

Memorandum

PY2015 Verification Report - Final

To: Jim Flanagan, Steve Grover, Jenny Fraser (Contract Manager)

From: Opinion Dynamics Evaluation Team

Date: November 28, 2016

Re: Verification of Hawaii Energy Program Year 2015 Programs

1. Introduction and Background

This memo provides the verified savings from the program year 2015 (PY2015) Energy Conservation and Efficiency Program (Hawaii Energy),¹ which is now in its seventh year under the management of a Public Benefits Fee Administrator (PBFA). This memo contains high-level information in the following sections:

- Summary of Findings (page 2): A summary of program year 2015 claimed, tracked, and verified savings and the associated performance award.
- Verification Methods and Results (page 5): An overview of evaluation methods and results by sector and program.
- Business Sector Detailed Verification Method and Results (page 8): Additional evaluation details further breaking down program results by measure.
- Residential Sector Detailed Verification Method and Results (page 13): Additional evaluation details further breaking down program results by measure.
- Market Transformation Program Verification Method and Results (page 17).

This memo also contains additional detail on evaluation activities in several appendixes, including:

- Business Sector Appendixes
 - Appendix A: Business Sector Verification: Detailed Methods (page 20)
 - Appendix B: Business Sector Detailed Verification Savings Adjustments (page 25)
 - Appendix C: Business Sector Total Resource Benefits (page 32)

¹ Hawaii Energy is a ratepayer-funded conservation and efficiency program administered by Leidos Engineering, LLC under contract with the Hawaii Public Utilities Commission 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. Program Year 2015 ran between July 1, 2015 and June 30, 2016.

- Residential Sector Appendices
 - Appendix D: Residential Sector Verification Detailed Methods (page 37)
 - Appendix E: Residential Sector Detailed Verification Savings Adjustments (page 44)
 - Appendix F: Residential Sector Total Resource Benefits (page 48)
- Other Appendices
 - Appendix G: Descriptions of Programs (page 52)
 - Appendix H: Glossary of Terms (page 56)

A team of consultants led by Opinion Dynamics with subcontractors InSynergy Engineering and Interface Engineering (collectively, the Evaluation Team) has been engaged by the Commission to conduct a comprehensive multi-year evaluation of the Hawaii Energy Conservation and Efficiency Program (Hawaii Energy). Leidos, an independent third party, serves as the PBFA under contract to the Commission. This memo presents the findings from evaluation activities conducted for PY2015, which ran from July 1, 2015 through June 30, 2016.

2. Summary of Findings

The Evaluation Team verified that the PBFA reached 104% of energy savings claimed in the PY2015 Hawaii Energy Annual Report². We verified 100.9% of the Business sector energy savings and 108.2% of the Residential sector energy savings. The relatively high verified residential savings rate is driven by the Peer Comparison Program verification results³. Table 1 below shows the verified first-year net and lifecycle net energy savings by sector, compared to the PBFA's tracked savings.⁴

² Final Hawaii Energy Annual Report PBFA provided to Opinion Dynamics on October 17, 2016.

³ The increase in verified savings for Peer Comparison is due to two reasons: 1) The tracked savings applied the TRM stipulated net-to-gross ratio for REEM of 0.79, but the Evaluation Team does not apply the net-to-gross for Peer Comparison (based on consultation with the Contract Manager) as we believe the 0.89% Peer Comparison savings rate stipulated in the TRM is meant to be a net savings percentage; and 2) Hawaii Energy estimates Peer Comparison impacts at the beginning of the program year and then claims those impacts equally across the year (i.e., 1/12 per month). The Evaluation Team had access to participation data (and the associated PY2015 usage data) which allows for a more precise final estimate.

⁴ "Claimed" savings refer to savings in the Final Hawaii Energy Annual Report PBFA provided to Opinion Dynamics on October 17, 2016. "Tracked" savings refer to savings from the program-tracking database PBFA provided to Opinion Dynamics on August 24, 2016. The total PY2015 tracked energy savings in this program-tracking database are 0.018% higher than the claimed savings in the Final Hawaii Energy Annual Report. This minor difference is not large enough to show up in the values presented in this report.

Table 1. PY2015 Tracked and Verified First-Year Net Energy Savings and Verified Lifecycle Net Savings (MWh) by Sector

Sector	First-Year Net Savings (MWh)		Verified Savings as % of Tracked Savings	Verified Savings as % of Total Verified Savings	Verified Lifecycle Net Savings (MWh)	Verified Savings as % of Total Verified Lifecycle Net Savings
	Tracked	Verified				
Business	64,653	65,229	100.9%	53.0%	820,329	61.4%
Residential	53,514	57,890	108.2%	47.0%	515,198	38.6%
Portfolio	118,167	123,119	104.2%	100.0%	1,335,527	100.0%

The business programs garner higher lifecycle net savings than the residential programs because measures installed in these programs, on average, last longer (12.6 years for business programs versus 8.9 years for residential programs).

The State of Hawaii Public Utilities Commission (Commission) sets performance goals and incentives for the PBFA. Table 2, shows claimed results and incentives by the PBFA and verified by the Evaluation Team.

Table 2. PY2015 Claimed and Verified Performance Award

Performance Indicator	Minimum	Target	Maximum	Claimed			Verified			
				Results	% of Target	Award	Results	% of Target	Award ^b	
Energy, Demand, and Cost Avoidance										
First Year Energy Reduction	kWh	91,682,791	122,243,721	134,468,093	118,167,139	96.7%	\$ 236,830	123,118,778	100.7%	\$ 245,000
Peak Demand Reduction	kW	12,863	17,150	18,865	20,253	118.1%	\$ 35,000	21,362	124.6%	\$ 35,000
Utility Cost Avoidance	TRB ^a	\$ 169,633,706	\$ 226,178,274	\$ 248,796,101	\$247,011,948	109.2%	\$ 280,000	\$ 247,223,104	109.3%	\$ 280,000
Market Transformation										
Behavior Modification	Participants	12,600	18,000	n/a	28,104	>100%	\$ 15,000	28,104	>100%	\$ 15,000
Professional Development	Participants	560	800	n/a	831	>100%	\$ 15,000	831	>100%	\$ 15,000
Technical Training	Participants	140	200	n/a	326	>100%	\$ 15,000	326	>100%	\$ 15,000
Hawai'i Energy Ally Program	Allies	175	250	n/a	272	>100%	\$ 5,000	272	>100%	\$ 5,000
Benchmarking	Sites	105	150	n/a	264	Met Target	\$ 20,000	264	Met Target	\$ 20,000
Codes & Standards	Items	1	2	n/a	2			2		
Demand Response ^c	Items	1	2	n/a	2			2		
Smart Grid	Items	1	1	n/a	1			1		
Electric Vehicle Support	Items	1	2	n/a	2			2		
Island Equity^d										
Honolulu County	Incentives	58.7%	73.4%	n/a	68.7%	93.6%	\$ 70,000	72.6%	98.9%	\$ 70,000
Hawaii County	Incentives	10.4%	13.0%	n/a	17.1%	131.5%		15.3%	117.8%	
Maui County	Incentives	10.8%	13.5%	n/a	14.2%	105.2%		12.1%	89.6%	
Total Performance Award							\$ 691,830			\$ 700,000

a Total Resource Benefits (TRB) are the monetized avoided utility costs from the lifecycle net energy and demand savings.

b According to page 26 of the PY2015 Hawaii Energy Annual Report, in PY2015, Leidos waived the opportunity to claim an additional amount when exceeding target performance goals, setting the maximum achievable amount to 100% of the performance target. We therefore capped the award at 100% of target for first-year net energy, demand, and TRB.

c Table 2 of the PY2015 Hawaii Energy Annual Report shows a Target of 1 for Demand Response and a Target of 2 for Smart Grid. Other tables within the PY2015 Hawaii Energy Annual Report indicate the reverse (i.e., a Target of 2 for Demand Response and a Target of 1 for Smart Grid). We confirmed through discussions with Hawaii Energy that the latter is accurate and therefore use those values for our Target and Claimed in Table 2.

d To obtain an award, the PBFA must distribute incentives at no less than 80% of the targeted PBFA funding from each county. Honolulu County covers the island of Oahu. Maui County includes the island of Maui and neighboring islands of Molokai and Lanai. We apply the Target from Table 12 of the PY2015 Hawaii Energy Annual Report (i.e., Contribution % of Total PBF). We calculate the Claimed % of Target as described on page 32 of the PY2015 Hawaii Energy Annual Report (i.e., % incentive distribution (Claimed Results) / % PBF contribution).

3. Verification Methods and Results Summary

The Evaluation Team performed several steps to arrive at verified savings depending on the program:

1. **Database and Technical Reference Manual (TRM) Review:** For all programs except for Custom Business Energy Efficiency Measures (CBEEM) and Custom Energy Solutions for the Home (CESH)⁵, we performed a database and TRM⁶ review. This process began with “cleaning” the program-tracking database, which consisted of removing negative quantities⁷, checking duplicates, removing measures with no savings (e.g., payment tracking, etc.), and confirming through discussions with PBFA that the tracked savings in the database matched their claimed savings at the time PBFA provided the database to us⁸. We then compared per-unit savings, Net-to-Gross-Ratios (NTGR), and Effective Useful Life (EUL) for each measure listed in the program-tracking database to the TRM.
2. **Quantity Review:** For Residential Energy Efficiency Measures (REEM), Business Energy Efficiency Measures (BEEM), and Business Hard to Reach (BHTR), we performed an additional step of reviewing a sample of applications and invoices to confirm the accuracy of the quantities listed in the program-tracking database. We limited this step to these three programs as they contributed more than 96% of the non-CBEEM tracked savings in the PY2015 portfolio. We provide additional information on sample sizes and results in the detailed sections below.
3. **Site Visits:** For CBEEM, we performed detailed desk reviews for a sample of 25 projects followed by on-site verification to all sampled projects.

Figure 1 displays the verification approach.

⁵ Custom Energy Solutions for the Home (CESH) is a small residential custom program accounting for <0.006% of total portfolio tracked savings. Due to the relative contribution to the portfolio, we assign a realization rate of 100% and do not perform any additional verification for CESH.

⁶ We used the PY2015 Hawaii Energy Efficiency Program Technical Reference Manual (TRM) (Version 17) for all TRM-related review activities.

⁷ In some cases, negative quantities were in the database to “cancel” a corresponding positive quantity. We reviewed all negative quantities on a case-by-case basis to determine the appropriate course of action (e.g., canceling a corresponding positive quantity, partially canceling a positive quantity, removing entirely, etc).

⁸ This memo relies on the program-tracking database PBFA provided to Opinion Dynamics on August 24, 2016. The total PY2015 tracked energy savings in this program-tracking database are 0.018% higher than the claimed savings in the Final Hawaii Energy Annual Report PBFA provided to Opinion Dynamics on October 17, 2016. This minor difference is not large enough to show up in the values presented in this report.

Figure 1. PY2015 Verification Methods

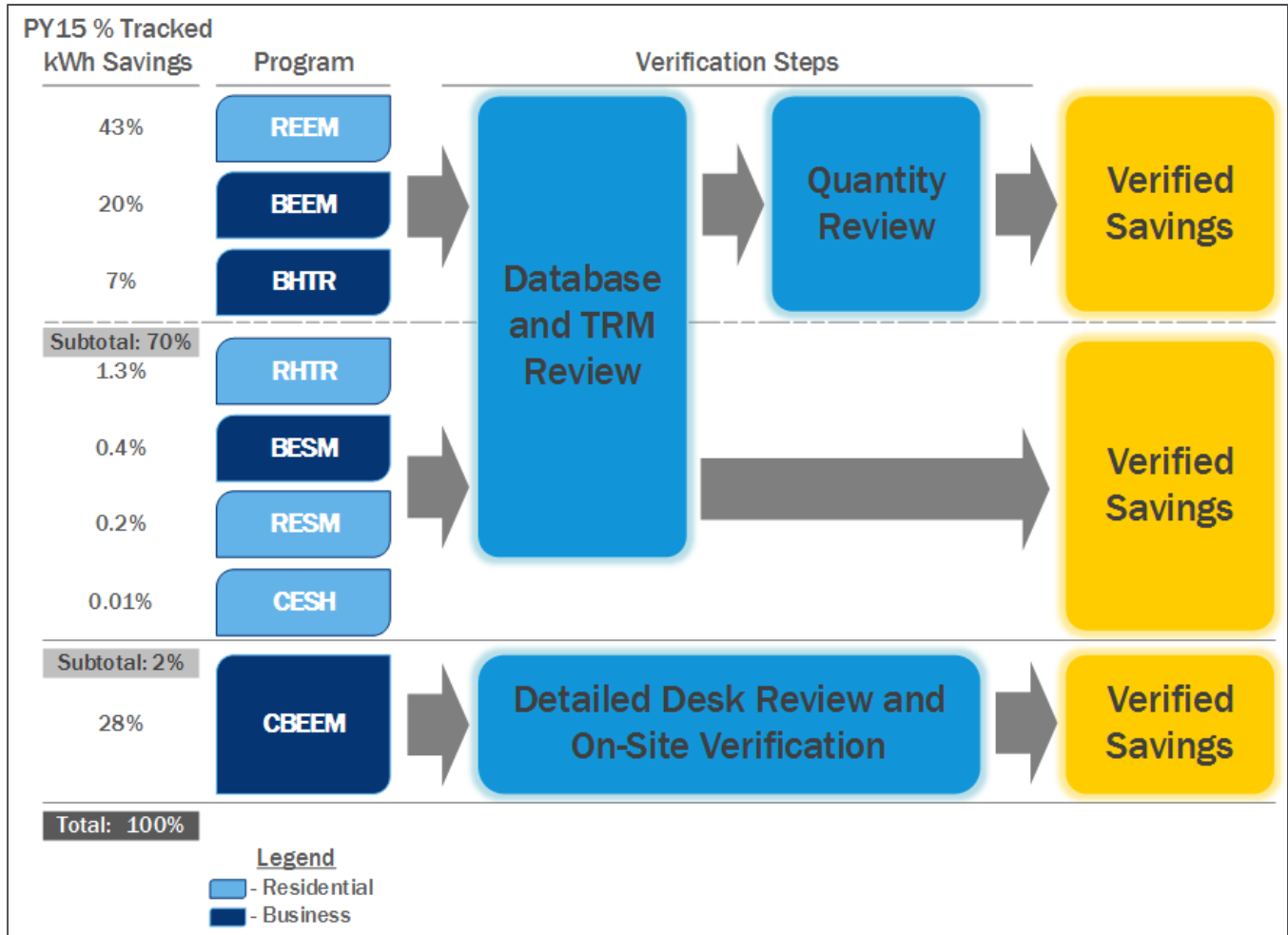


Table 3 below shows the PY2015 verified first-year net energy savings by program; accounting for the verification steps described above. The table compares the verified savings to the PBFA's tracked savings. Table 3 is organized to reflect the order of programs in Figure 1 above.

Table 3. PY2015 Tracked and Verified First-Year Net Energy Savings (kWh) by Program

Program	Net Tracked (kWh) [A]	Verification Steps			Verified Savings (kWh) [E]	Verification Rate [F]
		TRM Review (kWh) [B]	TRM Review % of Tracked [C]	Quantity Review [D]		
			C = B / A		E = B * D	F = E / A
REEM	51,076,574	55,473,688	108.6%	99.96%	55,451,206	108.6%
BEEM	22,156,918	21,873,8576	98.7%	100.04%	21,882,418	98.8%
BHTR	10,572,117	10,586,399	100.1%	100.00%	10,586,399	100.1%
RHTR	2,139,060	2,140,118	100.1%	N/A	2,140,118	100.1%
BESM	614,147	614,147	100.0%	N/A	614,147	100.0%
RESM	291,973	291,973	100.0%	N/A	291,973	100.0%
CESH	6,610	N/A	N/A	N/A	6,610	100.0%
CBEEM	31,309,741	N/A	N/A	N/A	32,145,906	102.7%
Totals	118,167,139	N/A	N/A	N/A	123,118,778	104.2%

Note: Values are rounded for reporting purposes and may not sum to the totals shown in the table above.

Table 4 summarizes the same net tracked and verified first-year energy savings displayed in Table 3, but organizes the information by sector and program. The table illustrates that the Evaluation Team verified 100.9% of the Business sector energy savings and 108.2% of the Residential sector energy savings.

Table 4. Tracked and Verified First-Year Net Energy Savings (kWh) by Sector and Program

Sector	Program	First-Year Net Savings (kWh)		Verified Savings as % of Tracked Savings	Verified Savings as % of Total Verified Savings
		Tracked	Verified		
Business	CBEEM	31,309,741	32,145,906	102.7%	26.1%
	BEEM	22,156,918	21,882,418	98.8%	17.8%
	BHTR	10,572,117	10,586,399	100.1%	8.6%
	BESM	614,147	614,147	100.0%	0.5%
	Business Total	64,652,923	65,228,871	100.9%	53.0%
Residential	REEM	51,076,574	55,451,206	108.6%	45.0%
	RHTR	2,139,060	2,140,118	100.0%	1.7%
	RESM	291,973	291,973	100.0%	0.2%
	CESH	6,610	6,610	100.0%	0.0%
	Residential Total	53,514,217	57,889,907	108.2%	47.0%
Portfolio Overall		118,167,139	123,118,778	104.2%	100.0%

Note: Values are rounded for reporting purposes and may not sum to the totals shown in the table above.

Table 5 shows the PY2015 verified lifecycle net energy savings by sector and program; accounting for the verification steps described above. We calculate lifecycle savings by multiplying first-year savings by the lifetime of each measure. Business programs account for 61.4% of the total verified lifecycle savings while residential programs account for 38.6%. The contribution of business programs to overall savings is higher on a lifecycle basis (61.4%) than first-year basis (53.0%) because measures installed through business program, on average, last longer (12.6 years vs. 8.9 years for residential).

It is also notable that the lifecycle verification rate for the business sector (100.3%) is very close to the first-year verification rate (100.9%). However, the lifecycle verification rate for the residential sector (101.2%) is significantly lower than the first-year verification rate (108.2%). This is because the Peer Comparison component of the REEM Program (with a first-year verification rate of 108.6%) has an effective useful life (EUL) of one year. Therefore, the impact of this relatively high first-year verification rate has little influence on the lifecycle results.

Table 5. PY2015 Tracked and Verified Lifecycle Net Energy Savings (MWh) by Sector and Program

Sector	Program	Lifecycle Net Savings (MWh)		Verified Savings as % of Tracked Savings	Verified Savings as % of Total Verified Savings
		Tracked	Verified		
Business	CBEEM	341,108	345,652	101.3%	25.9%
	BEEM	322,324	319,743	99.2%	23.9%
	BHTR	151,957	152,237	100.2%	11.4%
	BESM	2,697	2,697	100.0%	0.2%
	Business Total	818,087	820,329	100.3%	61.4%
Residential	REEM	492,033	497,410	101.1%	37.2%
	RHTR	15,567	16,229	104.3%	1.2%
	RESM	1,460	1,460	100.0%	0.1%
	CESH	99	99	100.0%	0.0%
	Residential Total	509,159	515,198	101.2%	38.6%
Portfolio Overall		1,327,245	1,335,527	100.6%	100.0%

Note: Values are rounded for reporting purposes and may not sum to the totals shown in the table above.

4. Business Sector Detailed Verification Method and Results

In PY2015, verified business sector savings accounted for slightly more than half of all Hawaii Energy first-year portfolio energy savings and slightly less than half of demand savings (at 53% and 44%, respectively), with 100.9% of tracked first-year net savings being verified.

4.1 Methods

As described earlier, the Evaluation Team performed a database and TRM review for all non-CBEEM business sector programs (BEEM, BHTR and Business Energy Services and Maintenance (BESM)). For

each measure type in the program-tracking database, we confirmed that the per-unit savings (kW and kWh), NTGR, and EUL values mirrored the stipulated values documented in the TRM. This consisted of three areas:

- **Savings Estimates.** The Evaluation Team referred to the PY2015 TRM for the correct savings estimates for all non-CBEEM measures. Additionally, we checked for any possible duplicates within the program-tracking database.
- **Net-To-Gross.** We applied the program specific NTG values found in the PY2015 TRM.
- **Effective Useful Life.** We applied the measure specific EUL values found in the PY2015 TRM.

The Evaluation Team conducted further verification activities for BEEM, BHTR, and CBEEM as they accounted for more than 99% of PBFA tracked savings from the business sector in PY2015. Further verification activities included:

- **Quantity Review.** We reviewed a statistically valid number of applications and invoices for BEEM and BHTR measures to ensure verification of measures installed. Our calculated precision for the business quantity reviews achieved precision of $\pm 1\%$ (or less) at the 90% confidence level.
- **Detailed Desk Review and Onsite Verification.** We conducted detailed desk reviews and site visits to a sample of sites within the CBEEM program to verify specific savings parameters. For all CBEEM site visits, we verified whether the measures were in-place and operating during the site visits. For three sites, we performed additional measurement and verification of expected savings. Our calculated precision for the CBEEM site visits achieved precision of $\pm 10\%$ for energy savings and $\pm 9\%$ for demand savings at the 90% confidence level.

Table 6 provides an overview of the methods, sampling and analysis conducted for business sector program verification. Please refer to Appendix A for more detailed information.

Table 6. PY2015 Business Sector Verification Method, Sample and Analysis Overview by Program

Program	Percent of Tracked PY2015 Savings	Method	Sample	Analysis
CBEEM	48.4%	Database and TRM Review	None	N/A
		Desk Review and Onsite Verification	25 projects (33% of overall tracked energy savings)	Performed detailed desk review for all projects in sample, conducted onsite verification (all), and metering for three sites.
BEEM	34.3%	Database and TRM Review	All measures included	Checked database per-unit, NTGR, and EUL values against TRM values.
		Quantity Review	92 applications: <ul style="list-style-type: none"> • 35 Lighting (non-midstream) out of 2,334 records • 22 Lighting (midstream) out of 1,022 records • 35 HVAC out of 471 records 	Checked database values for sample of measures against application / invoice data. Found a 99.5% verification rate for non-midstream lighting, 100% for midstream lighting, and 100.6% for HVAC.
BHTR	16.4%	Database and TRM Review	All measures included	Checked database per-unit, NTGR, and EUL values against TRM values.
		Quantity Review	35 applications out of 5,181 records	Checked database values for sample of measures against application / invoice data. Found a 100% verification rate for BHTR.
BESM	1.0%	Database and TRM Review	All measures included	Checked database per-unit, NTGR, and EUL values against TRM values.
		Quantity Review	None	Expected savings was small and not cost effective to evaluate in this step.

4.2 Results

The Business sector has a high verification rate of 100.9%. Table 7 shows the overall verification results by program and measure for the business sector.

Similar to other jurisdictions in which the Evaluation Team is familiar, per measure category verification rates can range significantly. For Hawaii Energy, the range was primarily due to database issues including database errors leading to incorrect savings values, savings based on outdated deemed values instead of those from the PY2015 TRM and incorrect NTG values being applied to some measures. However, while the range of differences within measure categories varied in some instances, at a portfolio level these differences largely cancelled each other out or were too small in relation to the overall savings to make a large impact. Specific reasons for differences between PY2015 tracked and verified per-measure savings are discussed in Appendix B.

Table 7. PY2015 Business Sector Verification Results by Program and Measure

Program	Measure	Tracked First-Year Net Energy Savings (kWh)	Verified First-Year Net Savings (kWh)	Verified % of Tracked First-Year Net Savings	Verified Savings as % of Total Sector Savings	Verified Lifecycle Net Savings (MWh)	Verified Lifecycle Net Savings as % of Total Sector Savings
Custom Business Energy Efficiency Measures	All Measures	31,309,741	32,145,906	102.7%	49.27%	345,652	42.12%
Business Energy Efficiency Measures	LED Specialty	4,030,324	4,049,292	100.5%	6.21%	60,739	7.40%
	LED Omni Directional	3,271,281	3,265,786	99.8%	5.01%	48,987	5.97%
	Chillers	2,803,718	2,821,463	100.6%	4.33%	56,429	6.88%
	Split Systems (VRF)	1,335,298	1,343,749	100.6%	2.06%	20,156	2.46%
	Fluorescent T12 to T8 Low Wattage	1,318,018	1,313,178	99.6%	2.01%	18,384	2.24%
	LED Lighting	941,036	988,910	105.1%	1.52%	14,834	1.81%
	Water Cooler Timers	745,848	745,848	100.0%	1.14%	3,729	0.45%
	VFD - AHU	701,028	705,464	100.6%	1.08%	10,582	1.29%
	Domestic Water Booster Packages	684,411	684,411	100.0%	1.05%	10,266	1.25%
	ECM Refrigeration	536,300	536,300	100.0%	0.82%	8,045	0.98%
	VFD Pump for Chilled Water / Condenser Water	524,936	528,259	100.6%	0.81%	7,924	0.97%
	Fluorescent Delamping with Reflectors	522,300	514,593	98.5%	0.79%	7,204	0.88%
	Submetering (Condo)	379,310	379,310	100.0%	0.58%	3,034	0.37%
	Fluorescent Delamping	374,102	376,039	100.5%	0.58%	5,265	0.64%
	CFL Omni-Directional	370,082	277,709	75.0%	0.43%	1,666	0.20%
Packaged Units	364,176	366,481	100.6%	0.56%	5,497	0.67%	

Program	Measure	Tracked First-Year Net Energy Savings (kWh)	Verified First-Year Net Savings (kWh)	Verified % of Tracked First-Year Net Savings	Verified Savings as % of Total Sector Savings	Verified Lifecycle Net Savings (MWh)	Verified Lifecycle Net Savings as % of Total Sector Savings
	Split Systems	361,895	364,185	100.6%	0.56%	5,463	0.67%
	ECM Fan Coil	357,119	357,119	100.0%	0.55%	5,357	0.65%
	T8 to T8 Low Wattage	321,517	178,529	55.5%	0.27%	2,499	0.30%
	Advanced Power Strips	298,635	224,003	75.0%	0.34%	1,120	0.14%
	Custom - EMS HVAC Controls	291,234	293,078	100.6%	0.45%	4,396	0.54%
	LED Exit Signs	267,585	271,242	101.4%	0.42%	4,340	0.53%
	Showerhead	194,750	146,074	75.0%	0.22%	730	0.09%
	CFL	172,058	171,587	99.7%	0.26%	515	0.06%
	Kitchen Ventilation	150,915	150,915	100.0%	0.23%	2,264	0.28%
	Heat Pump	142,269	143,169	100.6%	0.22%	1,432	0.17%
	VFD Fan for AHU	83,735	84,265	100.6%	0.13%	1,264	0.15%
	Window Film	82,975	82,975	100.0%	0.13%	830	0.10%
	LED Refrigerated Case Lighting	72,802	72,448	99.5%	0.11%	1,087	0.13%
	Cool Roof	65,977	65,977	100.0%	0.10%	990	0.12%
	Room Occupancy Sensors	65,801	65,482	99.5%	0.10%	524	0.06%
	VFD Pool Pumps	62,764	63,202	100.7%	0.10%	632	0.08%
	Refrigerator w/ Trade In	58,153	58,153	100.0%	0.09%	814	0.10%
	Faucet Aerator	44,955	33,798	75.2%	0.05%	169	0.02%
	Fluorescent T12 to T8 Standard	44,037	43,823	99.5%	0.07%	614	0.07%
	Transformer (Three-Phase)	25,031	25,031	100.0%	0.04%	801	0.10%
	VRF Air Conditioners	21,869	22,008	100.6%	0.03%	330	0.04%
	CFL Specialty	20,297	15,223	75.0%	0.02%	91	0.01%
	Solar Water Heating	10,047	10,047	100.0%	0.02%	201	0.02%
	Rid-A-Fridge (Refrigerator)	9,941	9,941	100.0%	0.02%	139	0.02%
	Metal Halide	9,149	9,105	99.5%	0.01%	127	0.02%
	Clothes Washer	8,411	13,392	159.2%	0.02%	147	0.02%
	Window AC w/ Trade In	4,285	4,308	100.5%	0.01%	39	0.00%

Program	Measure	Tracked First-Year Net Energy Savings (kWh)	Verified First-Year Net Savings (kWh)	Verified % of Tracked First-Year Net Savings	Verified Savings as % of Total Sector Savings	Verified Lifecycle Net Savings (MWh)	Verified Lifecycle Net Savings as % of Total Sector Savings
	Ceiling Fans	3,402	3,402	100.0%	0.01%	17	0.00%
	Transformer (Single-Phase)	1,381	1,381	100.0%	0.00%	44	0.01%
	Refrigerator	1,047	1,047	100.0%	0.00%	15	0.00%
	Rid-A-Fridge (Freezer)	716	716	100.0%	0.00%	10	0.00%
	Subtotal	22,156,918	21,882,418	98.8%	33.55%	319,743	38.98%
Business Hard to Reach	LED Specialty	2,921,274	2,921,274	100.0%	4.48%	43,819	5.34%
	LED Linear	2,353,107	2,353,107	100.0%	3.61%	32,943	4.01%
	Fluorescent T12 to T8 Low Wattage	2,184,341	2,184,341	100.0%	3.35%	30,581	3.73%
	Custom High Efficiency Lighting	1,551,700	1,551,700	100.0%	2.38%	21,724	2.65%
	LED Omni Directional	1,032,139	1,032,139	100.0%	1.58%	15,482	1.89%
	Fluorescent T12 to T8 Standard	208,303	208,303	100.0%	0.32%	2,916	0.36%
	LED Refrigerated Case Lighting	171,139	171,139	100.0%	0.26%	2,567	0.31%
	Reach-In Freezer	36,375	36,375	100.0%	0.06%	436	0.05%
	Steam Cooker	32,061	32,061	100.0%	0.05%	385	0.05%
	CFL	30,567	30,567	100.0%	0.05%	428	0.05%
	Custom - TBD	25,834	25,834	100.0%	0.04%	388	0.05%
	Combination Oven	12,632	12,632	100.0%	0.02%	152	0.02%
	LED Exit Signs	8,554	22,837	267.0%	0.03%	365	0.04%
	Reach-In Refrigerator	2,360	2,360	100.0%	0.00%	28	0.00%
	Ice Machine	886	886	100.0%	0.00%	11	0.00%
	Custom Lighting	844	844	100.0%	0.00%	12	0.00%
Subtotal	10,572,117	10,586,399	100.1%	16.22%	152,237	18.55%	
Business Services and Maint.	High Efficiency HVAC	382,692	382,692	100.0%	0.59%	383	0.05%
	Water Pumping	221,636	221,636	100.0%	0.34%	2,216	0.27%
	Energy Study	9,819	9,819	100.0%	0.02%	98	0.01%
	Subtotal	614,147	614,147	100.0%	0.94%	2,697	0.33%
All Business - Total		64,652,923	65,228,871	100.9%	100.00%	820,329	100.00%

Note: Values are rounded for reporting purposes and may not sum to the totals shown in the table above.

5. Residential Sector Detailed Verification Method and Results

In PY2015, verified residential sector savings accounted for slightly less than half of all Hawaii Energy first-year portfolio energy savings and slightly more than half of demand savings (at 47% and 56%, respectively), with 108.2% of tracked first-year net savings being verified.

5.1 Methods

The Evaluation Team performed a database and TRM review for all residential sector programs in PY2015, with the exception of CESH. For each measure type in the program-tracking database, we confirmed that the per-unit savings (kW and kWh), NTGR, and EUL values mirrored the stipulated values documented in the TRM. This review consisted of three areas:

- **Savings Estimates.** The Evaluation Team referred to the PY2015 TRM for the correct savings estimates for all non-CESH⁹ measures. We also checked for any possible duplicates within the program-tracking database.
- **Net-To-Gross.** We applied the program specific NTG values found in the PY2015 TRM.
- **Effective Useful Life.** We applied the measure-specific EUL values found in the PY2015 TRM.

The Evaluation Team also performed a quantity review for the REEM program. This consisted of reviewing applications and invoices to confirm the PBFA correctly tracks quantities in the program-tracking database. We performed this additional step for REEM as it accounted for 95% of the tracked net residential energy savings. Our calculated precision for the residential quantity reviews achieved precision of $\pm 2\%$ (or less) at the 90% confidence level.

Table 8 provides an overview of the methods, sampling and analysis conducted for residential sector programs. Please refer to Appendix D for more detailed information.

Table 8. PY2015 Residential Sector Verification Method, Sample and Analysis Overview by Program

Program	Percent of Tracked PY2015 Savings	Method	Sample	Analysis
	95.4%	TRM Review	All measures included	Checked database per-unit, NTG, and EUL values against TRM values.

⁹ Custom Energy Solutions for the Home (CESH) is a small residential custom program accounting for <0.006% of total portfolio tracked savings. Due to the relative contribution to the portfolio, we assign a realization rate of 100% and do not perform any additional verification for CESH.

Program	Percent of Tracked PY2015 Savings	Method	Sample	Analysis
Residential Energy Efficiency Measures (REEM)		Quantity Review	169 measures: <ul style="list-style-type: none"> • 49 Upstream Lighting out of 26,438 records • 40 SHW out of 1,537 records • 40 Refrigerators/Freezers out of 2,941 records • 40 VRF out of 3,102 records 	Checked database values for sample of measures against application / invoice data. Found a 100% verification rate for upstream lighting, solar hot water, and refrigerators/freezer measures. Found a 99.2% verification rate for VRF measures.
Residential Hard to Reach (RHTR)	4.0%	TRM Review	All measures included	Checked database per-unit, NTG, and EUL values against TRM values.
		Quantity Review	None	Expected savings was small and not cost effective to evaluate in this step.
Residential Energy Services and Maintenance (RESM)	0.6%	TRM Review	All measures included	Checked database per-unit, NTG, and EUL values against TRM values.
		Quantity Review	None	Expected savings was small and not cost effective to evaluate in this step.
CESH	0.01%	None	None	None.

5.2 Results

The residential sector has a high verification rate of 108.2%, primarily caused by an increase in verified savings for the Peer Comparison program. The increase in verified savings for Peer Comparison is due to two reasons: 1) The tracked savings applied the TRM stipulated net-to-gross ratio for REEM of 0.79, but the Evaluation Team does not apply the net-to-gross for Peer Comparison (based on consultation with the Contract Manager) as we believe the 0.89% Peer Comparison savings rate stipulated in the TRM is meant to be a net percentage; and 2) Hawaii Energy estimates Peer Comparison impacts at the beginning of the program year and then claims those impacts equally across the year (i.e., 1/12 per month). The Evaluation Team had access to participation data (and the associated PY2015 usage data) which allows for a more precise final estimate. Table 9 shows the overall verification results by program and measure for the residential sector.

Verification rates vary by measure type. For Hawaii Energy, the range of measure-specific verification rates was primarily due to database issues including database errors leading to incorrect savings values, savings based on outdated deemed values instead of those from the PY2015 TRM and incorrect NTG values being applied to some measures. Specific reasons for differences between PY2015 verified and tracked savings per measure are discussed in Appendix E.

Table 9. PY2015 Residential Sector Verification Results by Program and Measure

Program	Measure	Tracked First-Year Net Energy Savings (kWh)	Verified First-Year Net Savings (kWh)	Verified % of Tracked First-Year Net Savings	Verified Savings as % of Total Sector Savings	Verified Lifecycle Net Savings (MWh)	Verified Lifecycle Net Savings as % of Total Sector Savings
Residential Energy Efficiency Measures	LED	15,801,237	15,814,740	100.1%	27.3%	237,221	46.05%
	CFL	13,852,429	13,859,924	100.1%	23.9%	83,160	16.14%
	Peer Group Comparison	10,938,766	15,373,731	140.5%	26.6%	15,374	2.98%
	Solar Water Heating	2,763,115	2,763,115	100.0%	4.8%	55,262	10.73%
	VRF Air Conditioners	2,690,685	2,713,190	100.8%	4.7%	41,035	7.97%
	Refrigerator w/ Trade In	1,502,469	1,502,469	100.0%	2.6%	21,035	4.08%
	LED Lighting	1,374,406	1,374,464	100.0%	2.4%	20,617	4.00%
	Rid-A-Fridge (Refrigerator)	355,989	355,989	100.0%	0.6%	4,984	0.97%
	Residential Custom	305,114	305,114	100.0%	0.5%	2,746	0.53%
	Heat Pump Water Heater	205,471	205,471	100.0%	0.4%	2,055	0.40%
	Whole House Fan	162,105	162,105	100.0%	0.3%	3,242	0.63%
	LED Omni Directional	152,627	152,627	100.0%	0.3%	2,289	0.44%
	Solar Attic Fan	143,655	42,032	29.3%	0.1%	841	0.16%
	Advanced Power Strips	134,105	107,232	80.0%	0.2%	536	0.10%
	Water Cooler Timers	128,446	128,446	100.0%	0.2%	1,028	0.20%
	VFD Pool Pumps	100,887	100,887	100.0%	0.2%	1,009	0.20%
	Window AC w/ Trade In	100,745	100,643	99.9%	0.2%	906	0.18%
	Clothes Washer	81,648	130,004	159.2%	0.2%	1,430	0.28%
	Ceiling Fans	71,921	71,921	100.0%	0.1%	360	0.07%
	LED Specialty	70,995	70,995	100.0%	0.1%	1,065	0.21%
	Faucet Aerator	47,309	23,655	50.0%	0.0%	118	0.02%
	Rid-A-Fridge (Freezer)	40,579	40,579	100.0%	0.1%	568	0.11%
	Refrigerator	30,025	30,025	100.0%	0.1%	420	0.08%
	Showerhead	21,463	21,463	100.0%	0.0%	107	0.02%
	Room Occupancy Sensors	383	383	100.0%	0.0%	3	0.00%
Subtotal	51,076,574	55,451,206	108.6%	95.8%	497,410	96.57%	
	CFL Omni-Directional	743,853	744,246	100.1%	1.3%	4,465	0.87%

Table 9. PY2015 Residential Sector Verification Results by Program and Measure

Program	Measure	Tracked First-Year Net Energy Savings (kWh)	Verified First-Year Net Savings (kWh)	Verified % of Tracked First-Year Net Savings	Verified Savings as % of Total Sector Savings	Verified Lifecycle Net Savings (MWh)	Verified Lifecycle Net Savings as % of Total Sector Savings
Residential Hard to Reach	Residential Custom	554,298	554,298	100.0%	1.0%	5,996	1.16%
	Advanced Power Strips	356,453	356,496	100.0%	0.6%	1,782	0.35%
	Showerhead	259,836	259,853	100.0%	0.4%	1,299	0.25%
	LED Omni Directional	147,460	147,460	100.0%	0.3%	2,212	0.43%
	Faucet Aerator	61,569	62,174	101.0%	0.1%	311	0.06%
	CFL Specialty	7,862	7,862	100.0%	0.0%	47	0.01%
	LED Specialty	7,729	7,729	100.0%	0.0%	116	0.02%
	Subtotal	2,139,060	2,140,118	100.0%	3.7%	16,229	3.15%
Residential Energy Services and Maint.	Solar Water Heating Tune-up	291,973	291,973	100.0%	0.5%	1,460	0.28%
	Subtotal	291,973	291,973	100.0%	0.5%	1,460	0.28%
Custom Energy Solutions for the Home	LED Specialty	3,868	3,868	100.0%	0.0%	58	0.01%
	Residential Custom	2,742	2,742	100.0%	0.0%	41	0.01%
	Subtotal	6,610	6,610	100.0%	0.0%	99	0.02%
All Residential - Total		53,514,217	57,889,907	108.2%	100.0%	515,198	100.00%

Note: Values are rounded for reporting purposes and may not sum to the totals shown in the table above.

6. Market Transformation Program Verification Method and Results

The Evaluation Team verified achievements resulting from the nine Market Transformation programs offered by Hawaii Energy. These programs seek to determine and overcome market barriers that prevent residential and business customers from becoming energy-efficient in terms of energy savings actions or the equipment they use. Market Transformation programs include Behavior Modification, Professional Development, and Technical Knowledge and Training programs. In addition, through Energy in Decision Making pilots such as the Codes & Standards and Benchmarking pilots, Market Transformation also provides large energy users, such as business customers, support in developing energy management strategies. Although these programs may lead to future energy efficiency and conservation, Hawaii Energy does not set direct energy-savings goals for PY2015. For the purpose of this verification effort, the Evaluation Team categorized the various programs into nine programs based on the performance award. We describe each of the nine programs in Table 29, Appendix G.

6.1 Methods

The PBFA provided the Evaluation Team with documents to enable us to verify that each of the nine Market Transformation programs occurred in the PY2015 cycle. Specifically, the Evaluation Team verified accomplishments through the following tasks:

- Submission of a data request for the Market Transformation programs, two meetings with the PBFA, and email communications to confirm our understanding of the data.
- Review of event, presentation, or workshop attendance spreadsheets/signup sheets, presentation slides, and reports.
- Review of detailed information, specifically:
 - For the Behavior Modification, Professional Development, and Technical Knowledge and Training programs, we determined program participation counts.
 - For the Hawaii Energy Ally program, we determined the number of Clean Energy Allies, while for the Benchmarking pilot we determined the number of buildings or sites evaluated.
 - For the Codes & Standards, Shift for Savings Plan (Demand Response), Smart Grid, and Electric Vehicle Support pilots, we reviewed and counted the number of studies conducted and any other actions performed that aligned with these pilots.

6.2 Results

We found that the PBFA results match expected accomplishments in terms of the performance award. The PBFA met the target performance indicators for all nine of the programs as shown in Table 10.

Table 10. PY2015 Market Transformation Program Verified Summary

Market Transformation Programs	Performance Indicator		Verified Performance		
	Minimum	Target	Results	Met Minimum	Met Target
Behavior Modification	12,600 Participants	18,000 Participants	28,104 Participants	✓	✓
Professional Development	560 Participants	800 Participants	831 Participants	✓	✓
Technical Knowledge and Training	140 Participants	200 Participants	326 Participants	✓	✓
Hawaii Energy Ally Program	175 Allies	250 Allies	272 Allies	✓	✓
The following five pilot programs are considered as a single item when meeting the performance indicator. All five must meet their individual target levels to meet the overall performance target.					
Benchmarking	105 Sites	150 Sites	264 Sites	✓	✓
Codes & Standards	1 Action	2 Actions	2 Actions	✓	✓
Shift for Savings Plan (Demand Response)	1 Action	2 Actions	2 Actions	✓	✓
Smart Grid	1 Action	1 Action	1 Action	✓	✓
Electric Vehicle Support	1 Action	2 Actions	2 Actions	✓	✓

Upon reviewing program materials, we determined that the results in terms of participation counts, number of Clean Energy Allies, and building or sites exceeded targets for the Behavior Modification, Professional Development, Technical Knowledge and Training, Hawaii Energy Ally, and Benchmarking programs.

Similarly, the Codes & Standards, Shift for Savings Plan (Demand Response), Smart Grid, and Electric Vehicle Support pilot programs met each of their targeted number of actions, detailed below:

- In PY2015, the Codes & Standards pilot accomplished two of its targeted actions. The pilot provided code compliance assistance by developing, distributing, and providing training on code requirement checklists of the 2006 International Energy Conservation Code (IECC) Commercial Building Designer code and Plan Reviewer. The Codes & Standards pilot also developed an incentive program for early code adoption of new prescriptive chillers to be implemented in PY2016.
- The Shift for Savings Plan (Demand Response) pilot achieved its targeted two actions by continuing to test the load shifting capacity of residential heat pump water heaters, while measuring energy reduction from electric resistance water heaters. The pilot also installed GE GeoSpring™ heat pump water heaters.
- The Smart Grid pilot achieved its target action through continued implementation of the Home Energy Management System from PY2014. Through the Smart Grid program, Hawaii Energy installed Home-Area-Networks (HAN) for demand response pilot participants, including installation of In-Home Displays (IHD) and Zigbee compatible smart plugs on household appliances such as air conditioners, entertainment systems, and washing machines.
- The Electric Vehicle Support pilot achieved its targeted two actions by creating marketing collateral that includes mailers, Facebook, Youtube, and video ads, press releases and flyers, and a web-landing page. In addition, Hawaii Energy also distributed free energy saving kits to new and existing electric vehicle owners through online fulfillment.

Appendix A. Business Sector Verification: Detailed Methods

This appendix provides detailed information on our business sector verification methods. We based the sample design on first-year net savings as determined from the program-tracking database, shown in Table 11.

Table 11. PY2015 Business Sector Tracked Net Savings Summary

Program	Measures	First-Year Net Savings (GWh)	Percent of First-Year Net Savings
CBEEM	All	31.31	48.4%
BEEM	Non-midstream Lighting	6.77	10.5%
	HVAC	6.63	10.3%
	Midstream Lighting	4.64	7.2%
	Other	4.12	6.4%
BHTR	All	10.57	16.4%
BESM		0.61	1.0%
	Total	64.65	100.0%

Note: Values are rounded for reporting purposes and may not sum to the totals shown in the table above.

We explain the methodology used for our sample design for the business sector programs in more detail below.

CBEEM Projects: Site Visits

CBEEM was the largest energy-saving business sector program; completing 467 rebate applications that resulted in more than 31 GWh of first-year net tracked energy savings. Custom programs such as CBEEM require a sample design that enables evaluators to apply a verification rate from the sample back to the population of projects. Because of their very nature, custom projects do not lend themselves to a sample design based on the measure types involved. Rather, we typically develop a sample for custom projects based on energy savings which will include a mix of different measure types (e.g., lighting, HVAC).

We performed the following steps to determine how large of a sample we needed to evaluate for CBEEM:

1. Reviewed PY2014 CBEEM results from the sample of 40 projects to determine the realization rate and calculate the error ratio from that sample (i.e., 0.23).

2. Based on the error ratio of 0.23 from PY2014 and the total population of projects for PY2015 (N=461)¹⁰, we chose a sample of 25 projects resulting in an anticipated relative precision of $\pm 7.2\%$ at a 90% confidence level.
3. We completed the verification process for all 25 projects, resulting in relative precision of $\pm 10\%$ for energy savings and $\pm 9\%$ for demand savings at the 90% confidence level.

The Evaluation Team conducted desk reviews and site visits for 25 projects to verify the savings listed in the program-tracking database. We used a savings-stratified random sample design based on energy savings to choose which sites to audit, as shown in Table 12.

Table 12. PY2015 CBEEM Onsite Visit Sample Design – Strata Ranges¹¹

Savings Strata	Strata Range (kWh)	PY2015 Projects (N)	Sample Size (n)	Population Tracked First-Year Net Savings (kWh)	Population % of kWh Savings	Sample Tracked First-Year Net Savings (kWh)
Low	< 50,000	292	4	4,521,948	12%	135,018
Med	50,001 - 450,000	154	10	19,443,401	52%	1,102,101
High	> 450,000	15	11	13,721,128	36%	11,201,508
Total		461	25	37,686,477	100.0%	12,438,627

Note: Values are rounded for reporting purposes and may not sum to the totals shown in the table above.

Data collection activities for these 25 sites ranged from simple verification that measures were in-place and operating (n=22) to short-term metering (n=3). Each site received an engineering desk review prior to going onsite. Desk reviews include a complete review of the provided documentation (e.g., incentive applications, equipment invoices, and any other related project information included in the project database) to help outline the methodology behind calculating project energy savings and ensure site visits focused on the parameters needed to execute energy savings calculations.

Desk reviews included the following:

- **Project Documentation Review:** Identify the types of installed measures, quantity of installed measures, and other measure specific characteristics (i.e. wattage, installed location, horsepower, etc.).
- **Ex Ante Calculations:** Calculate ex ante savings using information found in project documentation. This step helps identify variables that require on site verification to provide more accurate savings estimates in ex post impacts.
- **Project Magnitude:** Define project size to estimate time needed to perform site visit.

¹⁰ We performed our initial sampling on the “non-frozen” database provided to Opinion Dynamics on July 14, 2016. The difference in CBEEM energy savings between this database and the “frozen” database provided to Opinion Dynamics on August 24, 2016 was less than 0.2% and did not result in any changes to our sample sizes.

¹¹ ibid

- **Sampling Strategy:** Determine whether sampling within the sample is required to gather adequate data that does not compromise or skew the verification results. For example, a site with more than 1,000 lighting fixtures would require site-specific sampling. If sampling is required, engineers collaborated with Opinion Dynamics to develop an appropriate sampling strategy prior to the site visit.

For the three sites for which the desk review indicated a need for short-term metering, the Evaluation Team created M&V plans as described below.

- **Measurement and Verification (M&V) Plan (Level 2 Requirement) including:**
 - Measure description
 - Summary of ex ante calculations
 - Ex post savings methodology
 - Determine what data to use as baseline and how it will be used
 - Determine what data is needed to record while on site and how it will be used
 - Identify algorithms for ex post savings calculations
 - Specific activities to perform while on site (i.e. record nameplate information, interview building operator, discuss hours of operation and plant shutdowns, etc.)
 - Detailed description of monitoring equipment and its purpose

The Evaluation Team independently calculated savings based on data gathered onsite and site-specific information from the PBFA. Each site received a verification rate that was the ratio of the savings value calculated by the Evaluation Team divided by the program tracking savings value. After completing verification of all sites, the Evaluation Team provided the PBFA the draft verification rates for each site and met to discuss them. Following discussion with the PBFA, we finalized the CBEEM calculations resulting in population realization rates of 102.7% for energy and 101% for demand. The primary reason for slightly higher verified savings was due to changes in hours of use assumptions through discussions with site contacts and short-term metering for certain projects.

BEEM Lighting and HVAC: TRM and Quantity Review

For all BEEM measures, the Evaluation Team performed a TRM review to assure that the per-unit savings (kW and kWh), NTGR, and EUL values in the program-tracking database mirrored the stipulated values documented in the TRM.

As shown in Table 11 above, midstream lighting, non-midstream lighting, and HVAC projects contributed to more than 81% of BEEM energy savings. Because they account for a significant portion of the program, we performed an additional quantity review step where we requested project documentation (e.g., applications, invoices, etc) on a sample of projects across midstream lighting, non-midstream lighting, and HVAC. The intent of this additional step was to confirm whether the quantities in the tracking database were accurate based on the project-specific documentation.

To develop our BEEM sample for midstream lighting, non-midstream lighting, and HVAC, we performed the following steps:

1. Reviewed PY2014 BEEM verification results from the sample of lighting (non-midstream) (40 projects) and HVAC (44 projects). Both samples provided a verification rate of 100% and a standard error of zero.
2. Based on the 100% verification rate from PY2014 (standard error of 0), we developed sample sizes of 22 for midstream lighting, 35 for non-midstream lighting and 35 for HVAC. We expected the precision to be near $\pm 0\%$ at a 90% confidence level assuming the standard error remained near zero for the PY2015 verification.
3. We completed all projects resulting in relative precision of $\pm 0\%$, $\pm 1\%$, and $\pm 1\%$ for midstream lighting, non-midstream lighting, and HVAC, respectively at the 90% confidence level as shown in Table 13.

Table 13 provides a summary of the PY2015 BEEM quantity review.

Table 13. PY2015 BEEM Quantity Review Results

Measures	PY2015 Sample Size	PY2015 Quantity Review Realization Rate	Relative Precision	Notes
Midstream Lighting	22	100%	$\pm 0\%$	No discrepancies.
Non-Midstream Lighting	35	99.5%	$\pm 1\%$	Minor discrepancy with one project.
HVAC	35	100.6%	$\pm 1\%$	Minor discrepancy with one project.

BHTR: TRM and Quantity Review

For all BHTR measures, the Evaluation Team performed a TRM review to assure that the per-unit savings (kW and kWh), NTGR, and EUL values in the program-tracking database mirrored the stipulated values documented in the TRM.

Additionally, because BHTR accounted for more than 16% of total business tracked energy savings as shown in Table 11 above, we performed a quantity review step where we requested project documentation (e.g., applications, invoices, etc) on a sample of projects across the BHTR program. The intent of this additional step was to confirm whether the quantities in the tracking database were accurate based on the project-specific documentation.

To develop our BHTR sample, we performed the following steps:

1. Reviewed PY2014 BHTR verification results, which provided a verification rate of 100% and a standard error of zero.
2. Based on the 100% verification rate from PY2014 (standard error of 0), we developed a sample size of 35, expecting the precision to be near $\pm 0\%$ at a 90% confidence level assuming the standard error remained near zero for the PY2015 verification.
3. We completed all projects resulting in relative precision of $\pm 0\%$ at the 90% confidence level as shown in Table 14.

Table 14 provides a summary of the PY2015 BHTR quantity review.

Table 14. PY2015 BHTR Quantity Review Results

Measures	PY2015 Sample Size	PY2015 Quantity Review Realization Rate	Relative Precision	Notes
All	35	100%	±0%	No discrepancies.

Appendix B. Business Sector Detailed Verification Savings Adjustments

This appendix provides detailed results from the verification of business sector savings along with reasons for any differences identified between tracked and verified values. Table 15 shows Hawaii Energy’s tracked net savings for all business programs, the verified savings, the percent difference between tracked and verified, and the reasons for the differences in savings. We discuss any significant differences between tracked and verified values (e.g., incorrect deemed value applied, database error) in the final “Reasons for Differences” column of Table 15. Minor differences (i.e., within 1%) are simply denoted as “N/A” as they are due to rounding or the quantity review adjustment step described above. Table 15 is sorted to show savings as a percent of total sector savings from high to low within each program. This order facilitates an understanding of the contribution of the measure level verified savings to the overall sector verified savings. It is notable that the realization rate for measures that contribute a small amount to overall verified savings, whether the rate be very high or very low, has little impact on overall program and sector level verified savings.

Table 15. PY2015 Verified Participation and Savings by Program and Measure Business Programs

Program	Measure	Tracked First-Year Net Energy Savings (kWh)	Verified First-Year Net Savings (kWh)	Verified % of Tracked First-Year Net Savings	Verified Savings as % of Total Sector Savings	Reasons for Differences
Custom Business Energy Efficiency Measures	All Measures	31,309,741	32,145,906	102.7%	49.27%	Savings vary based on on-site verification and monitoring for a sample of 25 projects. The realization rate (102.7%) for the sample was then applied at the population level.
Business Energy Efficiency Measures	LED Specialty	4,030,324	4,049,292	100.5%	6.21%	Tracked savings applied a net-to-gross ratio (NTGR) of 1.0, whereas verified savings applied the NTGR of 0.75 as specified in the PY2015 TRM. In addition, per the PBFA, a program-tracking database error prevented the application of correct tracked savings for several measures. These two adjustments effectively cancelled each other out resulting in a realization rate near 100%.
	LED Omni Directional	3,271,281	3,265,786	99.8%	5.01%	N/A
	Chillers	2,803,718	2,821,463	100.6%	4.33%	N/A

Table 15. PY2015 Verified Participation and Savings by Program and Measure Business Programs

Program	Measure	Tracked First-Year Net Energy Savings (kWh)	Verified First-Year Net Savings (kWh)	Verified % of Tracked First-Year Net Savings	Verified Savings as % of Total Sector Savings	Reasons for Differences
	Split Systems (VRF)	1,335,298	1,343,749	100.6%	2.06%	N/A
	Fluorescent T12 to T8 Low Wattage	1,318,018	1,313,178	99.6%	2.01%	N/A
	LED Lighting	941,036	988,910	105.1%	1.52%	Tracked savings excludes the interactive effect factor of 1.056 while verified savings includes the interactive effect factor per the TRM.
	Water Cooler Timers	745,848	745,848	100.0%	1.14%	N/A
	VFD - AHU	701,028	705,464	100.6%	1.08%	N/A
	Domestic Water Booster Packages	684,411	684,411	100.0%	1.05%	N/A
	ECM Refrigeration	536,300	536,300	100.0%	0.82%	N/A
	VFD Pump for Chilled Water / Condenser Water	524,936	528,259	100.6%	0.81%	N/A
	Fluorescent Delamping with Reflectors	522,300	514,593	98.5%	0.79%	Tracked savings incorrectly applied the TRM value of 149.2 kWh/lamp for 4' lamp kits, whereas verified savings applies the TRM value for 2' lamps (80 kWh/lamp). Additionally, tracked savings excludes interactive effects while verified savings includes interactive effects.
	Submetering (Condo)	379,310	379,310	100.0%	0.58%	N/A

Table 15. PY2015 Verified Participation and Savings by Program and Measure Business Programs

Program	Measure	Tracked First-Year Net Energy Savings (kWh)	Verified First-Year Net Savings (kWh)	Verified % of Tracked First-Year Net Savings	Verified Savings as % of Total Sector Savings	Reasons for Differences
	Fluorescent Delamping	374,102	376,039	100.5%	0.58%	Tracked savings excludes the interactive effect factor of 1.019 while verified savings includes the interactive effect factor per the TRM.
	Packaged Units	364,176	366,481	100.6%	0.56%	N/A
	Split Systems	361,895	364,185	100.6%	0.56%	N/A
	ECM Fan Coil	357,119	357,119	100.0%	0.55%	N/A
	Custom - EMS HVAC Controls	291,234	293,078	100.6%	0.45%	N/A
	CFL Omni-Directional	370,082	277,709	75.0%	0.43%	Tracked savings applied a net-to-gross ratio (NTGR) of 1.0, whereas verified savings applied the NTGR of 0.75 as specified in the TRM.
	LED Exit Signs	267,585	271,242	101.4%	0.42%	Tracked savings excludes the interactive effect factor while verified savings includes the interactive effect factor (varies by building type) per the TRM.
	Advanced Power Strips	298,635	224,003	75.0%	0.34%	Tracked savings applied a net-to-gross ratio (NTGR) of 1.0, whereas verified savings applied the NTGR of 0.75 as specified in the TRM.
	T8 to T8 Low Wattage	321,517	178,529	55.5%	0.27%	Tracked savings applied the Hawaii 2015 TRM (V11) "All Commercial" value of 38.9 kWh/lamp, whereas verified savings applied the TRM "Miscellaneous Commercial" value of 21.6 kWh/lamp.
	CFL	172,058	171,587	99.7%	0.26%	N/A
	Kitchen Ventilation	150,915	150,915	100.0%	0.23%	N/A

Table 15. PY2015 Verified Participation and Savings by Program and Measure Business Programs

Program	Measure	Tracked First-Year Net Energy Savings (kWh)	Verified First-Year Net Savings (kWh)	Verified % of Tracked First-Year Net Savings	Verified Savings as % of Total Sector Savings	Reasons for Differences
	Showerhead	194,750	146,074	75.0%	0.22%	Tracked savings applied a net-to-gross ratio (NTGR) of 1.0, whereas verified savings applied the NTGR of 0.75 as specified in the TRM.
	Heat Pump	142,269	143,169	100.6%	0.22%	N/A
	VFD Fan for AHU	83,735	84,265	100.6%	0.13%	N/A
	Window Film	82,975	82,975	100.0%	0.13%	N/A
	LED Refrigerated Case Lighting	72,802	72,448	99.5%	0.11%	N/A
	Cool Roof	65,977	65,977	100.0%	0.10%	N/A
	Room Occupancy Sensors	65,801	65,482	99.5%	0.10%	N/A
	VFD Pool Pumps	62,764	63,202	100.7%	0.10%	Tracked savings applied the TRM Residential value of 597 kWh/pump for one record out of seven in the tracking database, whereas verified applied the TRM Commercial value of 1,123 kWh/pump for all seven records.
	Refrigerator w/ Trade In	58,153	58,153	100.0%	0.09%	N/A
	Fluorescent T12 to T8 Standard	44,037	43,823	99.5%	0.07%	N/A
	Faucet Aerator	44,955	33,798	75.2%	0.05%	Tracked savings applied a net-to-gross ratio (NTGR) of 1.0, whereas verified savings applied the NTGR of 0.75 as specified in the TRM.
	Transformer (Three-Phase)	25,031	25,031	100.0%	0.04%	N/A

Table 15. PY2015 Verified Participation and Savings by Program and Measure Business Programs

Program	Measure	Tracked First-Year Net Energy Savings (kWh)	Verified First-Year Net Savings (kWh)	Verified % of Tracked First-Year Net Savings	Verified Savings as % of Total Sector Savings	Reasons for Differences
	VRF Air Conditioners	21,869	22,008	100.6%	0.03%	N/A
	CFL Specialty	20,297	15,223	75.0%	0.02%	Tracked savings applied a net-to-gross ratio (NTGR) of 1.0, whereas verified savings applied the NTGR of 0.75 as specified in the TRM.
	Clothes Washer	8,411	13,392	159.2%	0.02%	Tracked savings applied the deemed value of 206 kWh per clothes washer from the Hawaii PY2012 TRM. Verified savings applied the TRM value of 328 kWh per clothes washer.
	Solar Water Heating	10,047	10,047	100.0%	0.02%	N/A
	Rid-A-Fridge (Refrigerator)	9,941	9,941	100.0%	0.02%	N/A
	Metal Halide	9,149	9,105	99.5%	0.01%	N/A
	Window AC w/ Trade In	4,285	4,308	100.5%	0.01%	N/A
	Ceiling Fans	3,402	3,402	100.0%	0.01%	N/A
	Transformer (Single-Phase)	1,381	1,381	100.0%	0.00%	N/A
	Refrigerator	1,047	1,047	100.0%	0.00%	N/A
	Rid-A-Fridge (Freezer)	716	716	100.0%	0.00%	N/A
	Subtotal	22,156,918	21,882,418	98.8%	33.55%	
	LED Specialty	2,921,274	2,921,274	100.0%	4.48%	N/A
	LED Linear	2,353,107	2,353,107	100.0%	3.61%	N/A
	Fluorescent T12 to T8 Low Wattage	2,184,341	2,184,341	100.0%	3.35%	N/A

Table 15. PY2015 Verified Participation and Savings by Program and Measure Business Programs

Program	Measure	Tracked First-Year Net Energy Savings (kWh)	Verified First-Year Net Savings (kWh)	Verified % of Tracked First-Year Net Savings	Verified Savings as % of Total Sector Savings	Reasons for Differences
Business Hard to Reach	Custom High Efficiency Lighting	1,551,700	1,551,700	100.0%	2.38%	N/A
	LED Omni Directional	1,032,139	1,032,139	100.0%	1.58%	N/A
	Fluorescent T12 to T8 Standard	208,303	208,303	100.0%	0.32%	N/A
	LED Refrigerated Case Lighting	171,139	171,139	100.0%	0.26%	N/A
	Reach-In Freezer	36,375	36,375	100.0%	0.06%	N/A
	Steam Cooker	32,061	32,061	100.0%	0.05%	N/A
	CFL	30,567	30,567	100.0%	0.05%	N/A
	Custom - TBD	25,834	25,834	100.0%	0.04%	N/A
	LED Exit Signs	8,554	22,837	267.0%	0.03%	Tracked savings applied site-specific hours of use, which in some cases assumes operation less than 8,760 hours per year. Verified savings applied the TRM values that include interactive effect factors and 8,760 hours per year.
	Combination Oven	12,632	12,632	100.0%	0.02%	N/A
	Reach-In Refrigerator	2,360	2,360	100.0%	0.00%	N/A
	Ice Machine	886	886	100.0%	0.00%	N/A
	Custom Lighting	844	844	100.0%	0.00%	N/A
Subtotal	10,572,117	10,586,399	100.1%	16.22%		

Table 15. PY2015 Verified Participation and Savings by Program and Measure Business Programs

Program	Measure	Tracked First-Year Net Energy Savings (kWh)	Verified First-Year Net Savings (kWh)	Verified % of Tracked First-Year Net Savings	Verified Savings as % of Total Sector Savings	Reasons for Differences
Business Services and Maintenance	High Efficiency HVAC	382,692	382,692	100.0%	0.59%	N/A
	Water Pumping	221,636	221,636	100.0%	0.34%	N/A
	Energy Study	9,819	9,819	100.0%	0.02%	N/A
	Subtotal	614,147	614,147	100.0%	0.94%	
All Business - Total		64,652,923	65,228,871	100.9%	100.00%	

Note: Values are rounded for reporting purposes and may not sum to the totals shown in the table above.

Based on our review, we learned that the tracked savings for small business direct install BHTR lighting apply site-specific hours of use gathered during the implementer onsite visit. We agree this is a more appropriate method than the deemed hours of use provided in the TRM. We recommend that the next update to the TRM clearly state that hours of use are site-specific and gathered by contractors during the installation. For purposes of our verification, we used the hours of use provided in the program tracking data.

Appendix C. Business Sector Total Resource Benefits

This appendix provides detailed results from the verification and calculation of verified net TRB for the business sector. Table 17 shows the Evaluation Team’s independent estimate of savings for business programs and measures, ordered by verified net TRB from high to low within programs.

We calculated TRB estimates using the Excel algorithms in Equation 1 and parameters in Table 16.

Equation 1. TRB Calculation Excel Algorithms

$$\text{TRB} = \text{kWh TRB} + \text{kW TRB}$$

$$\text{kWh TRB} = [\text{First-Year of Avoided Cost} + \text{NPV}(\text{Discount Rate}, \text{First-Year of Avoided Costs across the range of Avoided Costs (years 1 to 25), \text{EUL}-1))] * \text{Verified First-Year Net kWh Savings} * \text{Line Losses}$$

$$\text{kW TRB} = [\text{First-Year of Avoided Cost} + \text{NPV}(\text{Discount Rate}, \text{First-Year of Avoided Costs across the range of Avoided Costs (years 1 to 25), \text{EUL}-1))] * \text{Verified First-Year Net kW Savings} * \text{Line Losses}$$

Table 16. TRB Parameters and Sources

Variable	Value	Source
Discount Rate	6%	PBFA
Avoided Costs	Varies	PBFA
EUL (effective useful life)	Varies by measure	PY2015 TRM
First-Year Net Savings	Verification of Impacts	Opinion Dynamics
Line Losses	0%	Not included in this analysis as the scalar is embedded in net savings.

Table 17. PY2015 Business Sector Verified Participation, Savings and TRB by Program and Measure

Program	Measure	Tracked First-Year Net Energy Savings (kWh) (A)	Tracked First-Year Net Savings (kW) (B)	kWh Verified Ratio (C)	kW Verified Ratio (D)	Verified First-Year Net Savings (kWh) (E = A * C)	Verified First-Year Net Savings (kW) (F=B * D)	EUL - in Program-Tracking Database (G)	Verified EUL from TRM (H)	Verified Net TRB (I)
Custom Business Energy Efficiency Measures	All Measures	31,309,741	4,186	1.03	1.01	32,145,906	4,230	10.9	10.8	\$60,996,872
Business Energy Efficiency Measures	LED Specialty	4,030,324	540	1.00	0.74	4,049,292	402	15.0	15.0	\$10,187,424
	Chillers	2,803,718	453	1.01	1.01	2,821,463	456	20.0	20.0	\$9,856,701
	LED Omni Directional	3,271,281	397	1.00	0.75	3,265,786	298	15.0	15.0	\$8,081,541
	Split Systems (VRF)	1,335,298	146	1.01	1.01	1,343,749	147	15.0	15.0	\$3,454,620
	Fluorescent T12 to T8 Low Wattage	1,318,018	163	1.00	1.00	1,313,178	163	14.0	14.0	\$3,268,368
	VFD - AHU	701,028	297	1.01	1.01	705,464	299	15.0	15.0	\$2,988,807
	LED Lighting	941,036	109	1.05	0.63	988,910	69	15.0	15.0	\$2,334,152
	VFD Pump for Chilled Water / Condenser Water	524,936	142	1.01	1.01	528,259	143	15.0	15.0	\$1,811,021
	Domestic Water Booster Packages	684,411	65	1.00	1.00	684,411	65	15.0	15.0	\$1,707,253
	ECM Refrigeration	536,300	58	1.00	1.00	536,300	58	15.0	15.0	\$1,373,010
	Fluorescent Delamping with Reflectors	522,300	65	0.99	1.00	514,593	66	14.0	14.0	\$1,288,054
	Packaged Units	364,176	63	1.01	1.01	366,481	63	15.0	15.0	\$1,064,206
	Split Systems	361,895	41	1.01	1.01	364,185	41	15.0	15.0	\$943,597
	ECM Fan Coil	357,119	41	1.00	1.00	357,119	41	15.0	15.0	\$926,948
	Fluorescent Delamping	374,102	39	1.01	1.03	376,039	40	14.0	14.0	\$902,101

Table 17. PY2015 Business Sector Verified Participation, Savings and TRB by Program and Measure

Program	Measure	Tracked First-Year Net Energy Savings (kWh) (A)	Tracked First-Year Net Savings (kW) (B)	kWh Verified Ratio (C)	kW Verified Ratio (D)	Verified First-Year Net Savings (kWh) (E = A * C)	Verified First-Year Net Savings (kW) (F=B * D)	EUL - in Program-Tracking Database (G)	Verified EUL from TRM (H)	Verified Net TRB (I)
	Custom - EMS HVAC Controls	291,234	39	1.01	1.01	293,078	39	15.0	15.0	\$790,389
	LED Exit Signs	267,585	31	1.01	1.02	271,242	32	15.3	16.0	\$746,929
	Water Cooler Timers	745,848	66	1.00	1.00	745,848	66	8.0	5.0	\$614,844
	Submetering (Condo)	379,310	49	1.00	1.00	379,310	49	8.0	8.0	\$568,284
	T8 to T8 Low Wattage	321,517	74	0.56	0.56	178,529	41	14.0	14.0	\$537,437
	Kitchen Ventilation	150,915	26	1.00	1.00	150,915	26	15.0	15.0	\$437,034
	CFL Omni-Directional	370,082	53	0.75	0.75	277,709	40	5.0	6.0	\$307,484
	VFD Fan for AHU	83,735	26	1.01	1.01	84,265	26	15.0	15.0	\$306,910
	Heat Pump	142,269	5	1.01	1.01	143,169	5	10.0	10.0	\$218,378
	LED Refrigerated Case Lighting	72,802	13	1.00	0.88	72,448	12	5.0	15.0	\$205,709
	Cool Roof	65,977	26	1.00	0.50	65,977	13	10.0	15.0	\$201,230
	Showerhead	194,750	160	0.75	0.75	146,074	120	5.0	5.0	\$197,301
	Window Film	82,975	22	1.00	1.00	82,975	22	10.0	10.0	\$192,151
	Advanced Power Strips	298,635	34	0.75	0.75	224,003	26	5.0	5.0	\$188,764
	Refrigerator w/ Trade In	58,153	2	1.00	1.00	58,153	2	14.0	14.0	\$121,209
	VFD Pool Pumps	62,764	5	1.01	1.01	63,202	5	15.0	10.0	\$107,106
	Fluorescent T12 to T8 Standard	44,037	3	1.00	1.00	43,823	3	14.0	14.0	\$96,663
	Room Occupancy Sensors	65,801	7	1.00	1.00	65,482	7	8.0	8.0	\$93,223

Table 17. PY2015 Business Sector Verified Participation, Savings and TRB by Program and Measure

Program	Measure	Tracked First-Year Net Energy Savings (kWh) (A)	Tracked First-Year Net Savings (kW) (B)	kWh Verified Ratio (C)	kW Verified Ratio (D)	Verified First-Year Net Savings (kWh) (E = A * C)	Verified First-Year Net Savings (kW) (F=B * D)	EUL - in Program-Tracking Database (G)	Verified EUL from TRM (H)	Verified Net TRB (I)
	Transformer (Three-Phase)	25,031	3	1.00	1.00	25,031	3	32.0	32.0	\$90,765
	CFL	172,058	26	1.00	0.51	171,587	13	3.0	3.0	\$80,553
	VRF Air Conditioners	21,869	7	1.01	0.85	22,008	6	15.0	15.0	\$76,498
	Faucet Aerator	44,955	44	0.75	0.75	33,798	33	5.0	5.0	\$49,147
	Solar Water Heating	10,047	3	1.00	1.00	10,047	3	15.0	20.0	\$41,628
	Clothes Washer	8,411	1	1.59	1.50	13,392	2	12.0	11.0	\$26,829
	Metal Halide	9,149	1	1.00	1.00	9,105	1	14.0	14.0	\$21,597
	Rid-A-Fridge (Refrigerator)	9,941	0	1.00	1.00	9,941	0	14.0	14.0	\$20,635
	CFL Specialty	20,297	3	0.75	0.75	15,223	2	6.0	6.0	\$16,826
	Window AC w/ Trade In	4,285	1	1.01	1.01	4,308	1	12.0	9.0	\$9,075
	Transformer (Single-Phase)	1,381	0	1.00	1.00	1,381	0	32.0	32.0	\$5,064
	Ceiling Fans	3,402	1	1.00	1.00	3,402	1	5.0	5.0	\$3,038
	Refrigerator	1,047	0	1.00	1.00	1,047	0	14.0	14.0	\$2,797
	Rid-A-Fridge (Freezer)	716	0	1.00	1.00	716	0	14.0	14.0	\$1,487
	Subtotal	22,156,918	3,352	0.99	0.88	21,882,418	2,950	14.5	14.6	\$56,564,785
	LED Specialty	2,921,274	614	1.00	1.00	2,921,274	614	15.0	15.0	\$9,070,001
	LED Linear	2,353,107	543	1.00	1.00	2,353,107	543	14.0	14.0	\$7,076,927
	Fluorescent T12 to T8 Low Wattage	2,184,341	502	1.00	1.00	2,184,341	502	14.0	14.0	\$6,559,929
	Custom High Efficiency Lighting	1,551,700	209	1.00	1.00	1,551,700	209	14.0	14.0	\$3,939,713

Table 17. PY2015 Business Sector Verified Participation, Savings and TRB by Program and Measure

Program	Measure	Tracked First-Year Net Energy Savings (kWh) (A)	Tracked First-Year Net Savings (kW) (B)	kWh Verified Ratio (C)	kW Verified Ratio (D)	Verified First-Year Net Savings (kWh) (E = A * C)	Verified First-Year Net Savings (kW) (F=B * D)	EUL - in Program-Tracking Database (G)	Verified EUL from TRM (H)	Verified Net TRB (I)
Business Hard to Reach	LED Omni Directional	1,032,139	196	1.00	1.00	1,032,139	196	15.0	15.0	\$3,092,469
	Fluorescent T12 to T8 Standard	208,303	46	1.00	1.00	208,303	46	14.0	14.0	\$615,697
	LED Refrigerated Case Lighting	171,139	24	1.00	1.00	171,139	24	15.0	15.0	\$466,464
	CFL	30,567	6	1.00	1.00	30,567	6	14.0	14.0	\$88,636
	Steam Cooker	32,061	7	1.00	1.00	32,061	7	12.0	12.0	\$81,447
	Reach-In Freezer	36,375	4	1.00	1.13	36,375	4	12.0	12.0	\$76,354
	LED Exit Signs	8,554	2	2.67	1.55	22,837	3	15.0	16.0	\$62,737
	Custom - TBD	25,834	0	1.00	1.00	25,834	0	15.0	15.0	\$52,739
	Combination Oven	12,632	3	1.00	1.00	12,632	3	12.0	12.0	\$31,880
	Reach-In Refrigerator	2,360	0	1.00	1.00	2,360	0	12.0	12.0	\$4,960
	Ice Machine	886	0	1.00	1.00	886	0	12.0	12.0	\$1,860
	Custom Lighting	844	-	1.00	N/A	844	-	14.0	14.0	\$1,589
	Subtotal	10,572,117	2,157	1.00	1.00	10,586,399	2,159	14.4	14.4	\$31,223,404
Business Services and Maintenance	High Efficiency HVAC	382,692	-	1.00	N/A	382,692	-	1.0	1.0	\$1,114,959
	Water Pumping	221,636	25	1.00	1.00	221,636	25	10.0	10.0	\$398,545
	Energy Study	9,819	-	1.00	N/A	9,819	-	10.0	10.0	\$13,941
	Subtotal	614,147	25	1.00	1.00	614,147	25	4.4	4.4	\$1,527,445
Business Total	64,652,923	9,721	1.01	0.96	65,228,871	9,363	12.7	12.6	\$150,312,506	

Note: Values are rounded for reporting purposes and may not sum to the totals shown in the table above.

Appendix D. Residential Sector Verification Detailed Methods

This appendix provides detailed information on our residential sector verification methods. We based the sample design on first-year net savings as determined from the program-tracking database, shown in Table 18.

Table 18. PY2015 Residential Sector Tracked Net Savings Summary

Program	Measures	Tracked First-Year Net Savings GWh	Percent of First-Year Net Savings
REEM	Upstream Lighting	31.24	58.4%
	Peer Comparison	10.94	20.4%
	Solar Hot Water (SHW)	2.76	5.2%
	Variable Refrigerant Flow	2.69	5.0%
	Refrigerators/Freezers	1.93	3.6%
	All Other Measures	1.51	2.8%
RTHR		2.14	4.0%
RESM		0.29	0.6%
CESH		0.01	0.01%
Total		53.51	100.0%

Note: Values are rounded for reporting purposes and may not sum to the totals shown in the table above.

The REEM program accounted for more than 95% of the PY2015 tracked energy savings. Therefore, we focused the residential verification efforts on this program when developing a sampling approach. Specifically, our approach prioritized the top five energy-saving measures within the REEM program: upstream lighting, peer comparison, solar hot water heating, refrigerators/freezers and variable refrigerant flow measures. Together, these five measure types accounted for nearly 93% of the total REEM PY2015 tracked energy savings. We describe our verification methods in more detail below.

REEM Upstream Lighting: MOU and Quantity Review

The residential upstream lighting program distributed approximately 1.82 million bulbs in PY2015. Over 51% of these bulbs were CFLs, as shown in Table 19.

Table 19. PY2015 REEM Upstream Lighting Measures by County

County	CFLs (N)	LEDs (N)	Total Bulbs (N)	% of Total Bulbs	Sample Size (n)
Honolulu ^a	649,928	528,671	1,178,599	64.8%	17
Hawaii	152,118	190,831	342,949	18.9%	16
Maui ^b	130,157	165,971	296,128	16.3%	16
Total	932,203	885,473	1,817,676	100%	49

^a Honolulu county covers the island of Oahu

^b Maui county includes the island of Maui and neighboring islands of Molokai and Lanai

Because of past high realization rates, we assumed an error ratio of 0.25, meaning we needed to review approximately 16-17 invoices per county to achieve $\pm 10\%$ precision at a 90% confidence level.

Due to the potential of differences by county, we oversampled. The sample design was a simple random sample within each county. The Evaluation Team obtained all data on the measures included in our sample from the PBFA. This included program-tracking data, invoices, and memorandums of understanding between retailers. We performed the following verification steps:

1. Checked compliance with the participation requirements set forth by the Memorandum of Understanding documents submitted by each of the ten manufacturers¹².
2. Verified quantities of equipment between invoice/rebate documentation, final program data, and Hawaii Energy PY2015 Hawaii Energy Annual Report.
3. We completed all projects resulting in a 100% verification rate (standard error of 0) resulting in a relative precision of $\pm 0\%$ at the 90% confidence level.

REEM Peer Comparison: Confirmation of Participation and Savings

Originally funded through the American Recovery and Reinvestment Act of 2009 (ARRA), the Peer Comparison program began in 2011 with an initial 15,000 pilot customers on the Island of Oahu (Phase 1). Hawaii Energy subsequently increased the number of recipients to include about 62,000 customers in Hawaii and Maui counties (Phase 2), then further expanded in PY2013 (around January 2014) to additional customers in Oahu (Phase 3). The PY2015 Annual Plan included plans to offer Peer Comparison reports to an additional 110,000 households on Oahu. Hawaii Energy went considerably beyond this, offering reports to over 140,000 new households starting in August 2015 (about 105,000 of which were on Oahu) and to an additional 20,000 households in April 2016 (about 13,000 of which were on Oahu).

Nearly 250,000 households were participating in the Home Energy Report (i.e., Peer Comparison) program at the end of PY2015. In addition, web portal access was available to all residential utility account holders (approximately 380,000 households). Table 20 summarizes the number of

¹² Our sample consisted of ten unique lighting manufacturers including CREE, Feit Electric Company, General Electric Lighting, Green Creative, Lighting Science Group, Osram Sylvania, Philips, Technical Consumer Products (TCP), Leedarson America, Inc., and Webco Hawaii, Inc.

customers who were participating at the start of PY2015, those who were added during PY2015, those who ended participation during PY2015 (due to moving or opting out of the program), as well as the number participating as of the end of PY2015.

Table 20. PY2015 Peer Comparison Program Participants by County

County	Participants: Start of PY2015 (N)	Participants: Added During PY2015 (N)	Participants: Attrition During PY2015 (N)	Participants: End of PY2015 (N)
Hawaii	23,282	27,049	4,874	45,457
Honolulu (Oahu) ^a	68,246	117,846	20,261	165,831
Maui ^b	23,034	17,961	3,947	37,048
Total	114,562	162,856	29,082	248,336

Note: Values are rounded for reporting purposes and may not sum to the totals shown in the table above.

^a Honolulu County covers the island of Oahu and several minor outlying islands.

^b Maui County covers the island of Maui and the neighboring islands of Molokai and Lanai.

We conducted an independent calculation to verify the savings claimed for Peer Comparison Program participants using a methodology stipulated in the PY2015 TRM. The most important aspect of the TRM is the fact that it deems (or stipulates) the kWh savings of a Peer Comparison household as 0.89% of that household’s base electricity usage for every month that they receive a home energy report.

Equation 2, below, details the kWh savings algorithm stipulated in the TRM. However, the TRM is effectively silent with respect to how one should determine base energy usage, the first of the three key inputs to the overall saving calculation. The central concept behind determining base energy usage is to establish the counterfactual or, to state more explicitly, to estimate what total energy use among Peer Comparison Program participants would have looked like had they not participated in the program. Our team considered, but ultimately ruled out, the use of PY2014 usage information as a base as differences in weather patterns and other influences on household energy use (e.g., number of occupants, presence of new equipment, etc.) between PY2014 and PY2015 could lead to different patterns in energy consumption. To avoid this problem, we decided to follow best practices for evaluating randomized control trial programs and use the energy use of the year under consideration (in this case PY2015) as the base.

Equation 2. TRM Algorithm for Calculating Peer Group Program Savings

$$\Delta\text{kWh} = (\text{Total Monthly Base Energy Usage})(\text{\#of Participating Months})(\%\text{Savings})$$

The intent of the first two inputs to Equation 2 is to establish the counterfactual. At a participating household level, this involves determining what energy consumption would have looked like under normal conditions (i.e., in absence of the program) over the duration of that household’s participation (be it for the entire 12 months of PY2015 or fewer¹³ months). Aggregated across all program

¹³ A household who was part of the program at the beginning of PY2015 could have subsequently dropped out during PY2015 or a new participant could have entered the program during PY2015. In either case, energy savings credit is only given for the months within PY2015 that the household actually participated (i.e., received Home Energy Reports).

participants, this counterfactual energy consumption total is then multiplied by the TRM stipulated savings percentage (0.89%) to arrive at overall PY2015 Program kWh savings.

To calculate overall Peer Comparison Program savings most accurately, we applied a three-step process that follows the principles outlined in Equation 2.

Step 1: Establish Baseline Usage (the Counterfactual). In this case, establishing baseline usage equates to estimating what PY2015 total kWh usage among Peer Comparison participants would have looked like in the absence of the program. To do this, we first use customer tracking data from Hawaii Energy to identify which households are participants (i.e., which households received the home energy reports) and for which months each household participated (all 12 months of PY2015 or something less than that). We then use HECO billing data to sum the observed PY2015 kWh usage for each household (for the appropriate months) and then sum savings across all participating households. Since this total observed kWh consumption across all participating households represents the consumption that actually took place during the program period (i.e., during PY2015) we further adjust it to establish baseline usage.¹⁴ Since the TRM stipulated savings is 0.89%, we can use that value to establish the baseline, as illustrated below.

Baseline Usage => Observed PY2015 total kWh Consumption¹⁵ for all participants ÷ (1 - %Savings).

Baseline Usage => 1,547,429,964 ÷ (1 - 0.0089) = **1,561,325,763**

Step 2: Determine Total or “Verified” Program Savings. The TRM stipulates Peer Comparison Program participant savings as 0.89% of baseline usage (kWh). Therefore, the computation of Total Program Savings is very straightforward.

Verified kWh Savings => Baseline Usage * %Savings

Verified kWh Savings => 1,561,325,763 * 0.0089 = **13,895,799**

Step 3: Determine Net Savings. The TRM stipulates a net-to-gross of 0.79 for all REEM program measures. However, through discussions with the Contract Manager, we determined that the calculated savings using the method in the TRM are already net and do not need an additional net-to-gross factor applied. We do however apply the system loss factors (SLF) by County per the TRM resulting in a total net energy savings of 15,373,731 kWh.

¹⁴ The observed consumption is the actual consumption of program participants during the treatment period (PY2015) and, therefore, it is not the baseline. The baseline is what their consumption would have looked like during PY2015 had they not participated in the program. Since the TRM stipulates a program savings rate of 0.89%, we can estimate what base usage would have been if that savings had not occurred.

¹⁵ For households that participated throughout PY2015 this includes 12 months of usage. For households that opted out during PY2015 or joined during PY2015, it includes usage for the months of participation only.

To estimate total demand savings, we divide this number by 3,000 per the TRM, resulting in total net demand savings of 5,125 kW.

Verified kWh Net Savings => Verified kWh Savings by County * (1+SLF)

Verified kW Net Savings => Verified kWh Net Savings / 3,000

Table 21 summarizes verified kWh and kW savings for the PY2015 Peer Comparison program. Step 1 establishes baseline kWh usage. Step 2 estimates verified kWh savings by multiplying baseline usage by the stipulated savings percentage (0.89%). Step 3 multiplies the system loss factor (1+SLF) by the verified kWh savings in Step 2.

Table 21. Summary of PY2015 Verified Savings

County	Step 1: Baseline Usage (kWh) PY2015 [A]	Savings Percentage [B]	Step 2: Verified kWh Savings [C] = A * B	System Loss Factor (SLF) [D]	Step 3: Net kWh Savings (with SLF) [E] = C * (1+D)	Net kW Savings [F] = E / 3,000
Hawaii	265,858,972	0.89%	2,366,145	0.0900	2,579,098	860
Honolulu	1,082,968,030		9,638,415	0.1117	10,715,026	3,572
Maui	212,498,762		1,891,239	0.0996	2,079,606	693
Total	1,561,325,763		13,895,799		15,373,731	5,125

Note: Values are rounded for reporting purposes.

REEM Solar Hot Water Heaters (SHW): TRM and Quantity Review

For all REEM measures, the Evaluation Team performed a TRM review to assure that the per-unit savings (kW and kWh), NTGR, and EUL values in the program-tracking database mirrored the stipulated values documented in the TRM.

Additionally, because REEM accounted for more than 95% of total residential tracked energy savings as shown in Table 18 above, we performed a quantity review step where we requested project documentation (e.g., applications, invoices, etc) on a sample of projects for solar hot water heaters, refrigerators, and variable refrigerant flow measures. The intent of this additional step was to confirm whether the quantities in the tracking database were accurate based on the project-specific documentation.

To develop our REEM sample for solar hot water heaters (SWH), we performed the following steps:

1. Reviewed PY2014 REEM SHW verification results (n=49), which provided a verification rate of 100% and a standard error of zero.
2. Based on the 100% verification rate from PY2014 (standard error of 0), we developed a sample size of 40, expecting the precision to be near ±0% at a 90% confidence level assuming the standard error remained near zero for the PY2015 verification.
3. We completed all projects resulting in a 100% verification rate for PY2015 and relative precision of ±0% at the 90% confidence level as shown in Table 22.

Table 22 provides a summary of the PY2015 REEM SHW quantity review.

Table 22. PY2015 REEM SHW Quantity Review Results

Measures	PY2015 Sample Size	PY2015 Quantity Review Realization Rate	Relative Precision	Notes
Solar Hot Water	40	100%	±0	No discrepancies.

REEM Refrigerators: TRM and Quantity Review

For all REEM measures, the Evaluation Team performed a TRM review to assure that the per-unit savings (kW and kWh), NTGR, and EUL values in the program-tracking database mirrored the stipulated values documented in the TRM.

Additionally, because REEM accounted for more than 95% of total residential tracked energy savings as shown in Table 18 above, we performed a quantity review step where we requested project documentation (e.g., applications, invoices, etc) on a sample of projects for solar hot water heaters, refrigerators, and variable refrigerant flow measures. The intent of this additional step was to confirm whether the quantities in the tracking database were accurate based on the project-specific documentation.

To develop our REEM sample for refrigerators, we performed the following steps:

1. Reviewed PY2014 REEM refrigerator verification results (n=50), which provided a verification rate of 100% and a standard error of zero.
2. Based on the 100% verification rate from PY2014 (standard error of 0), we developed a sample size of 40, expecting the precision to be close to ±0% at a 90% confidence level assuming the standard error remained near zero for the PY2015 verification.
3. We completed all projects resulting in a 100% verification rate for PY2015 and relative precision of ±0% at the 90% confidence level as shown in Table 23.

Table 23 provides a summary of the PY2015 REEM refrigerator quantity review.

Table 23. PY2015 REEM Refrigerator Quantity Review Results

Measures	PY2015 Sample Size	PY2015 Quantity Review Realization Rate	Relative Precision	Notes
Refrigerator	40	100%	±0	No discrepancies.

REEM Variable Refrigerant Flow (VRF): TRM and Quantity Review

For all REEM measures, the Evaluation Team performed a TRM review to assure that the per-unit savings (kW and kWh), NTGR, and EUL values in the program-tracking database mirrored the stipulated values documented in the TRM.

Additionally, because REEM accounted for more than 95% of total residential tracked energy savings as shown in Table 18 above, we performed a quantity review step where we requested project documentation (e.g., applications, invoices, etc) on a sample of projects for solar hot water heaters, refrigerators, and variable refrigerant flow measures. The intent of this additional step was to confirm

whether the quantities in the tracking database were accurate based on the project-specific documentation.

To develop our REEM sample for variable refrigerant flow (VRF) measures, we performed the following steps:

1. We did not perform a quantity review for VRF measures in PY2014 because they contributed a smaller share of the total REEM savings. However, based on the quantity review of SHW measures and refrigerator measures from PY2014, we anticipated finding very few (if any) discrepancies between the database and program-tracking data.
2. Based on the 100% verification rate from PY2014 (standard error of 0) for the other REEM projects, we developed a sample size of 40, expecting the precision to be close to $\pm 0\%$ at a 90% confidence level assuming the standard error remained near zero for the PY2015 verification.
3. We completed all projects resulting in a 99.2% verification rate for PY2015 and relative precision of $\pm 2\%$ at the 90% confidence level as shown in Table 24.

Table 24 provides a summary of the PY2015 REEM VRF quantity review.

Table 24. PY2015 REEM VRF Quantity Review Results

Measures	PY2015 Sample Size	PY2015 Quantity Review Realization Rate	Relative Precision	Notes
Variable Refrigerant Flow (VRF)	40	99.2%	$\pm 2\%$	We observed minor discrepancies across several projects resulting in minor overall changes to the realization rates. The verified capacity (tons) for the sample is overall 0.8% less than the tracked capacity for the sample. The tracked capacity is rounded to the nearest 1/4 ton, whereas the verified capacity is the actual installed capacity specified on the application and invoice.

Appendix E. Residential Sector Detailed Verification Savings Adjustments

This appendix provides detailed results from the verification of residential sector savings along with reasons for any differences identified between tracked and verified values. Table 25 shows Hawaii Energy’s tracked net savings for all residential programs, the verified savings, the percent difference between tracked and verified, and the reasons for the differences in savings. We discuss any significant differences between tracked and verified values (e.g., incorrect deemed value applied, database error) in the final “Reasons for Differences” column of Table 25. Minor differences (i.e., within 1%) are simply denoted as “N/A” as they are due to rounding or the quantity review adjustment step described above. Table 25 is sorted to show savings as a percent of total sector savings from high to low within each program. This order facilitates an understanding of the contribution of the measure level verified savings to the overall sector verified savings. It is notable that the realization rate for measures that contribute a small amount to overall verified savings, whether the rate be very high or very low, has little impact on overall program and sector level verified savings.

Table 25. PY2015 Residential Sector Verified Savings by Program and Measure

Program	Measure	Tracked First-Year Net Energy Savings (kWh)	Verified First-Year Net Energy Savings (kWh)	Verified Savings as % of Tracked Savings	Verified Program Savings as % of Total Verified Residential Savings	Reasons for differences between Tracked and Verified Values
Residential Energy Efficiency Measures	LED	15,801,237	15,814,740	100.1%	27.3%	N/A
	Peer Group Comparison	10,938,766	15,373,731	140.5%	26.6%	Tracked savings applied a NTG of 0.79; verified savings does not apply a NTG, as the savings calculated using a peer comparison group already represent net savings. In addition, tracked savings estimates are based on previous year consumption data since it is a planning number prior to the start of the program year. Verified savings relies on actual energy use during the program year.
	CFL	13,852,429	13,859,924	100.1%	23.9%	N/A
	Solar Water Heating	2,763,115	2,763,115	100.0%	4.8%	N/A

Table 25. PY2015 Residential Sector Verified Savings by Program and Measure

Program	Measure	Tracked First-Year Net Energy Savings (kWh)	Verified First-Year Net Energy Savings (kWh)	Verified Savings as % of Tracked Savings	Verified Program Savings as % of Total Verified Residential Savings	Reasons for differences between Tracked and Verified Values
	VRF Air Conditioners	2,690,685	2,713,190	100.8%	4.7%	Tracked savings applied savings to VRFs by assuming two different average capacities (in tons) for "small" and "large" VRFs. The TRM provides savings per ton, and therefore tracked savings applied these values by assuming all "small" VRFs are 1.28 tons and all "large" VRFs are 2.6 tons per installed VRF. Verified savings applied the TRM values per ton using the actual installed system capacity based on the model number provided in the tracking database.
	Refrigerator w/ Trade In	1,502,469	1,502,469	100.0%	2.6%	N/A
	LED Lighting	1,374,406	1,374,464	100.0%	2.4%	N/A
	Rid-A-Fridge (Refrigerator)	355,989	355,989	100.0%	0.6%	N/A
	Residential Custom	305,114	305,114	100.0%	0.5%	N/A
	Heat Pump Water Heater	205,471	205,471	100.0%	0.4%	N/A
	Whole House Fan	162,105	162,105	100.0%	0.3%	N/A
	LED Omni Directional	152,627	152,627	100.0%	0.3%	N/A
	Clothes Washer	81,648	130,004	159.2%	0.2%	Tracked savings applied a different per-measure value from what is specified in the TRM. The resource to the tracked per-measure savings values are unknown.
	Water Cooler Timers	128,446	128,446	100.0%	0.2%	N/A
	Advanced Power Strips	134,105	107,232	80.0%	0.2%	Tracked savings applied the per-measure value from the TRM that excludes the persistence factor of 0.80. As a result, tracked savings are overestimated by 20%.

Table 25. PY2015 Residential Sector Verified Savings by Program and Measure

Program	Measure	Tracked First-Year Net Energy Savings (kWh)	Verified First-Year Net Energy Savings (kWh)	Verified Savings as % of Tracked Savings	Verified Program Savings as % of Total Verified Residential Savings	Reasons for differences between Tracked and Verified Values
	VFD Pool Pumps	100,887	100,887	100.0%	0.2%	N/A
	Window AC w/ Trade In	100,745	100,643	99.9%	0.2%	N/A
	Ceiling Fans	71,921	71,921	100.0%	0.1%	N/A
	LED Specialty	70,995	70,995	100.0%	0.1%	N/A
	Solar Attic Fan	143,655	42,032	29.3%	0.1%	Tracked savings applied a different per-measure value from what is specified in the TRM. The resource to the tracked per-measure savings values are unknown.
	Rid-A-Fridge (Freezer)	40,579	40,579	100.0%	0.1%	N/A
	Refrigerator	30,025	30,025	100.0%	0.1%	N/A
	Faucet Aerator	47,309	23,655	50.0%	0.0%	Tracked savings multiplied the savings value from the TRM by the number of installed faucet aerators. However, the TRM savings value is provided in units of per household. Since each household installed 2 aerators, the tracked savings multiplied the TRM savings value by 2, thus mistakenly double counting savings.
	Showerhead	21,463	21,463	100.0%	0.0%	N/A
	Room Occupancy Sensors	383	383	100.0%	0.0%	N/A
	Subtotal	51,076,574	55,451,206	108.6%	95.8%	
Residential Hard to Reach	CFL Omni-Directional	743,853	744,246	100.1%	1.3%	N/A
	Residential Custom	554,298	554,298	100.0%	1.0%	N/A
	Advanced Power Strips	356,453	356,496	100.0%	0.6%	N/A

Table 25. PY2015 Residential Sector Verified Savings by Program and Measure

Program	Measure	Tracked First-Year Net Energy Savings (kWh)	Verified First-Year Net Energy Savings (kWh)	Verified Savings as % of Tracked Savings	Verified Program Savings as % of Total Verified Residential Savings	Reasons for differences between Tracked and Verified Values
	Showerhead	259,836	259,853	100.0%	0.4%	N/A
	LED Omni Directional	147,460	147,460	100.0%	0.3%	N/A
	Faucet Aerator	61,569	62,174	101.0%	0.1%	Tracked savings applied per-measure savings to 429 aerators (out of 2,205 aerators) that are between 5% - 6% less than the per-measure savings provided in the TRM. The resource to the tracked per-measure savings values are unknown.
	CFL Specialty	7,862	7,862	100.0%	0.0%	N/A
	LED Specialty	7,729	7,729	100.0%	0.0%	N/A
	Subtotal	2,139,060	2,140,118	100.0%	3.7%	
Residential Energy Services and Maintenance	Solar Water Heating Tune-up	291,973	291,973	100.0%	0.5%	N/A
	Subtotal	291,973	291,973	100.0%	0.5%	
Custom Energy Solutions for the Home	LED Specialty	3,868	3,868	100.0%	0.0%	N/A
	Residential Custom	2,742	2,742	100.0%	0.0%	N/A
	Subtotal	6,610	6,610	100.0%	0.0%	
All Residential - Total		53,514,217	57,889,907	108.2%	100.0%	

Note: Values are rounded for reporting purposes and may not sum to the totals shown in the table above.

Appendix F. Residential Sector Total Resource Benefits

This appendix provides detailed results from the verification and calculation of verified net TRB for the residential sector. Table 27 shows the Evaluation Team’s independent estimate of savings for residential programs and measures, ordered by verified net TRB from high to low within programs.

We calculated TRB estimates using the Excel algorithms in Equation 3 and parameters in Table 26.

Equation 3. TRB Calculation Excel Algorithms

$$\text{TRB} = \text{kWh TRB} + \text{kW TRB}$$

$$\text{kWh TRB} = [\text{First-Year of Avoided Cost} + \text{NPV}(\text{Discount Rate}, \text{First-Year of Avoided Costs across the range of Avoided Costs (years 1 to 25), \text{EUL}-1))] * \text{Verified First-Year Net kWh Savings} * \text{Line Losses}$$

$$\text{kW TRB} = [\text{First-Year of Avoided Cost} + \text{NPV}(\text{Discount Rate}, \text{First-Year of Avoided Costs across the range of Avoided Costs (years 1 to 25), \text{EUL}-1))] * \text{Verified First-Year Net kW Savings} * \text{Line Losses}$$

Table 26. TRB Parameters and Sources

Variable	Value	Source
Discount Rate	6%	PBFA
Avoided Costs	Varies	PBFA
EUL (effective useful life)	Varies by measure	PY2015 TRM
First-Year Net Savings	Verification of Impacts	Opinion Dynamics
Line Losses	0%	Not included in this analysis as the scalar is embedded in net savings

Table 27. PY2015 Residential Sector Verified Participation and Savings by Program and Measure

Program	Measure	Tracked First-Year Net kWh Savings (A)	Tracked First-Year Net kW Savings (B)	kWh Verification Ratio (C)	kW Verification Ratio (D)	Verified First-Year kWh Savings (E = A * C)	Verified First-Year kW Savings (F=B * D)	EUL - Useful Life in Program Tracking DB (G)	Verified EUL - Useful Life from TRM (H)	Verified Net TRB (I)
Residential Energy Efficiency Measures	LED	15,801,237	2,247.29	1.00	1.00	5,814,740	2,249.21	15.0	15.0	\$43,394,774
	CFL	13,852,429	1,955.64	1.00	1.00	13,859,924	1,956.70	6.0	6.0	\$15,319,155
	Solar Water Heating	2,763,115	617.91	1.00	1.00	2,763,115	617.91	20.0	20.0	\$10,724,897
	VRF Air Conditioners	2,690,685	816.10	1.01	0.94	2,713,190	763.08	15.0	15.0	\$9,443,041
	LED Lighting	1,374,406	195.47	1.00	1.00	1,374,464	195.48	15.0	15.0	\$3,771,453
	Refrigerator w/ Trade In	1,502,469	62.15	1.00	1.00	1,502,469	62.15	14.0	14.0	\$3,131,611
	Peer Group Comparison	10,938,766	3,605.00	1.41	1.42	15,373,731	5,124.58	1.0	1.0	\$2,475,171
	Whole House Fan	162,105	222.06	1.00	1.00	162,105	222.06	20.0	20.0	\$1,789,453
	Rid-A-Fridge (Refrigerator)	355,989	14.09	1.00	1.00	355,989	14.09	14.0	14.0	\$738,902
	Residential Custom	305,114	11.14	1.00	1.00	305,114	11.14	9.0	9.0	\$428,316
	LED Omni Directional	152,627	21.71	1.00	1.00	152,627	21.71	15.0	15.0	\$418,800
	Heat Pump Water Heater	205,471	26.25	1.00	1.00	205,471	26.25	10.0	10.0	\$378,850
	Clothes Washer	81,648	11.10	1.59	1.50	130,004	16.65	12.0	11.0	\$260,444
	Window AC w/ Trade In	100,745	27.48	1.00	1.00	100,643	27.48	12.0	9.0	\$212,001
LED Specialty	70,995	10.10	1.00	1.00	70,995	10.10	15.0	15.0	\$194,806	

Table 27. PY2015 Residential Sector Verified Participation and Savings by Program and Measure

Program	Measure	Tracked First-Year Net kWh Savings (A)	Tracked First-Year Net kW Savings (B)	kWh Verification Ratio (C)	kW Verification Ratio (D)	Verified First-Year kWh Savings (E = A * C)	Verified First-Year kW Savings (F=B * D)	EUL - Useful Life in Program Tracking DB (G)	Verified EUL - Useful Life from TRM (H)	Verified Net TRB (I)
	Water Cooler Timers	128,446	-	1.00	N/A	128,446	-	8.0	8.0	\$149,946
	VFD Pool Pumps	100,887	1.01	1.00	1.00	100,887	1.01	10.0	10.0	\$146,595
	Solar Attic Fan	143,655	5.32	0.29	-	42,032	-	5.0	20.0	\$104,453
	Advanced Power Strips	134,105	15.26	0.80	0.80	107,232	12.26	5.0	5.0	\$90,353
	Rid-A-Fridge (Freezer)	40,579	1.61	1.00	1.00	40,579	1.61	14.0	14.0	\$84,228
	Refrigerator	30,025	4.86	1.00	1.00	30,025	4.86	14.0	14.0	\$80,210
	Ceiling Fans	71,921	13.28	1.00	1.00	71,921	13.28	5.0	5.0	\$64,218
	Faucet Aerator	47,309	-	0.50	N/A	23,655	-	5.0	5.0	\$17,995
	Showerhead	21,463	-	1.00	N/A	21,463	-	5.0	5.0	\$16,327
	Room Occupancy Sensors	383	0.08	1.00	1.00	383	0.08	8.0	8.0	\$663
	Subtotal	51,076,574	9,884.89	1.09	0.63	55,451,206	11,351.66	9.6	8.7	\$93,436,661
Residential Hard to Reach	Residential Custom	554,298	115.96	1.00	1.00	554,298	115.96	11.0	10.8	\$1,171,216
	CFL Omni-Directional	743,853	106.32	1.00	1.00	744,246	106.07	5.0	6.0	\$824,059
	LED Omni Directional	147,460	20.97	1.00	1.00	147,460	20.97	15.0	15.0	\$404,623
	Showerhead	259,836	213.22	1.00	1.00	259,853	213.22	5.0	5.0	\$350,347
	Advanced Power Strips	356,453	40.57	1.00	1.01	356,496	40.81	5.0	5.0	\$300,414
	Faucet Aerator	61,569	112.61	1.01	1.00	62,174	112.61	5.0	5.0	\$127,932

Table 27. PY2015 Residential Sector Verified Participation and Savings by Program and Measure

Program	Measure	Tracked First-Year Net kWh Savings (A)	Tracked First-Year Net kW Savings (B)	kWh Verification Ratio (C)	kW Verification Ratio (D)	Verified First-Year kWh Savings (E = A * C)	Verified First-Year kW Savings (F=B * D)	EUL - Useful Life in Program Tracking DB (G)	Verified EUL - Useful Life from TRM (H)	Verified Net TRB (I)
	LED Specialty	7,729	1.10	1.00	1.00	7,729	1.10	15.0	15.0	\$21,208
	CFL Specialty	7,862	1.11	1.00	1.00	7,862	1.11	6.0	6.0	\$8,690
	Subtotal	2,139,060	611.86	1.00	1.00	2,140,118	611.85	7.3	7.6	\$3,208,489
Residential Energy Services and Maintenance	Solar Water Heating Tune-up	291,973	34.00	1.00	1.00	291,973	34.00	5.0	5.0	\$246,455
	Subtotal	291,973	34.00	1.00	1.00	291,973	34.00	5.0	5.0	\$246,455
Custom Energy Solutions for the Home	LED Specialty	3,868	0.56	1.00	1.00	3,868	0.56	15.0	15.0	\$10,665
	Residential Custom	2,742	0.54	1.00	1.00	2,742	0.54	15.0	15.0	\$8,328
	Subtotal	6,610	1.10	1.00	1	6,610	1.10	15.0	15.0	\$18,993
Residential Total		53,514,217	10,531.86	1.08	1.14	57,889,907	11,998.62	9.5	8.9	\$96,910,598

Note: Values are rounded for reporting purposes and may not sum to the totals shown in the table above.

Appendix G. Descriptions of Programs

The PY2015 Hawaii Energy portfolio consisted of eight programs aimed at attaining direct energy savings, with four targeting the business¹⁶ sector and four targeting the residential sector (Business Programs and Residential Programs, respectively). Table 28 presents a short description of each of these programs by sector¹⁷.

Table 28. PY2015 Hawaii Energy Program Summary – Business and Residential

Sector	Program	Program Description
Business	Business Energy Efficiency Measures (BEEM)	The objective of this program is to acquire electric energy and demand savings through customer installations of standard, known, energy efficiency technologies by applying prescriptive incentives in a streamlined application process. Incentivized measures include lighting, HVAC, motors, water heater, variable frequency drives, window tinting, and cool roof technology.
	Custom Business Energy Efficiency Measures (CBEEM)	The objective of this program is to provide a custom application and approval process for participants to receive incentives for installing non-standard energy efficiency technologies.
	Business Hard to Reach (BHTR)	The objective of this program is to help targeted geographies and demographics that have been traditionally underserved such as retail, restaurants and other small businesses. Additionally, this program conducted more aggressive outreach to lighting and electrical contractors with training, promotional materials and frequent communications on program updates.
	Business Energy Services and Maintenance (BESM)	This program focuses on developing viable projects through collaboration, competition and direct support in the form of expertise and/or equipment (i.e., metering).
Residential	Residential Energy Efficiency Measures (REEM)	This program represents the largest program in the residential portfolio and consists of six major initiatives including water heating, lighting, air conditioning, appliances, equipment kits, energy awareness, and measurement and control systems.
	Residential Energy Services and Maintenance (RESM)	This program targets ally-driven service offerings to enhance energy savings persistence. In PY2015, the program continued its solar water heater tune-up offering.
	Residential Hard to Reach (RHTR)	This program seeks to secure various projects among Hawaii residents that have traditionally been underserved.
	Custom Energy Solutions for the Home (CESH)	This program provides a flexibility within the prescriptive portfolio to accommodate unforeseen market opportunities with budgetary and unit cost targets that provide financial efficacy guidance to the Program and allies who champion these opportunities.

In addition to the eight programs described above, the Hawaii Energy portfolio also included various market transformation activities (also referred to as Transformational Programs). In PY2015, these programs focused on areas such as behavior modification, professional development, and technical

¹⁶ The term “business” includes all non-residential customer categories (commercial, industrial and agricultural).

¹⁷ Program summaries adapted from the PY2015 Hawaii Energy Annual Report. Leidos Engineering, LLC, Hawaii Energy.

training that may lead to future energy efficiency and conservation, but for which Hawaii Energy does not set direct energy-savings goals for PY2015. Table 29 summarizes these activities.

Table 29. PY2015 Hawaii Energy Program Summary – Market Transformation

Program Categories	Program Description	Programs
Behavior Modification ^a	Aimed to reach the mass market as well as hard-to-reach residents in underserved communities in Hawaii, Honolulu and Maui counties to build on the foundation of energy literacy established through various programs.	<ul style="list-style-type: none"> ▪ Sharing the Aloha ▪ Creation and Distribution of Transformative Messaging, ▪ Community Based Social Marketing (CBSM) ▪ Community Education Support ▪ Market Research testing different time-of-use rate structures to drive behavior change
Professional Development	Designed to educate professionals who are either new to the working world, new to energy efficiency or both	<ul style="list-style-type: none"> ▪ K-12 Educator Development ▪ Facility Management Degree Program ▪ Energy Efficiency Sales and Financial Analysis of Energy Projects Training ▪ Hawaii Energy Fellowship Program
Technical Knowledge and Training	Technical Knowledge and Training was focused on engineers, facility managers, architects, building operators, energy managers and similar trade professionals who have experience in infrastructure and energy, but need to enhance their technical skills in implementing energy efficiency upgrades or practices in facilities, offering Building Operator Certifications, sponsoring water efficiency and conservation education, and other additional trainings	<ul style="list-style-type: none"> ▪ Facilities Management Training ▪ Building Operator Certification (BOC®) Workshops ▪ Water and Wastewater Training ▪ Support Business and Residential Program Offerings
Energy in Decision- Making: Benchmarking Pilot	A continuation of PY2014, benchmarking the energy use of facilities and business sectors in order to identify energy-saving opportunities and provide technical assistance and incentives to save energy.	<ul style="list-style-type: none"> ▪ ENERGY STAR® Hawaii Energy Benchmarking Program ▪ Green Button and ENERGY STAR Partnering ▪ Hawaii Specific Tax-Map-Key (TMK) data integration ▪ Accessible by Registration Web Site to allow customers “Utility” Management tools ▪ Providing full cost incentives to targeted Benchmarking Participants
Energy in Decision- Making: Codes & Standards Pilot	Aimed to increase support of codes and standards to help the State reach its Energy Efficiency Portfolio Standard (EEPS) goals faster	<ul style="list-style-type: none"> ▪ Hawaii Energy 30 by 2030 – 30% Above Code Programs ▪ Assessment of Baseline Compliance, Code Compliance Assistance ▪ Compliance Enhancement – early adoption of International Energy Conservation Code 2012
Shift for Savings Plan Pilot (Demand Response (DR) Pilots)	Aimed to incorporate DR capacity acquisition activities to provide the Hawaiian Electric Companies (HECO) greater access to controllable loads	<ul style="list-style-type: none"> ▪ Direct Integration ▪ Demand Response Technology Screening and Pilot Projects
Smart Grid Pilot	Used to determine how to enhance implementation of smart grid project to include energy efficiency enhancements and options, and coordinating these efforts with HECO	<ul style="list-style-type: none"> ▪ Work with HECO ▪ Energy Usage and Participation Data Review ▪ Expanded Electric Vehicle Role
Electric Vehicles Support Pilot	Designed to identify opportunities for electric vehicle charging that minimize renewable curtailment and support grid reliability by	<ul style="list-style-type: none"> ▪ Net Zero Electric Car Purchase Package ▪ Awareness campaign

Program Categories	Program Description	Programs
	integrating the energy efficiency, demand response and electric vehicle offerings	

^a Behavior Modification projects include the Smart Grid, Electric Vehicles Support, and the Shift for Savings Plan (Demand Response) pilot programs, however, for the verification effort, they are reported as separate line items in Table 10 as the performance award for these three programs are bundled with the Codes & Standards and Benchmarking pilots.

Appendix H. Glossary of Terms

Table 30. Glossary of Terms Used in this Memo

Term	Abbreviation	Definition
Claimed	N/A	Information drawn from the PY2015 Hawaii Energy Annual Report (final). Usually refers to energy savings or achieved performance indicators.
Deemed	N/A	Energy or demand savings for a particular measure that the PUC and PBFA agree to prior to the beginning of a program year.
Effective Useful Life	EUL	The point in time when half of the measures installed in the first-year of a program are still in place and operating. The EUL is a mathematical artifact that allows for easier calculation of benefits from an energy efficiency program.
Technical Resource Manual	TRM	<i>Herein referring to the TRM used in Hawaii.</i> A document that provides the algorithms and background information for each non-custom measure included in the Hawaii Energy portfolio. Typically updated annually by the PBFA, this document is the source of deemed per-unit savings, EUL, and NTGR values.
Net-To-Gross-Ratio	NTGR	A value that accounts for the energy savings attributable to program actions. Typically between zero and one, a NTGR can go over one if the program causes savings to occur outside of the program, but because of the program.
Program-tracking Database	N/A	The database maintained by the PBFA and used to track Hawaii Energy program activity and participant information.
Public Benefits Fee Administrator	PBFA	The third-party consultant hired by the Hawaii Public Utilities Commission to implement the Hawaii Energy suite of programs.
Total Resource Benefits	TRB	Utility avoided costs from the lifecycle energy and demand savings.
Tracked	N/A	Information calculated directly from the PY2015 program-tracking database as received on August 24, 2016.
Verified or Verification	N/A	Program verification occurs through activities undertaken by the Evaluation Team to assure that planned program activities occurred and that measures are in place and operating, and therefore able to save energy as expected.
Verification Rate or Ratio	N/A	The verification rate or ratio derives from post-verification savings values divided by savings values in the program-tracking database.