EVERGREEN ECONOMICS

Evaluation of the *Hawaii Energy* Conservation and Efficiency Programs

Program Year 2011

Volume 1 of 2: Main Report

June 20, 2013

Prepared for the State of Hawaii Public Utilities Commission

Table of Contents

1. Executive Summary

This report presents the findings of the comprehensive evaluation of the Hawaii Energy Conservation and Efficiency Programs (Hawaii Energy or Program) for Program Year 2011 (PY2011), from July 1, 2011 through June 30, 2012.[1] The components of this evaluation (PY2011 Evaluation) included an impact evaluation, process evaluation, market assessment and comprehensive baseline study. Evergreen Economics led the team of industry experts, which conducted the study (Evaluation Team).[2] A number of separate evaluation activities were conducted throughout the program year; the results are summarized and synthesized in this report, with detailed memoranda describing each activity included as appendices.

The Program provides a suite of offerings for both residential customers (Residential Programs) and business customers (Business Programs). The individual Hawaii Energy programs addressed by this evaluation are:

Business Programs

Business Energy Efficiency Measures (BEEM). Provided prescriptive incentives to business customers[3] who purchased and installed qualifying energy efficiency measures, including lighting, air conditioning, water heating, water pumping, motors, building envelope improvements, ENERGY STAR® business equipment, and energy awareness, measurement and control systems.

Custom Business Energy Efficiency Measures (CBEEM). Provided custom financial incentives for the installation of qualifying energy efficiency measures based on calculated savings to commercial, institutional, governmental, and industrial sector customers.

Business Service and Maintenance (BESM). Provided incentives for the installation of qualifying energy efficiency measures and direct installation of measures to business customers, as well as design assistance, audits and commissioning services.

Business Hard-to-Reach (BHTR). Targeted traditionally underserved business customers such as restaurants, retail and other small businesses, providing certain free energy efficient measures, direct installation of select measures ("equipment

[1] Hawaii Energy is a ratepayer-funded conservation and efficiency program administered by Science Applications International Corporation (SAIC) under contract with the Hawaii Public Utilities Commission (PUC) as the Public Benefits Fee Administrator (PBFA) serving the islands of Hawaii, Lanai, Maui, Molokai, and Oahu. On July 1, 2009, Hawaii Energy took over management of the demand side management programs from Hawaiian Electric Company (HECO) and its subsidiaries, Maui Electric Company (MECO) and Hawaii Electric Light Company (HELCO), referred to as the HECO utilities. Note that throughout this report "Hawaii Energy" is used to refer to both the suite of programs offered through this initiative, as well as the organization that implements it.

[2] Other Evaluation Team members include EMI, Michaels Engineering, SMS, Robert Wirtshafter, Phil Willems and John Stevenson.

[3] The term "business" includes all non-residential customer categories (commercial, industrial and agricultural).

grants"), and comprehensive audits and other support such as assistance in RFP development and securing project financing. Similar audit, RFP and financing support was also provided to qualifying building owners ("landlord, tenant, Association of Apartment Owners (AOAO) measures").

Residential Programs

Residential Energy Efficiency Measures (REEM). Provided prescriptive incentives to residential customers who purchased and installed qualifying energy efficiency measures. Qualifying measures included water heating, lighting, air conditioning, appliances, and energy awareness, measurement and control systems.

Residential Energy Services and Maintenance (RESM). Provided incentives for the installation of qualifying energy efficiency measures and direct installations of measures to residential customers, as well as design assistance, audits and system tune-ups.

Residential Hard-to-Reach (RHTR). An expansion of the former Residential Low Income program, provided equipment grants in addition to landlord, tenant and AOAO measures.

Custom Energy Solutions for the Home (CESH). Included a call for projects that met a total dollar per kWh savings target from contractors, home auditors, and energy vendors that focused on high energy consumption homes.[4]

Additionally, in PY2011, Hawaii Energy scaled up the Residential Peer Group Comparison (PGC) pilot program begun in mid-2011. The program provides personalized information about energy use in an individual home and how to reduce energy consumption in a Home Energy Report (HER). It also compares consumption to similar "neighbor" households.

Major conclusions from the impact evaluation, market assessment and process evaluation are summarized below. Findings from the baseline study will be presented in a separate report to be submitted to the PUC in the summer of 2013.

1.1 Impact Evaluation

The goal of the impact evaluation was to develop an independent estimate of energy savings achieved by Hawaii Energy for PY2011.

Impact evaluation activities included:

- Review of Hawaii Energy's energy savings assumptions documented in its Technical Reference Manual (TRM);
- Validation of tracking database and savings calculations;
- Participant phone surveys and on-site verification inspections;
- Engineering desk review of large and custom project applications;

[4] There was no participation in this program during PY2011, and it is, therefore, not included in results tables in this report.

- Invoice audit for participating CFL retailers;
- RHTR program hard copy record audit; and
- Residential Peer Group Comparison (PCG) program assessment.

Below we discuss the key findings and conclusions of these impact evaluation activities.

1.1.1 Technical Reference Manual Review

An independent review of the TRM, which describes the methodology and the background assumptions used to calculate Program savings, was a key task for the PY2011 impact evaluation.[5] This review aided in developing an in-depth understanding of how the measure savings values were derived and in making an assessment of the reasonableness of these values.

We compared TRM values to those in a wide variety of industry sources such as program evaluations and market studies from across the nation. We found that there were three new measures and two changes to existing measures that needed to be reviewed, and that a few recommendations made in the PY2010 evaluation report had not been integrated into the TRM. It should be noted that most of these recommendations pertain to measure eligibility or quantities, and not the algorithms used to determine savings values.

In a December 2012 TRM review memo, we offered recommendations to modify a small number of TRM values and suggested conducting further research on a few categories of TRM values to improve their accuracy and reliability. Among others, recommendations included integrating the remaining recommended changes from the prior TRM Review and increasing the effective useful life (EUL) for business LEDs.

1.1.2 Verification of Savings

Verifying Hawaii Energy's PY2011 savings claims was the second major impact evaluation task. The two major components of the independent savings verification were validation of the Hawaii Energy tracking database and verification of measure installations.

We validated the savings claims by analyzing an extract of the Program tracking database and comparing it to the claimed savings documented in the *Hawaii Energy Conservation and Efficiency Programs Annual Report, Program Year 2011*(Annual Report).[6] We reviewed

[5]Energy and demand savings estimates for Program measures and activities are approved on an *ex ante* basis and must be documented in a TRM prepared by PBFA and reviewed by the EM&V contractor. The TRM must include estimates for all prescriptive measures, and descriptions of calculation methodologies for custom measures. The information in the TRM must be consistent with the information in any database or other tool used to calculate savings resulting from the Program. The PY2009 TRM was approved for use by Hawaii Energy for PY2010. Therefore, the EM&V review conducted during the last program cycle was used in the PY2011 and PY2012 cycles. In February 2012 the Evaluation Team reviewed and prepared a memo on the October 2011 TRM, and then in August 2012 compared the most recent TRM version (dated August 2012) to the February 2012 TRM memo. We then prepared and submitted a memo on that comparison to the Contract Manager in December 2012. Changes made during this calendar year (2013) should be included in the PY2013 TRM The Evaluation Team will review the TRM used for PY2013 in the fall of 2013.

[6]SAIC Energy, Environment & Infrastructure, LLC. *Efficiency Programs Annual Report, Program Year 2011.* (Honolulu, HI: Hawaii Public Utilities Commission, December 3, 2012). http://www.hawaiienergy.com/75/hawaii-energy-reports

the savings calculations and other inputs and checked for consistency with the approved TRM for PY2011.

We verified Program measure installations based on telephone and on-site surveys with participating residents and businesses. We also conducted engineering analyses of custom measure savings claims.

As a result of these activities, we verified 101 percent of the savings claimed, or 130GWh/year in first-year net electricity savings. These savings translate to net Total Resource Benefits (TRB)[7] of $53,046,072 for the residential sector and $80,852,272 for the business sector.

Table 1 shows the targets, claims and verified amounts for PY2011 net electricity savings, TRB, and the Program budget. Table 2 lists PY2011 claimed and verified first–year savings by individual program.

Table 1: Hawaii Energy Net Electricity Savings, TRB and Budget, PY2011[8]

	Residential	Business	Total
Target kWh	N/A	N/A	108,500,425
Claimed kWh	67,634,750	61,151,217	128,785,968
Verified kWh	68,990,014	61,115,749	130,108,676
Target TRB	N/A	N/A	$116,230,842
Claimed TRB	$53,006,396	$74,951,149	$127,957,545
Verified TRB	N/A	N/A	$133,903,765
Budget	$13,319,036	$16,278,822	$32,271,390

[7]The TRB is the estimated total net present value (NPV) of the avoided cost for the utility from the reduced lifetime demand (kW) and energy (kWh) from the energy efficiency projects and measures. The utility costs were determined using average avoided cost data for installed capacity to meet demand and cost to produce energy that was provided by HECO IRP4 and adjusted under the advice of the PBFA Contract Manager. Average annual avoided cost for capacity and energy for calendar year 2011 escalated for a 20-year period was the basis for the analysis. The TRB has incorporated avoided transmission and distribution costs into the avoided energy and capacity costs. The time value of money is represented by a discount rate of six percent. The discount rate is used to convert all costs and benefits to a "present value" for comparing alternative costs and benefits in the same year's dollars.

[8] The target and claimed amounts come from the Annual Report (see Table 11 on page 18, Table 13 on page 20 and Table 19 on page 30, as noted above, the Annual Report can be found at http://www.hawaiienergy.com/75/hawaii-energy-reports). Verified numbers were developed during the PY2011 Evaluation.

Table 2: Hawaii Energy Verification Results PY2011

Sector	Program	First-Year Net Savings (kWh)		Percent Verified of Claimed Savings
		Claimed	Verified	
Business				
	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%
	Business Total	**61,151,217**	**61,115,749**	**100%**
Residential				
	Residential Energy Efficiency Measures	65,511,035	66,877,382	102%
	Residential Energy Services and Mantenance	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%**

In PY2011, Hawaii Energy conducted market transformation offerings, encompassing a broad set of initiatives intended to generate long-term sustained market change and support projects that achieve energy reductions, demonstrate energy reduction capabilities, and/or provide on-the-job training for individuals in energy efficiency and energy conservation fields. "Transformational Program" offerings involve education, outreach and other government-support activities that may not result in direct quantifiable energy savings in the immediate timeframe of the activity, yet are likely to contribute energy savings within a five-year period. As such, there are no savings goals or claims for these activities and they are not included in the tables showing verified program savings throughout this report. However, these market transformation activities were reviewed as part of the validation task as discussed in Section 3.1 of Appendix A: Verification Memo.

We recommend that the PY2012 evaluation continue with the optimized sample sizes. For PY2011, we did not conduct on-site surveys with participants in the prescriptive rebate programs in order to reserve funds for the baseline study. We recommend that the PY2012 evaluation resume on-site surveys with a sample of prescriptive rebate program participants to ensure robust verification. We also recommend that the PY2012 evaluation conduct an evaluation of the RHTR program based on documentation that is being collected by Hawaii Energy.

1.1.3 Upstream Lighting Program Analysis

Because lighting measures contribute a significant portion of Hawaii Energy savings, we conducted a special analysis of the upstream lighting program, which provides incentives to retail stores that display and sell energy efficient lighting products. Sales records for qualifying lighting measures at participating retailers for the past three years (PY2009-PY2011) were reviewed to determine the number of qualifying measures sold through the program each year by lamp type and store type, as well as the relative distribution of rebate dollars. Key findings include:

- The total number of lamps purchased through the program nearly doubled in two years (PY2009 - PY2011) to account for the drop in deemed per unit savings from PY2009 to PY2010 (CFL savings as a fraction of total program savings held constant during the two year period);
- Introduced in PY2011, 11,438 LED lamps were sold through program;
- The program expanded the number of different participating chains/stores from 10 to 15 over the two-year period – including a substantial new presence in grocery stores;
- Standard CFLs, including spiral/twist and A-lamp types, became more predominant in PY2011. The PY2010 success in increasing the sale of the non-standard, specialty lamps was not repeated in PY2011. Specialty lamps' share of lamps sold dropped to only eight percent in PY2011, as compared to 27 percent in PY2010 and 19 percent in PY2009. This corresponds to nine percent of program rebate dollars in PY2011, and 27 percent and 37 percent of the same in PY2010 and PY2009, respectively; and
- Although more total qualifying units were sold in PY2011 than in PY2010, because so many of the CFLs sold in PY2011 were standard lamps (for which stores receive a lower rebate), total rebate dollars dropped from PY2010.

To track indicators of market progress in this area, for future evaluation cycles we recommend that program lighting products sold continue to be tracked by county for lamp type, store type and associated rebate dollars.

1.1.4 Residential Peer Group Comparison Program Assessment

In 2011 a PGC program was piloted with 15,000 participating residents on the island of Oahu using American Recovery and Reinvestment Act (ARRA) funds. In PY2011, Hawaii Energy scaled the program up to 62,000[9] residential electric utility customers on the islands of Hawaii, Lanai, Maui and Molokai.

As it is a new Hawaii Energy offering and because of its potential to impact Program activities and results, we conducted a review of the PY2011 PGC program. The research objectives for this analysis include the following:

- Develop an independent estimate of PGC program savings;
- Identify any differences in energy usage and equipment purchases between participants and the control group that might shed light on the impact estimates; and
- Estimate savings attributed to other Hawaii Energy programs that were indirectly due to participation in the PGC program (e.g., information gained by participating in the PGC program led a customer to install measures via REEM).

[9] Note that in the Hawaii Energy tracking data, the actual participation number is 73,000 households across Oahu (14,000), Big Island (30,000), and Maui (29,000).The discrepancy between the program vendor's numbers and the Hawaii Energy tracking database comes from the fact that Hawaii Energy used the number of households stipulated in its contract with the vendor, and the vendorused the actual number of households in the program.

Our research methods consisted of two complementary analysis activities:

- A phone survey of PGC participants and a control group that solicited information on how the HER influenced energy usage; and
- A billing regression on a sample of participants and a control group to develop an independent estimate of energy savings.

Key findings from these activities include the following.

From the phone survey:

- There were no significant differences between the participants and control group in terms of energy usage behavior, or adoption or planned adoption of energy efficiency measures; and
- PGC participants and the control group are purchasing CFLs at similar rates.

From the billing regression:

- Our attempt to replicate the vendor's savings estimates resulted in savings of 1.47 percent of average annual usage, which is very close to the estimate of 1.43 percent provided by the vendor for Oahu based on its pilot program there;
- Using alternative control groups did not affect the savings estimates, indicating that the control group selected by the vendor was appropriately determined;
- When basic data screens are applied to the billing regression dataset (to remove observations within insufficient data and/or unusually high or low values), the estimates drop from 1.47 percent to 1.25 percent of average annual usage, a decrease of 15 percent. This estimate is less than the vendor's estimate of 1.43 percent for Oahu and significantly less than the current TRM value of 1.73 percent; and
- With the recommended billing regression model that controls for participation in other Hawaii Energy programs, the savings estimates drops from to 1.25 percent to 0.89 percent of annual usage, a decrease of 29 percent. Note that this estimate does not account for savings resulting from CFLs. However as will be shown below, the results of this research indicate that no additional adjustment is needed to account for upstream CFL savings.

We recommend that the deemed savings for the PGC program be reduced to 0.89 percent of annual usage per participant. We also recommend that savings be claimed on a monthly basis, pro-rated at 1/12 the 0.89 percent savings, for participating months that occur during the relevant program year.

We also recommend that the evaluation team (rather than the program implementers) draw the sample for both the treatment and control groups. This will allow some testing to occur to ensure that two groups are well matched and that the selection process follows the appropriate protocols.

1.2 Market Assessment

Each evaluation cycle includes an assessment of some part or aspect of the market that may affect Program performance and/or activities. For the PY2011 Evaluation, we conducted a net-to-gross (NTG) assessment and a literature review related to non-energy benefits.

1.2.1 NTG Assessment

Attribution of savings is a critical component of program evaluation. For our impact evaluation, we must first assess gross energy savings for Program participants, and then make two adjustments to determine a net amount that is clearly attributable to the Program. The first adjustment is made to account for free-rider effects—reducing gross savings by removing savings that would have occurred even in the absence of the Program. The second adjustment is made to account for spillover or market effects[10] —increasing gross savings by including actions that were clearly induced by the Program but occurred outside of the direct Program activities.

Our NTG assessment is intended to help frame on-going discussions related to the issue of attribution (or NTG measurement) for demand-side management programs in Hawaii. Our activities in this area included an examination of secondary research and survey data from first two years of Program evaluation, and recommendations for revisions to NTG ratios as needed for the next program cycle. In our Net-to-Gross Assessment Memo (included as Appendix D hereto), we provide an overview of why NTG is relevant, highlight how the regulatory treatment of NTG can impact the success of energy efficiency goals, and provide both near- and long-term recommendations for dealing with this important issue.

Table 3 provides an estimate of how the individual NTG rates developed for each program aggregate into a system-wide NTG value for PY2011. Using the PY2011 percent of portfolio savings, we estimate the overall NTG rate as the sum of the individual NTG Adjusted Percent Savings. If PY2012 savings are distributed proportionally to PY2011, then the overall NTG rate will be 77.6 percent. This is slightly higher than the 73 percent currently assumed. The revised NTG approach proposed herein may lead to different composite NTG adjusted savings in subsequent years, depending on the relative mix of program savings.

[10]This report uses a broad definition of spillover that includes any program related change in the market that was not directly incented by the Program.

Table 3:Calculation of Composite NTG Rate for PY2011

Program	Measures	PY2011 percent of portfolio savings (Col 1)	Recommended NTG Rate (Col 2)	NTG Adjusted Percent Savings (Col 1 * Col 2)
BEEM	Business Energy Efficiency Measures	27.12%	.75	20.3%
CBEEM	Custom Business Energy Efficiency Measures	17.49%	.75	13.1%
BESM	Business Services and Maintenance	1.59%	.95	1.5%
BHTR	Business Hard-to-Reach	0.84%	.99	0.8%
REEM	Residential Energy Efficiency Measures	50.87%	.79	40.2%
CESH	Custom Energy Solutions for the Home	0%	.65	0.0%
RESM	Residential Services and Maintenance	0.07%	.92	0.1%
RHTR	Residential Hard-to-Reach	1.58%	1.00	1.6%
	Composite NTG Rate			**77.6%**

Since our initial presentation of these NTG recommendations in a memo dated January 8, 2013 the Program has adopted the recommended set of NTG ratios, which will be used to calculate net program savings for PY2012 and going forward. We recommend a gradual move towards more targeted segment-specific NTG values with both free-rider and spillover adjustments in the near term as data become available. These NTG values should be revisited periodically, such as through review of secondary sources and in conjunction with market research that is conducted with Hawaii customers and trade allies.

We also recommend, over the longer term, that Hawaii emphasize the continued development of programs that minimize the risk of free-ridership. This will most likely be accomplished by a more focused and significantly smaller emphasis on rebates, incentives for the PBFA to optimize portfolio expenditures relative to accomplishments, and greater market research to support the logic for entering specific markets.

1.2.2 Non-Energy Benefits Literature Review

The Evaluation Team conducted a review of literature on non-energy benefits of energy efficiency programs. Specific objectives of this review included:

- Provide an overview of common non-energy benefit categories;
- Discuss non-energy estimation methods;
- Summarize selected findings from the current non-energy benefit literature;
- Discuss applicability of current literature to Hawaii efficiency programs; and
- Provide recommendations on how non-energy benefits should be addressed in Hawaii.

As these objectives indicate, the related discussion in this report is intended as an introductory overview and does not provide a comprehensive review of all recent research

on this topic. For a broader discussion, we offer suggestions of other studies that provide a more extensive review of the current non-energy benefit literature, most of which is primarily on the residential sector. Our review focused on a subset of non-energy benefits that were among the most common studied in the literature and are applicable to Hawaii, including:

- Greenhouse gas (GHG) emissions reductions;
- Improved occupant comfort;
- Improved health and safety;
- Reduced operation and maintenance costs; and
- Increased productivity.

Key findings and recommendations from the literature review include:

- The literature contains a very wide range of non-energy benefit estimates. This variation is likely due to both the various estimation methods used and due to the different programs and customer groups being studied;
- The non-energy benefit estimates found in the literature are tailored to specific programs, making transferability to other jurisdictions problematic. For some of the non-energy benefits reviewed, there was a very large range of estimated values that varied by program type. An additional confounding factor is that many of the estimates are expressed in terms of the percentage of bill savings resulting from the energy efficiency measures installed through the program.
- The direct query method is unlikely to produce reliable estimates. One of the most common estimation methods is the direct query technique, in which respondents are simply asked to provide a value for a particular non-energy benefit. Given the abstract and somewhat intangible nature of these benefits and limited telephone survey time, it is unlikely that respondents can provide an accurate valuation.
- If the benefit of reduced GHG emissions is to be calculated for the Program, we recommend using a direct approach based on the price of carbon permits. This approach is relatively simple and can be based on information that is already readily available on the carbon content of Hawaii's electric generation mix and carbon prices.
- If non-energy benefits are to be counted in Hawaii, we recommend using a simple "adder" adjustment based on energy savings to calculate their value. This allows these benefits to be recognized in the cost-effectiveness calculations using a simple adjustment factor that avoids conducting separate research to develop more detailed estimates.
- If specific non-energy benefit estimates are desired for Hawaii, we recommend conducting a conjoint analysis experiment in which respondents provide information on how they would trade bill savings for increased comfort or other benefit categories of interest. Another option would be a contingent valuation study, for which customers are provided a series of questions (and possibly a monetary incentive) to elicit values placed on non-energy benefits.

1.3 Process Evaluation

To complete the PY2011 process evaluation, we aimed to receive feedback from Residential and Business Program participants in order to understand customer perspectives on key Program attributes. We then compared this feedback to that received over the past two evaluation cycles. In our analysis, we compared year-over-year results to identify any differences.

Key questions addressed in this evaluation are:

1. How important are the incentives currently available to program success?;
2. Which incentives are most impactful to energy efficient product adoptions?; and
3. Which incentives need adjusting?

In order to collect data on customer experiences with the Program, the Evaluation Team fielded a survey with 430 participating customers, each of whom had participated in one of the Hawaii Energy rebate programs. For residential customers, a proportional sample allocation was used based on measure category and island. This ensured that at least 50 sample points were obtained per island. Because the population of business customers was limited, all of these customers were contacted. The final number of surveys completed by customer type included:

- 380 Residential Program participants; and
- 50 Business Program participants.

The PY2011 process evaluation research dedicated to Residential Programs addressed feedback from customers participating in REEM, excluding those receiving efficient lighting upstream incentives (which account for over half of the PY2011 Residential Program savings), as well as participants in the RHTR and CESH programs. Findings from these surveys were analyzed and compared, when possible, to findings from prior year evaluations (PY2009 and PY2010). As a result of fielding the participant surveys over the last three program years, several key trends were identified across the residential market segment. Participating residential customers reported:

- Awareness of the Residential Programs is primarily driven by in-store interactions with salespeople, signage and advertising displays;
- Strong awareness and broad adoption rates for CFLs;
- Social media can play an effective role in spreading the awareness of incentives and rebate programs;
- High satisfaction with rebates and the Residential Programs across program years; and
- The desire to reduce energy consumption and corresponding energy costs is a key motivation for pursuing energy efficiency.

Findings from the current year business surveys were analyzed, compared to findings from prior year evaluations (PY2009 and PY2010), included in this process evaluation. The overall findings from analysis of the survey results are provided below.

- Over a three-year period, the most reported source for learning of available resources was through word-of-mouth, specifically through contractors or distributors;
- Satisfaction with rebates and the programs is consistently high among both residential and business participants;
- The majority of participating business customers reported they were either *very likely* or *somewhat likely* to have purchased the same product without the rebate; and
- In general, participating customer perspectives on the various Business Program elements has remained unchanged.

The process evaluation findings suggest that if the Program is to continue leading energy efficiency improvements in the market, many of its current goals, measures and incentives need to be updated.

- Data gathered for the PY2011 process evaluation suggest that the need for adjusting rebates depends on the type of technology (e.g., CFLs and appliances). The Evaluation Team has identified specific areas where adjusting requirements for incentive qualifications would be most impactful. Survey responses of Residential Program participants show that the impact of rebates on customer purchasing decisions is decreasing. This is especially true for consumer products such as appliances. As a result of our deeper analysis of consumer products, the Evaluation Team has developed recommendations to help Hawaii Energy maintain strong energy savings and make the adjustments necessary for programs in markets that are already beginning to see transformation to be able to continue driving adoption of the most energy efficient products and opportunities available. The Evaluation Team recommends the following: Shift focus of CFL incentives. Shift the focus of incentives from traditional CFLs to specialty lamps and expand the program to include more LEDs. This adjustment will help Hawaii Energy to continue realizing strong energy savings through lighting measures by rewarding increased demand for the most energy efficient lighting products.
- Maintain current solar water heater program. Continue to offer strong incentives for solar water heaters with limited adjustments needed to the program design. This will help ensure that the program continues to provide value to customers and encourage them to adopt this efficient technology by offsetting the still high upfront costs.
- Shift to tiered incentives for energy efficient products (e.g., appliances). Shift incentives for energy efficient products to a tiered structure that still rewards ENERGY STAR qualifying purchases, but encourages selection of the most energy efficient products by reserving the largest incentives for those products that exceed ENERGY STAR requirements by 30 percent.

- Conduct comprehensive process evaluation for PY2013. Include a broader process evaluation for the PY2013 evaluation, since the last comprehensive process evaluation was conducted for PY2009. This would provide an opportunity to examine the effectiveness and efficiency of Program operations.

2. Introduction

This report presents the results of a comprehensive evaluation conducted of the Hawaii Energy Conservation and Efficiency Programs (Hawaii Energy or Program) during the third year of operations, Program Year 2011 (PY2011), from July 1, 2011 through June 30, 2012. The components of this evaluation (PY2011 Evaluation) included an impact evaluation, process evaluation, market assessment and comprehensive baseline study.

2.1 Background

The Program is administered by Science Applications International Corporation (SAIC), under contract to the Hawaii Public Utilities Commission (PUC) beginning in 2009, at which time Hawaii Energy took over management of the state's demand side management programs from Hawaiian Electric Company (HECO) and its subsidiaries, Maui Electric Company (MECO) and Hawaii Electric Light Company (HELCO). The Program is funded by ratepayers in the HECO Companies' service territories via a Public Benefits Fee (PBF) that is intended to promote the development of programs and services that increase energy efficiency, reduce electricity consumption and demand, and ultimately decrease Hawaii's dependence on imported fossil fuels.[11] The Program provides a suite of offerings for both residential customers (Residential Programs) and business customers (Business Programs). In its role with Hawaii Energy, SAIC serves as the state's Public Benefits Fee Administrator (PBFA).[12]

Hawaii Energy uses several subcontractors to implement the Program including Honeywell (Residential Program administration support), Wall-to-Wall Studios (marketing and creative design services) and Milici Valenti Ng Pack (MVNP)(public relations).

Hawaii Energy also has an implementation and oversight organization, the Technical Advisory Group (consisting of the PUC, the PBF administration contract manager, fiscal agent and contract evaluator, and local energy stakeholders), to provide expertise and technical guidance. It has assumed a supporting role in the Hawaii Clean Energy Initiative (HCEI), a collaborative effort between the State of Hawaii and the U.S. Department of Energy (D.O.E.) focusing on transforming the energy sector of Hawaii to a clean energy economy based on 70 percent clean sources by 2030. Hawaii Energy is also participating in the Integrated Resource Planning (IRP) Framework[13] and Energy Efficiency Portfolio Standards (EEPS)[14] open dockets.

---

[11] For further detail on the origination of the PBF, refer to Evergreen Economics. *Evaluation of the Hawaii Energy Conservation and Efficiency Programs Program Year 2009*. (Honolulu, HI: Hawaii Public Utilities Commission, March 2011). http://www.hawaiienergy.com/125/evaluation-measurement-verification-em-v.

[12] For more detail on the PBFA role, the related contract between the PUC and SAIC may be downloaded from the Hawaii Energy site at http://www.hawaiienergy.com/75/hawaii-energy-reports

[13] A summary of the IRP since its inception in 1992 is available on the HECO web site at http://www.heco.com/portal/site/heco/menuitem.8e4610c1e23714340b4c0610c510b1ca/?vgnextoid=b71bf2b154da9010Vgn

2.2 Program Overview

Hawaii Energy continued a few of its existing Residential and Business Programs in PY2011, including:

Residential Programs

Residential Energy Efficiency Measures (REEM). Provided prescriptive incentives to residential customers who purchased and installed qualifying energy efficiency measures. Qualifying measures, included water heating, lighting, air conditioning, appliances, and energy awareness, measurement and control systems.

Business Programs

Business Energy Efficiency Measures (BEEM). Provided prescriptive incentives to business customers[15] who purchased and installed qualifying energy efficiency measures, including lighting, air conditioning, water heating, water pumping, motors, building envelope improvements, ENERGY STAR business equipment, and energy awareness, measurement and control systems.

Custom Business Energy Efficiency Measures (CBEEM). Provided custom financial incentives for the installation of qualifying energy efficiency measures based on calculated savings to commercial, institutional, governmental, and industrial sector customers.

Additionally, Hawaii Energy modified a few of its legacy programs before launching in PY2011. The Residential Programs saw the following changes for PY2011:

- The New Residential Programs Incubator or NEW, which included design and audits, and energy services and maintenance, was eliminated and two new programs were added:
  - **Custom Energy Solutions for the Home (CESH)** - includes target cost request for proposals; and
  - **Residential Services and Maintenance (RESM)** - includes direct installation, design and audits (all of which used to be a part of NEW), and system tune-ups.
- In order to expand coverage and intent of the program, Residential Low Income (RLI) has been altered to be **Residential Hard to Reach (RHTR)**, and now includes energy efficiency equipment grants, and landlord, tenant and Association of Apartment Owners (AOAO) measures.

VCM10000053011bacRCRD&vgnextfmt=defau. Information about the current IRP process and Advisory Group meetings can be found at https://docs.google.com/folder/d/0BxvCvKr8bi94Z1Y3cnA1MkxURzg/edit?pli=1

[14] More information on the EEPS can be found on the DSIRE web site at http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=HI15R

[15] The term "business" includes all non-residential customer categories (commercial, industrial and agricultural).

Hawaii Energy Business Programs were also redesigned to more accurately describe the programs and avoid customer confusion:

- The New Business Programs Incubator or NEW which included design and audits and energy services and maintenance has been eliminated and **Business Services and Maintenance (BESM)** has been added. BESM includes direct installation, design and audits (all of which used to be a part of NEW), and services and maintenance.
- Another Program addition includes **Business Hard to Reach (BHTR),** which includes energy efficiency equipment grants, and landlord, tenant and AOAO measures.

Table 4 summarizes Hawaii Energy offerings for PY2011.

Table 4: Hawaii Energy Residential and Business Programs - PY2011

Program	Measures/Services
Residential Programs	
REEM	***Residential Energy Efficiency Measures***
	High Efficiency Water Heating
	High Efficiency Lighting
	High Efficiency Air Conditioning
	High Efficiency Appliances
	Energy Awareness, Measurement and Control Systems
CESH	***Custom Energy Solutions for the Home***
	Target Cost Request for Proposals
RESM	***Residential Energy Services and Maintenance***
	Residential Direct Installation
	Residential Design and Audits
	Residential System Tune-Ups
RHTR	***Residential Hard-to-Reach***
	Energy Efficiency Equipment Grants
	Landlord, Tenant, AOAO Measures
Business Programs	
BEEM	***Business Energy Efficiency Measures***
	High Efficiency Lighting
	High Efficiency HVAC
	High Efficiency Water Heating
	High Efficiency Water Pumping
	High Efficiency Motors
	Commercial Industrial Processes
	Building Envelope Improvements
	ENERGY STAR Business Equipment
	Energy Awareness, Measurement and Control Systems
CBEEM	***Custom Business Energy Efficiency Measures***

	Customized Project Measures
BESM	***Business Service and Maintenance***
	Business Direct Installation
	Business Design, Audits and Commissioning
BHTR	***Business Hard-to-Reach***
	Energy Efficiency Equipment Grants
	Landlord, Tenant, AOAO Measures

Additionally, in PY2011, Hawaii Energy scaled the Residential Peer Group Comparison (PGC) pilot program begun in mid-2011 in Hawaii with 15,000 participating residents in Oahu up to 62,000[16] residential electric utility customers on the islands of Hawaii, Lanai, Maui and Molokai. The centerpiece of the PGC program is the Home Energy Report (HER), which provides personalized information about energy use in an individual home and how to reduce energy consumption. It also compares consumption to similar "neighbor" households as part of the PGC program.

Additional PY2011 changes, made based on suggestions from the PUC, included a larger allocation of the budget going to Business Programs, and the introduction of market transformation offerings. These "transformational" programs encompassed a broad set of initiatives intended to generate long-term sustained market change and support projects that achieve energy reductions, demonstrate energy reduction capabilities, and/or provide on-the-job training for individuals in energy efficiency and energy conservation fields. Transformational program offerings involve education, outreach and other government-support activities that may not result in direct quantifiable energy savings in the immediate timeframe of the activity, yet are likely to contribute energy savings within a five-year period.

As part of its planning process, Hawaii Energy must receive PUC approval of goals for annual energy savings and Total Resource Benefit (TRB), and a budget to provide Program services to achieve these. The TRB is the estimated total net present value (NPV) of the avoided cost for the utility from the reduced lifetime demand (kW) and energy (kWh) from the energy efficiency projects and measures. The utility costs were determined using average avoided cost data for installed capacity to meet demand and cost to produce energy that was provided in HECO's fourth IRP and adjusted under the advice of the PBFA Contract Manager. Average annual avoided cost for capacity and energy for calendar year

[16]Note that in the Hawaii Energy tracking data, the actual participation number is 73,000 households across Oahu (14,000), Big Island (30,000), and Maui (29,000).The discrepancy between the vendor's numbers and the Hawaii Energy tracking database comes from the fact that Hawaii Energy used the number of households stipulated in its contract with the vendor, and the vendor used the actual number of households in the program.

2011 escalated for a 20-year period was the basis for the analysis. The TRB has incorporated avoided transmission and distribution costs into the avoided energy and capacity costs. The time value of money is represented by a discount rate of six percent. The discount rate is used to convert all costs and benefits to a "present value" for comparing alternative costs and benefits in the same year's dollars. Table 5 shows PY2011 targets for Program electricity savings and TRB, and the Program budget.[17]

Table 5: Hawaii Energy Electricity Savings and TRB Targets and Budget- PY2011

	kW	kWh	TRB	Total Budget
Total	16,401	108,500,425	$116,230,842	$32,271,390

2.3 State of Hawaii Context

It is important to consider economic, geographic, and climate differences when reviewing the Program, as these variants each influence the decisions surrounding resource allocation and affect Program performance. This section discusses contextual issues for the state of Hawaii in order to provide background on how and why its energy efficiency program portfolio is unique as compared to other states. Key elements include:

- Tourism and agriculture compose a large portion of economic activity;
- A temperate climate minimizes energy needs tied to heating and air conditioning; and
- A high dependence on petroleum for energy needs heightens vulnerability to price fluctuations.

2.3.1 Climate

The most obvious difference between Hawaii and much of the nation is its climate. Most of the islands do not require heating in the winter months – except for some of the up-country regions at higher elevations. In 2006, Hawaii rated fifty-first among all states in average heating degree-days. Comparing efficiency program portfolios across the U.S. reflects varied demand for heating among both residential and business consumers. Cooling is also only required on a year-round basis by parts of Hawaii, although when compared to other states it has a much higher ranking for cooling degree-days.[18]

2.3.2 Economy

Hawaii's business sector is composed primarily of small businesses, and tourism is a major economic driver. Tourists outnumber the local population by a five-to-one ratio each

[17] There are no savings goals or claims for market transformation activities and they are not included in the tables showing verified program savings throughout this report.

[18] U.S. Department of Energy (DOE), Energy Efficiency and Renewable Energy, "Clean Energy in My State: Hawaii Residential Energy Consumption," U.S. DOE web site, http://apps1.eere.energy.gov/states/residential.cfm/state=HI.

year.[19] With the high flow of temporary visitors, condominiums are often not at their maximum occupancy. Diversification of business and revenue sources has been an on-going goal of the state, as it would lower its vulnerability to a significant decline in any one of its major industries. There is a significant military presence in the state, with the U.S. Pacific Command (USPACOM) based there, with 325,000 military and civilian personnel (one-fifth of total U.S. military strength).[20] Agriculture remains a major source of income, with primary crops including sugar, pineapple, flowers, nuts and seeds, coffee, cattle and milk.

The recent recession has significantly impacted Hawaii, reducing tourism and building construction. However, in February 2013, the unemployment rate (which peaked at nine percent in early 2009) was lower than the national rate. Oahu (at 4.5 percent unemployment) leads its neighboring islands, with unemployment rates of just under six percent for Maui and seven percent for the island of Hawaii.[21]

2.3.3 Energy

Due to its isolation and lack of fossil fuel reserves, Hawaii relies predominantly on imported petroleum, which supplies close to nine-tenths of its energy. In December 2012, the state's demand for petroleum used for electric generation represented 55 percent of all such demand in the U.S.[22] Solar, geothermal, biomass, wind, water and coal are used for the rest of Hawaii's energy needs, but the still-high level of dependence on imported petroleum makes the state vulnerable to fluctuations in price.

When compared to the rest of the nation, Hawaii's population has a much higher cost of electricity on a per unit basis, as shown in Figure 1. High dependence on one source of energy and the inability to connect to a national grid are a few of the contributing factors to the higher than average cost per kWh. The relatively high cost of electricity likely encourages consumers to conserve energy in order to lower their utility bills.

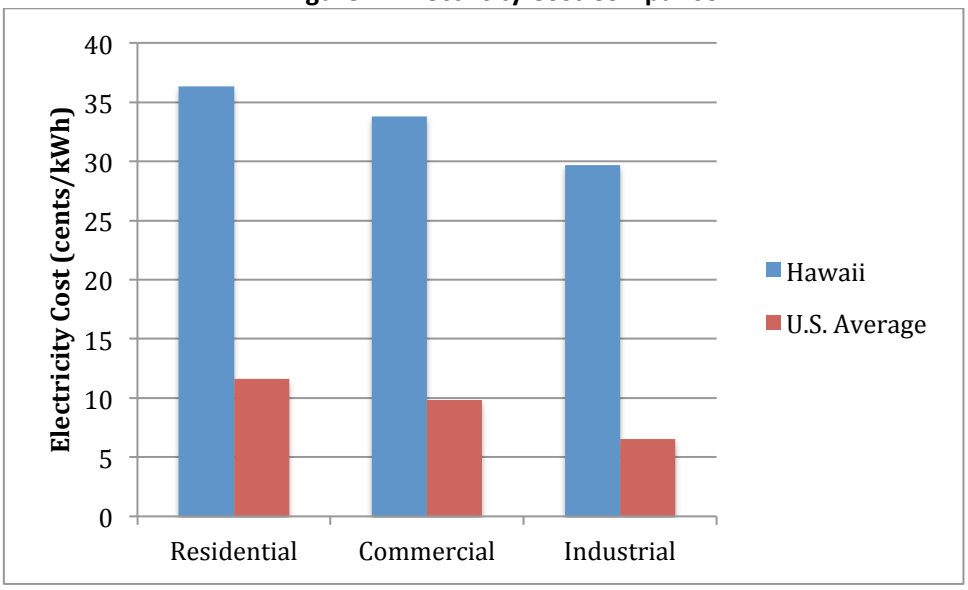
[19] Hawaii Department of Business, Economic Development & Tourism (DBEDT),"Outlook for the Economy, First Quarter 2012," Hawaii DBEDT web site at http://hawaii.gov/dbedt/info/economic/data_reports/qser/outlook-economy, accessed 04/17/13.

[20] USPACOM is one of six geographic Unified Combatant Commands of the United States Armed Forces. Commander, U.S. Pacific Command (CDRUSPACOM) is the senior U.S. military authority in the Pacific Command AOR. CDRUSPACOM reports to the President of the United States through the Secretary of Defense and is supported by four component commands: U.S. Pacific Fleet, U.S. Pacific Air Forces, U.S. Army Pacific, and U.S. Marine Forces, Pacific. These commands are headquartered in Hawaii and have forces stationed and deployed throughout the region.

[21] "Hawaii's Unemployment Rate Unchanged at 5.2 Percent in February," State of Hawaii Department of Labor and Industrial Relations press release, March 28, 2013, on the Department's web site at http://labor.hawaii.gov/wp-content/uploads/2013/04/20130328Feb-UI-Rate-PR.pdf.

[22] U.S. Energy Information Administration (EIA), "Hawaii State Energy Profile," U.S. EIA web site at http://www.eia.gov/state/print.cfm?sid=HI

Figure 1: Electricity Cost Comparison



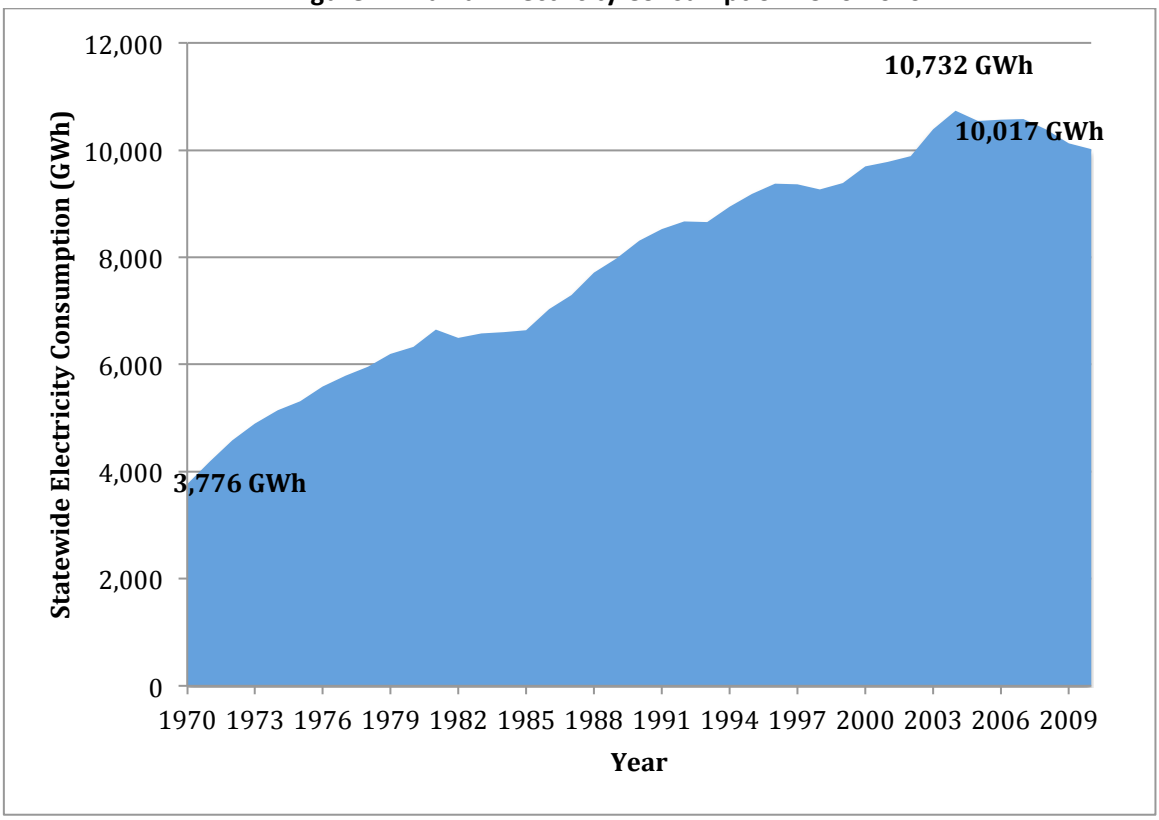
Sources: U.S. Energy Information Administration:http://www.eia.gov/state/state-energy-profiles-data.cfm?sid=HI#Pricesandhttp://www.eia.gov/state/state-energy-rankings.cfm?keyid=18&orderid=1

Higher energy costs and lower heating needs likely contribute to Hawaii's residential per capita average kWh consumption being about two-thirds of the national average for the residential and business sectors.[23] Although energy use per capita is relatively low due to the mild climate, Hawaii still has the highest monthly average residential bill in the U.S. at about $200/month in 2011.

Recently, Hawaii's electricity consumption has been on the decline, as illustrated in Figure 2, while expenditure on fuel has been on the rise, as illustrated in Figure 3. Electricity sales in 2010 totaled 10 billion kWh, supplied by Hawaii Electric Light Company (for the island of Hawaii), Hawaiian Electric Co. (for Oahu), Kauai Island Utility Cooperative (for Kauai) and Maui Electric Co. (for Maui, Molokai and Lanai). Hawaii Gas Company provided 32.3 million therms of gas (synthetic natural gas and liquefied petroleum gas (propane) from byproducts of imported petroleum) to about 70,000 business and residential customers across the state.

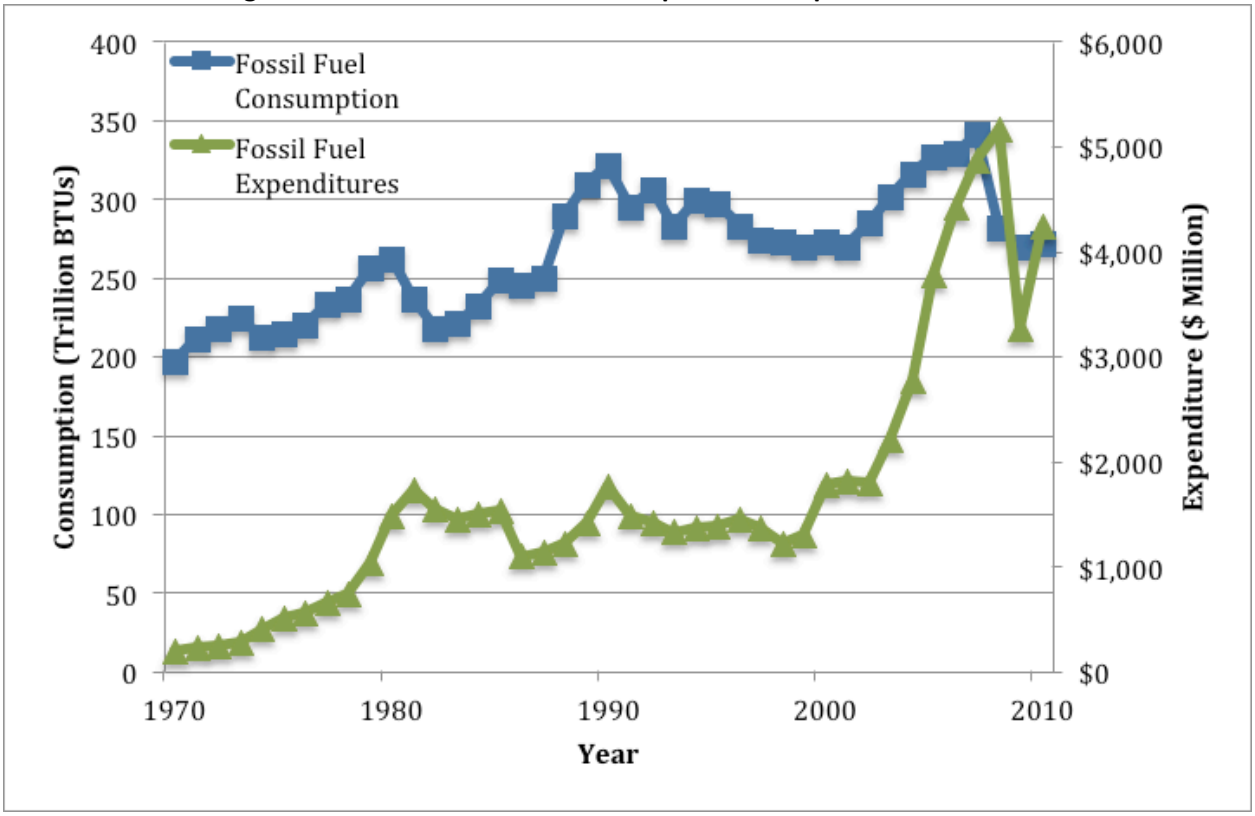
[23] U.S. Energy Information Administration (EIA) Electric Sales, Revenue, and Average Price, "Residential average monthly bill by Census Division, and State 2011," September 27, 2012, U.S. EIA web site at http://www.eia.gov/electricity/sales_revenue_price/pdf/table5_a.pdf

Figure 2: Hawaii Electricity Consumption 1970-2010



Source: U.S. Energy Information Administration, *State Energy Data System (SEDS): Hawaii,* June 29, 2012, http://www.eia.gov/state/seds/data.cfm?incfile=/state/seds/sep_use/tx/use_tx_HI.html&sid=HI

Figure 3: Hawaii Fossil Fuel Consumption and Expenditures 1970-2010



Source: :U.S. Energy Information Administration, *State Energy Data System (SEDS): Hawaii Primary Energy Use,* June 29, 2012, http://www.eia.gov/state/seds/seds-data-complete.cfm?sid=HI#Consumption

2.3.4 History of Conservation and Efficiency

The state has a history of conserving energy, beginning in 1996 with formal energy efficiency programs offered by the public electric utility companies in response to an integrated resources energy planning process initiated by the Hawaii Public Utilities Commission. According to HECO, its efficiency programs and those of its subsidiaries, MECO and HELCO, reduced demand for electricity by 169 MW (equivalent to a large power plant), saved 1.6 million barrels of oil and reduced carbon dioxide emissions by 864,000 tons annually.[24]

The programs continued for 13 years through 2008 until they were transferred to SAIC and became the Hawaii Energy Program. The HECO utilities' energy efficiency programs were similar to those in other states and regions of the country, but with a focus on solar water

[24] "Energy Efficiency Programs transition to new Public Benefits Fee administrator on July 1,"Hawaiian Electric Company press release, June 25, 2009,on the HECO web site at http://hecoirp.com/portal/site/heco/menuitem.508576f78baa14340b4c0610c510b1ca/?vgnextoid=5294bf099e812210VgnVCM1000005c011bacRCRD&vgnextfmt=default&cpsextcurrchannel=1

heating (SWH) due to the state's climate and lack of heating load, which reduced the need for a primary emphasis on HVAC measures.

The extensive SWH program efforts paved the way for legislation requiring SWH systems to be installed in all single-family new home construction (HB 1464), which went into effect on January 1, 2010.

2.3.5 Future of Clean Energy

Hawaii is the most oil dependent state in the nation, vulnerable to fluctuations in oil prices. The state recently set goals and a road map to achieve 70 percent clean energy by 2030, with 30 percent from energy efficiency and 40 percent from renewable energy. As mentioned above, the HCEI seeks to reduce reliance on foreign oil reserves, increase economic stability and security, and to create a green economy sector to balance reliance on tourism and the military (which together make up half the economy).[25] Hawaii's EEPS has a goal of achieving 4,300 GWh of energy savings by 2030 and its RPS requires that 20 percent of net electricity sales come from renewable energy by 2020. Both the EEPS and the RPS are important components of the HCEI.

Several working groups have been created, consisting of community members and national experts, to facilitate progress towards the initiative's goals. The end-use efficiency working group is focused on energy efficiency, complemented by transportation (alternative fuels), electricity (renewable energy) and fuels (biomass) working groups.

The American Council for a Clean Energy Economy's (ACEEE) 2011 state scorecard report ranks Hawaii twelfth among U.S. states based on its use of best practices and leadership in energy efficiency policy and program implementation.[26] The report cites the state's efforts to set policy and implement programs such as Hawaii Energy to advance its Clean Energy Initiative. Like many states, Hawaii is taking a leadership role in energy policy to promote its economic future, in lieu of comprehensive federal energy legislation.

Hawaii Energy, as the state's energy efficiency program, supports the initiative by achieving energy efficiency savings across the islands in both the residential and business sectors. The State Energy Office also contributes to energy efficiency through policy, and codes and standards development. The legislation that established Hawaii Energy as PBFA also specified that the Program must be evaluated by an independent auditor to verify energy savings claims and other mandated deliverables. The results of the subject

[25] More information on the Hawaii Clean Energy Initiative can be found on its web site at http://www.hawaiicleanenergyinitiative.org/

[26] American Council for an Energy Efficient Economy, *2011 State Energy Efficiency Scorecard*, October 20, 2011, http://aceee.org/research-report/e115

evaluations of this report serve to meet requirements of SB 3001 (2008), Hawaii Revised Statutes §269-124.[27]

2.4 Evaluation Overview

Evergreen Economics has contracted with the Hawaii PUC to conduct a comprehensive multi-year evaluation of Hawaii Energy. The PY2011Evaluation Team consisted of the following firms and expert associates:

- **Evergreen Economics** managed the overall evaluation and led the impact evaluation work.
- **EMI** led the process evaluation and assisted with the market assessment work.
- **Michaels Engineering** managed all on-site metering and verification work and conducted fieldwork. It also led the review of *ex ante* savings values.
- **SMS** fielded all of the phone surveys for this evaluation.
- **Robert Wirtshafter** was involved with the net-to-gross analysis.
- **Phil Willems** assisted with all the process evaluation and market baseline work.
- **John Stevenson** supported the development of the phone survey instruments.

During the 2012 calendar year, we conducted extensive research on Hawaii's residential and business sectors to evaluate the effectiveness of the Program, assess the state's energy efficiency markets, and estimate energy savings. The PY2011 Evaluation approach consisted of the following key activities:

- **Impact Evaluation** to provide an independent assessment of the Program's energy savings accomplishments, through the following activities:
    - **Technical Reference Manual (TRM) Review** – Conduct an engineering review of the Program's deemed savings values as presented in the TRM;
    - **Verification of Savings** – Perform savings validation and measure installation verification, including participant telephone and on-site surveys and project file review;
    - **Upstream Lighting Program Analysis** – Review sales records for PY2009 – PY2011 to determine the number of qualifying lighting measures sold through the program each year by lamp type and store type, as well as the relative distribution of rebate dollars; and
    - **Residential PGC Program Assessment** –Analyze PGC participant and non-participant survey results and perform a billing analysis to inform an estimate of savings associated with the PY2010 pilot program. These results will be used to inform the PY2012 TRM review.

[27] "Before January 2, 2008, and every three years thereafter, require verification by an independent auditor of the reported energy and capacity savings and incremental renewable energy production savings associated with the programs delivered by the public benefits fee administrator contracted by the Public Utilities Commission to deliver energy-efficiency and demand-side management programs under section 269-121." http://www.capitol.hawaii.gov/session2008/bills/SB3001_HD1_.pdf

- **Market Assessment** to gain insights into various market aspects that may affect Program performance, activities and/or design. For the PY2011 Evaluation this component includes:
    - **NTG Assessment**– Review existing evaluation reports for similar programs in other regions and analyze survey data collected during the first two years of the Hawaii Energy evaluation, in order to recommend revisions to NTG ratios as needed for the next program cycle;
    - **Non-Energy Benefits Literature Review** – Review the literature on non-energy benefits of energy efficiency programs to provide an introductory overview of the topic and recommendations for addressing these benefits in Hawaii.
- **Process Evaluation** to determine the effectiveness of Program processes, based on Program participant interviews, and Program data and materials review.
    - **Program Participant Feedback**– Conduct primary data collection and develop estimates of remaining energy efficiency potential for residential and business customers on the islands of Oahu, Maui and Hawaii.

3. Evaluation Approach

This section provides an overview of the evaluation methods used to conduct the PY2011 Evaluation. A number of evaluation activities were conducted throughout the annual cycle, summarized in stand-alone memoranda (attached hereto as appendices). This report synthesizes the material into an overarching document, adding some additional detail where applicable. The reader is referred to Appendix A: Verification Results Memorandum, Appendix B: Technical Reference Manual Review Results Memorandum, Appendix C: Opower Assessment Results Memorandum, and Appendix D: Net-to-Gross Assessment Memorandum for a discussion of the comprehensive methods and results for these research tasks. Appendix E provides research instruments and Appendix F includes quantitative survey results for the Program participant telephone surveys. Discussion of and findings from the baseline study will be presented in a separate report to be submitted to the PUC in the summer of 2013

3.1 Impact Evaluation

3.1.1 Technical Reference Manual Review

Energy and demand savings estimates for Program measures and activities are approved on an *ex ante* basis and must be documented in a TRM prepared by the PBFA and reviewed by the EM&V contractor. The TRM must include estimates for all prescriptive measures, and descriptions of calculation methodologies for custom measures. The information in the TRM must be consistent with the information in any database or other tool used to calculate savings resulting from the Program. The PY2009 TRM was approved for use by Hawaii Energy for PY2010. Therefore, the EM&V review conducted during the last program cycle was used in the PY2011 and PY2012 cycles. In February 2012 the Evaluation Team reviewed and prepared a memo on the October 2011 TRM, and then in August 2012 compared the most recent TRM version (dated August 2012) to the February 2012 TRM memo. We then prepared and submitted a memo on that comparison to the Contract Manager in December 2012. Changes made during this calendar year (2013) should be included in the PY2013 TRM. The Evaluation Team will review the TRM used for PY2013 in the fall of 2013.

The review of the Hawaii Energy TRM submitted on August 14, 2012 (PY2012 TRM) was two pronged. We first reviewed new measures included in the PY2012 TRM, and then conducted a review to check for the inclusion of changes recommended by the evaluation team during the PY2010 evaluation cycle. Three new residential measures, three new business measures, and changes to two business measures required review in the PY2012 TRM. A discussion of the review findings is included in Section 4.1, below. Additionally, a redlined version of the PY2012 TRM (attached with Appendix B) was also created to provide an additional resource regarding recommended changes to new measures and past recommendations that had not been implemented.

3.1.2 Verification Research

Three research tasks were intended to evaluate Program energy savings claims:

1. **Savings Database Validation.** We obtained a database from Hawaii Energy including Program participant information and energy savings values for PY2011 and summarized the savings claims by program (e.g., REEM) and energy efficiency measure (e.g., ceiling fans). We then compared this summary to Hawaii Energy's program- and measure-level summary of savings claims in the *Hawaii Energy Conservation and Efficiency Programs Annual Report, Program Year 2011*(Annual Report).[28] We also compared per unit savings values against the approved ("deemed") values in the approved PY2011 TRM. We also verified savings for the PY2011 Residential PGC program.

2. **Measure Verification.** We conducted telephone and site surveys with statistically representative samples of participants by program. We also conducted site surveys of large business customer projects to verify that measures contained in the Program tracking database were actually installed, Program qualifying, operational, and that the correct savings inputs and calculations were used. For business custom measures, we conducted engineering analyses based on on-site surveys to confirm claimed savings.

3. **HTR Verification.** As part of our overall Program savings verification, we conducted additional verification on CFLs distributed under the RHTR program and Advanced Power Strips (APS) distributed through the BEEM, REEM and RHTR programs. For PY2011 this HTR verification was a streamlined review to ensure that tracking information was being recorded correctly and that equipment was being distributed according to protocols established by the PUC's EM&V contract manager (Contract Manager). In the PY2012 evaluation cycle, we will conduct a more extensive HTR verification.

The overall verification results presented below represent a combination of findings from these activities. 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 having 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 the PY2011 Program.

[28]SAIC Energy, Environment & Infrastructure, LLC.*Efficiency Programs Annual Report, Program Year 2011.* (Honolulu, HI: Hawaii Public Utilities Commission, December 3, 2012). http://www.hawaiienergy.com/75/hawaii-energy-reports

3.1.2.1 Savings Database Validation

Hawaii Energy provided the Evaluation Team with the final data from its tracking system for PY2011 in its entirety. We used these data to generate an independent estimate of claimed savings and compared our estimate to that reported in the Annual Report.

The validation exercise included summarizing the measure installation counts and total savings in the tracking database and comparing them to those in 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 TRB ratio results from the Annual Report by doing 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 PY2011 TRM.

kWh Savings for Residential Peer Group Comparison

As a new program and a more complicated measure than most we validate, we here discuss in more detail the approach used to verify savings for the PY2011 Residential PGC.

A provisional value for the PGC program was approved in the PY2011 TRM, based on secondary research, with the proviso that the Evaluation Team would conduct independent analysis of that provisional value and, if necessary, update the value for *subsequent* program years. (The results of the billing analyses conducted to develop a forward-looking savings estimate for the PGC are described elsewhere in this report.) To review the PY2011 savings claim, the applicable approach entailed ensuring that the approved PY2011 TRM value was applied properly to the correct number of customers. The approved TRM value for PY2011was expressed as a 1.73 percent reduction in a customer's annual kWh usage. In order to validate the savings claims, we collected information from Hawaii Energy on the number of participants per month and their average monthly energy usage. We then calculated the total validated savings as follows:

$$\text{Validated Savings for Residential Peer Group Comparison} = \sum_i Participants_i * Usage_i * 0.0173$$

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, Hawaii Energy claimed savings based on calculations performed by the vendor, which are based on its estimates of realized savings calculated using 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 Contract Manager, the approved PY2011 TRM value was used in this validation analysis to re-calculate savings for the Residential PGC program. This approach reaffirmed the arrangement that had been agreed-upon for purposes of estimating program savings for PY2011. The approved PY2011 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 PGC 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 PY2011 Evaluation, we conducted an independent measurement study of this program. We also reviewed the program's savings calculations as part of our broader evaluation effort.[29] This evaluation approach is consistent with the overall evaluation approach for deemed measures.

3.1.2.2 Measure Verification

The measure verification research methods included fielding telephone and on-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.

Sample Design

We used program tracking data from the first three quarters of PY2011 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 (on June 30, 2012). The samples drawn from the first three quarters and the subsequent research results were believed to be representative of the full-year Program, since the program design did not change in the fourth quarter.

Hawaii Energy provided the Evaluation Team 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 Hawaii Energy program tracking database on May 14, 2012. We used this dataset to develop samples for phone and on-site surveys, which we used to verify REEM, BEEM and CBEEM program measures.

For the Business Programs, we supplemented the Q1-Q3 sample frame with large projects (>150,000 kWh) in the BEEM program and all projects in the CBEEM program recorded in the tracking database in Q4 of PY2011. We worked closely with Hawaii Energy over the

[29] For the PY2011 Evaluation, the PGC program assessment was split into "measurement," updating savings values prospectively, and "verification," assessing how the savings were claimed (based on deemed values for PY2011) to calibrate PY2011 savings claims. See Section 3.1.4 and Section 4.3 for more detail.

summer of 2012 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 of PY2011.

Table 6 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 individual program, the third column lists the first-year net energy savings claims represented by the sample, the fourth column includes the first-year net energy savings claims represented by the full-year participation database, and the fifth column shows the fraction full-year energy savings 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 6: Net Energy Savings for Measure Verification Sample as a Fraction of the Participant Population, by Sector and Program – PY2011

		(kWh)		Sample as a % of Total Program Savings
Sector	**Program**	**Sample**	**Total Program Savings**	
Business				
	Business Energy Efficiency Measures[1]	0	34,929,190	0%
	Business Energy Systems Management[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%
	Business Total	**25,587,139**	**61,151,217**	**42%**
Residential				
	Residential Energy Efficiency Measures[5]	301,995	65,511,035	0%
	Residential Energy Systems Management[4]	923	91,481	1%
	Residential Hard to Reach[3]	-	2,032,234	0%
	Residential Total	**302,918**	**67,634,750**	**0%**
Total		**25,890,057**	**128,785,967**	**20%**

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 the savings of which 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 with measure descriptions indicating "CBEEM."

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 Program participants were "downstream" customers who lived in a residential home or operated a commercial, industrial or government facility ("business customers"), and

received a rebate for Program-qualifying equipment. Typically they mailed in a rebate application and were then mailed a rebate check. The Program also paid rebates directly to lighting manufacturers and distributors ("upstream" or "mid-stream" market actors) for 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 business projects. For PY2011 the HTR verification was conducted as a spot check to ensure that tracking information was recorded correctly and that equipment was distributed according to protocols established by the 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 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 business customers in the summer of 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 and RESM, and those who installed small and medium projects through BEEM.

  To determine the allocation for residential customers, 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.

  Due to the small number of Business Program participants across all islands, no sample allocation was made. Instead, a census of all 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 business surveys covering 59 measures.[30]

- **Customer on-site surveys and document reviews.** Michaels Energy conducted a sample of on-site surveys of measures installed in business locations for CBEEM and large BEEM projects 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 from the 36 projects with the highest savings from Q1-Q4 (representing 27 percent of total BEEM savings).[31] Five BEEM sites had on-site and document reviews, and five had document reviews only.

  The business 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 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 program projects. Of the 278 custom projects, 10 had both on-site surveys 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 Hawaii Energy program tracking database. For this sample of invoices we compared CFL quantities and savings against the invoice detail in the tracking database and confirmed that products are Program qualifying (e.g., matching the unique retail product number with the ENERGY STAR website.)[32]

[30] Note that for PY2009 and PY2010, 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 PY2011, we conducted only telephone verification surveys for this sub-sample of the participant population, reserving on-site surveys for the custom and large business projects. This freed up evaluation budget for other purposes, notably a baseline study to assess appliance and equipment saturation, and building characteristics throughout the state.

[31] 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.

[32] This review was streamlined from our approach the prior two years, for which we undertook a third stage involving a more detailed review of a sample of actual invoices. Both years we found that 100 percent of the invoices were validated against the program tracking data.

3.1.2.3 HTR Verification

As part of the overall Program savings verification, we conducted additional verification work on the CFLs distributed through the RHTR program and APSs distributed through the BEEM, REEM and RHTR programs. For PY2011 the HTR verification was conducted to ensure that tracking information was being recorded correctly and that equipment was being distributed in accordance with protocols established by the Contract Manager. In the PY2012 evaluation cycle, 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 PY2011 was conducted in three parts:

1. Checking compliance with the documentation requirements set forth by the Contract Manager in a memorandum dated October 5, 2011;
2. Verifying quantities of equipment between tracking spreadsheets, final program data, and the Annual Report; and
3. Reviewing a sample of distribution logs from giveaway and exchange events, and comparing related quantities to the tracking spreadsheets.

To conduct the HTR CFL and APS equipment review, Hawaii Energy provided the Evaluation Team with tracking spreadsheets for the full program year with purchase and distribution information for both CFLs and APSs, along with a sample of distribution logs from giveaway or exchange events in the community.

To check compliance with the documentation requirements, the Evaluation Team 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.

3.1.2.4 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 verified to be installed and Program qualifying. When 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 Program 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.

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

For **large and custom business facilities** that were reviewed by engineers based on electronic project files and on-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. When 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 PY2011. For upstream CFLs and RHTR measures for which 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 used in the prior two evaluation cycles and resulting from more robust verification efforts.

3.1.3 Upstream Lighting Program Analysis

Because lighting measures contribute a significant portion of Hawaii Energy savings, we conducted a special analysis of the upstream lighting program, which provides incentives to retail stores that display and sell energy efficient lighting products. Sales records for qualifying lighting measures at participating retailers for the past three program years (PY2009-PY2011) were reviewed to determine the number of qualifying measures sold through the program each year in each of three participating counties by lamp type and store type, as well as the relative distribution of rebate dollars.

3.1.4 Residential Peer Group Comparison Program Assessment

Our research methods consisted of two complementary analysis activities:

1. A phone survey of program participants and a control group that solicited information on how the HER influenced energy usage; and
2. A billing regression on a sample of customers and a control group to develop an independent estimate of energy savings.

3.1.4.1 Phone Survey

SMS conducted a phone survey of 300 PGC participants and 300 people in a control group in January 2012. The survey included batteries for the topics summarized in Table 7.

Table 7:PGC Assessment Phone Survey Batteries

Battery	Information to be Collected
Recollection of the program	Confirm if the household recalls receiving the HER, and if they have read it.
Influence of the program	Questions regarding changes in behavior, asking about behaviors recommended by vendor to participants, from the Reports sent to participants during its implementation in Hawaii.
CFL purchases	Has the household purchased CFLs since receiving the HER, and did the HER influence the purchase decision. The questions ask about number of CFLs purchased, location of purchase and other information that allows us, with reasonable certainty, to determine if they were program bulbs, and whether the CFLs are installed.
Appliance purchases	Has the household purchased any rebated energy efficient appliances since receiving the HER, and did the HER influence the purchase decision.
Billing analysis battery	To explain any changes in energy usage associated with behaviors and changes outside the PGC and other Hawaii Energy programs.
Home and household characteristics	Basic information about the dwelling and composition of the household to support demographic (and optional billing) analyses.

3.1.4.2 Billing Analysis

The second analysis component was a billing regression conducted using data on the participant group and a randomly selected control group.

The billing regression analysis was structured to accomplish the following research objectives:

- Develop an independent estimation of program savings.
- Determine the effect on savings estimation of screening outliers in the data.
- Verify the control group is statistically similar to the participant group.
- Quantify the impact of double counting energy savings due to participation in other Hawaii Energy programs.

To address these issues, the Evaluation Team developed two fixed effects billing regression models using monthly panel billing data for the PY2010 PGC pilot program participants collected from April 2010 to May 2012.

The first model estimates changes in household monthly energy consumption from the pre-report period to the post-report period and between the control and participant groups while controlling for changes in weather. The specification of this model is based on models

used in previous industry evaluations of the Opower program.[33] Because we are not aware of the method the vendor uses to estimate savings, we use this model as our best approximation of the approach we believe it has adopted (hereinafter referred to as the "Standard PGC Model").

The second model expands on the Standard PGC Model, incorporating participation data from other Hawaii Energy programs to investigate and control for potential double counting of energy savings. Variables are added to the model to indicate if a household participated in one or more other Hawaii Energy programs. The results of adding these variables to the model indicate that some energy savings attributed to the PGC program in the Standard PGC Model are due to participation in other Hawaii Energy programs. This suggests the potential for double counting energy savings at the Program level. We recommend that this second model (hereinafter referred to as the "Recommended PGC Model") be used to estimate PGC savings.

Both models were run using monthly panel billing data for PGC pilot program participants collected from April 2010 to May 2012. The models were first run using all billing data for all PGC participants. The models were then run employing a data screen to remove participants with insufficient data and outliers.

Lastly, because we did not know how the vendor selected its control group, we estimated the PGC Standard Model using the PGC participant group, replacing the PGC selected control group with repeated samples of Hawaii Energy customers from the same region, essentially, creating new, randomly selected control groups. Taking the average of the resulting savings estimates and comparing this with the savings estimates derived from the original PGC group helped determine if the control group was appropriately selected.

3.2 Market Assessment

3.2.1 Net-to-Gross Assessment

Attribution of savings is a critical component of program evaluation. For our impact evaluation, we must first assess gross energy savings for Program participants, and then make two adjustments to determine a net amount that is clearly attributable to the Program. The first adjustment is made to account for free-rider effects -reducing gross savings by removing savings that would have occurred even in the absence of the Program. The second adjustment is made to account for spillover or market effects[34] - increasing gross savings by including actions that were clearly induced by the Program but occurred outside of the direct Program activities.

[33] Earlier evaluations of programs implemented by Opower, the PGC vendor, include *Puget Sound Energy's Home Energy Reports Program – 20-Month Impact Evaluation*, prepared by KEMA for Puget Sound Energy (October 2010) (https://conduitnw.org/_layouts/Conduit/FileHandler.ashx?RID=484) and *Evaluation Report: OPOWER SMUD Pilot Year 2*, prepared by Navigant Consulting (February, 2011) (http://opower.com/uploads/library/file/6/opower_smud_yr2_eval_report_-_final-1.pdf).

[34]This report uses a broad definition of spillover that includes any program related change in the market that was not directly incented by the Program.

Our NTG assessment is intended to help frame on-going discussions related to the issue of attribution (or NTG measurement) for demand-side management programs in Hawaii. Our activities in this area included an examination of secondary research and survey data from the first two years of Program evaluation, and recommendations for revisions to NTG ratios as needed for the next program cycle. In our Net-to-Gross Assessment Memo (included as Appendix D hereto), we provide an overview of why NTG is relevant, highlight how the regulatory treatment of NTG can impact the success of energy efficiency goals, and provide both near- and long-term recommendations for dealing with this important issue.

Development of program-specific NTG adjustment factors was undertaken this cycle as a means of encouraging the PBFA to design the Program to reap the greatest net benefits. For previous cycles a single NTG factor had been applied across the program portfolio. With each cycle, Hawaii Energy has been modifying program implementation and offerings, and as a result a more fine-grained approach for characterizing NTG has become appropriate. We developed a set of recommended NTG values, based on those used in California, Massachusetts, New York and Wisconsin.

The methodology used to derive the recommendations is a simple one. We assembled a set of values for free-ridership and spillover from the available evaluation reports for the four large active states that conduct extensive free-rider and spillover assessments (as listed above). Sources for these studies are the California Public Utilities Commission (CPUC), Massachusetts Energy Efficiency Advisory Council (MAEEAC), New York State Energy Research and Development Authority (NYSERDA), and Wisconsin Focus on Energy (WFOE). From these raw values we estimated the appropriate free-rider rate for each program based on averaging the values found from each state.

A detailed explanation of the methodology is described in Appendix D. The decision was made to produce averages at the program level rather than at the measure level. For those states that had measure level data, we estimated the program-level data by simply averaging the values of the statewide program-level results. When there was no program-level result, for example no state has a program result for a Business Service and Maintenance Program, we used our best judgment as to which measures or programs from the four states were closest to the Hawaii program and used those free-rider values for Hawaii.

3.2.2 Non-Energy Benefits Literature Review

The Evaluation Team conducted a review of literature on non-energy benefits of energy efficiency programs. Specific objectives of this review included:

1. **Provide an overview of common non-energy benefit categories.** We discuss a sample of non-energy benefits that are most commonly found in the literature. We choose the non-energy benefits reviewed to be the most applicable to Hawaii and that have received the most attention in the literature.
2. **Discuss non-energy estimation methods.** A variety of estimation techniques have been developed for estimating the dollar value associated with various non-energy benefits. Given that non-energy benefits are somewhat abstract, the techniques

needed to develop accurate estimates of their value are complicated and can be very expensive to implement. We discuss the most common estimation methods along with the strengths and weaknesses of each.

3. **Summarize select findings from the current non-energy benefit literature.** For the selected non-energy benefits, we include a range of value estimates found in the literature. The studies reviewed were judged as the most likely to provide reliable results. Despite our attempt to limit the review to the most credible research available, the quality of the studies included still ranged considerably.
4. **Discuss applicability of current literature to the Program.** We limited the scope of this review to cover those non-energy benefits that are common in the literature, have been researched using credible methods and are most applicable to Hawaii. It should be noted that it was difficult to find non-energy benefit estimates that could be applied to Hawaii directly from the literature. Many benefit value estimates were tailored to very specific programs and we encountered a number of challenges associated with some of the estimation methods.
5. **Provide recommendations on how non-energy benefits should be addressed in Hawaii.** Based on the findings in the literature and their relevance to Hawaii, we provide our recommendations on how to incorporate non-energy benefits in the overall benefit-cost assessment of the Program.

As these objectives indicate, the related discussion in this report is intended as an introductory overview and does not provide a comprehensive review of all recent research on this topic.

3.2.2.1 Non-Energy Benefits Reviewed

The literature contains numerous descriptions of different non-energy benefits associated with energy efficiency programs. However, many of these benefits have not been extensively researched, and some of the methods used to estimate the less common benefits are not credible and are unlikely to produce reliable results. Additionally, many of the studied benefits are not applicable to Hawaii. The list of non-energy benefits included in this review includes only those that are relevant to Hawaii businesses and households.

To narrow the focus of this review, we selected non-energy benefits based on the following criteria:

1. **Benefit is commonly found in the literature.** The non-energy benefits selected were those that are most commonly considered in other jurisdictions and therefore were most commonly addressed in the literature. This typically enabled us to find benefit estimates for both the residential and non-residential sectors, as well as for a range of different program types.
2. **Study included primary data collection.** Studies that involved only a review of existing literature without conducting any additional primary data collection on non-energy benefits are not included in this review. These literature reviews tend to cite existing studies without conducting any analysis on the quality of studies being reviewed. In this manner, sub-standard studies can get cited repeatedly and eventually obtain an appearance of legitimacy that is not merited.

3. **Applicability to Hawaii.** The non-energy benefits needed to be relevant for Hawaii in order to be included in the review. As a result, benefits relating to heating (e.g., reduced fire hazards) and similar impacts associated with cold weather were excluded from the final review.
4. **Estimates based on credible analysis methods.** Our review focused on those studies that used the more commonly accepted approaches, as discussed below. However, while these approaches have seen widespread use, it is not necessarily true that researchers used them appropriately to produce credible estimates. We used our professional judgment in reviewing these articles, and excluded those studies in which the analysis did not appear credible.

Based on the above criteria, our review focused on a subset of non-energy benefits that were among the most common studied in the literature and are applicable to Hawaii, including:

- Greenhouse gas (GHG) emissions reductions;
- Improved occupant comfort;
- Improved health and safety;
- Reduced operation and maintenance costs; and
- Increased productivity.

3.3 Process Evaluation

The objective of the PY2011 process evaluation was to provide a status update on the effectiveness of the energy efficiency programs to ensure they are meeting statewide energy efficiency goals. During the first evaluation of Hawaii Energy (for PY2009), a comprehensive process evaluation was conducted, but in subsequent years, these efforts were scaled back to focus on providing cost effective annual updates on key program metrics with minimal effort.

In order to collect data on customer experiences with the Program, the Evaluation Team fielded a survey with 430 participating customers, each of whom had participated in one of the Hawaii Energy rebate programs. For residential customers, a proportional sample allocation was used based on measure category and island. This ensured that at least 50 sample points were obtained per island. Because the population of business customers was limited, all of these customers were contacted. The final number of surveys completed by customer type included:

- 380 Residential Program participants; and
- 50 Business Program participants.

We asked these customers a core set of questions that we have asked year-over-year to provide insight into trends in Program-participant perspectives over time. We compare this feedback to that received over the past two evaluation cycles in order to identify trends that warranted additional study.

An important focus of our analysis this year was the influence of consumer rebates in the residential sector. The key questions addressed in this evaluation are:

1. How important are the incentives currently available to program success?;
2. Which incentives are most impactful to energy efficient product adoptions?; and
3. Which incentives need adjusting?

Out of this analysis, the Evaluation Team identified some important implications for the longer-term design of the appliance rebate program (REEM).

3.3.1 Program Participant Feedback

3.3.1.1 Residential Programs

For residential customers, a proportional sample allocation was used covering a total of 401 measures. Surveys conducted in the current year referenced participation in the prior year program. The objective was to capture participant perspectives on the Program and serve as a Program status check.

Data collection efforts centered on a CATI survey of residential customers participating in the Program during PY2011. The sample of residential customers selected was based on population data pulled from the participant database maintained by Hawaii Energy on April 25, 2012. The population comprised the participants in Residential Programs implemented during the first three quarters of PY2011. Feedback is limited to the perspectives provided by REEM program participants (representing 41 percent of Residential Program savings). It excludes responses from participants in the upstream lighting and CFL exchange/giveaway programs, which accounts for the remainder of savings from the Residential Programs.

Surveys conducted with participating residential customers examined a variety of topics designed to provide a status update on key metrics of Hawaii Energy programs, and results discussed in Section 6 are organized into two sections, as follows:

- General Program Feedback
    - Initial Awareness of Programs
    - Role of social media as an information source
    - Motivation for reducing energy usage
    - Energy savings efforts
    - Adoption of CFLs
    - Reasons for installing solar water heaters
    - Cost barriers of energy efficient products
- Rebate Impact Feedback
    - Knowledge of rebates
    - Rebate satisfaction
    - Importance of rebate
    - Influence of rebate on purchase of specific technologies
    - Rebate impact on timing of purchases

3.3.1.2 Business Programs

As with participating residential customer surveys, surveys conducted with participating business customers were focused on collecting perspectives on the Program during PY2011. The objective of this survey was also to provide a status update on the Business Programs, which account for about a third (39 percent) of the total portfolio savings. The procedure used to determine the sample frame for the PY2011 Evaluation was similar to that used for the PY2010 evaluation. Surveys conducted each year reference participation in the Program during the prior year. Due to the small number of business participants across all islands, no proportional sample allocation was made. Instead, all business participants were contacted in an effort to complete the target number of 50 surveys across a total of 59 measures.

Data collection efforts were conducted using a CATI survey of business customers participating in the Program during PY2011. The sample of business participants selected was based on population data pulled on April 25, 2012 from the participant database maintained by Hawaii Energy. Additional participant-level information specific to the BEEM program was downloaded from the participant database on May 14, 2012. The population comprises all participants in the BEEM, BESM, BHTR and CBEEM programs, including military operations.

The Evaluation Team conducted telephone surveys with participating business customers and compared survey responses from PY2011 to findings from prior surveys conducted for PY2010 and PY2009. Business participant responses were analyzed and categorized into the following program topic areas:

- Initial awareness of program;
- Knowledge of ways to save energy;
- Importance of energy efficiency equipment;
- Influence of rebate on purchase decisions; and
- Satisfaction with program elements.

4. Impact Evaluation

The impact evaluation included the TRM review, savings validation, measure installation verification and the Residential PGC program assessment. The reader is also referred to Appendix A: Verification Results Memorandum, Appendix B: Technical Reference Manual Review Results Memorandum, and Appendix C: Opower Assessment Results Memorandum for the comprehensive methods and results for these research tasks.

4.1 Technical Reference Manual Review

The TRM review is conducted twice each program year to review savings assumptions being used for the current program, and then at the close of the program year to ensure that any recommendations made were incorporated into the final program savings claims. Three new residential measures, three new business measures and changes to two existing business measures required review in the PY2012 TRM, the TRM reviewed during this cycle as part of the PY2011 Evaluation.[35] A discussion of the review of the new measures and changes follows below. Additionally, a redlined version of the TRM created to provide an additional resource regarding any recommended changes to new measures and past recommendations that had not been implemented is included in Appendix B to this report.

4.1.1 New Residential Measures

Three new (or substantially changed) measures required review in the PY2012 TRM:

- LED Lighting (PY2012 TRM Section 8.2.2);
- Residential Daylighting (PY2012 TRM Section 8.2.3); and
- Hawaii Energy Hero Audits (PY2012 TRM Section 10.2.3).

4.1.1.1 LED Lighting (PY2012 TRM Section 8.2.2)

This measure involves the installation of LED lamps to replace either a standard incandescent lamp or CFL. Baseline lamps are assumed to be either a 40W or 60W incandescent or a 13W or 23W spiral CFL. Installed lamps are assumed to be either a 7W or 12.5W LED lamp.

The baseline wattage is assumed to be an equal weighted average of all the possible baseline fixtures. The result is an assumed baseline wattage of 35W. The proposed wattage is assumed to be the average of the 7W and 12.5W LED lamps, or 10W.

[35] As discussed above in Section 3, the reason for reviewing the PY2012 TRM as part of the PY2011 Evaluation is as follows. The PY2009 TRM was approved for use by Hawaii Energy for PY2010. Therefore, the EM&V review conducted during the last program cycle was used in the PY2011 and PY2012 cycles. In February 2012 the Evaluation Team reviewed and prepared a memo on the October 2011 TRM, and then in August 2012 compared the most recent TRM version (dated August 2012) to the February 2012 TRM memo. We then prepared and submitted a memo on that comparison to the Contract Manager in December 2012. Changes made during this calendar year (2013) should be included in the PY2013 TRM. The Evaluation Team will review the TRM used for PY2013 in the fall of 2013. The review of the Hawaii Energy TRM submitted on August 14, 2012(PY2012 TRM) was two pronged .We first reviewed new measures included in the PY2012 TRM, and then conducted a review to check for the inclusion of changes recommended by the evaluation team during the PY2010 evaluation cycle.

The wattages used in this measure are reasonable for the associated types of fixtures. Additionally, the annual hours of use and coincidence factors used are consistent with the other residential lighting measures.

However, the effective useful life (EUL) and incremental cost values should be adjusted. An EUL of five years is issued in the PY2012 TRM. However, other jurisdictions use between 15- and 20-year EULs for LED lamps.[36] Additionally, manufacturer data suggests useful lives substantially longer than five years, and LED lamps are also not adversely affected by switching as CFLs are. Therefore, we recommend increasing the EUL for LED lamps to 15 years.

The incremental cost used in the PY2012 TRM for LED lamps is $35. However, research of large retailers with stores in Hawaii, such as Wal-Mart and Home Depot, yields prices for LED lamps between $15 and $20. There is no resource or citation provided in the TRM for the incremental cost, so it is not clear how the $35 value was derived. Further market research should be conducted to determine the most appropriate incremental cost for LED lamps in residential applications.

4.1.1.2 Residential Daylighting (PY2012 TRM Section 8.2.3)

This measure involves the installation of a tubular daylighting device (TDD) to reduce the amount of lighting used during the day. The installation of the TDD is assumed to eliminate the need for the use of baseline fixtures, which are assumed to be two 75W incandescent fixtures and two 18W CFL lamps.

The baseline fixture wattages are reasonable based on lumen levels. However, the TDD installed is assumed to be the largest size available, recommended for spaces of up to 300 square feet. Several manufacturers, including the one referenced in the TRM, have multiple sizes of TDDs available for purchase.[37] Therefore, it is recommended that an additional size of TDD be added for the measure in the TRM to account for the smaller version of the TDDs that may be installed.

Based on manufacturer data referenced in the PY2012 TRM,[38] the smaller TDD is sufficient to light an area of two-thirds the size of that lit by the larger TDD, and has an average light output of 2,228 lumens, approximately half of the 4,541 average lumens provided by the larger TDD. This would suggest that the smaller TDD would be able to provide the same amount of light as one 75W incandescent bulb and one 18W CFL lamp. This smaller size of TDD should be added as a possible measure choice to ensure the most appropriate size

[36] For example, Xcel Energy (which administers energy efficiency programs in eight U.S. western and Midwestern states) uses a 20-year EUL for residential LEDs, and the California Database for Energy Efficient Resources (DEER) and the current Arkansas Statewide TRM use 16- and 22-year EULs, respectively.

[37] Information on TDD size and availability was found on the following manufacturer web sites: Solatube at www.solatube.com, ODL at www.odl.com, and Velux at http://suntunnelskylights.veluxusa.com/. The PY2012 TRM refers to Solatube.

[38] Related manufacturer data from Solatube is found at http://www.solatube.co.uk/residential/solatube-product-info/unrivalled-performance/index.php

TDD is incented. The smaller TDD would have energy savings of 78.1 kWh per year. Additionally, the incremental cost and potential rebate amount should either be separate for each size of TDD, or the weighted average of the two sizes.

4.1.1.3 Hawaii Energy Hero Audits (PY2012 TRM Section 10.2.3)

This measure involves the completion of a home energy audit that could result in the installation of an outlet energy monitor and some other energy-saving devices. This measure assumes a four percent reduction in energy savings, or 300 kWh per year, as a result of the audit.

The TRM does not state what equipment might be installed as part of the energy audit. The two related calculations in the PY2011 TRM suggest that a power strip and at least one CFL are assumed to be installed as part of this measure. However, the sum of the savings from these two items is only 114.3 kWh, well below the assumed measure savings of 300 kWh.

More detail should be included with this measure to justify energy savings of 300 kWh. Based on the information in the PY2012 TRM, the savings suggested by the measure is only 114.3 kWh.

4.1.2 New Business Measures

Three new business measures in the PY2012 TRM required, as did changes to two existing measures. Reviewed measures include:

- New Measures:
  - LED Lighting (PY2012 TRM Section 12.1.7);
  - Sensors (PY2012 TRM Section 12.1.13); and
  - Demand Controlled Kitchen Ventilation (PY2012 TRM Section 12.6.3).
- Changed Measures:
  - Addition of "Military Residential" Building Type for Compact Fluorescent Lighting (PY2012 TRM Section 12.1.1); and
  - Addition of Interactive Effects for Business Lighting (PY2012 TRM Section 3.0).

4.1.2.1 LED Lighting (PY2012 TRM Section 12.1.7)

This measure involves the installation of LED fixtures in business buildings. Energy savings are broken down by building type and lamp type in the TRM. The baseline and proposed fixture wattage values used are all reasonable and accurate. Additionally, the building hours of use and coincidence factors are all consistent with the other business lighting measures.

There is no EUL listed in the PY2012 TRM for this measure. It would be expected that the EUL for business and residential LEDs will be similar, as LED lamps are not affected by switching. Thus, it is recommended that the useful life for LEDs be changed to 15 years.

4.1.2.2 Sensors (PY2012 TRM Section 12.1.13)

This measure involves the installation of occupancy sensors to reduce the hours of operation of light fixtures when no occupants are present. Energy savings are calculated on a per sensor basis, assuming that each reduces lighting run-time hours by 33 percent.

The assumed run-time reduction of 33 percent is slightly higher than that used by other jurisdictions and industry experts. The most common average value used for all building and room types is 30 percent.[39] Therefore, the savings percentage should be reduced to 30 percent.

Energy savings calculations for this measure currently assume that the lighting is operating for 10 hours a day. However, this may not be the most representative value for all building types. Therefore, hours of operation should be broken down by building type using the lighting hours by building type for other business lighting measures in the PY2012 TRM.

The final issue related to this measure relates to the use of number of fixtures (and/or watts) controlled by each senor as the basis for calculating savings. The most accurate way to calculate energy savings for occupancy sensors is to use the wattage of lighting controlled by them. The PY2012 TRM assumes that each sensor controls two lamp T8 fixtures. This may be the case for office spaces, however, locations with high bay high-intensity discharge (HID) lighting and large open areas controlled via a single sensor will have savings that are significantly underestimated. Utility programs in Illinois, Michigan, Arkansas, Iowa, Minnesota, Colorado and Wyoming all use the watts controlled as the basis for this measure instead of the number of sensors installed. This will ensure that all circuit sizes are accurately accounted for.

4.1.2.3 Demand Controlled Kitchen Ventilation (PY2012 TRM Section 12.6.3)

This measure involves the installation of a temperature or smoke sensor to modulate kitchen exhaust fan air flows according to ventilation requirements. This reduces the energy usage compared to standard on/off controls.

The calculation methodology used to derive energy savings for this measure is reasonable and well thought through. The analysis used is consistent with engineering fundamentals, and is clearly presented in the TRM. The resulting savings values and percentages are also consistent with other utilities, as well as an in-depth data based case study conducted by Southern California Edison in 2009.[40] Therefore, no changes are recommended at this time.

[39] Examples of the others using the lower run-time reduction assumption include the state of Ohio (in its Draft TRM) the state of Arkansas (in its Statewide TRM), the IES (in the 9th edition of the *Illuminating Engineering Society Lighting Handbook*), and the New Buildings Institute.

[40] Southern California Edison Customer Service Business Unit, Design& Engineering Services, *Demand Control Ventilation for Commercial Kitchen Hoods*, June 30, 2009,http://www.etcc-ca.com/images/stories/et_07_10_dcv_com_kitch_hoods_final_report.pdf.

4.1.2.4 Compact Fluorescent Lighting (PY2012 TRM Section 12.1.1)

In the PY2012 TRM, the "military residential" building type was added for this measure due to the significant participation of associated customers. Based on preliminary research conducted and described in the TRM review memo of August 2012, it was recommended that CFLs installed in military residential buildings be attributed one and a half times the savings of non-military and multi-family homes. This recommendation was based on indications that military families use more electricity because they do not have to pay for it directly.

This change has since been implemented and no further changes are recommended at this time. However, the original recommendation was based on a limited data set and additional research for this measure is needed.

4.1.2.5 Interactive Effects (PY2012 TRM Section 3.0)

The final addition to the TRM for PY2011 was the inclusion of interactive air conditioning savings for efficient business lighting projects. The values included in the TRM are consistent with the recommended values described in the PY2012 TRM review. The numbers used are still accurate and represent the best information available at this time. No additional changes are recommended.

4.1.3 Previous Recommendations

A number of recommendations were provided as part of the PY2010 evaluation in the February 2012 review memo on the October 2011-dated TRM. After initial review, there appeared to be several recommendations made during the PY2010 evaluation that had not yet been incorporated. It should be noted that most of these recommendations pertain to measure eligibility or quantities, and not the algorithms. As a result, these corrections have been made in the redlined version of the August 2012-dated TRM included in Appendix B hereto. The original recommendations (from the February 2012 review memo of the October 2011- dated TRM) are listed in Table 8.

Table 8: PY2010 Evaluation Cycle Recommendations for TRM – Not Incorporated as of February 2012

February 2012 Review Memo Recommendation Number		Redlined Section and Page of *October* 2011 TRM	Recommendation
4.1.4	**56**	section 4.0 page 9	Ensure that section 4.0 (**persistence of measure savings**) and the calculations found in the TRM are consistent in their descriptions of how persistence is used.
4.1.5	**3**	section 8.1.4 page 29	Adjust the **heat pump water heater** baseline resistance heating element size to 4.0 kW to be consistent with the other measures found in the TRM.
4.1.6	**7**	section 11.1.3 page 97	To be consistent with program policy, add to the TRM that only up to five **CFLs** are to be given away or exchanged per **low-income** household.
4.1.7	**23**	section 10.3.1 page 81	Reduce the savings percentage for **residential AC tune-ups** from 20 percent to 8 percent to be consistent with the literature. Also, the measure description should be changed since it is worded in a way that customers can have up to two AC tune-ups annually per unit. It should be worded to say: one AC tune-up per unit per year or two per location if there is more than one unit.
4.1.8	**24**	section 10.3.2 page 85	Adjust the eligibility for the **solar water heating tune-up measure** so that an incentive is available once per system per year. This will avoid any duplicate incentives being paid for the same system.
4.1.9	**26**	section 11.1.1 page 88	Include a description for the *solar water heater inspection* measure including a basis for the savings estimate. A more detailed review can be completed once more information on this measure is presented.
4.1.10	**49**	section 12.7.2 page 170	Include the lookup table in the measure description for **cool roofs.**
4.1.11	**32**	section 12.2.5 page 147	Conduct additional research to determine the most appropriate values for **military residential** savings, since these homes may be associated with longer operating hours for **lighting and cooling measures.**

4.2 Verification of Savings

One component of the PY2011 evaluation was to estimate energy savings by measuring and verifying the Program energy savings claims. Our research to estimate the energy savings included:

- TRM review;
- Savings database validation;
- Measure installation verification; and
- Hard-to-Reach verification

This section presents the results of the last three of these activities. These activities are typically performed as one component of a larger program impact evaluation, and 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 PY2011 TRM;
- Verify that the measures for which savings were claimed were installed;
- 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 intended to measure Program energy savings 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.

4.2.1 Overall Verification Results

The overall validation and verification results indicate that the program realized 101 percent of the energy savings claimed in the Annual Report.[41] In some cases, the Program realized fewer saving than claimed, while in others, it realized more. The net effect was that the Program realized slightly more energy savings than 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 9 presents the overall verification results by individual program. The values shown in the table by column are:

- **Sector** and **Program**, which indicate the sector (residential or business) and the individual program;

[41] Net savings are reported at the measure level in Attachment B of the Annual Report.

- **Claimed First-Year Net[42] Savings** (kWh), which summarize the first-year energy savings claims from the Annual Report by individual program;

- **Verified First-Year Net Savings** (kWh), which summarize the overall verified energy savings by individual program, based on the combination of the savings validation and measure installation verification results; and

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

Please see Appendix A: Verification Results Memorandum, for the full text of the verification memorandum.

Table 9: Claimed and Verified First-Year Energy Savings, by Sector and Program – PY2011

Sector	Program	First-Year Net Savings (kWh)		Percent Verified of Claimed Savings
		Claimed	Verified	
Business				
	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%
	Business Total	**61,151,217**	**61,115,749**	**100%**
Residential				
	Residential Energy Efficiency Measures	65,511,035	66,877,382	102%
	Residential Energy Services and Mantenance	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%**

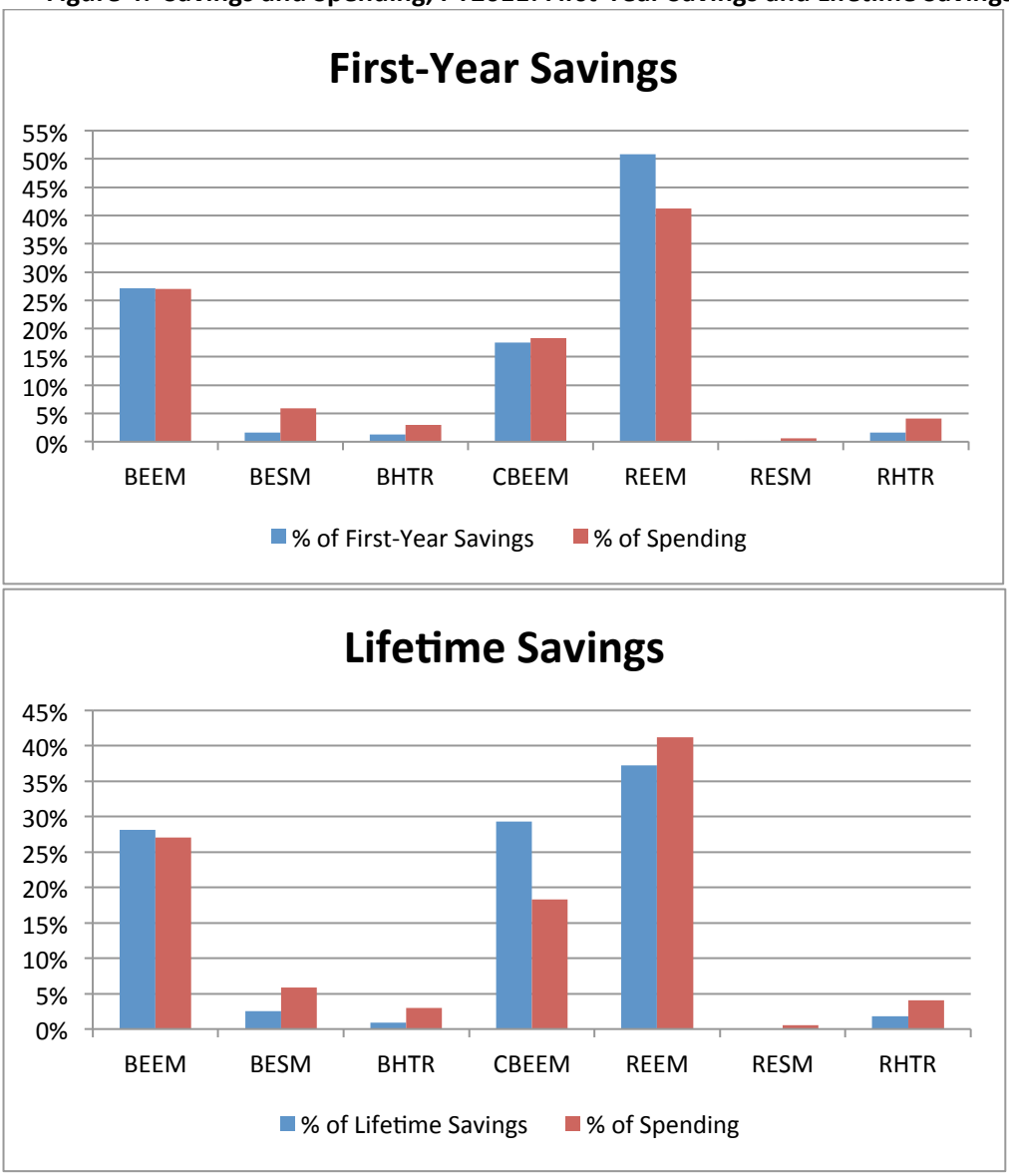
Verifying measures and savings allows us to accurately analyze and compare first-year and lifetime savings and the associated costs across programs and measures. Such analysis aids in determining both resource costs and benefits.

Figure 4 compares the portion of total savings attributable to each program and the portion of total spending for each program calculated across both the first year and the measure lifetime. This comparison shows that there is greater variance between the percent of savings and the percent of spending per program over the course of measure lifetime than in its first year of savings. For example, when we consider lifetime savings, CBEEM accounts for 30 percent of total Hawaii Energy savings and 18 percent of total spending, but if we consider first-year savings, the same program accounts for 17 percent of total

[42] Net savings refer to the individual program-level savings reported by Hawaii Energy in the Annual Report and tracking data, which use a NTG ratio of 0.73 across all programs and measures.

savings and 18 percent of spending. This variance is due to the mix of measures – and each measure's respective effective useful life – offered in each program.

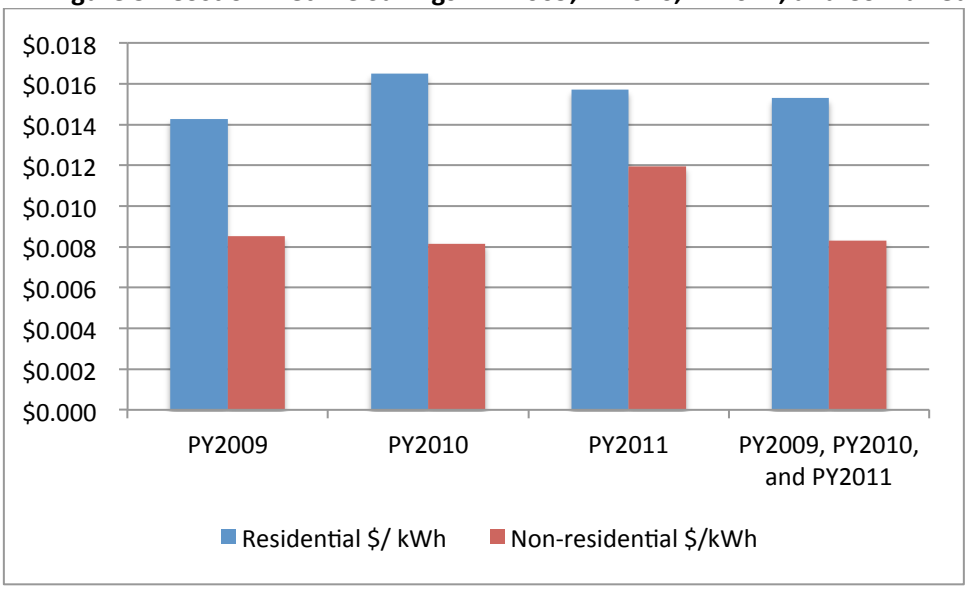
Figure 4: Savings and Spending, PY2011: First-Year Savings and Lifetime Savings



Source: Evergreen analysis of PY2011 Program tracking database (system-level savings, first-year savings, and lifetime savings)

Figure 5 shows the cost of savings from a different perspective, illustrating the cost per kWh of lifetime savings by sector for PY2009, PY2010, and PY2011 and all program years combined.

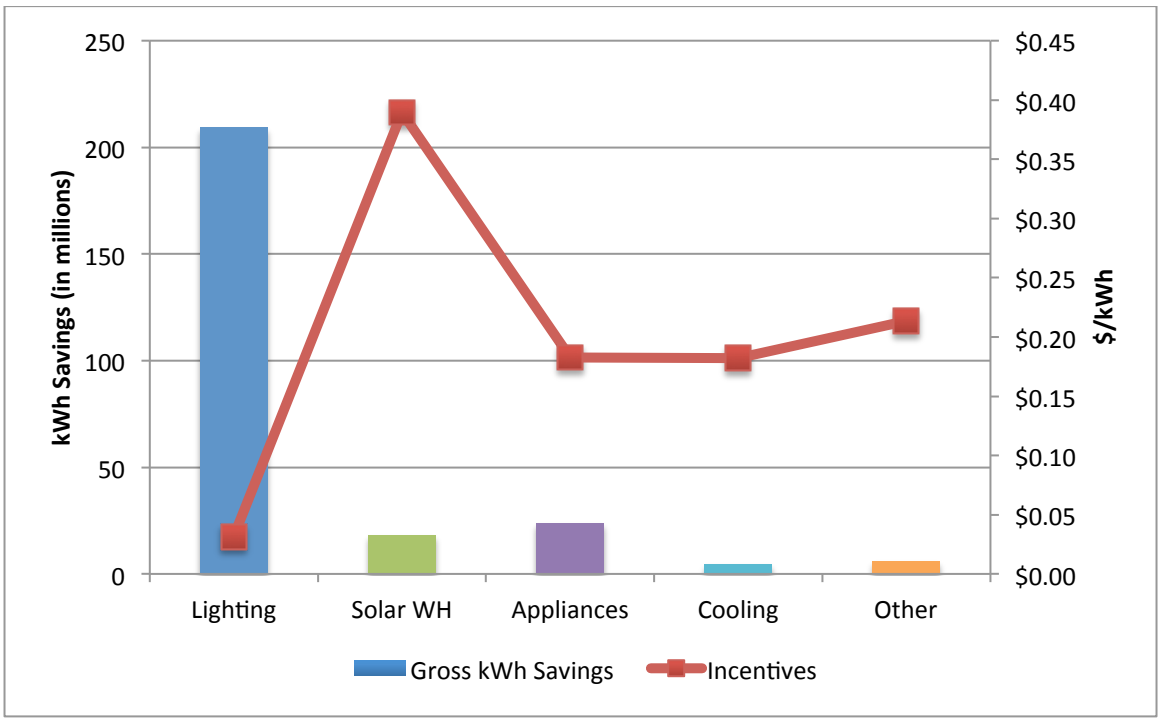
Figure 5: Cost of Lifetime Savings - PY2009, PY2010, PY2011, and Combined



Source: Evergreen analysis of PY2009/PY2010/PY2011 program tracking database (system-level savings, life cycle)

Figure 6 compares the cost of incentives to the cumulative gross kWh first-year savings in the residential sector by end use for PY2009, PY2010, and PY2011 combined. The chart shows that lighting measures provide the most savings for the lowest cost. Savings attributable to lighting are substantially larger than for any other measure type and the cost of the incentive is lower on a per kWh basis.

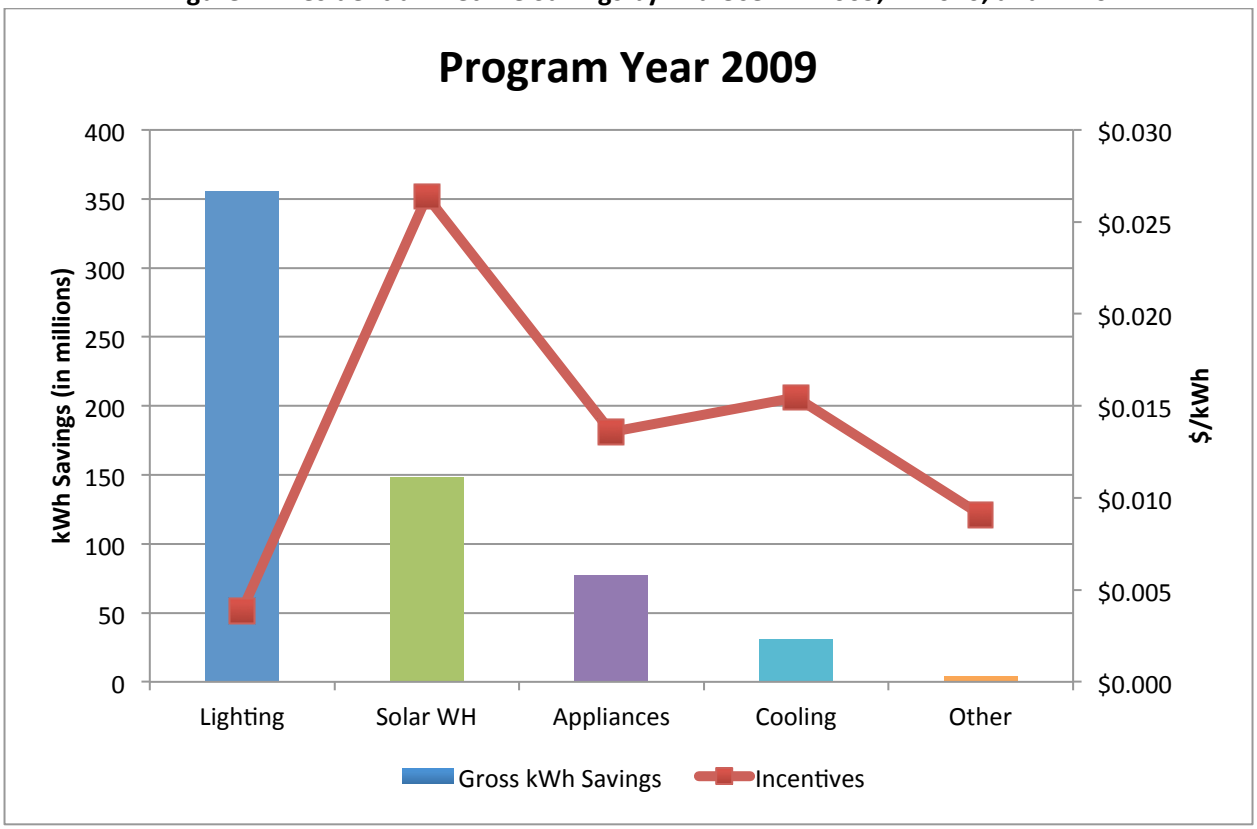
Figure 6: Cumulative First-Year Residential Savings by End Use - PY2009, PY2010, and PY2011 Combined

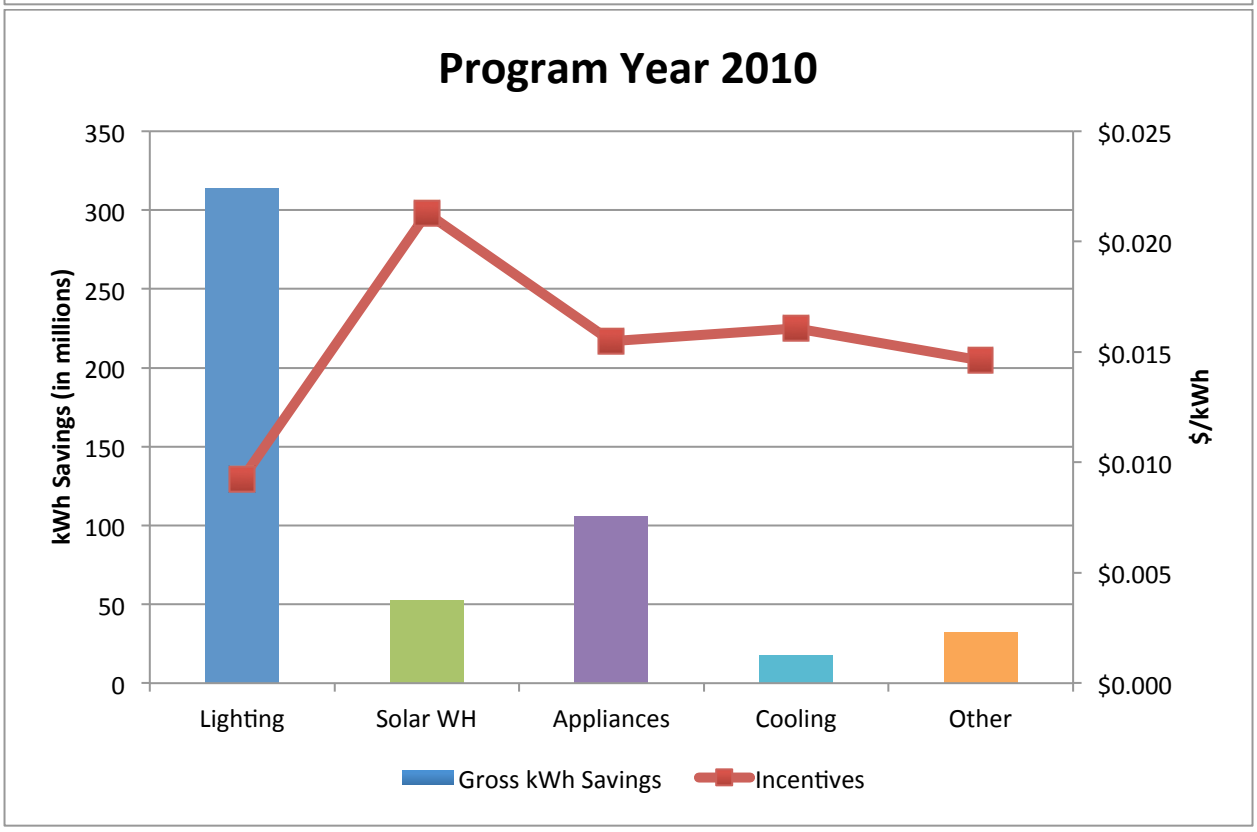


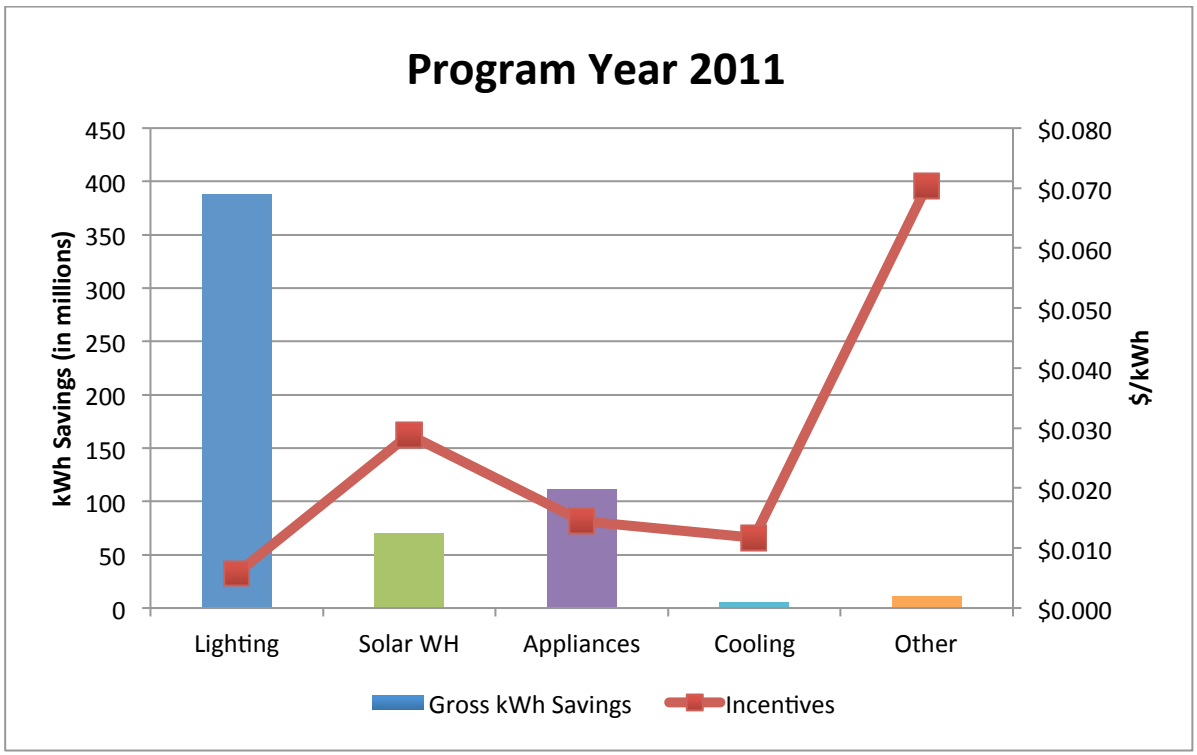
Source: Evergreen analysis of PY2009/PY2010/PY2011 Program tracking database (system-level savings)

Figure 7 compares lifetime savings calculations of various residential measures for PY2009, PY2010, and PY2011. While lighting provides significantly more savings than any other measure in each program year, appliances and SWH have now reversed positions since PY2009, with the former outranking SWH in gross kWh savings in both PY2010 and PY2011. This is reasonable given the comparatively lower incentive dollar spent per kWh for appliances.

Figure 7: Residential Lifetime Savings by End Use - PY2009, PY2010, and PY2011



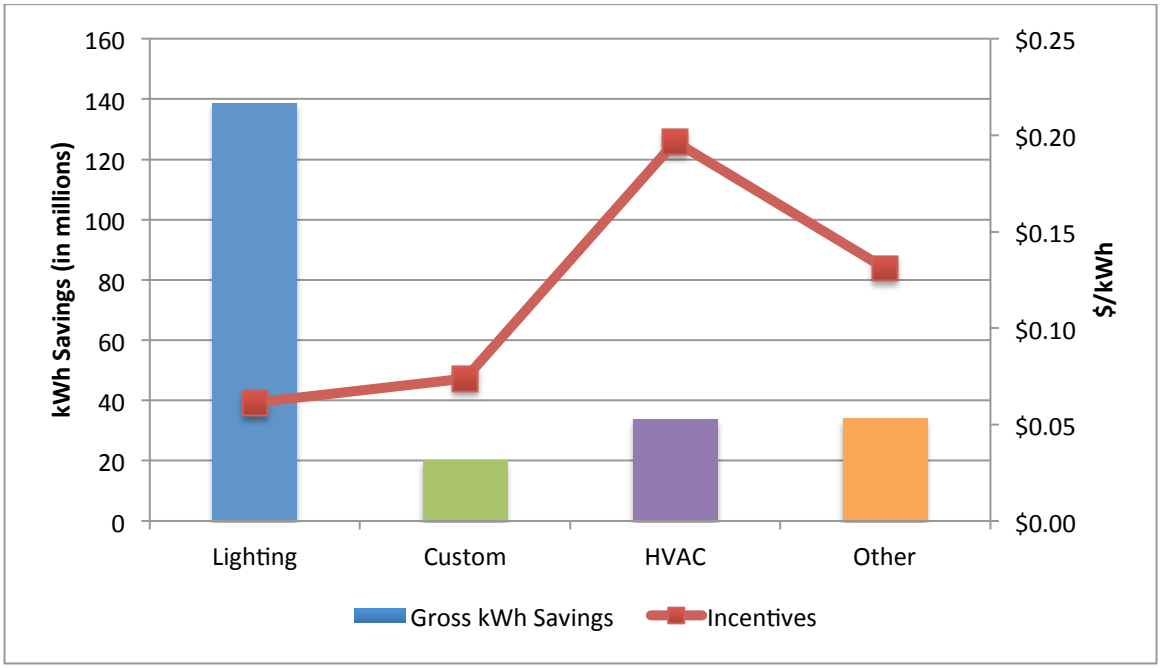




Source: Evergreen analysis of PY2009/PY2010/PY2011 Program tracking database (system-level savings)

Figure 8 presents the cost of incentives to cumulative gross kWh savings for PY2009, PY2010, and PY2011 for the non-residential sector by end use. The figure shows that lighting measures provide the most savings at the lowest cost of savings per kWh for the non-residential sector, too. Custom measures, the smallest source of savings, also have a low cost.

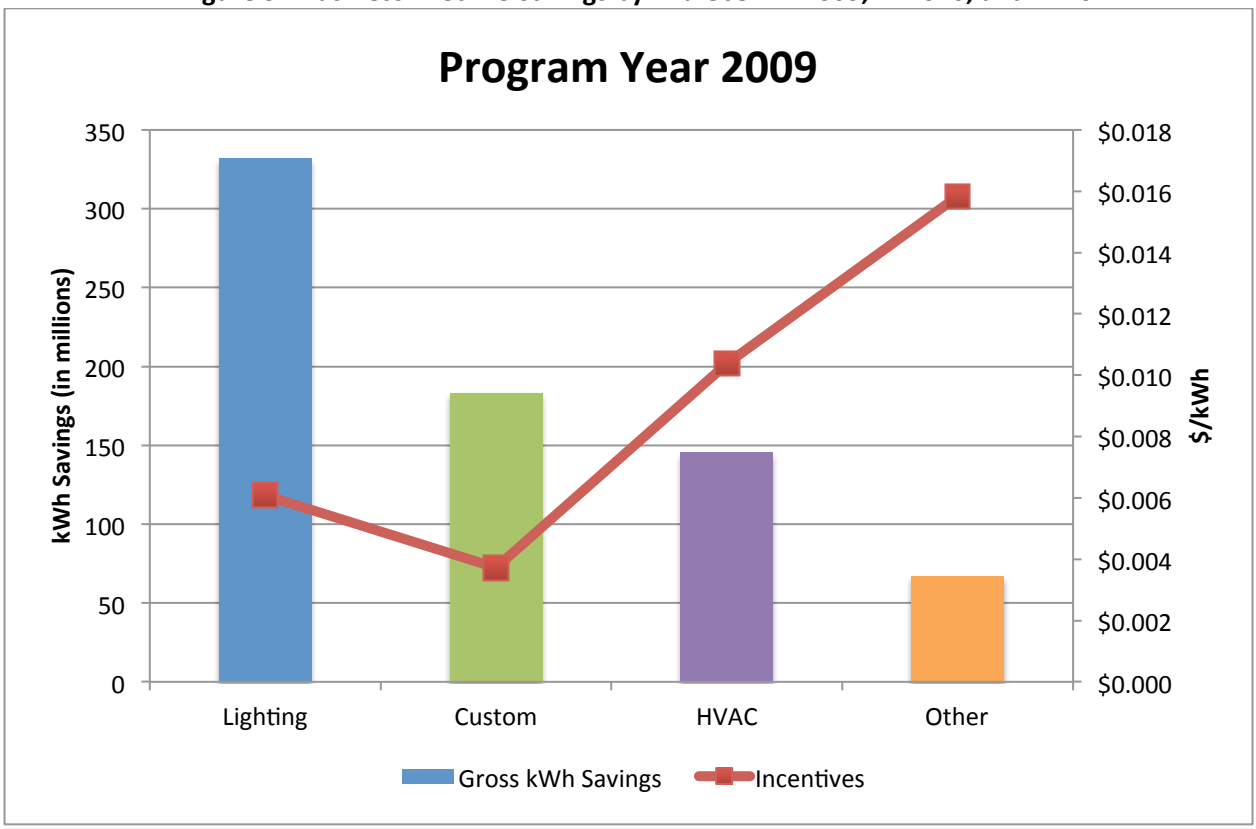
Figure 8: Cumulative Business First-Year Savings by End Use - PY2009, PY2010, and PY2011 Combined

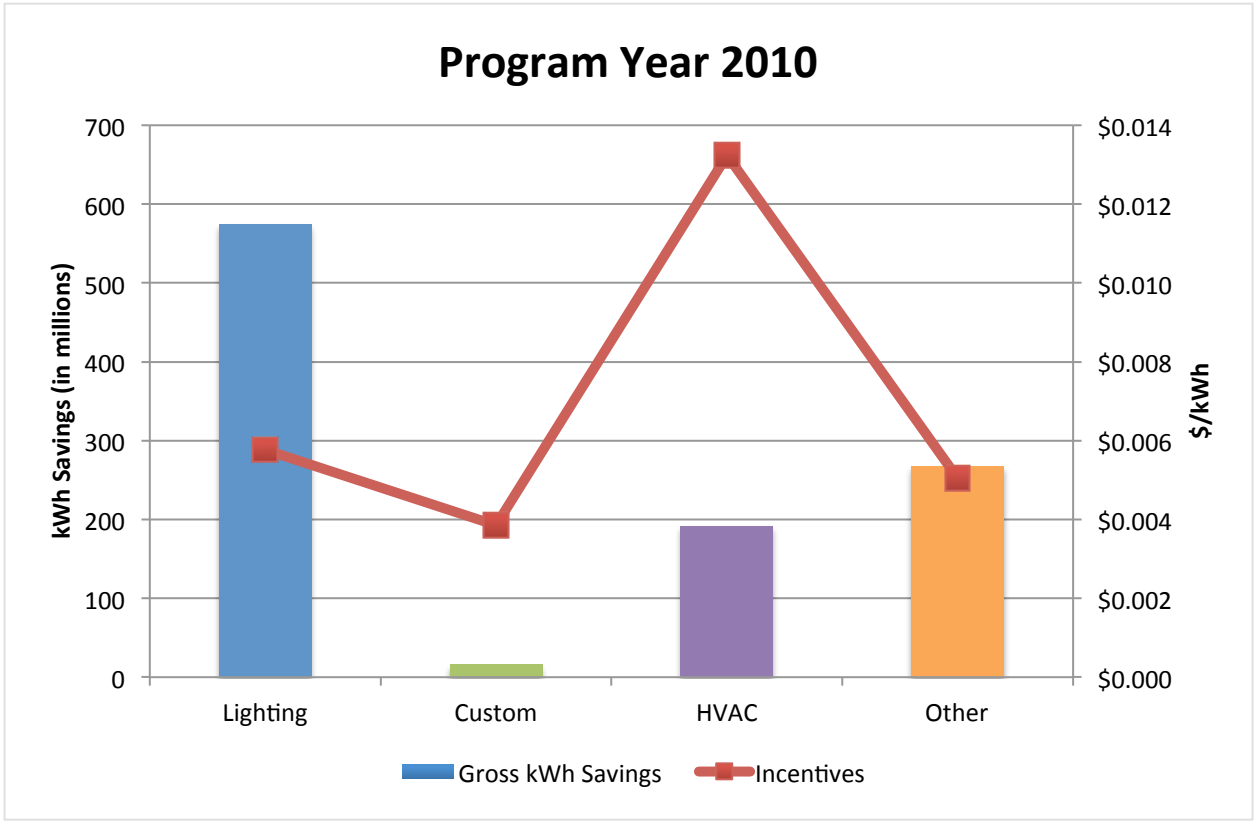


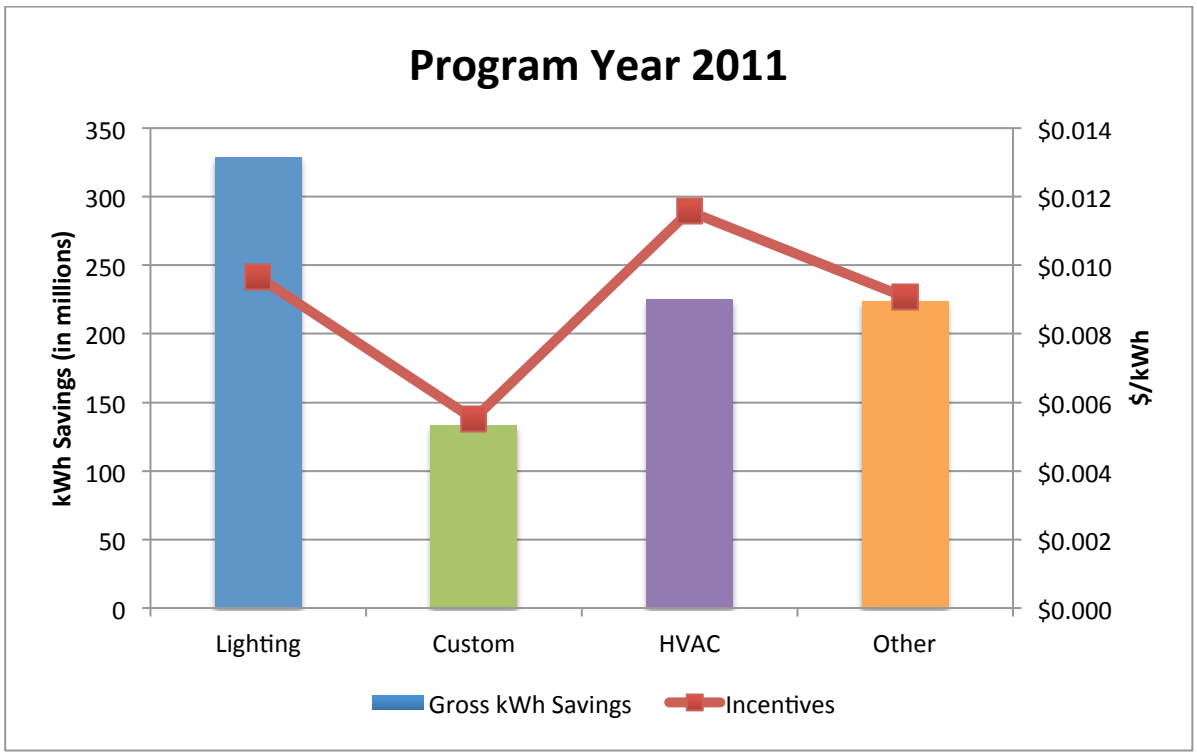
Source: Evergreen analysis of PY2009/PY2010/PY2011 program tracking database (system-level savings)

PY2010 and PY2011 programs have a much lower incentive per kWh for "Other" measures, and a greater increase in incentive costs per kWh for HVAC measures across lifetime savings. The lifetime figures in Figure 9 also show that PY2011 saw a return in lifetime kWh savings from custom projects after a decrease in PY2010.

Figure 9: Business Lifetime Savings by End Use - PY2009, PY2010, and PY2011



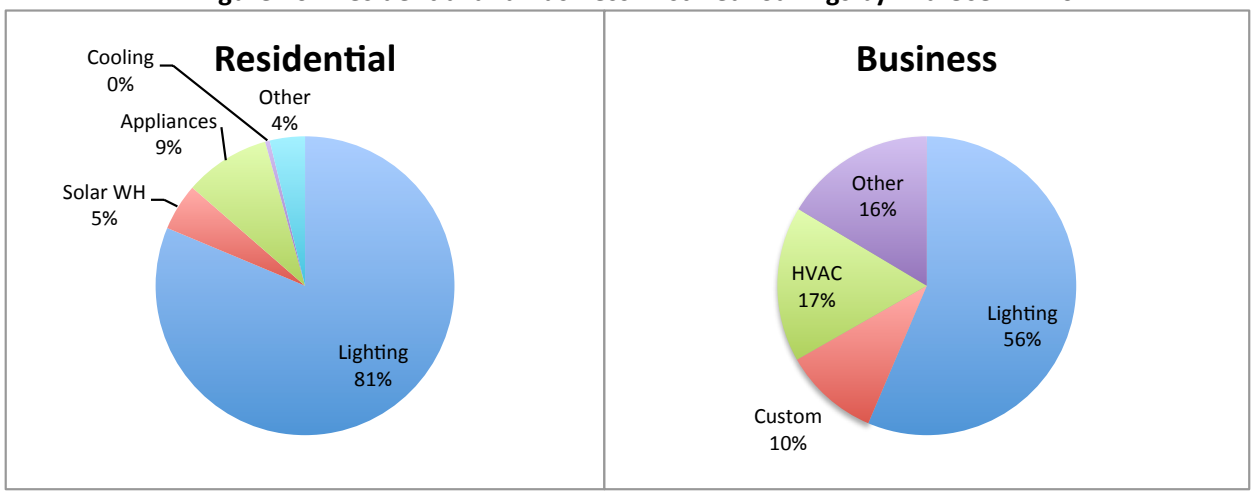




Source: Evergreen analysis of PY2009/PY2010/PY2011 Program tracking database

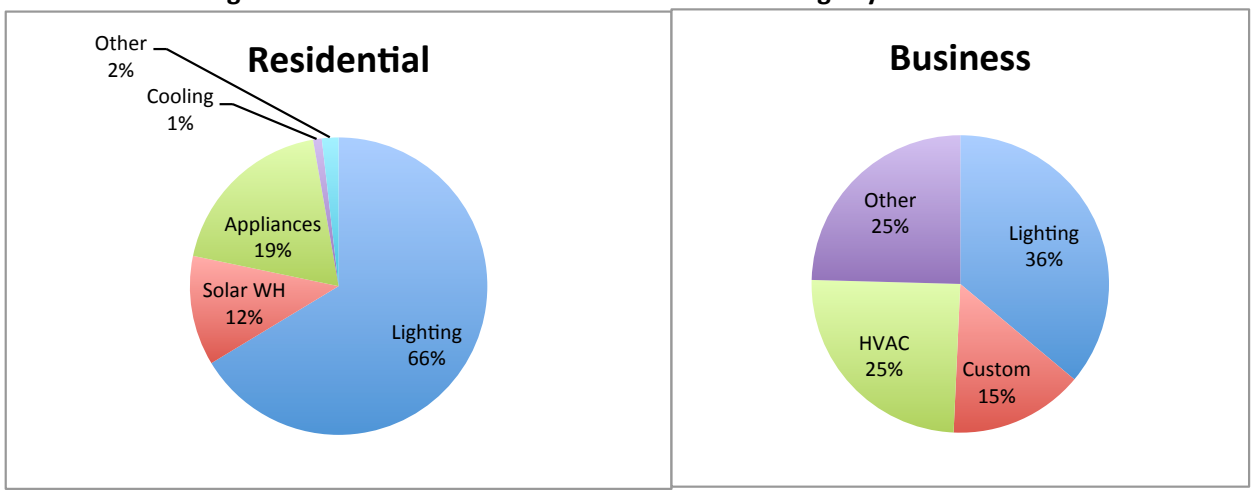
Figure 10 shows PY2011 first-year savings by end use for the residential and business sectors. The figure shows that lighting makes up the vast majority of savings in both sectors: 81 percent of residential savings and 56 percent of business savings. For the residential sector, appliances are a distant second (nine percent), with SWH and cooling making up five percent of total residential savings. For the business sector, custom projects, which include all types of Program measures, make up 10 percent of savings (a significant drop from its one percent in PY2010, but closer to its 16 percent in PY2009), with HVAC and other projects making up 33 percent of all non-residential savings. Savings allocation by end use changes when we consider lifetime savings. In this case, while lighting remains the "biggest piece of the pie" for both sectors, HVAC (business), and appliances and SWH (residential) represent a larger portion of savings than they did for first-year savings, as seen in Figure 11.

Figure 10: Residential and Business First-Year Savings by End Use - PY2011



Source: Evergreen analysis of PY2011 Program tracking database (system-level savings)

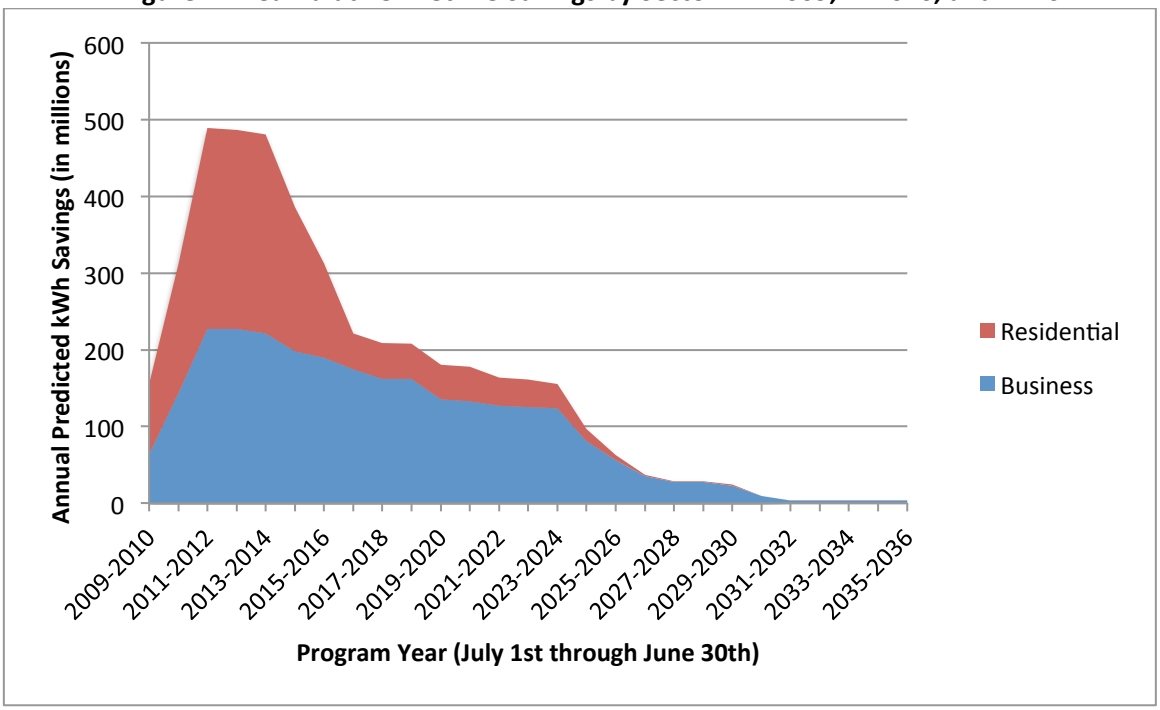
Figure 11: Residential and Business Lifetime Savings by End Use - PY2011



Source: Evergreen analysis of PY2011 Program tracking database (system-level savings)

Figure 12 shows cumulative lifetime savings for PY2009 and PY2010 measures for the residential and business sectors, incorporating the first-year savings with each measure's effective useful life.

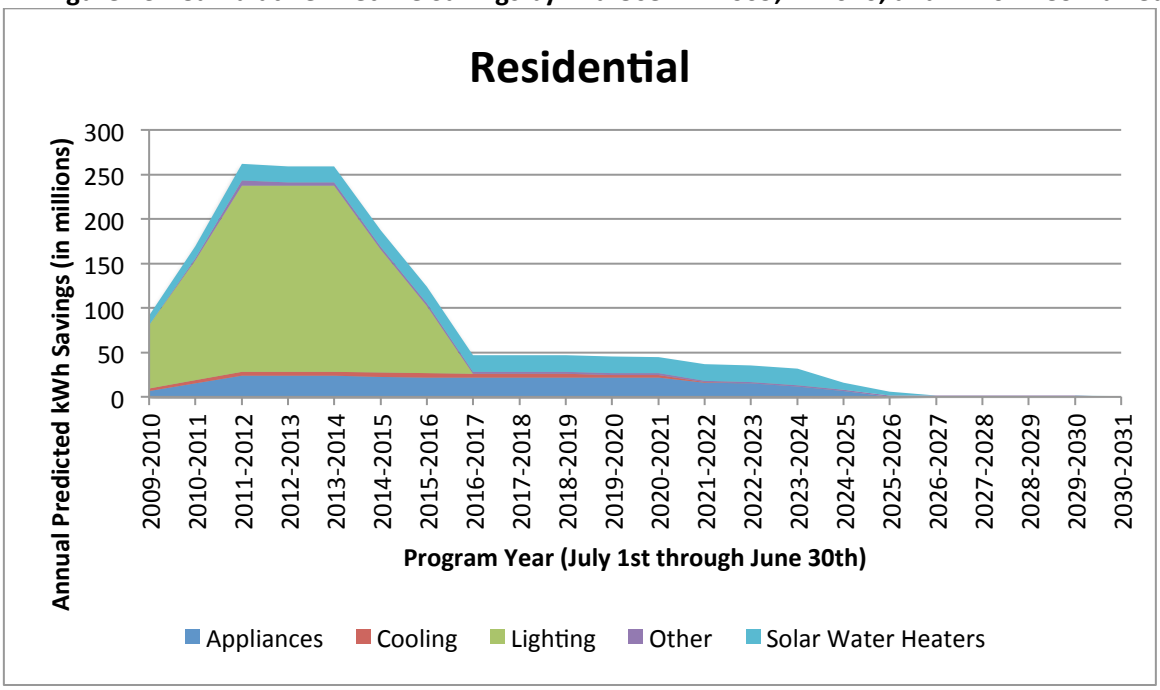
Figure 12: Cumulative Lifetime Savings by Sector - PY2009, PY2010, and PY2011

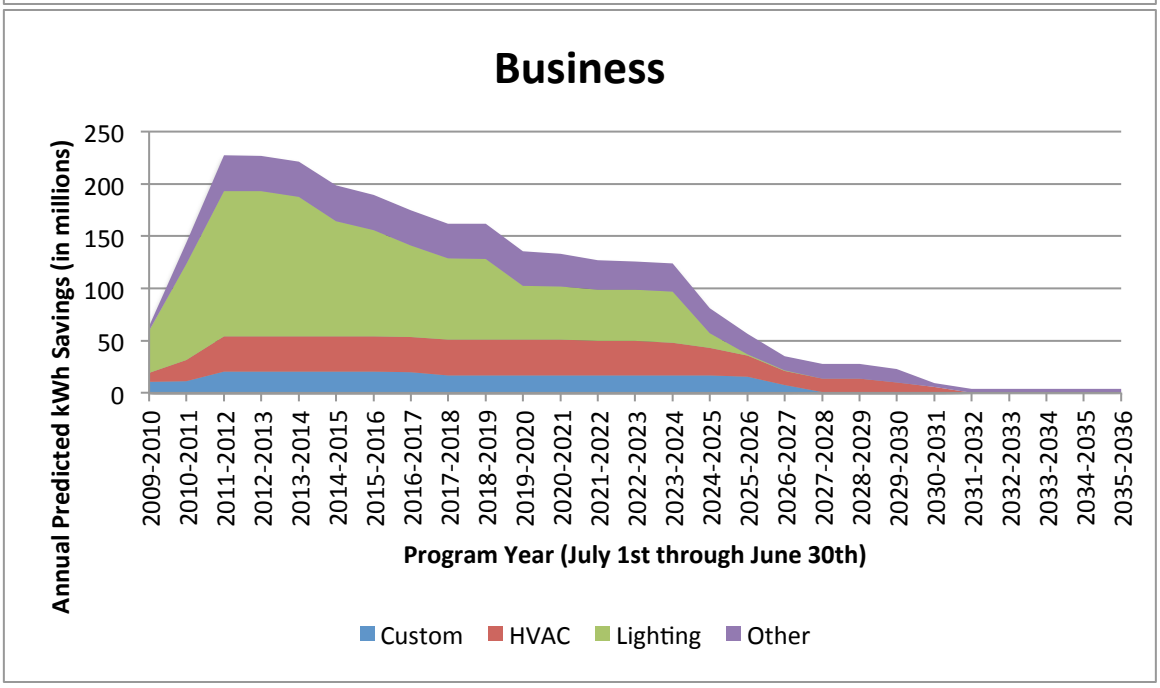


Source: Evergreen analysis of PY2009/PY2010/PY2011 Program tracking database (system-level savings)

Figure 13 breaks out cumulative lifetime savings for each measure by sector. Lighting provides a large portion of savings over time in both sectors, although residential SWH and business "Other" measures offer a fair amount. Savings in the business sector are generally sustained over a longer period than those in the residential sector, due to the difference in lifetime of equipment in these sectors. Figure 13 shows that savings from PY2011 activities in both sectors persist well beyond the first year and continue to help Hawaii achieve its energy goals in the coming years.

Figure 13: Cumulative Lifetime Savings by End Use - PY2009, PY2010, and PY2011 Combined





Source: Evergreen analysis of PY2009/PY2010/PY2011 Program tracking database (system-level savings)

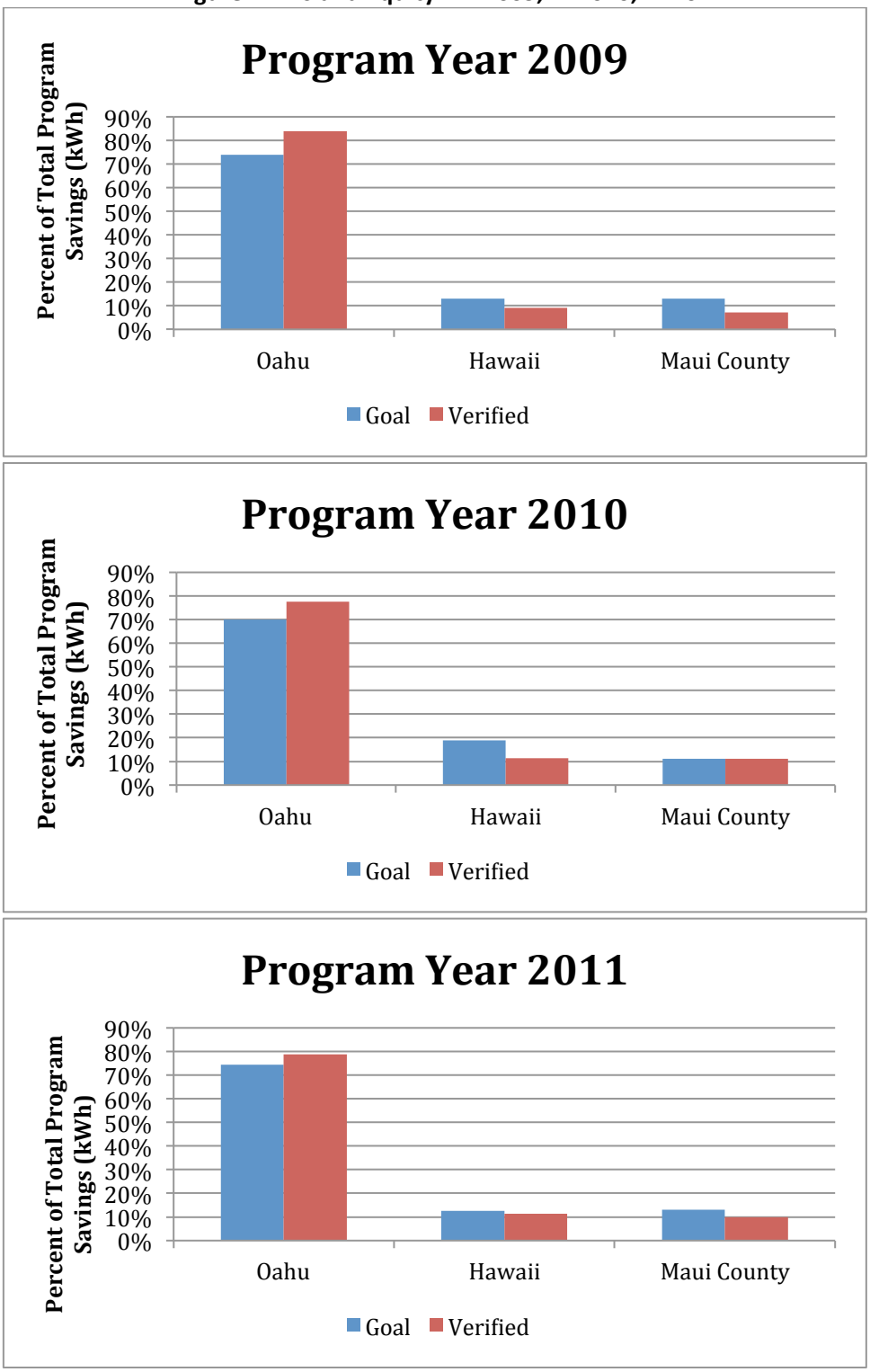
Understanding which measures provide cost-effective savings over both the short- and long-term is critical to the ongoing development of the Program as it works to help Hawaii meet its aggressive energy reduction goals. One of the key takeaways from this section is that in both the residential and business sectors, lighting equipment provides the greatest amount of savings for the least amount of money (incentive dollars). This value benefit is worth noting, considering that lighting makes up the majority of first-year and lifetime

kWh savings for both sectors. Savings resulting from lighting are sustained for many years in the business sector, while savings from lighting in the residential sector (from CFLs) are sustained for just a few years. On the other hand, SWH is the most expensive residential equipment type, and makes up a relatively small portion of savings. HVAC equipment was the most expensive measure type for the business sector in PY2011 but still made up a significant portion of savings, especially when measure lifetimes are taken into account.

4.2.2 Island Equity Achievements

Verified savings were also used to evaluate how well the Program is meeting its goals to distribute benefits across islands in a manner deemed equitable by the PUC. Figure 14 shows island equity achievements for PY2009, PY2010 and PY2011, where the equity is shown in terms of the distribution of kWh savings across islands. Equity goals were not achieved in PY2009 or PY2011, but were achieved in PY2010. In PY2009 and PY2011, the goal was to provide benefits (rebate dollars) within plus or minus 20 percent of PBF contribution dollars, while in PY2010 the goal was based on kWh savings. As Figure 14 shows, the program increased its kWh savings contributions to Maui and Hawaii from PY2009 to PY2010, and contributions remained similar to PY2010 levels in PY2011.

Figure 14: Island Equity - PY2009, PY2010, PY2011[43]



[43]Maui County includes the islands of Maui, Molokai and Lanai. Elsewhere in the report, unless otherwise specified, references to Maui are meant to indicate solely the island of Maui. Source: Evaluation Team analysis of PY2009/PY2010/PY2011 Program tracking database.

4.3 Upstream Lighting Program Analysis

Because lighting measures contribute a significant portion of Hawaii Energy savings, we conducted a special analysis of the upstream lighting program, which provides incentives to retail stores that display and sell energy efficient lighting products. Sales records for qualifying lighting measures at participating retailers for the past three years (2009-2011) were analyzed. Key findings for PY2011 include:

- The total number of lamps purchased through the program nearly doubled in two years (PY2009 - PY2011) to account for the drop in deemed per unit savings from PY2009 to PY2010 (CFL savings as a fraction of total program savings held constant during the two year period);
- Introduced in PY2011, 11,438 LED lamps were sold through program;
- The program expanded the number of different participating chains/stores from 10 to 15 over the two-year period – including a substantial new presence in grocery stores;
- Standard CFLs, including spiral/twist and A-lamp types became more predominant in PY2011. The PY2010 success in increasing the sale of the non-standard, specialty lamps was not repeated in PY2011. Specialty lamps' share of lamps sold dropped to only eight percent in PY 2011, as compared to 27 percent in PY2010 and 19 percent in PY2009. This corresponds to nine percent of program rebate dollars in PY2011, and 27 percent and 37 percent of the same in PY2010 and PY2009, respectively; and
- Although more total qualifying units were sold in PY2011 than in PY2010, because so many of the CFLs sold in PY2011 were standard lamps (for which stores receive a lower rebate), total rebate dollars dropped from PY2010.

Table 10 provides a summary of the types of lamps sold by number during the last three program years. The number of qualifying lamps sold has increased by 93 percent over that period. With an increase from 81 percent of total sales in PY 2009 to 92 percent in PY2011, sales of standard CFLs in the A-lamp and spiral/twist varieties represent the area of largest growth. This reverses the trend in PY2010 that saw these types of lamps diminishing in importance. LED lamps were added as a measure in PY2011, and over 11,000 of them were sold through the program in this introductory year. It is notable that although the number of CFL units sold increased substantially from PY2009 to PY2010, kWh savings attributed to them remained relatively consistent, as the deemed per unit savings were substantially reduced in PY2010.

Table 10: Program Lamps Sold by Type

	PY2009	PY2010	PY2011	Percent Change PY2009 to PY2011	Percent Change PY2010 to PY2011
A-Lamp (CFL)	111,196	378,570	28,516	**-74%**	**-92%**
Specialty (CFL)	181,522	262,149	127,534	**-30%**	**-51%**
Spiral/Twist (CFL)	656,061	955,743	1,661,744	**153%**	**74%**
LED			11,438	**NA**	**NA**
Grand Total	948,779	1,596,462	1,829,232	**93%**	**15%**
Percent of Net kWh Savings from CFLs	43%	37%	41%		

Table 11 shows rebate dollars distributed through the program by lamp type. Although more total qualifying units were sold in PY2011 than in PY2010, because so many of the CFLs sold in PY2011 were standard lamps (for which stores receive a lower rebate), total rebate dollars dropped from PY2010. The share of total rebate dollars for specialty lamps decreased from 37 percent in PY2009 to nine percent in PY2011.

Table 11: Program Rebate Dollars by Lamp Type

	PY2009	PY2010	PY2011	Percent Change PY2009 to PY2011	Percent Change PY2010 to PY2011
A-Lamp (CFL)	$308,839	$988,736	$28,317	**-91%**	**-97%**
Specialty (CFL)	$479,840	$688,573	$141,794	**-70%**	**-79%**
Spiral/Twist (CFL)	$518,312	$837,982	$1,888,773	**264%**	**125%**
LED			$114,380		
Grand Total	$1,282,979	$2,519,362	$2,167,433	**69%**	**-14%**

The distribution of program-qualifying lamp sales by store type is shown in Table 12. In PY2011, warehouse and home improvement stores accounted for 86 percent of all such sales. This is slightly higher than the PY2009 82 percent and PY2010 78 percent share for the same. The program now offers lamps in 15 different stores/chains across the state, representing an increase from 10 and 12 stores/chains in PY2009 and PY2010, respectively. One other noteworthy accomplishment in PY2011 was the successful penetration into grocery stores, which jumped by more than 6,000 percent as compared to each PY2009 and PY2010.

Table 12: Program Lamps by Store Type

	PY2009	PY2010	PY2011	Percent Change PY2009 to PY2011	Percent Change PY2010 to PY2011
Drugstore chain	23,619	52,842	27,964	**18%**	**-47%**
Franchise/hardware	17,175	186,306	122,436	**613%**	**-34%**
Grocery chain	347	364	23,680	**6,724%**	**6,405%**
Home improvement	61,066	382,942	471,872	**673%**	**23%**
Variety chain store	126,300	111,940	85,702	**-32%**	**-23%**
Warehouse	720,272	862,068	1,097,578	**52%**	**27%**
Grand Total	951,250	1,596,869	1,829,390	**92%**	**15%**

As Table 13 shows, the distribution of program lamps sold across the three counties has held steady for the three years analyzed. For each of the three years, approximately 76 percent of program lamps have been sold on Oahu, 13 percent on Hawaii, and 10 percent on Maui.

Table 13: Program Lamps by County

	PY2009	PY2010	PY2011	Percent Change PY2009 to PY2011	Percent Change PY2010 to PY2011
Hawaii	122,867	215,777	242,410	**97%**	**12%**
Maui	99,864	168,961	189,677	**90%**	**12%**
Oahu	728,519	1,212,131	1,397,303	**92%**	**15%**
Grand Total	951,250	1,596,869	1,829,390	**92%**	**15%**

Table 14 illustrates program rebate dollar distribution by county. From PY2009 to PY2011, there was a small drop (78 percent to 76 percent) in the percentage of rebates distributed to Oahu.

Table 14: Program Rebate Dollars by County

	PY2009	PY2010	PY2011	Percent Change PY2009 to PY2011	Percent Change PY2010 to PY2011
Hawaii	$ 147,892	$ 278,403	$ 285,019	**93%**	**2%**
Maui	$ 136,664	$ 238,605	$ 231,659	**70%**	**-3%**
Oahu	$ 998,422	$ 2,002,354	$ 1,650,755	**65%**	**-18%**
Grand Total	$ 1,282,979	$ 2,519,362	$ 2,167,433	**69%**	**-14%**

Table 15 and Table 16 provide more detailed county-specific results of the number of program lamps sold by lamp type and store type.

Table 15: Program Lamps by Lamp Type by County

	PY2009	PY2010	PY2011	Percent Change PY2009 to PY2011	Percent Change PY2010 to PY2011
Hawaii Island	**121,655**	**215,610**	**242,360**	**97%**	**12%**
A-Lamp	4,724	11,433	5,215	**10%**	**-54%**
LED	NA	NA	2,355		
Specialty	26,181	41,761	24,029	**-8%**	**-42%**
Spiral/Twist	90,750	162,416	210,761	**132%**	**30%**
Maui	**99,831**	**168,908**	**189,650**	**90%**	**12%**
A-Lamp	5,247	15,091	5,203	**-1%**	**-66%**
LED			2,592		
Specialty	29,312	39,163	20,157	**-31%**	**-49%**
Spiral/Twist	65,272	114,654	161,698	**148%**	**41%**
Oahu	**727,293**	**1,211,944**	**1,397,222**	**92%**	**15%**
A-Lamp	101,225	352,046	18,098	**-82%**	**-95%**
LED			6,491		
Specialty	126,029	181,225	83,348	**-34%**	**-54%**
Spiral/Twist	500,039	678,673	1,289,285	**158%**	**90%**
Grand Total	**948,779**	**1,596,462**	**1,829,232**	**92%**	**15%**

Table 16: Program Lamps by Store Type by County

	PY2009	PY2010	PY2011	Percent Change PY2009 to PY2011	Percent Change PY2010 to PY2011
Hawaii Island	**122,867**	**215,610**	**242,360**	**97%**	**12%**
Drugstore chain	947	3,035	2,401	154%	-21%
Franchise/hardware	46	1,601	4,510	9,704%	182%
Grocery chain	8,651	45	721	-92%	1,502%
Home improvement	1,212	91,478	108,096	8,819%	18%
Variety chain store	26,714	23,569	15,245	-43%	-35%
Warehouse	85,297	95,882	111,387	31%	16%
Maui	**99,864**	**168,908**	**189,650**	**90%**	**12%**
Drugstore chain	1,217	3,724	4,813	295%	29%
Franchise/hardware	57	960	1,788	3,037%	86%
Grocery chain	5,714	46	3,790	-34%	8,139%
Home improvement	33	49,990	65,496	198,373%	31%
Variety chain store	12,292	13,943	9,008	-27%	-35%
Warehouse	80,551	100,245	104,755	30%	4%
Oahu	**727,293**	**1,211,944**	**1,397,222**	**92%**	**15%**
Drugstore chain	21,455	46,083	20,750	-3%	-55%
Franchise/hardware	17,175	183,745	116,138	576%	-37%
Grocery chain	244	273	19,169	7,756%	6,922%
Home improvement	46,701	241,474	298,280	539%	24%
Variety chain store	87,294	74,428	61,449	-30%	-17%
Warehouse	554,424	665,941	881,436	59%	32%
Grand Total	**951,250**	**1,596,869**	**1,829,390**	**92%**	**15%**

4.4 Residential Peer Group Comparison Program Assessment

Key findings from the analysis of the PGC program are:

From the phone survey:

- There were no significant differences between the participants and control group in terms of energy usage behavior, adoption or planned adoption of energy efficiency measures.
- PGC participants and the control group are purchasing CFLs at similar rates.

From the billing regression:

- Our attempt to replicate the vendor's savings estimates resulted in savings of 1.47 percent of average annual usage, which is very close to the estimate of 1.43 percent provided by the PGC vendor for Oahu.
- Using alternative control groups did not affect the savings estimates, indicating that the control group selected by the vendor was appropriately determined.
- When basic data screens are applied to the billing regression dataset (to remove observations within insufficient data and/or unusually high or low values), the estimates drop from 1.47 percent to 1.25 percent of average annual usage, a decrease of 15 percent. This estimate is less than the vendor's estimate of 1.43 percent for Oahu and significantly less than the current TRM value of 1.73 percent.
- With the recommended billing regression model that controls for participation in other Hawaii Energy programs, the savings estimates drops from to 1.25 percent to 0.89 percent of annual usage, a decrease of 29 percent. Note that this estimate does not account for savings resulting from CFLs. However, the results of this research indicate that no additional adjustment is needed to account for upstream CFL savings.

Details on the PGC program analysis methods and results are presented in Appendix C, with the phone survey results presented first, followed by the billing regression.

5. Market Assessment

5.1 Net-to-Gross Assessment

Hawaii has thus far chosen to take a relatively pragmatic approach to the NTG issue. To date, the state has applied a single free-ridership adjustment factor in reporting net savings, using a weighted average of 73 percent derived from earlier research conducted by KEMA on behalf of HECO. The Evaluation Team recommends a the adoption of a NTG Strategy that focuses on program design to maximize net impacts and that uses free-ridership adjustment factors as a policy tool to drive the Program to better help Hawaii achieve its goal of a 30 percent reduction in energy use by 2030.

5.1.1 Hawaii Energy Program Refinements to Maximize Net Impacts

Since the Program has been transitioned to a third-party implementer (the PBFA) and culminating in the most recent Program plan for PY2012, several very important refinements have been made to the original Program design in order to maximize net Program impacts. Several of these refinements will likely decrease free-ridership and increase spillover. Therefore, any near-term strategy for refining the NTG estimates should include a continued focus on these changes, and other refinements that may be practicable within the current Program scope. Such planned refinements include:

- Switching to TRB as the most important performance metric:
  - This ensures that lifetime benefits are taken into account rather than simply focusing on first-year savings accomplishments.
- Increasing HTR programs such as the Small Business Direct Install and low-income lighting programs:
  - Such hard-to-reach segments are unlikely to be free-riders in any program design.
- Introducing a new suite of market transformation programs emphasizing training and education:
  - Training and education efforts result in long-term market transformation and enhance the spillover effects of existing programs.
- Introducing new behavioral programs:
  - Such programs address changes in behavior that are unlikely to have occurred without program assistance, and are therefore very low in free-ridership.
- Eliminating measures that are known for high free-ridership:
  - Large refrigerators, dishwashers, and split systems AC were eliminated, all of which were identified during evaluation efforts as having a higher than average rate of free-ridership.
- Using upstream incentives to change stocking practices and availability:

    - This acts to increase long-term market transformation and spillover effects from rebate programs.
- Offering large incentives for new products (e.g., LED, monitoring equipment, and vending miser):
    - All such measures would likely otherwise have very low presence in the marketplace.
- Adding new or expanding recently introduced programs and program elements, all of which, initially at least, have low free-ridership, and thus have NTG values that are likely near 1.0. These include:
    - Small Commercial Direct Install- expansion of a low- to no-cost program for small businesses, providing efficiency lighting, garage demand ventilation control, variable refrigerant flow, and high efficiency chillers;
    - Tool Lending Library – a strategy that is part of the Program's Workforce Development and Training programs that provide training in use of tools which are made available through lending libraries.
    - Central Plant Optimization (retro-commissioning)- outreach to building engineers to bring in proposed projects that meet cost per kWh cost criteria to improve the performance of cooling systems.
    - Bounty Program- expansion of a program that offers incentives to customers to turn in old refrigerators, and freezers.
    - Cool Roofs- offering an incentive based on ENERGY STAR Qualified roofing products.
    - Sub-Metering- providing incentives and education for the installation of billing sub-meters for tenants within a master metered facility.
    - Trade Wind Design Support for New Construction- providing designers and builders with an incentive to pursue and execute minimal AC designs using trade wind capturing designs.
    - Solar System Tune Up- identifying older solar water heater installations and offering tune-ups to ensure energy savings persist.

5.1.2 NTG Values

Table 17 shows the averages of NTG values without spillover that are recorded in industry literature. We recommend that these values be the starting point for negotiated NTG values to be applied in a prospective manner (i.e., for subsequent program years). After a period of time, an assessment of their appropriateness can be performed. For the most contentious of these values, we recommend that the Evaluation Team perform some limited studies to estimate NTG values.

Table 17: Recommended NTG (Free-ridership and Spillover) Values

Program	Measures	Range of Values	Average Value without Spillover	Recommended Free-Rider Value	Average Value with Spillover	Recommended NTG Value
BEEM	Business Energy Efficiency Measures	.58 to 1.17	.70	.70	.85	.75
CBEEM	Custom Business Energy Efficiency Measures	N/A	N/A	.70	N/A	.75
BESM	Business Services and Maintenance	N/A	N/A	.90	N/A	.95
BHTR	Business Hard-to-Reach	.93 to .96	.94	.94	.96	.99
REEM	Residential Energy Efficiency Measures	.72 to 1.13	.74	.74	1.43	.79
CESH	Custom Energy Solutions for the Home	.60	.60	.60	.60	.65
RESM	Residential Services and Maintenance	.87	N/A	.87	N/A	.92
RHTR	Residential Hard-to-Reach	.93 to 1.0	.97	.97	1.00	1.00

All of these numbers are first passes at reasonable NTG values, and opinions of other stakeholders may vary. Principally, in establishing the recommended values, we have not disaggregated the values to the end-use or sub-sector level. For example, Hawaii may find it necessary or desirable in future years to create a separate NTG for projects done by the military or in large office buildings. As more data are collected, the Program may find it prudent to create a separate NTG for LED lighting or other technologies for which data shows a marked difference in NTG rates.

This report recognizes that values derived in other areas of the country do not necessarily reflect the specific conditions under which Hawaii Energy operates. There are conditions in Hawaii that might suggest using a lower NTG than other parts of the U.S., and there are conditions that suggest just the opposite. Because Hawaii has the highest electric rates in the U.S., one might conclude that NTG rates in Hawaii would be high. However, the mild climate means that Hawaii homes and businesses use much less energy than is used elsewhere; and thus the relative importance of energy in overall expenditures is smaller. There are many other factors that contribute to the NTG rate, as well, including the availability of trained trade allies, the maturity of the market, the percentage of renters versus owners, the availability of information and the existence of other energy resources.

With all of these factors in mind, it is not possible to look at the average values derived here and say with any certainty how the values in Hawaii may differ from them. We were not able to find indications in the previous evaluations reviewed as to how Hawaii values might deviate from these derived averages. The evaluation community has not looked at NTG this way, and it is not clear that one could accurately adjust NTG values by comparing how the factors that affect NTG differ across programs. In most cases, it is not even clear whether specific characteristics would increase or decrease NTG rates. For example, the maturity of a program will affect NTG but not in a linear way. Early adopters are predominantly free-riders. As a program reaches into the general population free-ridership is low, and rises as the price of a measure comes down and the availability increases. At some point, if the program continues, free-ridership is likely to occur. However, one cannot predict exactly how differences in maturity of the programs will influence the NTG rate. A good example of the difficulty in discerning how program context might affect NTG is found in military involvement in Hawaii Energy Programs. The PY2010 Evaluation Report noted that the military's commitment to energy efficiency may – or may not - suggest that the NTG assumed for their projects may be too high since the military is subject to a number of mandates designed to increase energy efficiency.

> On the other hand, military energy managers say that these are "unfunded mandates," which forces them to pursue non-DOD sources of funding, including, for the Navy: USDA, DOE, State, County, Utility and industry partnerships; other 3rd Party Financing 'Vehicles' such as Power Purchase Agreements, Energy Savings Performance Contracts, Utilities Energy Service Contracts and Enhanced Use Leases. A Navy energy manager also reports that individual projects must be submitted to the Admiral in charge of facilities, and that the availability of Hawaii Energy rebates improves payback and thereby helps projects get funded.[44]

The extent of spillover has yet to be measured in Hawaii. As the market transformation programs become more mature and focused on activities that generate spillover, it will be important that Hawaii credits these savings appropriately. In the interim, we recommend that the NTG estimates include a small spillover adder, for example, five percent of total Program savings. It is also recommended, that a future evaluation include an exploratory study of spillover. This study would identify specific program activities that are likely to create spillover and implement a survey to detect if spillover is occurring. No attempt will be made to quantify spillover savings (the element of studies elsewhere that has been most costly and of questionable value). Importantly, the information developed through such a study will also be extremely useful in informing a longer-term strategy, which is focused on maximizing spillover and minimizing the presence of free-riders through smart program design.

Table 18 provides an estimate of how the individual NTG rates developed for each program aggregate into a system wide NTG value for PY2011. Using the PY2011 percent of portfolio savings, we estimate the overall NTG rate as the sum of the individual NTG Adjusted

[44]Evergreen Economics, *Evaluation of the Hawaii Energy Conservation and Efficiency Programs, Program Year 2010* (Honolulu, HI: Hawaii Public Utilities Commission April 18, 2012), 1:100.

Percent Savings. If PY2012 savings are distributed proportionally to PY2011, then the overall NTG rate will be 77.6 percent. This is slightly higher than the 73 percent currently assumed. The revised NTG approach proposed herein may lead to different composite NTG adjusted savings in subsequent years, depending on the relative mix of program savings.

Table 18: Calculation of Composite NTG Rate for PY2011

Program	Measures	PY2011 percent of portfolio savings (Col 1)	Recommended NTG Rate (Col 2)	NTG Adjusted Percent Savings (Col 1 * Col 2)
BEEM	Business Energy Efficiency Measures	27.12%	.75	20.3%
CBEEM	Custom Business Energy Efficiency Measures	17.49%	.75	13.1%
BESM	Business Services and Maintenance	1.59%	.95	1.5%
BHTR	Business Hard-to-Reach	0.84%	.99	0.8%
REEM	Residential Energy Efficiency Measures	50.87%	.79	40.2%
CESH	Custom Energy Solutions for the Home	0%	.65	0.0%
RESM	Residential Services and Maintenance	0.07%	.92	0.1%
RHTR	Residential Hard-to-Reach	1.58%	1.00	1.6%
	Composite NTG Rate			**77.6%**

5.2 Non-Energy Benefits Literature Review

Key findings from our review of literature on non-energy benefits of energy efficiency programs are presented below. We first discuss non-energy benefit value estimation methods, and then each of the selected benefits, particularly as they apply to the Hawaiian context.

5.2.1 Non-Energy Benefit Estimation Methods

One of the reasons that non-energy benefits are usually omitted from evaluation studies is that quantifying these benefits is notoriously difficult. And, while some techniques for estimating these benefits have been developed and refined over the years, creating a properly designed study that requires extensive data collection can be prohibitively expensive.

Despite these challenges, a variety of estimation techniques have been developed for estimating the dollar value of non-energy benefits. Common estimation methods include those discussed below.

5.2.1.1 Direct Query/Survey

Direct query was the most common method we found in the literature for valuing non-energy benefits and involves simply asking respondents about their experiences. A typical

series of questions might first ask if they experienced any particular non-energy benefits associated with their new energy efficient equipment (e. g., reduced operations and maintenances, employee satisfaction and increased productivity). If the respondent answers "yes" to the existence of any of these benefits, a follow-up question asks them to place a dollar value on the benefit, or express the value as a percentage of energy savings resulting from the new equipment. The appeal of this method is its simplicity and low cost. The disadvantage is non-reliability, as it is very questionable that someone can provide accurate cost information on-the-spot on certain things like employee satisfaction, comfort, or the value placed on reducing greenhouse gas emissions. Even less abstract impacts such as improved equipment reliability would require some background research by the respondent prior to providing a dollar value. Despite serious concerns about reliability, this method was commonly used in the studies reviewed.

5.2.1.2 Contingent Valuation /"Willingness to Pay" Surveys

The contingent valuation method is a survey technique that moves beyond directly asking the respondent about the value they would place on a particular non-energy benefit. The method relies on a series of questions to elicit from respondents what they might be willing to pay for a certain non-energy benefit (e.g., reduced emissions, improved comfort and safety, and improved environmental quality). A well designed contingent valuation study will ground these responses in something tangible to increase the reliability of the responses. A respondent might be asked if they would be willing to pay $5 extra a month on their utility bill in order to preserve wetlands, for example. Since the customer is not actually paying for these benefits, but rather answering questions on what they would hypothetically pay. These types of data are referred to as *stated preference* as respondents are merely stating a preference about what they would do if given an actual opportunity for action. Given that there is no requirement that they actually follow through with these statements, the reliability of the contingent valuation method is always a concern.[45]

5.2.1.3 Conjoint Analysis

A different type of stated preference data collection technique is known as conjoint analysis. In a conjoint study, respondents are asked to rank a series of hypothetical choices, such as program design options or energy efficient equipment choices. Each choice is defined using several different characteristics with a range of possible values for each. For example, different equipment options may be defined by varying levels of cost, rebate amount, energy savings, and whether or not the program provides financing or an energy audit. Respondents must evaluate the trade-offs between the various attributes, and when the data are entered into a statistical model it can be determined which of the features is really driving the rankings. Conjoint analysis has the advantage of forcing respondents to

[45] More sophisticated (and consequently much more expensive) study designs sometimes provide respondents with money and then ask them to actually make a payment (or keep the money, if they desire) to express the value they place on the benefit being studied. Similar variations on these types of experiments can increase the reliability of the stated preference responses by making the experiment more closely simulate an actual payment. However, given the added expense, these more elaborate studies are rarely conducted as part of energy efficiency program evaluations, which primarily are concerned with the direct measure of energy benefits.

make trade-offs between attributes when ranking the choices, much as they would when making an actual purchase. However, as discussed with contingent valuation, the conjoint data are still hypothetical stated preference data, as no actual purchase is being made. As a consequence, the reliability of these types of data is always a concern, as there is no guarantee that the respondents would make similar choices when actually making a real purchase.

5.2.1.4 Hedonic Pricing Models

The hedonic pricing model is a statistical model that estimates changes in prices (often home prices) based on various characteristics. With a large enough sample size, the contribution that each characteristic is making toward the price can be determined while controlling for other factors. For example, examining the change in value of homes located next to parks or green spaces is sometimes used to estimate the value the market places on these types of environmental amenities. In the context of energy, a hedonic pricing model can be used to estimate the value placed on energy efficient improvements relative to a similar home without the energy efficiency benefits. The advantage of the hedonic method is that it relies on actual market data and, therefore, is considered *revealed preference data* as customers have actually revealed the value they place on these amenities. Since customers have actually made these purchases, revealed preference data are generally considered more reliable than stated preference data. The main disadvantage of the hedonic pricing model is that it captures both the effect of direct energy benefits (e.g., bill savings) and non-energy benefits (e.g., improved comfort, safety and air quality) simultaneously. However, if the value of the direct energy benefits is already being measured as part of a separate impact evaluation, the hedonic pricing model has the potential of double-counting these benefits.

5.2.1.5 Input-Output Models

Input-output models are designed specifically to estimate the economic impacts of spending. In the context of energy efficiency programs, the spending that results from the program (e.g., equipment costs, installation costs, program implementation costs, and energy savings to households and businesses) are used as inputs into a model that estimates the economic impacts in terms of changes in jobs, income, economic output and tax revenue. Common input-output models used in these applications are IMPLAN® and REMI.[46]

Since the Evaluation Team recently completed an economic impact analysis for the Program,[47] we did not include additional studies in this literature review. Rather, attention

[46] Created by MIG, the IMPLAN software system helps analysts address questions about economic study and analysis, and can create a localized model to investigate the consequences of projected economic transactions in a specific geographic region. Regional Economics Model, Inc. (REMI) was founded in 1980 to assist government decision-makers test the economic effects of their policies before they're implemented. The REMI model incorporates aspects of four major modeling approaches: Input-Output, General Equilibrium, Econometric, and Economic Geography.

[47] *Hawaii Energy Efficiency Program Economic Impacts.* Prepared by Evergreen Economics for the Hawaii Public Utilities Commission (March 26, 2012).

was focused on non-energy benefit categories that are not currently tracked for Hawaii Energy.

5.2.2 Non-Energy Benefits

5.2.2.1 GHG Emissions Reductions

One important category of non-energy benefits is GHG emissions reductions. The direct measure of GHG emissions reductions is relatively simple, since utilities often need to report on their reduction levels, or at least electricity generation mix, from which GHG emissions can be calculated directly. The U.S. EPA also provides information on emissions resulting from electricity generation for each state on its website.[48]

Once the amount of GHG emissions per kWh generated is identified for Hawaii, the total reduction in GHG emissions attributable to the Program can be estimated directly by multiplying this factor by the total kWh reduction achieved by Hawaii Energy.

The dollar value associated with GHG emissions reductions is more complicated to calculate. The simplest approach is to multiply the GHG reduction tonnage by the price per ton of carbon from the various carbon trading markets. The price per ton of carbon can serve as a proxy for the environmental benefit associated with a reduction in GHG emissions, although whether this price captures all of potential benefits (some of which are not market based) is debatable. At the time of this report, carbon prices are approximately $3.90 per ton.[49]

We did not attempt to review estimates of the societal benefits of reducing GHG emissions, which include those associated with mitigating or avoiding global warming, sea level rise, species loss and others. These impacts are wide ranging and studies attempting to quantify them are voluminous.

5.2.2.2 Comfort

The non-energy benefit "comfort" covers a range of different attributes, most of which can be generally related to indoor air temperature. Other related benefits such as noise reduction and lighting quality are included here in our summary of the literature.

Findings from the literature related to comfort are provided in Table 19. The table presents the estimated value, typically expressed either as a percentage of annual bill savings or an annual dollar value (exceptions to this are noted in the table). Along with these estimates, the estimation method is listed along with the type of program being evaluated and program location. The most common methods used for estimation were survey (direct query) of program participants and conjoint analysis. In the cases where the direct query

[48] http://www.epa.gov/ghgreporting/index.html.

[49] Stanley Reed and Mark Scott, "Europe's Carbon Market is Sputtering as Prices Dive," *New York Times*, April 21, 2013. http://www.nytimes.com/2013/04/22/business/energy-environment/europes-carbon-market-is-sputtering-as-prices-dive.html?pagewanted=all&_r=0

method was used, respondents were first asked if they experienced any improvement in comfort from the new efficiency measures. If there was an improvement in comfort, the respondents were then asked to provide an estimated value for the increase in comfort, with the value expressed as a percentage of energy bill savings.

The estimated value placed on comfort is largest in the commercial sector, which is not surprising given that commercial spaces contain more people than residential spaces, and that occupant comfort can be tied to worker productivity. For those studies that addressed occupant comfort (defined as either "comfort" or "even lighting distribution"), values ranged from six to 33 percent of bill savings for the commercial sector. For the residential programs, estimates for comfort (defined as either "comfort" or "noise reduction") ranged from 37 to 93 percent of energy bill savings resulting from the program.

When benefits were estimated as a dollar value (rather than as a percentage of energy bill savings), there was also a wide range of estimates. For commercial programs, estimates for the value of comfort ranged from $86 to $49,913 annually, with a separate study estimate as a one-time value of $2,406 for improved comfort. For residential programs, values were expressed several different ways. Estimates per person range from $30 to $125 annually based on the results from several Massachusetts program evaluations. On a per-home basis, a separate evaluation of the Massachusetts ENERGY STAR Homes program resulted in values of $146 to $371 annually for improved comfort.

The wide range of estimates on this single non-energy benefit illustrates the challenge of measuring these types of benefits, as well as the problem of trying to apply estimates from other studies to the Program. The estimates reviewed in the literature are tailored to individual programs, which may have different characteristics than the programs offered in Hawaii. For example, the commercial estimates reviewed in the literature may be much larger and/or involved in different industries, and these factors contribute to the high dollar estimates placed on comfort. These commercial and industrial characteristics may be significantly different than those that have been participating in Hawaii Energy, making the estimates less appropriate for the Hawaii context. Similarly, since many of the savings estimates are expressed in terms of share of bill savings, it may not be appropriate to apply them to a different program where these savings may be substantially different.

Table 19: Non-Energy Benefit Estimation Summary - Comfort

Study	Non-Energy Benefit Measured	Approximate Range of Benefit Value		Estimation Method	Program/Measure Evaluated (State)
		% Bill Savings	Dollar Value		
Bicknell, et al. (2004)	Comfort	33%	NA	Direct Query	Comm. Audit Program (WA)
Wobus et al. (2007)	Even Light Distribution	6%	$2,046 (one time)	Conjoint	Comm/Ind Retrofit, Small Commercial Lighting (NY)
Wobus, et al. (2007)	Comfort	11%	NA	Direct Query	Comm/Ind Retrofit, Small Commercial Lighting (NY)
Tetra Tech MA (2011)	Comfort	NA	$77-$125 per person annually	Survey	Res retrofit, Res new construction, Low income (MA)
Tetra Tech MA (2011)	Noise reduction	NA	$30-$40 per person annually	Survey	Res retrofit, Res new construction, Low income (MA)
Summit Blue NY (2006)	Comfort/ HVAC Effectiveness	NA	$49,913 per project annually	Conjoint	Non-res New Construction (NY)
Summit Blue NY (2006)	Lighting quality	NA	$26,038 per project annually	Conjoint	Non-res New Construction (NY)
Summit Blue NY (2006)	Comfort/ HVAC Effectiveness	NA	$4,685 per project annually	Conjoint	Comm/Ind Retrofit (NY)
Summit Blue NY (2006)	Lighting quality	NA	$7,251 per project annually	Conjoint	Comm/Ind Retrofit (NY)
Summit Blue NY (2006)	Lighting effectiveness	NA	$86 per project annually	Conjoint	Small Comm Lighting Program (NY)
Tolkin, et al. (2009)	Comfort	70-93%	$279-371 per home annually	Direct Query Homeowners	ENERGY STAR Homes (MA)
Tolkin, et al. (2009)	Noise Reduction	37-71%	$146-284 per home annually	Direct Query Builders	ENERGY STAR Homes (MA)

5.2.2.3 Health and Safety

Another common non-energy benefit in the literature relates to the health and safety of building occupants. This category covers improved air quality, which can help reduce illnesses. Efficiency improvements can also affect occupant safety by improving working conditions for commercial spaces (thereby reducing on-the-job accidents). Various reports

suggest key measures that might trigger these improvements are lighting, air economizers, heat recovery, operable windows, insulation and thermal windows.

The health and safety non-energy benefit research has focused primarily on examining the health benefits associated with improved air quality and/or improved safety relating to new energy efficient measures. Since these benefits are often measured in terms of reduced sick time or downtime due to illness or accidents, the health and safety benefits sometimes get comingled with benefits relating to improved productivity. Note that many of the studies reviewed of residential programs examined the safety benefit in terms of improved home heating for low income households. Given the limited applicability to Hawaii, these studies were not included in the summary below.

Several studies we reviewed provided benefit estimates for health and safety relating to new efficiency measures, and these are summarized in Table 20. A variety of estimation methods were used, with the most common being either a phone survey or direct query of respondents regarding the value they place on improved health and safety resulting from the new energy efficiency measures. As with the estimates of comfort, benefit estimates for improvements to health and safety were estimated as either a percentage of bill savings or as a dollar value for the project.

The benefit of improved health and safety for commercial participants was estimated for a Washington audit program to be 51 percent of bill savings. For a commercial and industrial retrofit program in New York, the estimated benefit was $6,358 per project annually.

For residential participants, the value of benefits from improved health and safety ranged from $4 to $181 per home annually. One study in California expressed the value slightly differently, with an estimate of $3.78 per person annually due to reductions in sick days.

Table 20: Non-Energy Benefit Estimate Summary - Health and Safety

Study	Non-Energy Benefit Measured	Approximate Range of Benefits Value		Estimation Method	Program/Measure Evaluated (State)
		% Bill Savings	Dollar Value		
Bicknell, et al. (2004)	Safety	51%	NA	Direct Query	Comm Audit Program (WA)
Tetra Tech MA (2011)	Health	NA	$4-$19 annually per home	Survey	Res retrofit, Res new construction, Low income (MA)
Summit Blue NY (2006)	Indoor Air Quality/ Safety	NA	$6,358 per project annually	Conjoint	Comm/Ind Retrofit (NY)
Summit Blue NY (2006)	Safety	NA	$181 per project annually	Conjoint	ENERGY STAR Homes (NY)
TecMarket (2001)	Lost work/school days from illness	NA	$3.78 per person annually	Survey	Low Income (CA)
Tolkin, et al. (2009)	Safety	26%	$105 per home annually	Direct Query Homeowners	ENERGY STAR Homes (MA)
Tolkin, et al. (2009)	Indoor Air Quality	32%	$126 per home annually	Direct Query Builders	ENERGY STAR Homes (MA)

5.2.2.4 Productivity

Worker productivity is another category of non-energy benefit that has received some attention in the literature. This is generally quantified as employees being more efficient at their jobs, although as this may suggest, attempting to quantify the benefit of, say, energy efficient lighting on office workers is challenging at best. Worker productivity is also closely related to worker comfort and safety, which are usually studied separately. Similarly, changes in operations and maintenance costs are also closely related to productivity. When estimating these types of non-energy benefits, it is important that benefits are not double-counted across these closely related categories. For example, Bicknell, et al. measures several such benefits as a percentage of energy savings: "Productivity" is valued at 33 percent of energy savings, "efficiency" at 27 percent, "lower maintenance" at 44 percent, and "equipment works better" at 62 percent. If one were to add these categories up, the total benefit estimate would be 166 percent of energy savings, even though it seems likely that the respondents would treat these as variations of the same benefit.

Despite these challenges in quantifying productivity changes, some values were found in the literature and these are summarized in Table 21. When expressed as a percentage of bill savings, estimates of productivity improvement range from 13 to 33 percent. Estimates for several New York efficiency programs highlight the wide range of estimates. For a small

commercial lighting program, the benefit due to increased productivity is $62 per project annually, while for a non-residential new construction project the estimate increases substantially to $54,671.

Table 21: Non-Energy Benefit Estimate Summary - Productivity

Study	Non-Energy Benefit Measured	Approximate Range of Benefits Value		Estimation Method	Program/Measure Evaluated (State)
		% Bill Savings	Dollar Value		
Bicknell, et al. (2004)	Productivity	33%	NA	Direct Query	Comm Audit Program (WA)
Wobus, et al. (2007)	Productivity	13%	NA	Direct Query	Comm/Ind Retrofit, Small Commercial Lighting (NY)
Summit Blue NY (2006)	Occupant Productivity	NA	$54,671 per project annually	Conjoint	Non-res New Construction (NY)
Summit Blue NY (2006)	Occupant Productivity	NA	$10,598 per project annually	Conjoint	Comm/Ind Retrofit (NY)
Summit Blue NY (2006)	Worker Productivity	NA	$62 per project annually	Conjoint	Small Comm Lighting Program (NY)

5.2.2.5 Operations and Maintenance

Reduced operations and maintenance (O&M) cost is a non-energy benefit closely related to productivity. Simply by replacing older equipment, customers often receive an additional benefit of increased equipment reliability and fewer costs associated with maintaining older and less reliable equipment. While this benefit is sometimes included as part of a broader "productivity" category, a few studies were found in the literature that estimate the O&M benefits as a separate non-energy benefit.

Select findings from the literature are provided in Table 22, with trends that mirror those found in estimates of productivity shown in Table 21. As estimated as share of bill savings, lower O&M costs are estimated to be 19 to 44 percent of energy savings. When expressed as an annual per-person value, estimates range from $54 to $149 for residential programs. Estimates for commercial programs in New York range from $23 per project annually for a small commercial lighting program to $43,209 per project annually for a new construction program.

Table 22: Non-Energy Benefit Estimate Summary - Operation & Maintenance

Study	Non-Energy Benefit Measured	Approximate Range of Benefits Value		Estimation Method	Program/Measure Evaluated (State)
		% Bill Savings	Dollar Value		
Bicknell, et al. (2004)	Lower Maintenance	44%	NA	Survey / IDI	Comm Audit Program (WA)
Lily and Pearson (1999)	Lower O&M	19%	NA	Direct Query	Industrial Efficiency (WA)
Wobus, et al. (2007)	Lower O&M	22%	NA	Direct Query	Comm/Ind Retrofit, Small Commercial Lighting (NY)
Tetra Tech MA (2011)	Lower O&M (Occupant Home)	NA	$35-$149 per person annually	Survey	Res retrofit, Res new construction, Low income (MA)
Tetra Tech MA (2011)	Lower O&M (Occupant Appliances)	NA	$54-$124 per person annually	Survey	Res retrofit, Res new construction, Low income (MA)
Tetra Tech MA (2011)	Lower O&M (Building Owner – HVAC equip)	NA	$3.91 per building annually	Survey	Res retrofit, Res new construction, Low income (MA)
Summit Blue NY (2006)	Lower O&M	NA	$43,209 per project annually	Conjoint	Non-res New Construction (NY)
Summit Blue NY (2006)	Lower O&M	NA	$23 per project annually	Conjoint	Small Comm Lighting Program (NY)

5.2.3 Overarching Non-Energy Benefit Findings

The literature contains a very wide range of non-energy benefit estimates. As indicated by just the sample of studies included in this review, there is a very wide range of estimates for each benefit category. This variation is likely due to both the various estimation methods used, and the different programs and customer groups being studied. Even when similar methods are used, the same benefit (comfort, for example) is typically valued more highly in the commercial sector than the residential sector, as more people are usually affected and the benefit might have a direct effect on economic activity.

The non-energy benefit estimates found in the literature are tailored to specific programs, making transferability to other jurisdictions problematic. For some of the non-energy benefits reviewed, there was a very large range of estimated values that varied by program type. This indicates that (in the best case scenario), non-energy benefit estimates from the literature should only be applied to similar programs in other areas. An additional confounding factor is that many of the estimates are expressed in terms of the percentage of bill savings resulting from the energy efficiency measures installed through

the program. The studies reviewed generally do not include the total amount of bill savings, which prevents any type of adjustments to be made for different levels of bill savings in other jurisdictions. Given that bill savings from similar programs will naturally vary across states based on external factors such as weather and home size, applying the estimates from the literature to the Hawaii programs is problematic.

The direct query method is unlikely to produce reliable estimates. One of the most common estimation methods is the direct query technique, where respondents are simply asked directly to provide a value on a particular non-energy benefit. Given the abstract and somewhat intangible nature of these benefits (worker comfort and productivity, for example), it is unlikely that respondents can provide an accurate estimate for a value of these benefits on the spot during a typical phone survey. Furthermore, many of these studies ask respondents to express the value as a share of energy savings resulting from the energy efficiency measures. Given the substantial work required to estimate incremental energy savings as part of a formal impact evaluation, it is unlikely that respondents have an accurate idea of the bill savings given all the compounding factors (e.g., changes in weather and productivity). This additional source of uncertainty further compounds the problem of the direct query method.

6. Process Evaluation

6.1 Program Participant Feedback

The results of our process evaluation data collection efforts are presented below, first for the Residential Programs and then for the Business Programs.

6.1.1 Residential Program Participant Results

In order to collect data on experiences with the Residential Programs, which account for 55 percent of Hawaii Energy savings, the Evaluation Team fielded a survey with 380 Hawaii Energy residential rebate program participants. As noted above, the survey excluded the upstream lighting and CFL exchange/giveaway programs, low-income rebates, and any custom measures, which will not be evaluated via an end-use customer survey.

Residential participant results are organized into two sections: (1) general program feedback, and (2) rebate impact feedback, each sub-divided as follows:

- General Program Feedback
  - Initial Awareness of Programs
  - Role of social media as an information source
  - Motivation for reducing energy usage
  - Energy savings efforts
  - Adoption of CFLs
  - Reasons for installing solar water heaters
  - Cost barriers of energy efficient products
- Rebate Impact Feedback
  - Knowledge of rebates
  - Rebate satisfaction
  - Importance of rebate
  - Influence of rebate on purchase of specific technologies
  - Rebate impact on timing of purchases

6.1.1.1 General Program Feedback

This section is intended to serve as a status update on key Program metrics based on participant perspectives. Findings were compared across program years where relevant and against general population findings from PY2009.

Initial Awareness of Programs

Residential participants reported becoming aware of REEM through a variety of methods. As found during prior year evaluations, nearly half of the PY2011 respondents (48 percent) learned of the program at a retail store where rebates were offered on qualifying products. In addition, 58 percent of participants reported that they became aware of the rebate before deciding to purchase the product. In PY2011, the second most reported source for initially learning about the program was from a television, radio, or newspaper advertisement (17 percent). Although program sources of awareness have varied slightly

across program years, none of the differences are statistically significant (as shown in Table 23).

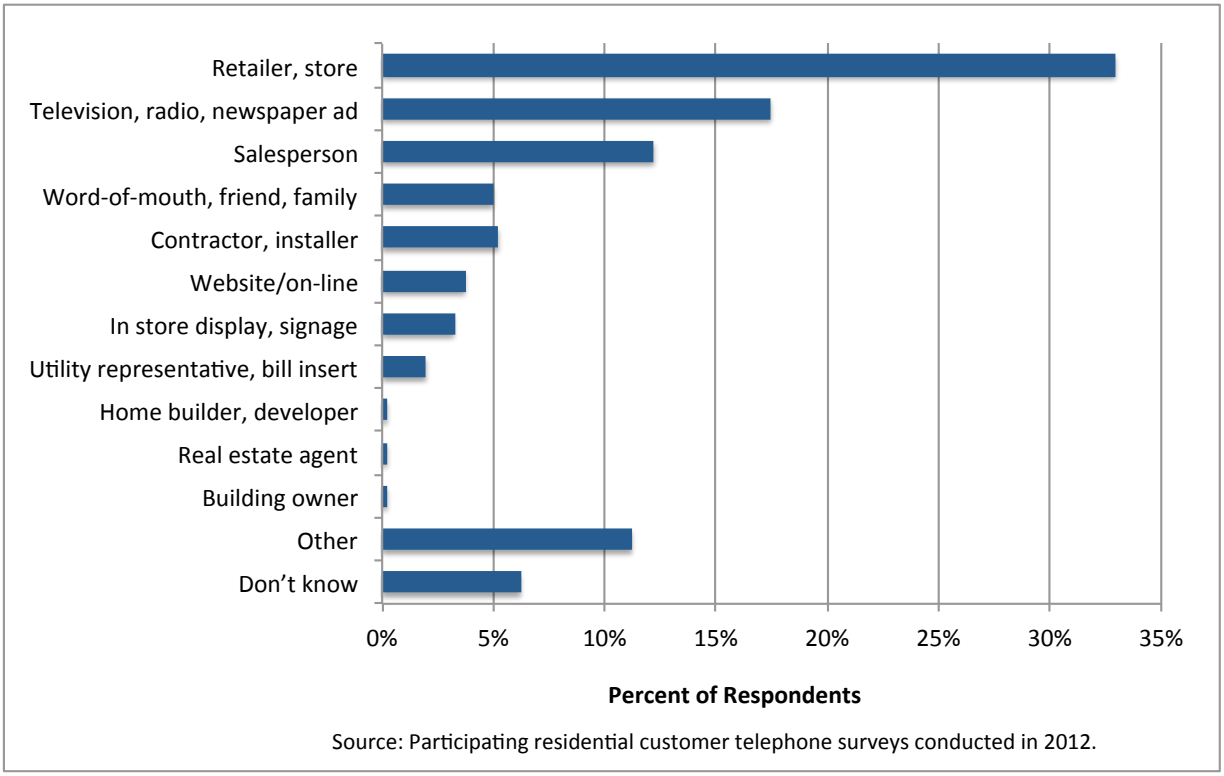
Table 23: Comparison of Residential Participant Initial Rebate Information Source

How Customer Was Initially Informed (Primary Response)	PY2011 Participants		PY2010 Participants		PY2009 Participants	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
In store (all)	194	48%	350	54%	540	53%
Retailer, store (general)	132	33%	238	37%		0%
Salesperson	49	12%	77	12%		0%
In store display, signage	13	3%	35	5%		0%
Television, radio, newspaper ad	70	17%	106	16%	214	21%
Contractor, installer	21	5%	52	8%	56	5%
Word-of-mouth, friend, family	20	5%	51	8%	77	8%
Utility information source (all)	23	6%	27	4%	95	9%
Website/on-line	15	4%	15	2%		0%
Utility representative, bill insert	8	2%	7	1%		0%
Participated or received rebate before		0%	3	0%		0%
Hawaiian Electric Company/ HECO		0%	2	0%		0%
Already knew/ had it for years		0%	13	2%		0%
Other	48	12%	18	3%	1	0%
Don't know	25	6%	27	4%	36	4%
Total	**401**	**100.0%**	**644**	**100.0%**	**1,019**	**100.0%**

Source: Participating residential customer telephone surveys conducted in 2010, 2011, and 2012.

The question about how program participants first learned of program rebates was structured as an open response that allowed for multiple answers. As with the prior year survey findings, participants mentioned a variety of sources of information including, but not limited to word-of-mouth, utility representatives and bill inserts, all of which appear to be less effective at spreading rebate awareness. Participant responses naming utility representatives as a source of awareness highlight a potential lack of distinction between Hawaii Energy and the utility (e.g., HECO and MECO) for residential participants. As shown in Figure 15, retail stores are the initial program rebate information source most mentioned by residential participants. This suggests that efforts to continue assisting stores by providing training and marketing materials is likely the most effective approach to increasing program awareness.

Figure 15: PY2011 Residential Rebate Participant Initial Rebate Information Source (n=401)

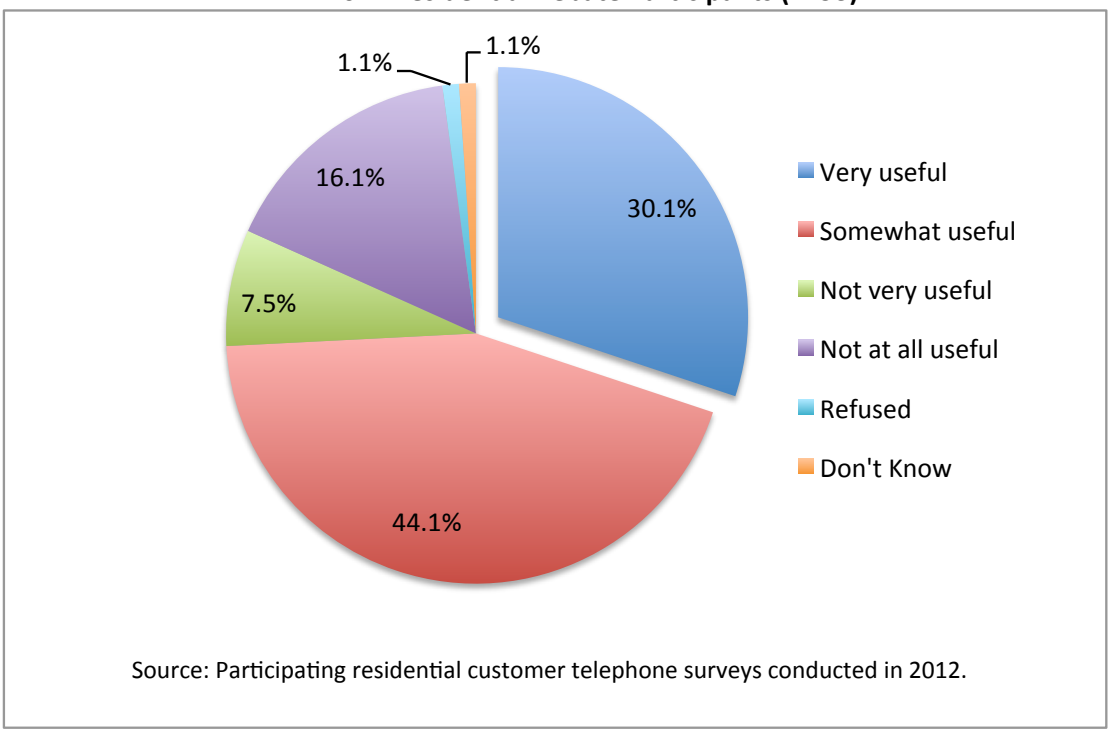


Source: Participating residential customer telephone surveys conducted in 2012.

Role of Social Media as an Information Source

Residential participants were questioned about the role social media plays as a useful source of information. Figure 16 illustrates that roughly three-quarters (74 percent) of participants reported that social media is either *somewhat useful* or *very useful* as an information source.

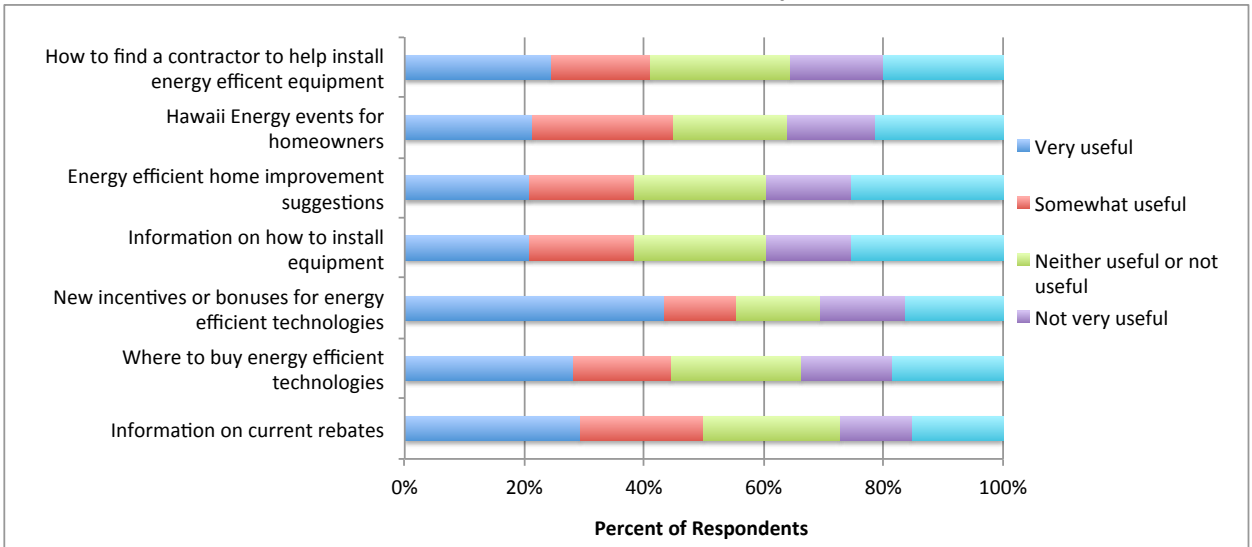
Figure 16: Usefulness of Social Media as an Information Source for PY2011 Residential Rebate Participants (n=93)



Source: Participating residential customer telephone surveys conducted in 2012.

This suggests that making quality information available via social media could be a valuable method for communicating residential participants. In addition to understanding the general usefulness of social media, a comparison of responses reveals what type of information social media is most useful at providing. Almost half of participants (43 percent) reported that using social media to learn more about new incentives or bonuses for energy efficient technologies was *very useful*. The remaining uses for social media, as shown in Figure 17, were fairly equally distributed across the remaining response categories. One possible explanation for these results is that the large volume of general energy efficiency information online makes it less valuable to consumers than information on rebates and incentives specific to Hawaii. These findings suggest that social media may be an effective tool to market incentives and bonuses for energy efficient technologies.

Figure 17: Comparison of Various Uses of Social Media among PY2011 Residential Rebate Participants (n=93)

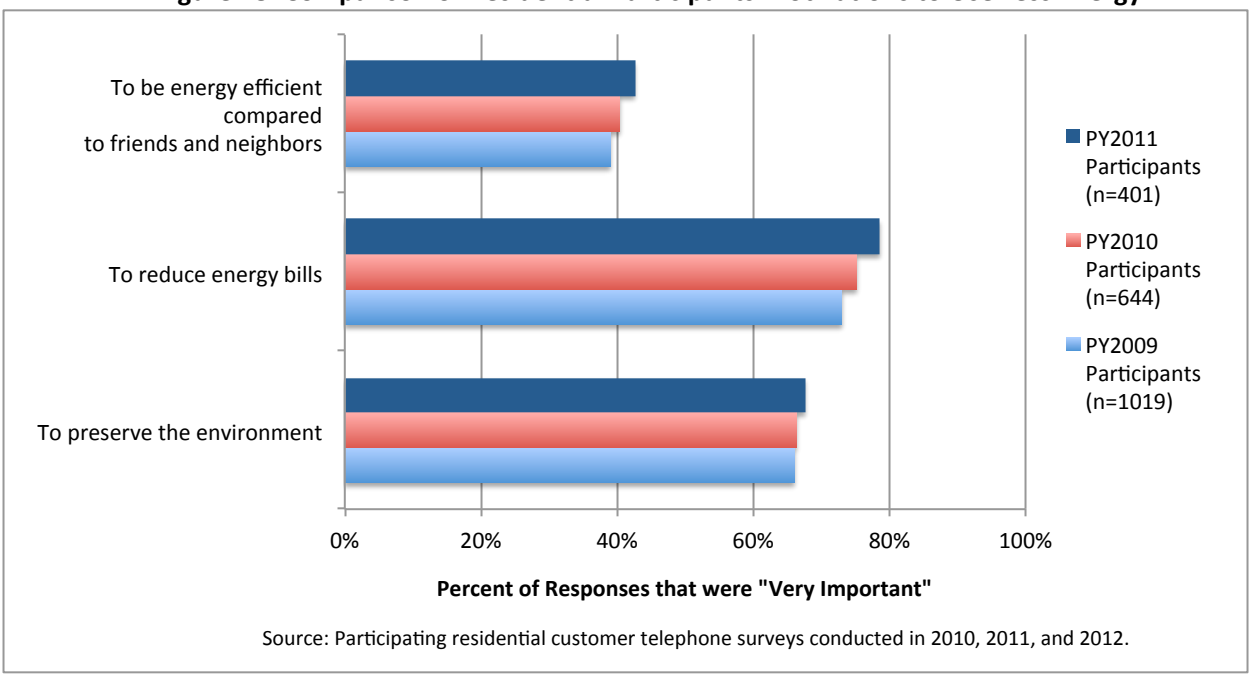


Source: Participating residential customer telephone surveys conducted in 2012.

Motivation for Reducing Energy Usage

Motivations for PY2011 residential participants in to reduce energy use are similar to those in both the PY2010 and PY2009 surveys (shown in Figure 18). Across all three program years, the percentage of participants who rated the motivations as *very important* has steadily increased, though not statistically significantly. The motivation most cited as *very important* by participants was to reduce energy bills. Approximately three-quarters of participants each program year reported this motivation as *very important* (79 percent in PY2011, 75 percent in PY2010 and 73 percent in PY2009). These do not represent significant changes in motivation, but instead highlight that reducing energy use and overall cost has remained a significant driver for increasing energy efficiency. Preserving the environment was the second strongest motivation, reported as *very important* by approximately two-thirds of participants in each of the program year surveys (68 percent in PY2011, 66 percent in PY2010 and 66 percent in PY2009). There is no significant difference across program year within responses for the two above-discussed motivations.

Figure 18: Comparison of Residential Participants Motivations to Use Less Energy

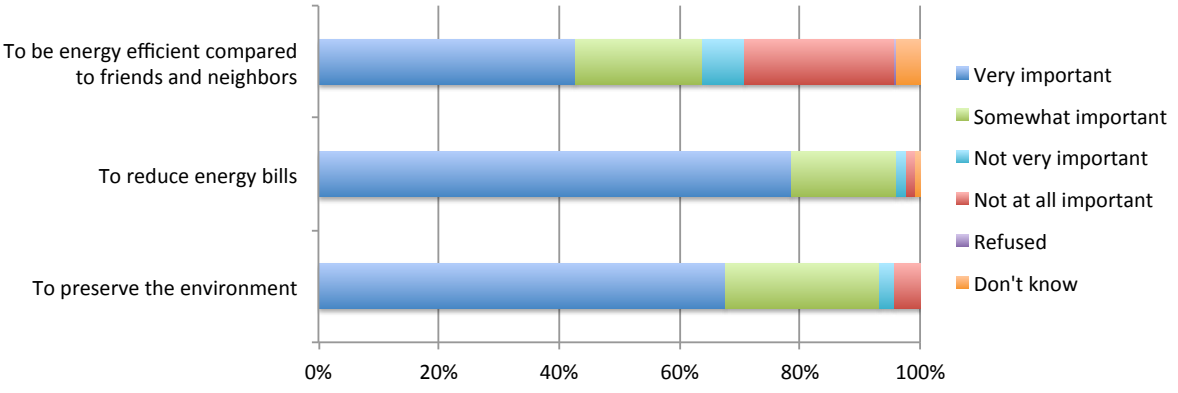


Source: Participating residential customer telephone surveys conducted in 2010, 2011, and 2012.

As shown in Figure 19, the majority of PY2011 residential participants (96 percent) reported that it is *somewhat* or *very important* to use less energy to reduce energy bills. In addition, 93 percent said that it is *somewhat* or *very important* to use less energy to help preserve the environment. About one-third (32 percent) of participants responded that being energy efficient compared to their neighbors is *not very* or *not at all important.* This finding illustrates that peer comparisons among participants may not be as strong of a motivating factor as saving money or preserving environmental quality.[50]

[50] It is important to note that the theory behind peer comparisons is that individuals often do not fully realize how strong a motivation peer comparisons are.

Figure 19: Importance of Motivations to Use Less Energy among PY2011 Residential Participants (n=401)

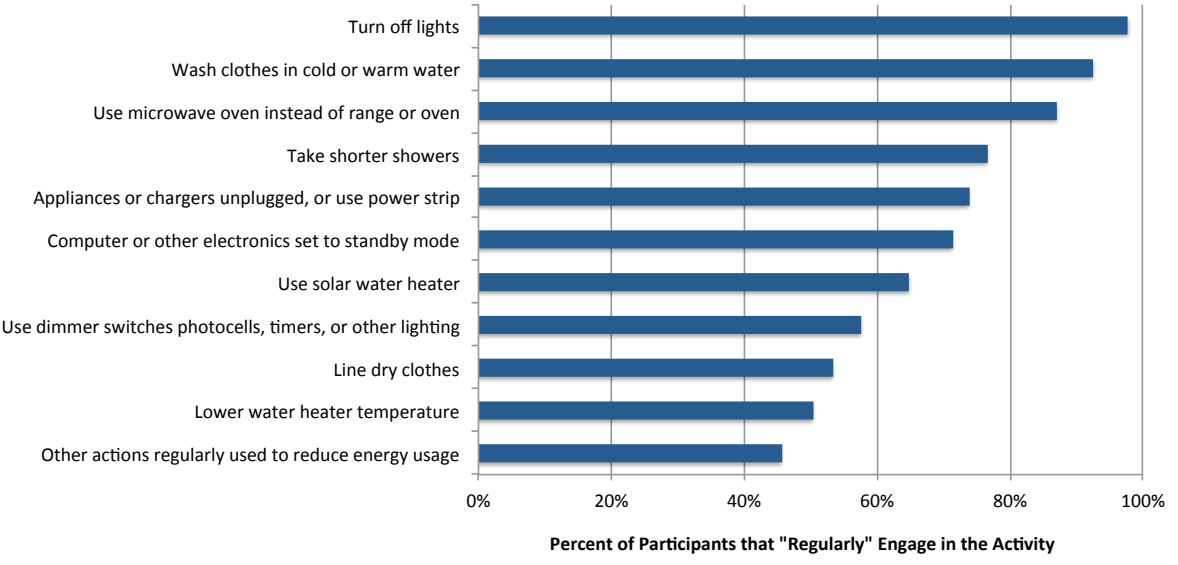


Source: Participating residential customer telephone surveys conducted in 2012.

Energy Savings Efforts

Residential participants were questioned about their current energy savings activities. Not surprisingly, the most widely reported (98 percent) energy savings activity that participants *regularly* engage in is turning off lights. As shown in Figure 20, those activities that are easy to implement and require less behavior change tend to have a significant percentage of engagement.

Figure 20: Actions PY2011 Residential Rebate Participants Take to Reduce Energy Usage (n=401)



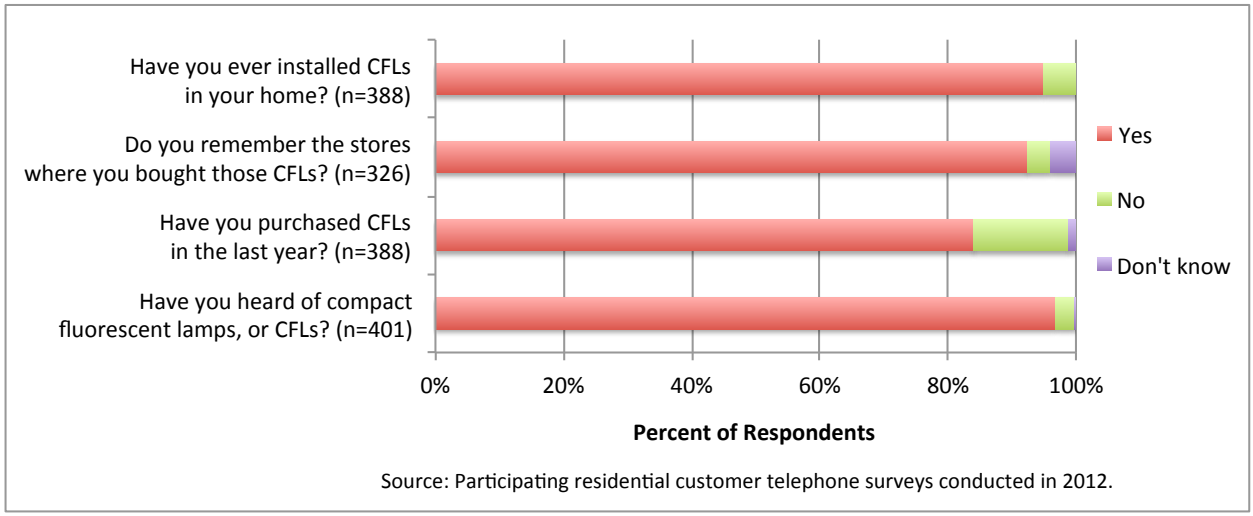
Source: Participating residential customer telephone surveys conducted in 2012.

Adoption of CFLs

In the PY2011 survey, the vast majority of residential participants reported not only a strong awareness of CFLs (97 percent), but also a sizable installation rate (95 percent).

These findings are in alignment with the general population survey conducted for PY2009, in which 94 percent of respondents reported awareness of CFLs before taking the survey and 91 percent reported installing CFLs in their home. In addition, most residential participants purchased CFLs in the last year (84 percent) and even remembered the store where they purchased them (92 percent). In combination, as shown in Figure 21, these findings suggest that there is broad awareness and adoption of CFLs across Residential Program participants.

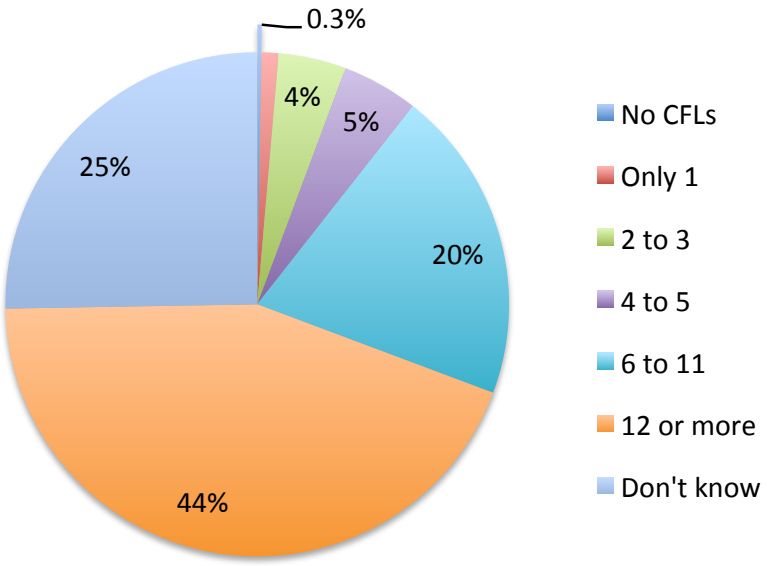
Figure 21: PY2011 Residential Rebate Participant Awareness and Adoption of CFLs



Source: Participating residential customer telephone surveys conducted in 2012.

Among residential participants, almost half (44 percent) reported that they currently have 12 or more CFLs installed in their home (shown in Figure 22), which further illustrates broad market adoption. This finding is consistent with the general population survey findings from the PY2009 evaluation that showed only one percentage point lower current installation rate (43 percent) among residential respondents.

Figure 22: CFLs Installed in the Home among PY2011 Residential Rebate Participants (n=368)

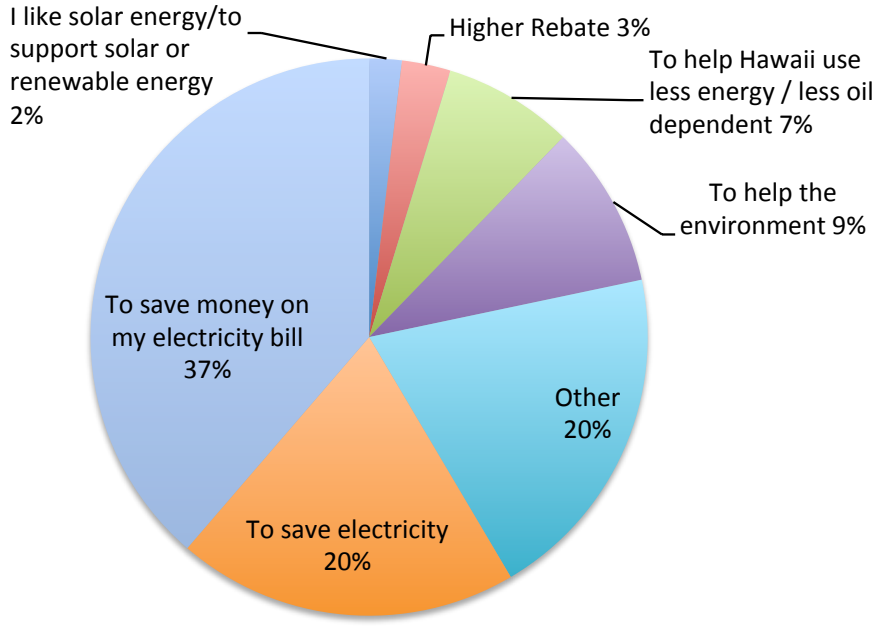


Source: Participating residential customer telephone surveys conducted in 2012.

Reasons for Installing Solar Water Heaters (SWH)

Residential participants were also asked about their motivations for installing a solar water heater. Over half (57 percent) of residential customers participating in the solar water heater program reported that the main reason for installing a solar water heater was to either save money on their electricity bill or save electricity (Figure 23). This is down from the 71 percent of PY2010 participants surveyed who reported installing a solar water heater system in order to help reduce energy usage and costs. This suggests that there is growing importance of other motivating reasons beyond just cost savings. These include helping the environment (nine percent), reducing Hawaii's oil dependence (seven percent), and supporting solar or renewable energy (two percent).

Figure 23: PY2011 Residential Program Participant Reasons for Installing SWH (n=107)

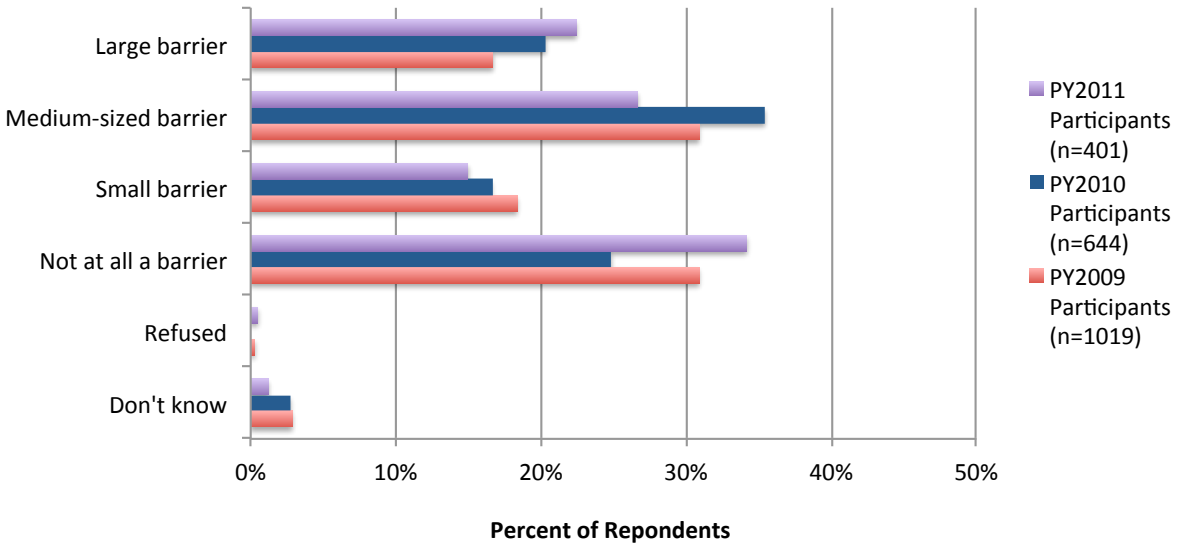


Source: Participating residential customer telephone surveys condcuted in 2012.

Cost Barriers of Energy Efficient Products

In the PY2011 survey, Residential Program participants were questioned about the impact that the cost of energy efficient products has on purchase decisions. As shown in Figure 24, the extent to which participants view cost as a barrier to purchasing energy efficient products varies considerably across program years. When participant responses are compared to those given in the general population survey conducted for the PY2009 evaluation, findings are quite consistent. In the general population survey, 31 percent reported that the purchase cost was not a barrier at all, while 20 percent reported it as a large barrier.

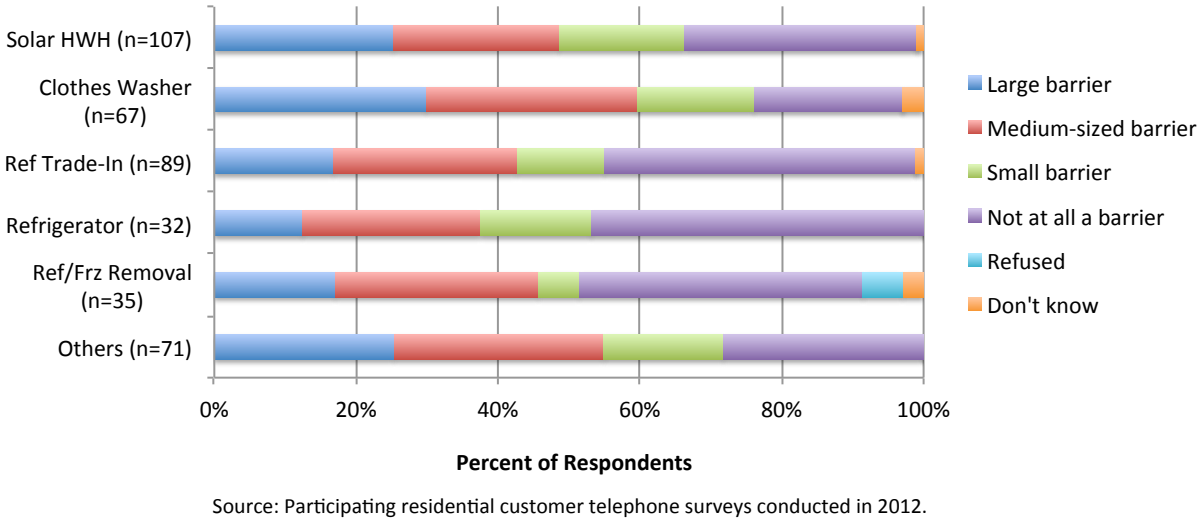
Figure 24: Comparison of Purchase Cost as a Barrier for Residential Rebate Participants



Source: Participating residential customer telephone surveys conducted in 2010, 2011, and 2012.

In addition, Residential Program participants are fairly split in the degree to which they perceive the purchase cost of energy efficient products as a barrier across technology types. The survey results, shown in Figure 25, illustrate that the cost of energy efficient products are viewed as a *medium size* or *large barrier* from 38 percent for refrigerators to 60 percent for clothes washers. This variation in survey findings suggests that there are other more pressing factors impacting appliance purchase decisions than just the absolute cost of the technology.

Figure 25: 2011 Residential Rebate Participant Perception of Purchase Cost as a Barrier by Technology



Source: Participating residential customer telephone surveys conducted in 2012.

6.1.1.2 Rebate Impact Feedback

This section addresses the impact of rebates on program participation, for areas that findings from questions on rebates revealed trends that warranted additional analysis. The findings discussed in this section only represent perspectives from residential customers who received solar water heater incentives and/or consumer rebates for appliance, which together account for 13 percent of Hawaii Energy savings. A key finding from the additional analysis this year is that the influence of consumer rebates in the residential sector varies by technology and measure type.

Knowledge of Rebates

When asked about their knowledge of program rebates, 66 percent of survey respondents reported that they were aware of the rebate before they bought the product, as shown in Table 24. This was a general question about rebate awareness and did not specifically address a single technology. As with findings from the PY2010 survey, this suggests the possibility that rebates partially influenced this portion of those surveyed.

Table 24: Comparison of When Residential Rebate Participants Became Aware of Rebate

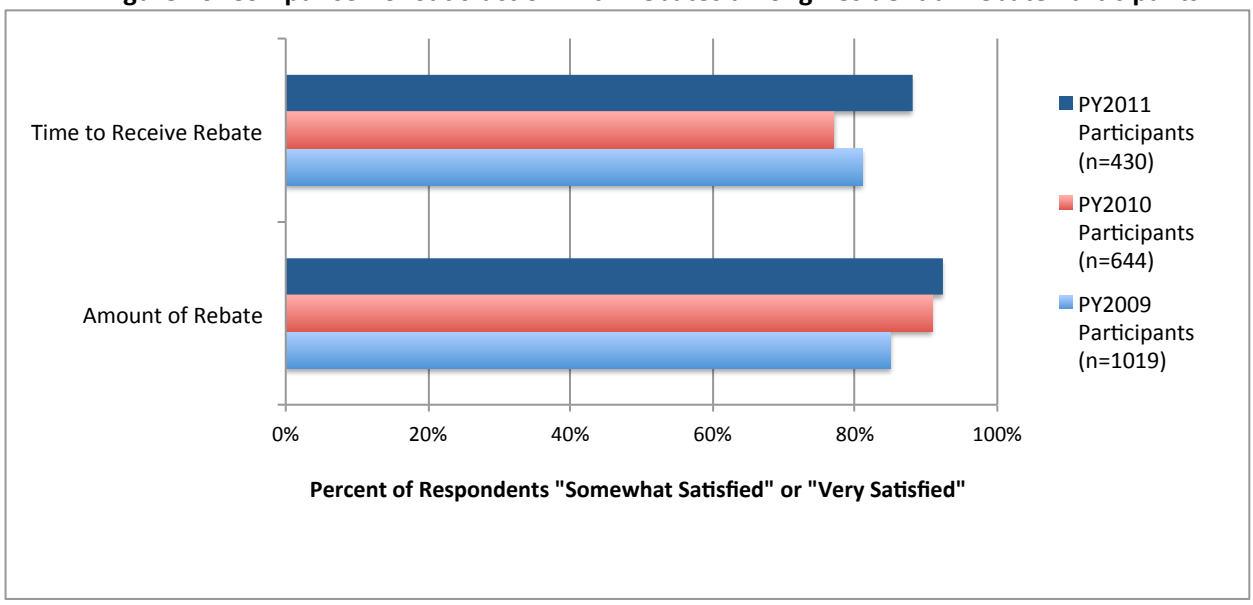
Did you become aware of the rebate before or after you decided to get the product?	2011 Program Participants		2010 Program Participants	
	Frequency	Percent	Frequency	Percent
Before	250	58%	402	62%
After	167	39%	224	35%
Don't know	12	3%	2	0%
Refused	1	0%	16	2%
Total	**430**	**100%**	**644**	**100%**

Source: Participating residential customer telephone surveys conducted in 2011 & 2012 (not asked in 2010).

Rebate Satisfaction

As shown in Figure 26, a comparison of responses from residential participants on various aspects of satisfaction with program rebates reveals that the vast majority (more than 80 percent) is *somewhat satisfied* or *very satisfied*. The satisfaction level for the amount of the rebate was fairly consistent across multiple program years, with nearly all participants (92 percent in PY2011, 91 percent in PY2010, and 85 percent in PY2009) each program year being satisfied. In the current program year though, satisfaction for the amount of time it takes to receive a rebate increased by 14 percent over PY2010.

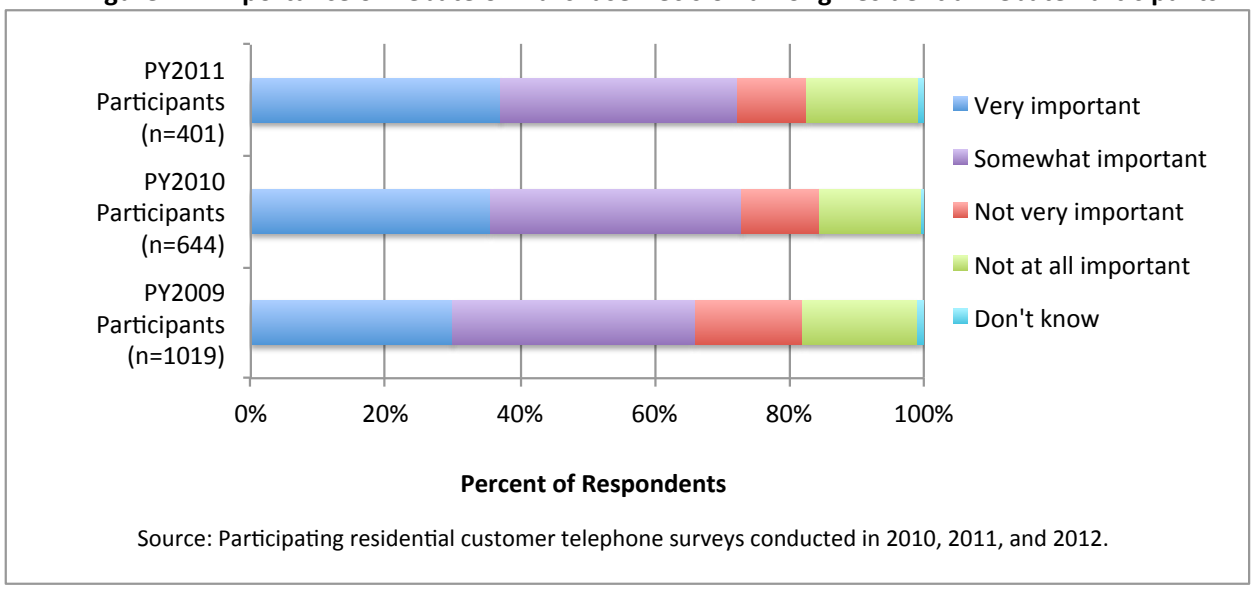
Figure 26: Comparison of Satisfaction with Rebates among Residential Rebate Participants



Importance of Rebate

Analyses of survey data found that 72 percent of residential participants reported that the rebate was *somewhat important* or *very important* to the purchase decision (Figure 27). In addition, the importance of rebate availability on purchase decisions has remained fairly consistent across the last three program years. This finding highlights that the reported importance of rebate availability is irrespective of the purchase cost of the product, as illustrated previously.

Figure 27: Importance of Rebate on Purchase Decision among Residential Rebate Participants

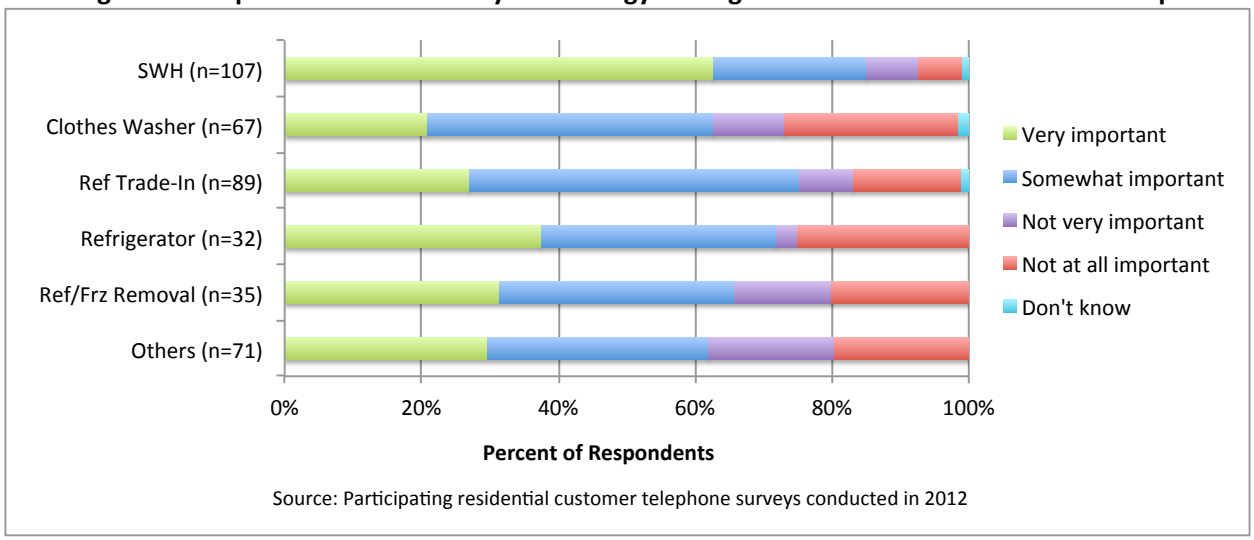


Source: Participating residential customer telephone surveys conducted in 2010, 2011, and 2012.

Comparing rebate importance across various technology types specifically for PY2011, as illustrated in Figure 28, highlights the importance of rebates on premium energy efficiency upgrades when significantly less expensive alternative models are available (e.g., solar

water heater versus traditional water heaters). More than half (63 percent) of participants who purchased a solar water heater reported that the rebate was *very important* to their decision to complete the purchase.

Figure 28: Importance of Rebate by Technology among PY2011 Residential Rebate Participants



Source: Participating residential customer telephone surveys conducted in 2012

Influence of Rebate on Purchase of Specific Technologies

The rebate was very important for 17 percent of respondents, but much less important for 67 percent of respondents, who reported that they were *somewhat likely* or *very likely* to have purchased the same product without the rebate (shown in Table 25).

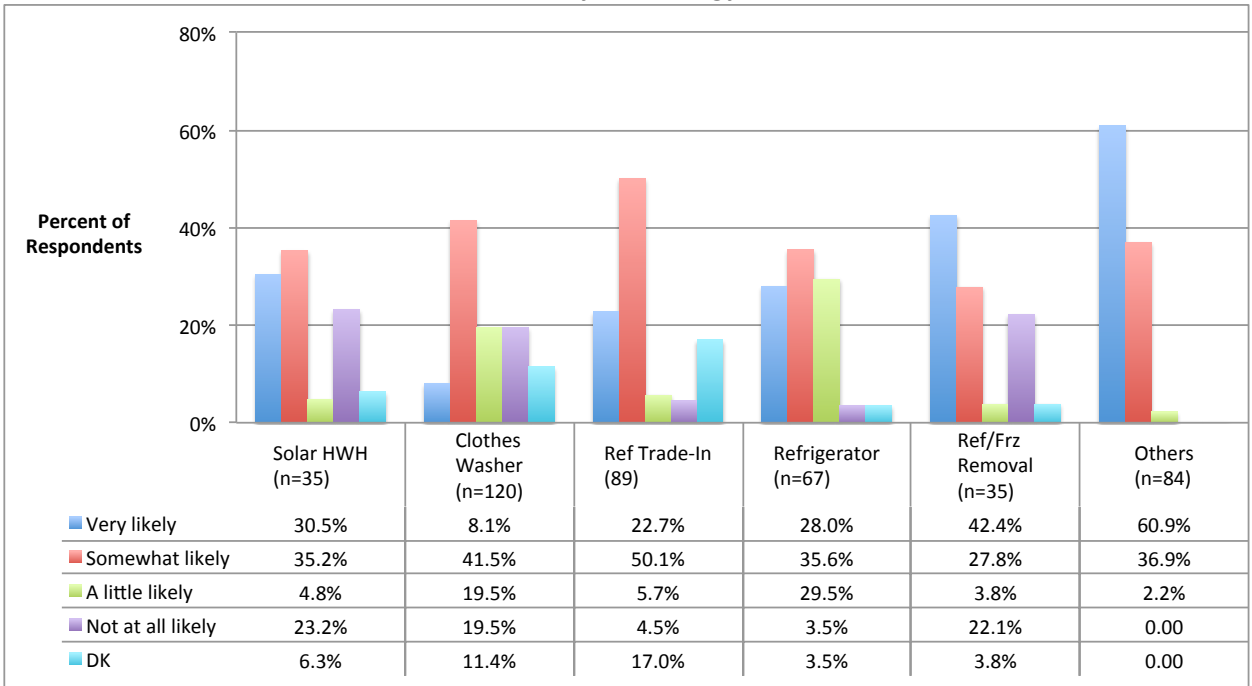
Table 25: PY2011 Residential Rebate Participant Likelihood of Purchasing Product without Rebate

How likely do you think it was that you would have gotten the same product if there had been no rebate?	2011 Program Frequency	Participants Percent
Very likely	40	33%
Somewhat likely	42	34%
A little likely	10	8%
Not at all likely	21	17%
Don't know	10	8%
Total	**123**	**100.0%**

Source: Participating residential customer telephone surveys conducted in 2012.

The reported finding among Residential Program participants that approximately two-thirds would likely have purchased the same product with the rebate is also fairly consistent across specific products, as shown in Figure 29.

Figure 29: PY2011 Residential Rebate Participant Likelihood of Purchasing Product without Rebate by Technology

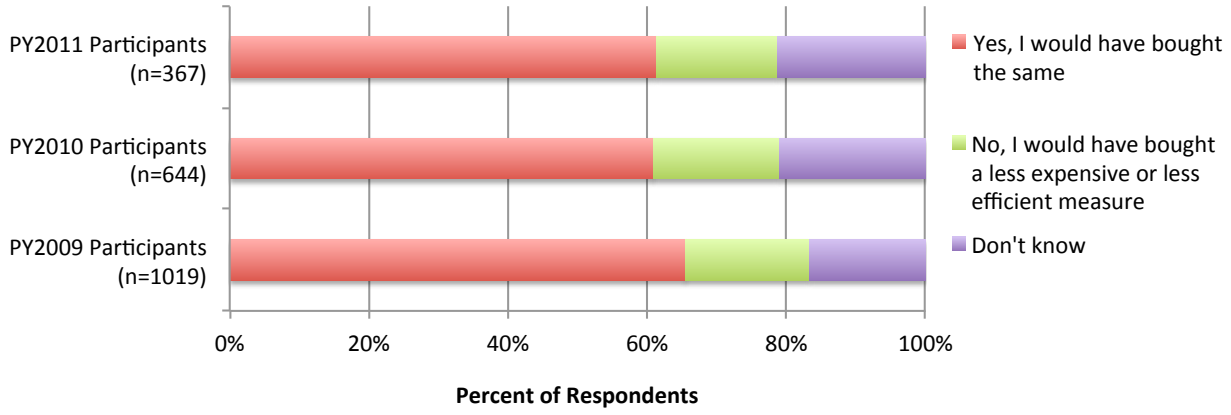


	Solar HWH (n=35)	Clothes Washer (n=120)	Ref Trade-In (89)	Refrigerator (n=67)	Ref/Frz Removal (n=35)	Others (n=84)
Very likely	30.5%	8.1%	22.7%	28.0%	42.4%	60.9%
Somewhat likely	35.2%	41.5%	50.1%	35.6%	27.8%	36.9%
A little likely	4.8%	19.5%	5.7%	29.5%	3.8%	2.2%
Not at all likely	23.2%	19.5%	4.5%	3.5%	22.1%	0.00
DK	6.3%	11.4%	17.0%	3.5%	3.8%	0.00

Source: Participating residential customer telephone surveys conducted in 2012.

The survey data was also analyzed across the last three program years, as shown in Figure 30, to understand trends in purchase decisions. In PY2011, there was no significant change in the percent of respondents that would have bought the same product without the rebate.

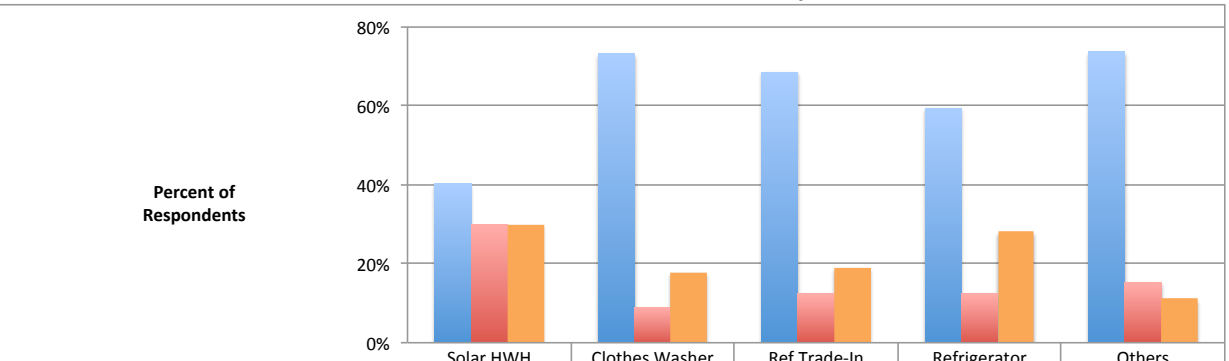
Figure 30: Comparison of Residential Rebate Participant Product Purchase Without Rebate



Source: Participating residential customer telephone surveys conducted in 2010, 2011, and 2012.

The survey data consistently found that rebates, aside from those for solar water heater, have little impact in specific product choice decisions (shown in Figure 31).

Figure 31: Influence of Rebate on Purchase of Specific Product among PY2011 Residential Rebate Participants



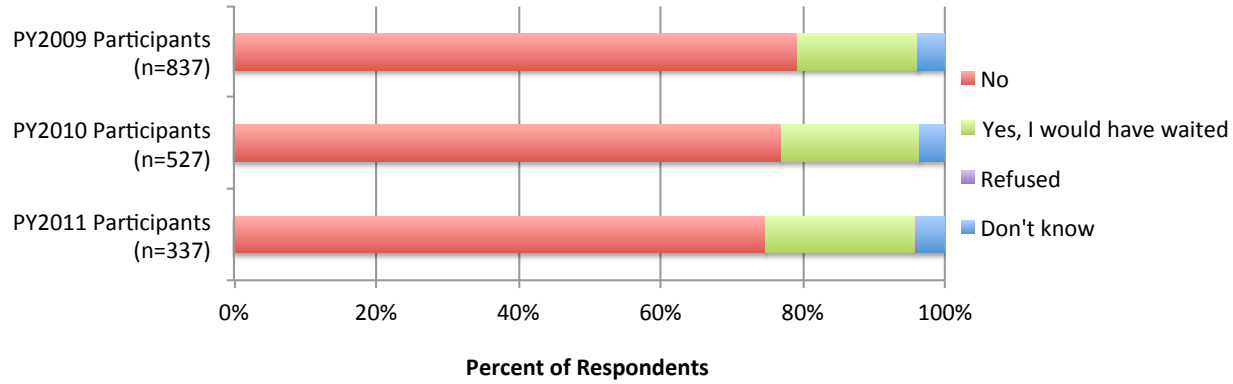
	Solar HWH (n=107)	Clothes Washer (n=67)	Ref Trade-In (n=89)	Refrigerator (n=32)	Others (n=72)
Yes, I would have bought the same	40.2%	73.1%	68.5%	59.4%	73.6%
No, I would have bought a less expensive or less efficient measure	29.9%	9.0%	12.4%	12.5%	15.3%
Don't know	29.9%	17.9%	19.1%	28.1%	11.1%

Source: Participating residential customer telephone surveys conducted in 2012.

Rebate Impact on Timing of Purchases

The majority of respondents (>75 percent) across all three of the last program years reported that they would not have waited to make a purchase if the rebate was not available. However, as shown in Figure 32, the percent of respondents who reported that the rebate was a critical component to the decision to purchase an energy efficient product at the time they did has increased each of the three program years, from 17 percent in PY2009 to 21 percent in PY2011. This illustrates that there is variation in the role that rebates have on the timing of participant purchases.

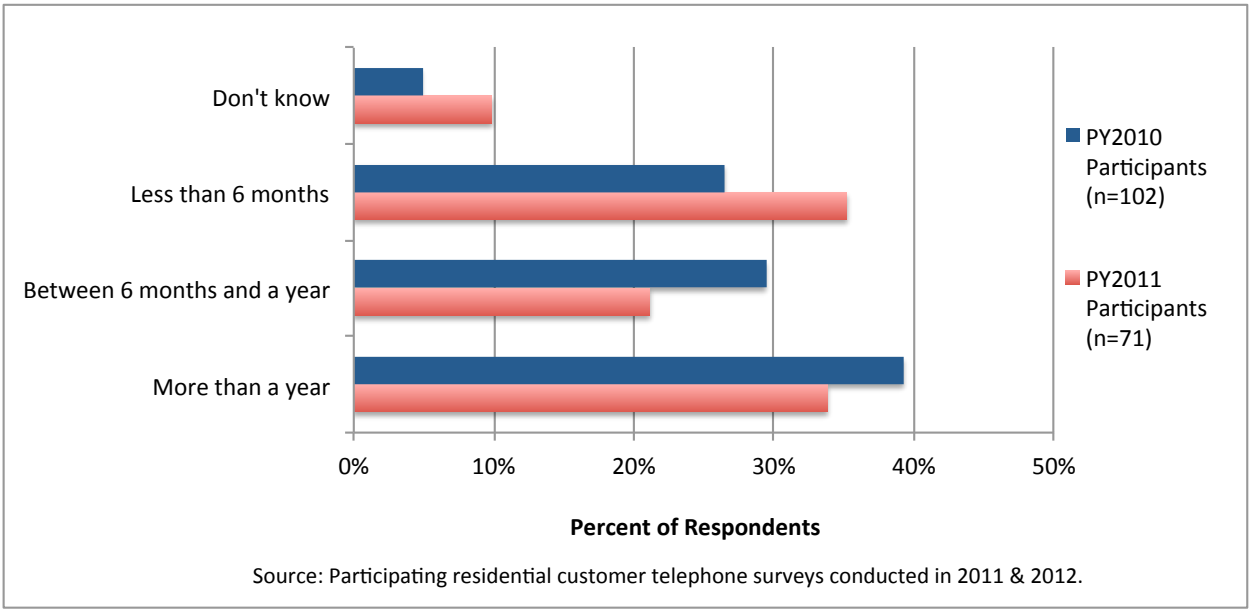
Figure 32: Comparison of Rebate Impact on Delaying Purchase among Residential Rebate Participants



Source: Participating residential customer telephone surveys conducted in 2010, 2011, and 2012.

The length of time respondents seem willing to wait to make a product purchase in the absence of a rebate is fairly consistent. In PY2011, only 55 percent of respondents reported that they would be willing to wait more than six months to make a purchase without a rebate, whereas in PY2010, 69 percent reported the same willingness. These findings, shown in Figure 33, do not represent statistically significant difference across years.

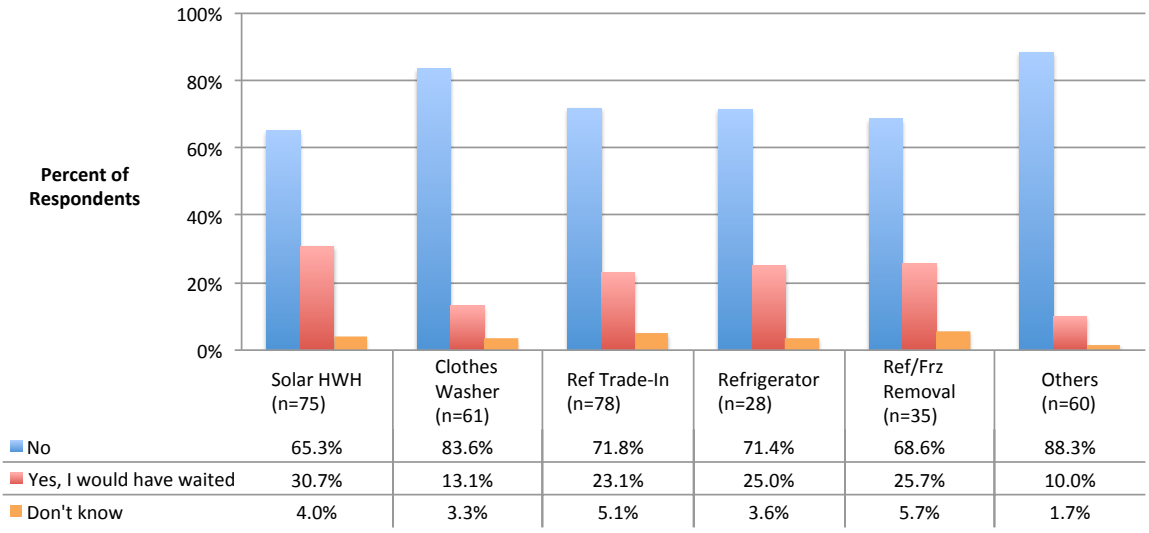
Figure 33: Amount of Time Residential Rebate Participants would Delay their Purchase if no Rebate were Available



Source: Participating residential customer telephone surveys conducted in 2011 & 2012.

Survey data from respondents on willingness to delay purchases is also fairly consistent across a variety of technology types (shown in Figure 34), suggesting that rebates for energy efficient products may not be a strong influence on purchase decisions.

Figure 34: Influence of Rebate on Delaying Purchase by Technology among PY2011 Residential Rebate Participants



	Solar HWH (n=75)	Clothes Washer (n=61)	Ref Trade-In (n=78)	Refrigerator (n=28)	Ref/Frz Removal (n=35)	Others (n=60)
No	65.3%	83.6%	71.8%	71.4%	68.6%	88.3%
Yes, I would have waited	30.7%	13.1%	23.1%	25.0%	25.7%	10.0%
Don't know	4.0%	3.3%	5.1%	3.6%	5.7%	1.7%

Source: Participating residential customer telephone surveys conducted in 2012.

6.1.2 Business Program Participant Results

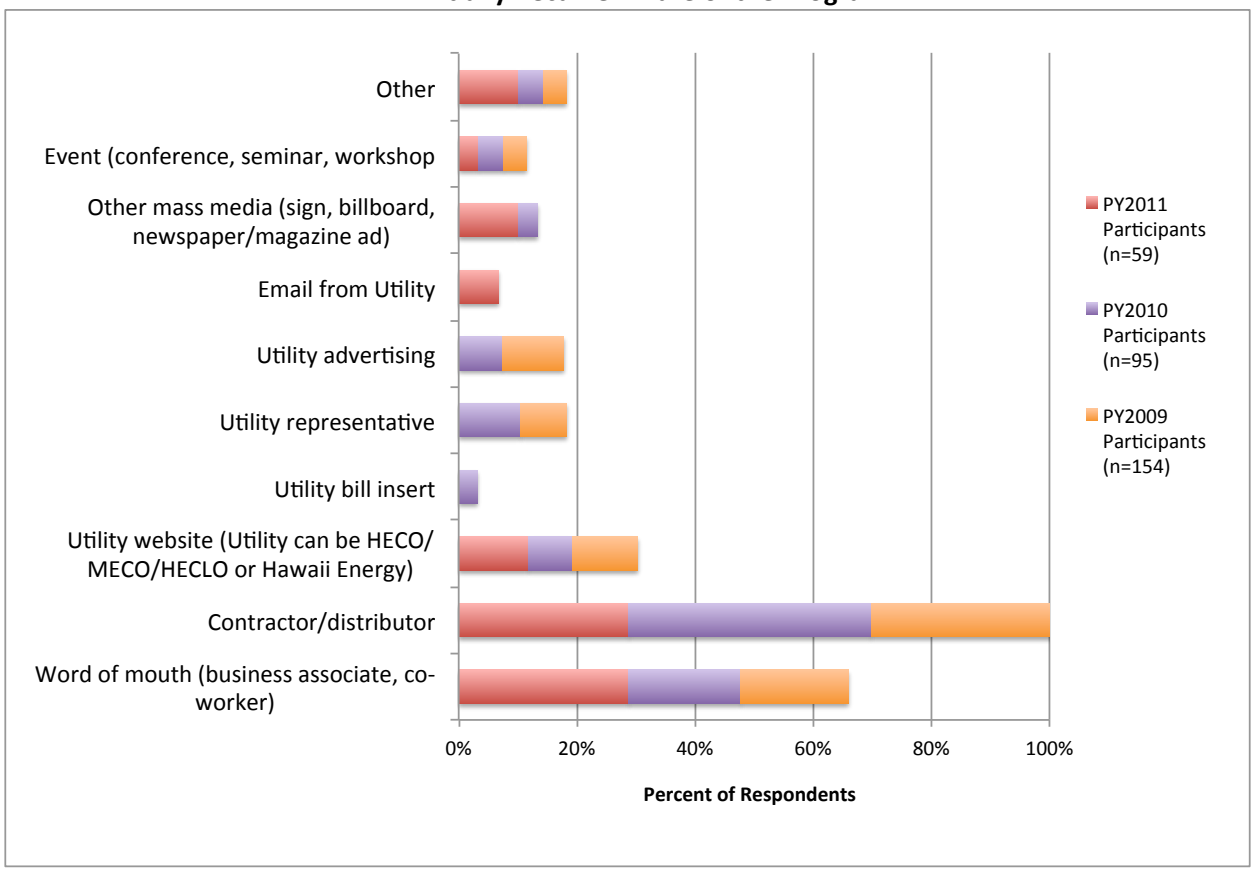
As with residential participant surveys, surveys conducted with participating business customers were focused on collecting perspectives on the Program during PY2011. Business participant responses were analyzed and categorized into the following program topic areas:

- Initial awareness of program;
- Knowledge of ways to save energy;
- Importance of energy efficiency equipment;
- Influence of rebate on purchase decisions; and
- Satisfaction with program elements.

Initial Awareness of Program

Over the last three program years, Business Program participants have reported a variety of ways they first learned about the Program (shown in Figure 35). Similar to previous years, the PY2011 process evaluation found the two most reported ways of initially learning of the program were from contractors or distributers directly, or through word-of-mouth. However, the percentage of participants learning of the Program or obtaining an application form from contractors or distributers fell (41 percent in PY2010 and 29 percent in PY2011) while the percentage of participants learning of the program through word-of-mouth rose (19 percent in 2010 and 29 percent in 2011). As in PY2010, in the current evaluation there were no discernible differences to initial awareness when analyzing by technology purchased.

Figure 35: Comparison of How Business Program Participants Initially Became Aware of the Program

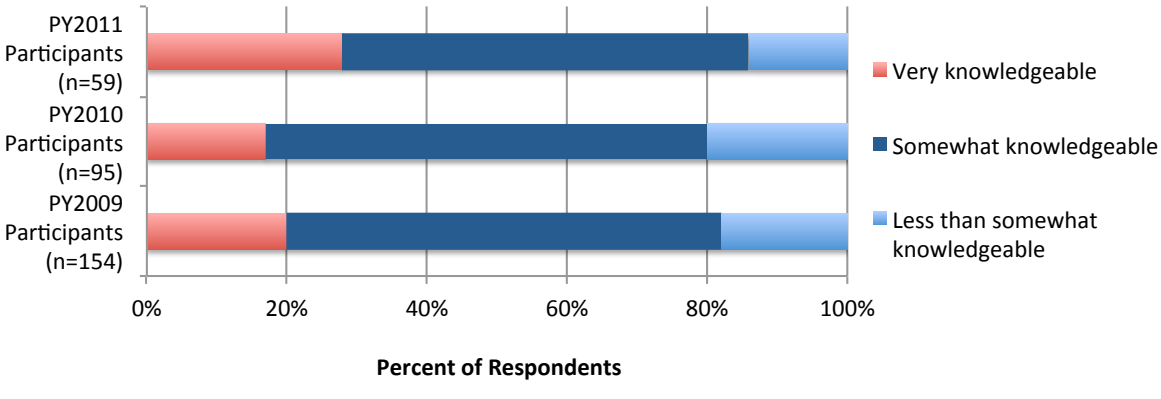


Source: Participating business customer telephone surveys conducted in 2010, 2011, and 2012.

Knowledge of Ways to Save Energy

Comparisons of survey results across the last two program years show a moderate increase in the amount of businesses that consider themselves to be *very knowledgeable* about ways to save energy in their business, as illustrated in Figure 36. In PY2011 there was an 11 percentage point increase (from 17 percent to 28 percent) in business participants who claimed to be *very knowledgeable* of ways to save energy. Interestingly, the level of awareness of ways to save among Business Program participants is lower than reported in the general population survey for PY2009, where 35 percent reported they were *very knowledgeable* of ways to save energy. When combined with those claiming to be *somewhat knowledgeable* (58 percent) the total represents 93 percent of the general population responses.

Figure 36: Comparison of Business Program Participant Level of Knowledge of Ways to Save Energy

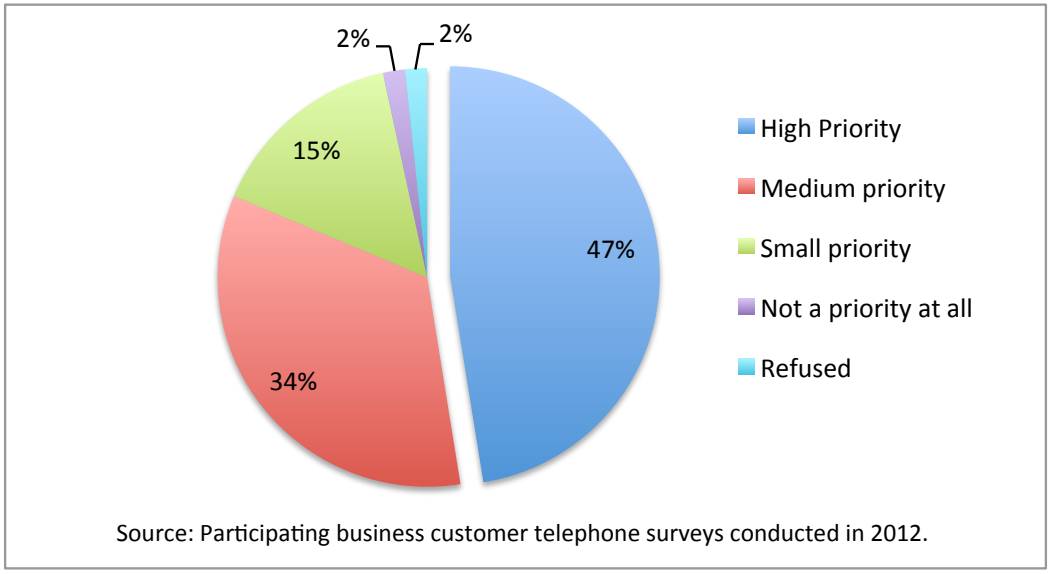


Source: Participating business customer telephone surveys conducted in 2010, 2011, and 2012.

Importance of Energy Efficiency Equipment

Among business participants, the vast majority (81 percent) reported that energy efficiency is either a *medium priority* or *high priority* for equipment installation decisions (Figure 37).

Figure 37: Importance of Energy Efficiency to Installation Decisions for PY2011 Business Program Participants (n=59)



Source: Participating business customer telephone surveys conducted in 2012.

Influence of Rebate on Purchase Decisions

Similar to survey findings for residential participants, shown in Table 26, more than two-thirds (72 percent) of business participants reported that they are *somewhat likely* or *very likely* to have purchased the same product even if no rebates were available. In addition, 66 percent of business participants reported that they would have gone forward with the project as planned even if the incentives were not available.

Table 26: PY2011 Business Program Participant Likelihood of Purchasing Product Without Rebate

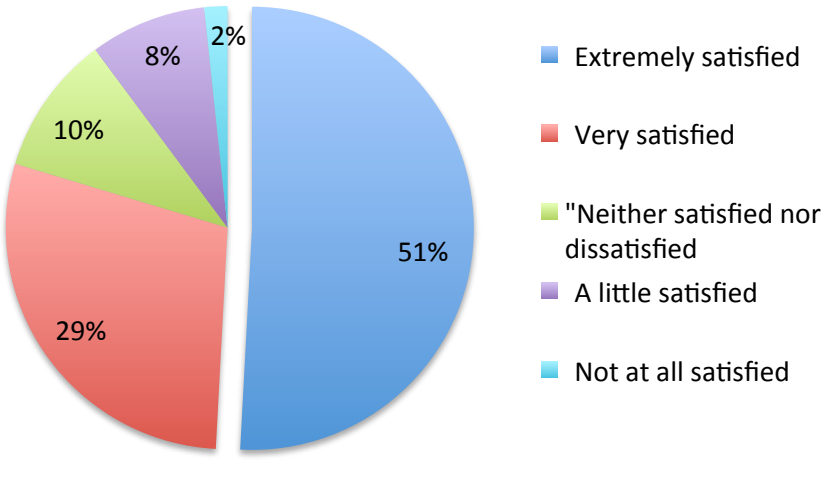
How likely do you think it was that you would have got the same measure if there had been no rebate?	PY2011 Participants	
	Frequency	Percent
Very likely	8	29%
Somewhat likely	12	43%
Not very likely	1	4%
Not at all likely	4	14%
Don't know	1	4%
Refused	2	7%
Total	**28**	**100.0%**

Source: Participating non-residential customer telephone surveys conducted in 2012.

Satisfaction with Program Elements

Analysis of PY2011 survey data found that the vast majority (80 percent) of business participants were either *very satisfied* or *extremely satisfied* with their overall experience with the Program.

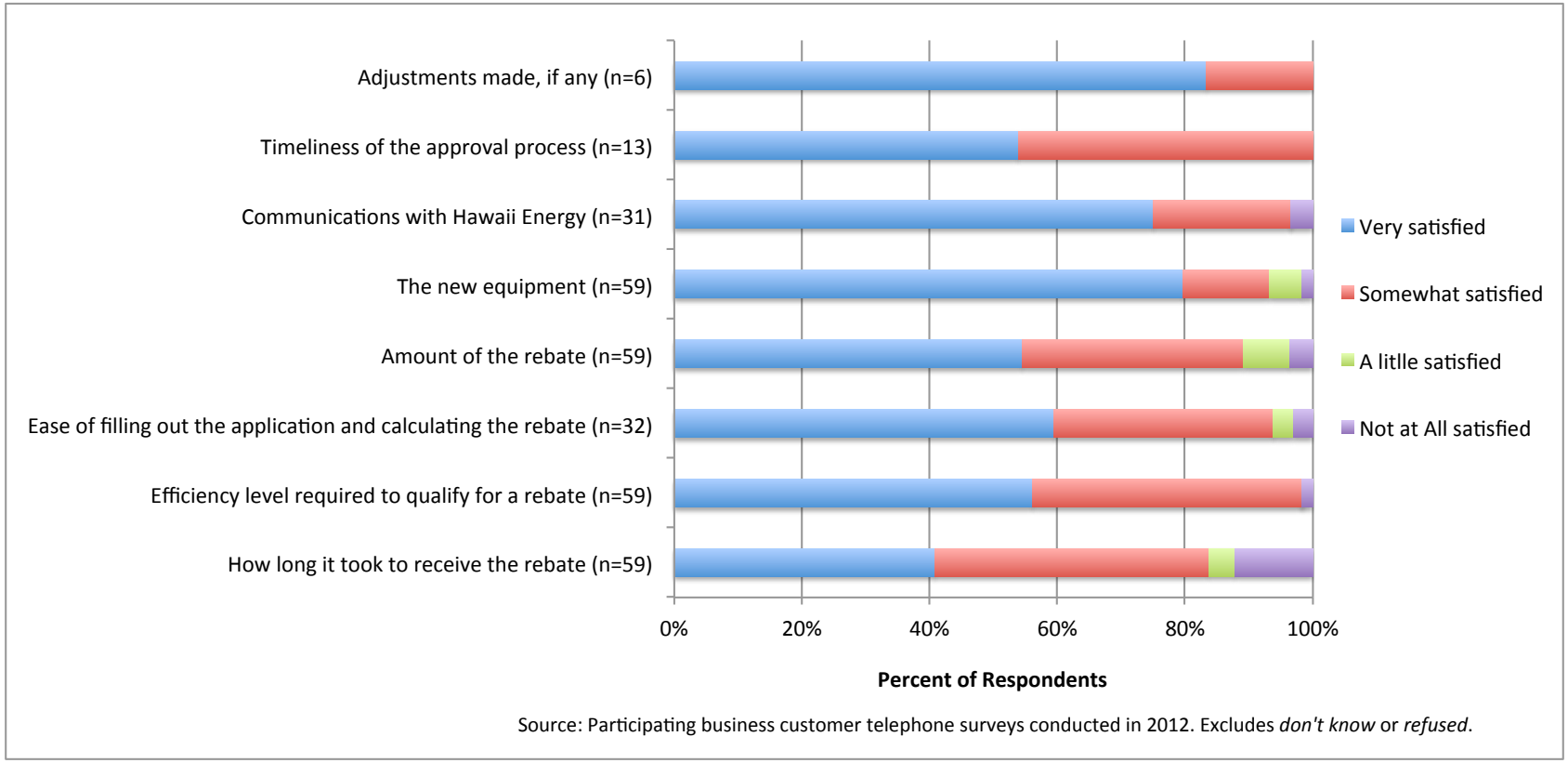
Figure 38: PY2011 Business Program Participant Overall Satisfactions with the Program (n=59)



Source: Participating non-residential customer telephone surveys conducted in 2012.

In addition, business participant survey data for PY2011 show that the general satisfaction with the Program extends across most of its attributes. As shown in Figure 39, satisfaction levels for each of the various program elements is very positive, with all aspects receiving a rating of *somewhat satisfied* or *very satisfied* by at least 70 percent of participants. These findings illustrate that the energy efficiency programs continue to be well received by business participants.

Figure 39: PY2011 Business Program Participant Satisfaction with Various Program Elements



Source: Participating business customer telephone surveys conducted in 2012. Excludes *don't know* or *refused*.

6.1.3 Summary of Findings

6.1.3.1 Residential

As a result of fielding the participant surveys over the last three program years, several key trends were identified across the residential market segment, including:

- Awareness of the programs is primarily driven by in-store interactions with salespeople, signage and advertising displays;
- Strong awareness of CFLs and broad adoption rates for the measure;
- Social media can play an effective role in spreading the awareness of incentives and rebate programs;
- Residential participants are highly satisfied with rebates and the programs across program years; and
- The desire to reduce energy consumption and corresponding energy costs is a key motivation for pursuing energy efficiency.

6.1.3.2 Business

The overall findings from analysis of the business participant survey results are provided below.

- Over a three-year period, the most reported source for learning of available resources was through word-of-mouth, specifically through contractors or distributors;
- Satisfaction with rebates and the programs is consistently high among both residential and business participants;
- The majority of participating business customers reported they were either *very likely* or *somewhat likely* to have purchased the same product without the rebate; and
- In general, participating business customer perspectives on the various program elements has remained unchanged.

7. Conclusions and Recommendations

Below we present conclusions and recommendations based on the impact evaluation, process evaluation and market assessment of the PY2011 Program.

7.1 Impact Evaluation

7.1.1 Technical Reference Manual Review

The TRM review is conducted twice each program year to review savings assumptions being used for the current program, and then at the close of the program year to ensure that any recommendations made have been incorporated into the final program savings claims. We noted a small number of new measures in the PY2012 TRM that required review at the start of the PY2011 Evaluation (listed in Table 27), and a few recommendations from the PY2010 review that had not yet been updated in the TRM (listed in Table 8 in Section 4.1.3). We continue to assert these recommendations.

We also recommend continuing this bi-annual cycle, as conducting two reviews each year is an effective method to ensure independent review of savings assumptions early in the program year, that recommendations are addressed, and that the claimed savings are consistent with final approved TRM savings values.

Table 27: PY2011 Evaluation – Recommendations for the PY2012 TRM

Measure	PY2012 TRM Section	Recommendation
		Residential Measures
LED Lighting	8.2.2	Increase the EUL of residential LED lamps to 15 years. Conduct further research of local retailers to determine the most appropriate incremental cost for LED lamps in Hawaii, and/or provide documentation in the TRM of how incremental cost values were derived
Residential Daylighting	8.2.3	Include a smaller TDD choice for this measure that would replace one 75W incandescent and one 18W CFL lamp. The energy savings for this smaller version would be 78.1 kWh per year and 0.0 peak kW.
Hawaii Energy Hero Audits	10.2.3	In order to justify the listed savings value, provide additional details on the equipment included as part of the energy audit.
		Business Measures
LED Lighting	12.1.7	Increase the expected useful life for business LEDs to 15 years.
Sensors	12.1.13	Reduce the energy savings percentage from 33 percent to 30 percent. Break down the energy savings for occupancy sensors by building type using the hours of operation and coincidence factors currently used for other business lighting measures in the PY2012 TRM. Consider using watts controlled as the basis for the savings calculations for this measure. This will require more information to be obtained from participants, but will lead to much greater accuracy in the savings claims.
Demand Controlled Kitchen Ventilation	12.6.3	No changes are recommended at this time.
Compact Fluorescent Lighting	12.1.1	Research should continue to be a priority for this measure to determine the most appropriate hours of use for military residential applications.
Interactive Effects	3.0	No additional changes are recommended.

7.1.2 Verification of Savings

The participant survey sample sizes have been reduced for the past two years to be consistent with the close to 100 percent verification rates we have found. (In the first Program evaluation, we specified higher sample sizes based on an assumption of the worst case/highest sample size scenario of 50 percent.) We recommend that the PY2012 evaluation continue with the optimized sample sizes. For PY2011, we did not conduct on-site surveys with participants in the prescriptive rebate programs in order to reserve funds for the baseline study. We recommend that the PY2012 evaluation resume on-site surveys

with a sample of prescriptive rebate program participants to ensure robust verification. We also recommend that the PY2012 evaluation conduct an evaluation of the RHTR program based on documentation that is being collected by Hawaii Energy.

7.1.3 Upstream Lighting Program Analysis

For the PY2011 Evaluation, sales records for PY2009 – PY2011 were reviewed to determine the number of qualifying lighting measures sold through the upstream lighting program each year by lamp type and store type, as well as the relative distribution of rebate dollars. To track indicators of market progress in this area, for future evaluation cycles we recommend that program lighting products sold continue to be tracked by county for lamp type, store type and associated rebate dollars.

7.1.4 Residential Peer Group Comparison Program Assessment

For the PY2011 Evaluation we independently estimated savings for the PGC program, which was introduced as a pilot program in PY2010. We developed savings estimates of 0.89 percent of each participant's annual usage, when taking into account participation in other Hawaii Energy programs.

We recommend that the deemed savings for the PGC program be reduced to 0.89 percent of annual usage per participant. We also recommend that savings be claimed on a monthly basis, pro-rated at 1/12 the 0.89 percent savings, for participating months that occur during the relevant program year.

We also recommend that the evaluation team (rather than the program implementers) draw the sample for both the treatment and control groups. This will allow some testing to occur to ensure that two groups are well matched and that the selection process follows the appropriate protocols.

7.2 Market Assessment

7.2.1 Net-to-Gross Assessment

Until our PY2011 Evaluation NTG assessment, the Program had used a single NTG factor across the program portfolio. The Evaluation Team conducted a secondary review of NTG ratios used by program administrators across the nation and developed a set of NTG ratios (including free-ridership and spillover) for programs in the Hawaii Energy portfolio. We recommended that these NTG ratios be applied at the individual program level to encourage Hawaii Energy to emphasize programs and strategies associated with higher NTG ratios.

Since our initial presentation of these NTG recommendations in a memo dated January 8, 2013 the Program has adopted the recommended set of NTG ratios, which will be used to calculate net program savings for PY2012 and going forward. We recommend a gradual move towards more targeted segment-specific NTG values with both free-rider and spillover adjustments in the near term as data become available. These NTG values should

be revisited periodically, such as through review of secondary sources and in conjunction with market research that is conducted with Hawaii customers and trade allies.

We also recommend, over the longer term, that Hawaii emphasize the continued development of programs that minimize the risk of free-ridership. This will most likely be accomplished by a more focused and significantly smaller emphasis on rebates, incentives for the PBFA to optimize Program expenditures relative to accomplishments, and greater market research to provide a strong rationale for entering specific markets.

7.2.2 Non-Energy Benefits Literature Review

If the benefit of reduced GHG emissions is to be calculated for the Hawaii Energy programs, we recommend using a direct approach based on the price of carbon permits. This approach is relatively simple and can be based on information that is already available on the carbon content of Hawaii's electric generation mix. Information on the carbon prices from carbon permit trading exchanges is also readily available.

Given the challenges with estimating non-energy benefits (other than GHG emissions discussed above) and the difficulty in finding credible values in the literature that are applicable for Hawaii, if such benefits are to be counted in Hawaii, we recommend using a simple "adder" adjustment based on energy savings to calculate their value. Using an adder, by which the direct energy savings are increased by a set adjustment factor to account for the additional non-energy benefits, allows these benefits to be recognized in cost effectiveness calculations using a simple adjustment factor that avoids conducting separate research to develop more detailed estimates. If an adder is to be used, we recommend that it be set at no more than 10 percent, which puts it at the low end of the most of the values found in the literature.

If specific non-energy benefit estimates are desired for Hawaii, we recommend conducting a conjoint analysis experiment in which respondents provide information on how they would trade off bill savings for increased comfort or other benefit categories of interest. Another option would be a contingent valuation study, in which customers are provided a series of questions (and possibly a monetary incentive) to elicit values placed on non-energy benefits. Any contingent valuation exercise should include extensive planning and question design to make the scenario as realistic as possible. An appropriately designed study would go well beyond what we observed in the literature using the direct query method, with the added study elements designed to improve the credibility (and minimize the bias) of the non-energy benefit value estimate.

7.3 Process Evaluation

Data gathered for the PY2011 process evaluation suggest that the need for adjusting rebates depends on the type of technology (e.g., CFLs and appliances). The Evaluation Team has identified specific areas where adjusting requirements for incentive qualifications would be most impactful. Survey responses of Residential Program participants show that the impact of rebates on customer purchasing decisions is decreasing. This is especially

true for consumer products such as appliances. As a result of our deeper analysis of consumer products, the Evaluation Team developed recommendations to help Hawaii Energy maintain strong energy savings and make the adjustments necessary for programs in markets that are already beginning to see transformation to be able to continue driving adoption of the most energy efficiency products and opportunities available. These include:

- **Shift focus of CFL incentives**. Energy efficient lighting represents the single largest source (39 percent) of portfolio level energy savings and also accounts for 59 percent of residential program measure savings for Hawaii Energy. As awareness and adoption of standard CFL lamps continues to grow, so will the need to make adjustments to program measures in order to maintain energy saving levels. The evaluation team recommends shifting the focus of incentives from traditional CFLs to specialty lamps and expanding the upstream lighting program to include more LEDs. This adjustment will help Hawaii Energy continue to realize strong energy savings through lighting measures by rewarding increased demand for the most energy efficient lighting products.
- **Maintain current solar water heater program**. Accounting for six percent of Hawaii Energy savings, the current solar water heater program is an evolving program that continues to provide value to customers. High upfront costs of the technology means that incentives offered through the program continue to be an important factor in purchasing decisions. We recommend that Hawaii Energy continue to offer strong incentives for solar water heaters with limited adjustments needed to program design.
- **Shift to tiered incentives for energy efficient products (e.g., appliances)**. Among the incentives offered for consumer products though, we found a growing trend that rebates are not an important factor when selecting and purchasing energy efficient products. Evidence suggests that this is due to a limited selection of non-program-qualifying ENERGY STAR appliances. Without adjustments, Hawaii Energy programs that use ENERGY STAR qualification as a standard for rebate qualification will continue to see diminishing program impacts. To address this issue, the Evaluation Team recommends shifting incentives for energy efficient products to a tiered structure that still rewards ENERGY STAR qualifying purchases, but encourages selection of the most energy efficient products by reserving the largest incentives for those products that are exceed ENERGY STAR requirements by 30 percent.

We also recommend that the PY2013 evaluation include a broader process evaluation, since the last comprehensive process valuation was conducted for PY2009. This would provide an opportunity to examine the effectiveness and efficiency of Program operations across the portfolio. Conducting a periodic process evaluation of a single program or portfolio of programs is standard evaluation practice.

7.4 General Evaluation Recommendations

Hawaii Energy introduced its "Transformational Programs" in PY2011, encompassing a broad set of initiatives intended to generate long-term sustained market change. Transformational Program offerings involve education, outreach and other government

support activities that may not result in direct quantifiable energy savings in the immediate timeframe of the activity (and, so, do not have energy-saving goals), yet are likely to contribute energy savings within a five-year period. Hawaii Energy will dedicate a greater amount of effort to its Transformational Programs across sectors in PY2012.

We recommend that the PY2012 evaluation address the Transformational Programs. Although these programs accounted for only a small percentage of the PY2011 budget (10 percent of the Program incentive budget), given that they are being continued and in some cases expanded, and their potential for energy savings, including them in the next evaluation provides an opportunity to ensure that program strategies are effective and to maximize energy savings opportunities.

The PY2012 evaluation work plan was recently finalized and includes a task that will address the Transformational Programs.[51]

[51] The plan will be posted on the Hawaii Energy website.

8. Appendices

Appendix A: Verification Memo

Appendix B: Technical Reference Manual Review

Appendix C: Opower Assessment Results Memo

Appendix D: Net-to-Goss Assessment Memo

Appendix E: Research Instruments

Appendix F: Quantitative Survey Results- Banner Tables

Appendix G: Acronym Glossary

Appendix H: References