats	17	17	8,220	1.44	98%	137,229	24	7.9	\$ 129,754.83
	Fresh Water Pumping Motors	1	1	485,850	-	98%	477,131	-	15.0	\$ 546,259.54
	Heat Pumps	2	2	30,127	1.66	98%	59,173	3	15.0	\$ 92,839.43
	HID Pulse Start	1	1	12,034	1.95	98%	11,818	2	14.0	\$ 19,921.94
	Hotel Guestroom HVAC Control	3	3	195,574	28.62	98%	576,194	84	13.3	\$ 852,842.98
	HVAC Controls	5	5	534,217	49.20	98%	2,623,147	242	14.4	\$ 3,984,483.75
	LED	121	121	33,409	4.83	98%	3,969,983	574	5.4	\$ 2,990,486.26
	Low E Glass w/ Wall Insulation	10	10	264,369	33.95	98%	2,596,248	333	24.5	\$ 5,765,447.08
	MR16	1	1	4,765	1.73	98%	4,679	2	5.0	\$ 4,842.51
	PC Power Management	10	10	34,852	-	98%	342,264	-	7.0	\$ 209,885.51
	Refrigeration	5	5	90,046	10.43	98%	442,149	51	15.8	\$ 719,543.91
	Solar Thermal Dehumidification	1	1	249,960	-	98%	245,474	-	15.0	\$ 281,040.22
	Solar Thermal Water Heating	7	7	21,777	6.02	98%	149,705	41	14.6	\$ 325,390.74
	Submetering	2	2	26,918	5.64	98%	52,871	11	15.0	\$ 103,146.09
	T5 / T8HO	9	9	42,810	6.67	98%	378,379	59	11.0	\$ 511,919.09
	T8 /T8LW	12	12	73,246	9.21	98%	863,183	108	13.3	\$ 1,315,987.39
	Vending Miser	1	1	3,989	-	98%	3,918	-	5.0	\$ 1,847.24
	VFD Applications	11	11	138,413	17.67	98%	1,495,224	191	15.3	\$ 2,464,650.49
	Subtotal	274	274	-	-	98%	22,115,468	2,481	-	\$ 31,951,091.42
All Non-Residential - Total		198,372	3,828			100%	61,115,749	8,232		80,852,272



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Table A-2. Program Year 2011 Validated and Verified Participation and Savings by Program and Measure, Residential Programs

Program	Measure	Number of Measures Installed (A)	Number of Participants (B)	Net kWh Savings Per Unit (C)	Net kW Savings Per Unit (D)	Overall Verification Ratio (E)	Verified & Validated Net kWh Savings (F = A x C x E)	Verified & Validated Net kW Savings (G = A x D x E)	EUL (H)	Verified & Validated Net TRB (I)
Residential Energy Efficiency Measures	Refrigerator Trade-In and Refrigerator/Freezer Recycling - Bounty	7,584	7,584	565	0.02	100%	4,282,173	176	13.9	\$ 5,323,654.00
	Ceiling Fan	2,950	2,097	135	0.02	100%	398,219	45	5.0	\$ 258,659.28
	CFL	1,817,472	17,854	29	0.00	99%	52,876,482	7,283	5.0	\$ 36,241,352.27
	Clothes Washer	7,285	7,285	166	0.02	100%	1,212,557	165	11.3	\$ 1,660,442.00
	Dishwasher	901	901	54	0.01	100%	48,770	11	12.0	\$ 84,291.00
	Heat Pumps	243	243	1,215	0.21	100%	295,144	51	9.3	\$ 373,708.00
	High Efficiency Water Heaters - Electric Resistance	84	84	129	0.03	100%	10,847	2	9.0	\$ 14,776.00
	LED	11,918	234	13	0.00	99%	158,660	29	15.0	\$ 292,044.60
	Refrigerator (Legacy & < \$600)	4,046	4,046	85	0.01	96%	329,758	53	14.0	\$ 557,332.84
	Residential Peer Group Comparison	73,000	3	23	-	200%	3,403,183	-	1.0	\$ 341,679.54
	Smart Strip - Event Promotion	1,246	17	63	-	99%	78,209	-	5.0	\$ 36,852.22
	Solar Attic Fans	140	117	430	0.01	100%	60,148	2	5.0	\$ 31,024.00
	Solar Thermal Water Heating	2,133	2,133	1,537	0.34	99%	3,244,558	722	15.0	\$ 6,494,683.00
	Split System AC	225	222	913	0.18	100%	205,435	41	12.0	\$ 335,406.00
	VRF AC Systems	161	159	552	0.15	100%	88,842	25	12.0	\$ 168,553.00
	Whole House Energy Metering	23	23	175	0.01	100%	4,021	0	5.0	\$ 2,110.00
	Whole House Fan	182	169	814	0.41	100%	148,075	74	5.0	\$ 184,463.00
	Window AC	132	132	302	0.15	81%	32,303	16	12.0	\$ 85,685.68
	Subtotal	1,929,725	43,303	-	-	102%	66,877,383	8,695	-	\$ 52,486,716.43
Residential Energy Services and Maintenance	AC Annual Tune Up	13	13	261	0.06	100%	3,399	1	1.0	\$ 585.00
	Efficiency Inside Home Design	1	1	24,517	-	100%	24,517	-	20.0	\$ 33,731.00
	Solar Water Heater Tune Up	318	320	200	0.02	100%	63,565	7	5.0	\$ 41,634.00
	Subtotal	332	334	-	-	100%	91,481	8	-	\$ 75,950.00
Residential Hard to Reach	CFL	64,690	2	26	0.00	99%	1,674,849	257	-	\$ 170,935.40
	Smart Strip - Event Promotion	3,994	115	63	-	99%	248,784	-	5.0	\$ 117,227.14
	Solar Water Heater- Direct Install, Inspections and Solar Water Heating Inspections - WAP	132	132	746	0.17	99%	97,516	22	14.6	\$ 195,243.92
	Subtotal	68,816	249	-	-	99%	2,021,150	279	-	\$ 483,406.46
All Residential - Total		1,998,898	43,887			102%	68,990,014	8,982		\$ 53,046,072.89
Program Overall		2,197,306	47,737			101%	130,108,676	17,214		\$ 133,903,765.37



4. Appendix B-Sample Design

This appendix provides detailed data regarding Evergreen's sample design for the measure verification research.

Evergreen developed sample frames by customer category, based on our research approach. For the non-residential sector, we developed four customer strata:

- Small and Medium Business End-Use Customers – small and medium non-residential BEEM customers who pay their own utility bill based on the Q1-Q3 data extract;
- Large Business End-Use Customers – non-residential customers who completed projects in the BEEM program with large savings in Q1-Q4; and
- Custom – non-residential customers who completed custom projects through CBEEM in Q1-Q4, including two BESM projects that were described as CBEEM in the Q4 data.

For the residential sector, we developed three customer strata:

- Residential End-Use Customers – residential customers who pay their own utility bill based on the Q1-Q3 data extract and participate through the REEM and RESM programs. Upstream CFLs from the REEM program are separated into another customer segment;
- Residential Hard to Reach – CFL and power strip measures distributed through the RHTR program from the full program year; and
- Upstream CFLs – CFL sales through the REEM program.

Each sample frame was developed based on the most current data available to the team at the time that the sample frame was created.

The following sample strata used data from Q1-Q3 to form the sample frame:

- Small and Medium Business End-Use Customers
- Residential End-Use Customers

The following sample strata used data from Q1-Q4 to form the sample frame:

- Residential Hard to Reach
- Upstream CFLs
- Large Business End-Use Customers
- Custom Projects



Tables B-1 and B-2 below present a summary of the fraction of savings each sample category represents of the total claimed program savings. The second row shows the survey mode used and the third row shows the sample category.

**Table B-1. Program Savings Represented by Verification Samples
(First-Year Net Energy kWh Savings Claimed by the Program)**

		Survey Mode and Verification Sample Category								Total	
		Telephone Survey		On-Site Survey with Technical Review		Technical Review					
		Residential End-Use Customers	Small and Medium Business End-Use Customers	Large Business End-Use Customers	Custom	Large Business Upstream End-Use Customers	Custom	Hard to Reach	Upstream CFLs		
Sector	Program										
Non-Residential											
	Business Energy Efficiency Measures		789,696	9,293,610		6,062,252				16,145,558	
	Business Energy Service and Maintenance ¹									-	
	Business Hard to Reach									-	
	Custom Business Energy Efficiency Measures				¹ 8,339,502		1,102,079			9,441,581	
	Non-Residential Total	-	789,696	9,293,610	8,339,502	6,062,252	1,102,079	-	-	25,587,139	
Residential											
	Residential Energy Efficiency Measures	301,995							9,129,293	9,431,288	
	Residential Energy Services and Maintenance	923								923	
	Residential Hard to Reach							380,692		380,692	
	Residential Total	302,918	-	-	-	-	-	380,692	9,129,293	9,812,903	
Total			302,918	789,696	9,293,610	8,339,502	6,062,252	1,102,079	380,692	9,129,293	35,400,042

¹The CBEEM sample included one project that was selected from the frame whose savings accrued to the BESM program, because its measure description indicated "CBEEM."



**Table B-2. Verification Samples as a Percent of Program kWh Savings
(First-Year Net Energy Savings Claimed by the Program)**

		Survey Mode and Verification Sample Category								
Sector	Program	Telephone Survey		On-Site Survey with Technical Review		Technical Review				Sample as a % of Total Program Savings
		Residential End-Use Customers	Small and Medium Business End-Use Customers	Large Business Upstream End-Use Customers	Custom	Large Business Upstream End-Use Customers	Custom	Hard to Reach	Upstream CFLs	
Non-Residential										
	Business Energy Efficiency Measures	-	2%	27%	-	17%	-	-	-	46%
	Business Energy Service and Maintenance ¹	-	-	-	-	-	-	-	-	0%
	Business Hard to Reach	-	-	-	-	-	-	-	-	0%
	Custom Business Energy Efficiency Measures ^{1,2}	-	-	-	35%	-	5%	-	-	40%
	Non-Residential Total	-	1%	15%	14%	10%	2%	-	-	42%
Residential										
	Residential Energy Efficiency Measures	0%	-	-	-	-	-	-	14%	14%
	Residential Energy Services and Maintenance	1%	-	-	-	-	-	-	-	1%
	Residential Hard to Reach	-	-	-	-	-	-	19%	-	19%
	Residential Total	0%	-	-	-	-	-	1%	13%	15%
Total		0%	1%	7%	6%	5%	1%	0%	7%	27%

¹ The CBEEM sample included one project that was selected from the frame whose savings accrued to the BESM program, because its measure description indicated "CBEEM".

² The CBEEM sample frame included two BESM sites where their measure descriptions indicated "CBEEM."