AEG
Applied Energy Group

TETRA TECH

HAWAIʻI ENERGY PY2019 VERIFICATION REPORT

FINAL

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Prepared for:
HAWAII PUBLIC UTILITIES COMMISSION

Energy Solutions. Delivered.

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EXECUTIVE SUMMARY

This report presents the verified savings and performance results of program year 2019 (PY2019)[1] for Hawai'i Energy. The verification's chief purpose was to provide an independent review of Hawai'i Energy's performance relative to the Triennial Plan performance targets.[2]

The targets span a range of performance indicators, including energy and demand savings for clean energy technologies, accessibility and affordability, economic development and market transformation, and customer satisfaction. Successfully meeting the performance targets related to these indicators can lead to a financial reward of up to $750,000[3], of which $534,987, or 71 percent, was calculated to have been earned per the AEG team's analysis. The table below summarizes the performance targets and incentive awards at the overarching performance indicator level.

Overall, Hawai'i Energy met nearly all of its performance targets. They exceeded the target for first year and lifetime energy savings as well as for peak demand savings (percent verified of 102%, 105%, and 120%, respectively). The Total Resource Benefit percent verified was 95%. Even for areas where Hawai'i Energy did not achieve its target, the PY2019 verification results show evidence of substantial effort on Hawai'i Energy's part. Compared to the PY2019 percent verified of 71% (in table below), Hawai'i Energy achieved 98 percent of its financial reward target in PY2018 and 99 percent in PY2017. Additional information about the award details can be found in Table ES-1-2 and in Appendix A.

Table ES-1-1 PY2019 Verified Performance Award – High Level

Performance Indicator	Fraction of Award	Target Award	Verified Award	Percent Verified
Clean Energy Technologies	70%	$525,000	$354,987	68%
Accessibility and Affordability	20%	$150,000	$120,000	80%
Economic Development and Market Transformation	8%	$60,000	$52,500	88%
Customer Satisfaction	2%	$15,000	$7,500	50%
Total	***100%***	***$750,000***	***$534,987***	***71%***

Each performance indicator includes different metrics. The specific metrics verified as part of this effort included the following.

- Clean energy technologies metrics include:
  - first-year energy savings, lifetime energy savings, peak demand reduction, and total resource benefits (TRB) for each program, aggregated to the residential and business sector portfolio of programs, as well as the Hawai'i Energy portfolio for that program year;
  - projects, products, or customers served as part of Hawai'i Energy's grid services ready focus area (new for PY2019); and

[1] Program Year 2019 began on July 1, 2019 and ended June 30, 2020.

[2] PY2019 is the first year of a three-year triennial plan. Additionally, the AEG team reviewed Hawai'i Energy's PY2019 annual report.

[3] Note that if Hawai'i Energy exceeds 100 percent for one or more of the CET sub-targets it would be possible for Hawai'i Energy to receive a financial reward that exceeds $750,000. The CET sub-target awards are each capped at 115 percent of the base award (for 100 percent achievement) for meeting or exceeding 115 percent the CET sub-target.

  - reduced greenhouse gas emissions and displaced barrels of oil (new for PY2019).
- The extent to which Hawai'i Energy funds achieved equitable distribution across islands and to economically disadvantaged customers.
- Hawai'i Energy's execution of all contractually agreed upon economic development, market transformation, and customer satisfaction activities.

Under the categories of clean energy technologies, accessibility and affordability, economic development and market transformation, and customer satisfaction, Hawai'i Energy had multiple performance targets based on the various metrics discussed above, referred to as "Key Focus Areas." Verified results for each metric and awards for each Key Focus Area are in Table ES-1-2.

Verification Process

The verification process provides an overall verification rate at the program portfolio level. Verification activities spanned a wide range, including tracking database reviews and replication, engineering desk reviews, ensuring that Technical Reference Manual (TRM) gross savings values and related adjustments were correctly applied, reviewing additional documentation regarding equity and engagement with hard-to-reach communities, and surveys.[4]

The AEG team also assessed whether recommendations from past verifications were implemented by Hawai'i Energy, as appropriate.

During the verification process, the AEG team received data and documents from Hawai'i Energy and engaged with the Energy Efficiency Manager (EEM), Hawaii Public Utilities Commission (HPUC), and Hawai'i Energy to discuss observations, confirm data and approaches, and generally worked collaboratively to develop the verification results.

Clean Energy Technologies Verification Activities

Verification activities **were** designed to determine the extent to which incented projects/ measures were appropriately "tracked" in Hawai'i Energy's program database and to ensure that estimated savings values and related adjustments were properly applied. For measures covered by the TRM, the scope of the verification was limited to assessing whether TRM-stipulated gross savings values and related adjustments that produce net savings were being applied properly.

Verification activities **were not** designed to review the validity of the TRM's stipulated savings or adjustment factors—only their appropriate use for calculating savings for the clean energy technologies' program performance. That is, this verification process did not involve a review or scrutiny of measure-level gross savings values or the adjustments to them (e.g., net-to-gross ratios, system loss factors, etc.) as stipulated in the TRM.

Verification Findings and Recommendations

The table below provides the target award, and claimed and verified details for the PY2019 performance targets for each overarching performance indicator and its key focus area derived by the AEG team. Additional information related to the performance award source information can be found in Appendix A.

[4] As a separate task, the AEG team regularly completes an in-depth review of the TRM, which is coordinated with the EEM, HPUC, and Hawai'i Energy.

Table ES-1-2 PY2019 Claimed and Verified Performance Award by Performance Indicator

Performance Indicator	Milestone*	Target	Metric	Fraction of Award	Target Award	Claimed Results	Claimed Percent of Target	Claimed Award	Verified Results**	Percent of Target**	Verified Award**
Clean Energy Technologies - Key Focus Areas	***Minimum 95%***	***100%***		**Fraction of Award 70%**							
First Year Energy Reduction	95,884,312	100,930,855	kWh	15%	$112,500	103,667,855	102.7%	$103,456.08	102,907,723	102.0%	$83,338.24
Lifetime Energy Reduction (new)	1,091,661,022	1,149,116,865	kWh	15%	$112,500	1,377,415,952	119.9%	$89,004.42	1,204,862,879	104.9%	$71,107.81
Peak Demand Reduction	14,883	15,666	kW	15%	$112,500	18,969	121.1%	$119,840.49	18,837	120.2%	$119,840.49
Total Resource Benefit	$154,739,810	$162,884,010	$	20%	$150,000	$172,234,065	105.7%	$100,898.82	$154,710,054	95.0%	$43,200.22
Grid Services Ready (new)	N/A	800	projects/ products	5%	$37,500	1,004	125.5%	$37,500.00	1,004	125.5%	$37,500.00
Greenhouse Gas Emissions/ Barrel of Oil (new)	N/A	107,000 / 180,000	tons / barrels	0%	$0	71,169 / 165,488	66.5% / 91.9%	$0.00	70,647 / 164,275	66.0% / 91.3%	$0.00
Accessibility & Affordability - Key Focus Areas				**Fraction of Award 20%**							
Economically Disadvantaged											
Energy Advantage											
Customers Served	N/A	650	Customers served	2%	$15,000	403	62.0%	$0	403	62.0%	$0
Bill Savings	N/A	$1,500,000	Customer bill savings	2%	$15,000	$1,511,084	100.7%	$15,000	$1,510,641	100.7%	$15,000
Single & Multifamily Direct Install											
Customers Served	N/A	1,934	Customers served	2%	$15,000	2,019	104.4%	$15,000	2,019	104.4%	$15,000
Bill Savings	N/A	$10,089,930	Customer bill savings	2%	$15,000	$1,674,146	16.6%	$0	$1,674,146	16.6%	$0
Community Based Energy Efficiency (new)	N/A	2	Communities served	1%	$7,500	2	100.0%	$7,500	2	100.0%	$7,500
EmPower Hawai'i Project (new)	N/A	7	Participating non-profits	1%	$7,500	7	100.0%	$7,500	7	100.0%	$7,500
Island Equity											
County of Hawaii		13%	Target spend must be met in			16.4%	125.8%		16.4%	125.8%	
County of Maui	N/A	13%	Hawaii & Maui Counties for	10%	$75,000	15.4%	118.4%	$75,000	15.4%	118.4%	$75,000
City & County of Honolulu		74%	Milestone & Target Award			68.3%	92.2%		68.3%	92.2%	
Economic Development & Market Transformation - Key Focus Areas				**Fraction of Award 8%**							
Behavior Change											
Workshop and Presentations											
STEM based student workshop	N/A	1,200	Number of participant-hours of Training	1%	$7,500	1,350	112.5%	$7,500	1,350	met target	$7,500
Adult learning	N/A	2,750	Number of participant-hours of Training	1%	$7,500	3,191	116.0%	$7,500	3,191	met target	$7,500
Gamification Campaigns and Competitions	N/A	1,000	Number of participants	0%	$0	1,399	139.9%	$0	1,399	met target	$0
Exhibit Educational Resources	N/A	2	Number of Stakeholder Collaboration Events	0%	$0	2	100.0%	$0	2	met target	$0
Sustained Outreach	N/A	1	Participation Agreements	0%	$0	1	100.0%	$0	1	met target	$0
Behavioral Insights	N/A	1	Number of Program Interventions	0%	$0	1	100.0%	$0	1	met target	$0
Professional Development & Technical Training											
Clean Energy Ally Support											
Targeted Ally Training Opportunities											
Targeted Participant Training Opportunities	N/A	10,000	Number of participant-hours of Training	4%	$30,000	12,471	124.7%	$30,000	12,298	met target	$30,000
Educator Training and Grants											
Degree Program Support											
Vocational Training											
Energy in Decision Making											
Strategic Energy Management (SEM)	N/A	6	Number of new participating institutions	1%	$7,500	4	66.7%	$0	4	target not met	$0
Codes and Standards											
Appliance Standards Advocacy (new)	N/A	5	Advocacy Events			12			12	met target	
Improve Code Compliance	N/A	1	Establishing compliance roadmap and tracking savings			1			1	met target	
Code-Related Training	N/A	100	Number of participant-hours of Training	1%	$7,500	158	0.0%	$7,500	158	met target	$7,500
Leading edge technologies and strategies	N/A	4	Meeting and one final report			4			4	met target	
Clean Energy Innovation Hub											
Innovation and Emerging Technologies	N/A	1	Companies supported	0%	$0	0	0.0%	$0	0	target not met	$0
Customer Satisfaction - Key Focus Areas				**Fraction of Award 2%**							
Application Processing Customer Experience - Commercial	N/A	>9	Overall customer satisfaction score	1%	$7,500	9.0	100.0%	$7,500	9.0	target not met	$0
Application Processing Customer Experience - Residential	N/A	>9	Overall customer satisfaction score	1%	$7,500	9.3	103.3%	$7,500	9.3	met target	$7,500
Total Performance Award				**100%**	**$750,000**			**$638,200**			**$534,987**

* The "Milestone" is the minimum threshold to earn an incentive for some of the metrics and is set at 95 percent of the full target across the three years of the triennial plan; the "Target" is the 100 percent goal for each metric.
** Determined by the AEG team.

Below are key reasons for the differences between the Hawai'i Energy claimed award values and the AEG team verified values. From an overarching perspective, the primary adjustments to savings for the prescriptive programs were systemic and the primary adjustments to the custom business program were project specific. Details related to these findings can be found in Chapter 2.

Table ES-1-3 Key Reasons for Claimed and Verified Award Differences

Metric	Claimed Award	Verified Award	Difference	Key Reason for Difference
Total Resource Benefit	$100,898.82	$43,200.22	$(57,688.60)	TRBs are driven by the first-year energy and lifetime energy reductions. The minimum targets were not met for business prescriptive for both first-year energy and lifetime energy reductions due to adjustments for deemed values not matching the TRM. The business prescriptive and residential prescriptive programs also fell short of the minimum target for TRBs due to adjustments for dual baselines (i.e., Hawai'i Energy did not appropriately apply dual baselines in the TRB calculation for certain measures).
First-Year Energy Reduction	$103,456.08	$83,338.24	$(20,117.84)	The minimum targets were not met for business prescriptive for both first-year energy and lifetime energy reductions due to adjustments for deemed values not matching the TRM.
Lifetime Energy Reduction	$89,004.42	$71,107.81	$(17,896.61)	The minimum targets were not met for business prescriptive for both first-year energy and lifetime energy reductions due to adjustments for deemed values not matching the TRM.
Commercial Customer Satisfaction	$7,500.00	$ -	$(7,500.00)	Hawai'i Energy reported that they achieved a 9.0 satisfaction rating. A rating of greater than 9.0 was required in order to claim this reward.
GHG/ Barrel of Oil	N/A	N/A	N/A	This was a new key focus area for Hawai'i Energy, and no award dollars were allocated to this metric. In verifying this metric, the AEG team observed that even if Hawai'i Energy had achieved their first-year energy savings at 100 percent, achieving either of the GHG emissions goals would not have been possible.
All others	$337,340.49	$337,340.49	$0.00	
Totals	**$638,199.81**	**$534,986.76**	**$(103,213.05)**	

Through the AEG team's verification activities, the following important achievements by Hawai'i Energy during PY2019 were identified.

- Hawai'i Energy rebated more than one million energy efficient items which are now installed in homes and business throughout the state. While most of these are LEDs, there were over 20,000 high-efficiency appliances and 11,000 electronics purchased through the upstream initiative.
- The Hawai'i Energy programs, primarily through hard-to-reach efforts, saved economically disadvantaged customers nearly 22 million dollars on their utility bills in the first year.
- Savings from Hawai'i Energy's programs offset the use of more than 180,000 barrels of oil and avoided 107,000 metric tons of GHG emissions. For the state, this is equivalent to removing approximately

25,000 passenger cars[5] from the road or offsetting the energy use of more than 18,000 homes[6] for one year.[7]

The table below summarizes the verification findings and recommendations from the PY2019 verification activities. The table presents verification findings and the associated recommendations in order of importance. The conclusions chapter (Chapter 6) includes ongoing recommendations from prior years' verification reports.

Table ES-1-4 Verification Findings, Implications/Outcomes, and Associated Recommendations

Verification Finding	Implication/Outcome	Recommendation
1. Lifetime savings estimates did not consistently align with TRM deemed savings values. Typically, this misalignment affected measures that did not appropriately account for the dual baseline approach.	Verification-based adjustments to lifetime savings for these measures accounted for most adjustments and lowered realization rates for lifetime savings in REEM and BEEM.	**Recommendation 1**. Ensure all changes to TRM deemed measures are implemented in the tracking system calculations.
2. For CBEEM custom projects, lighting measures installed may qualify for dual baselines. Even though custom measure calculations are not following the prescriptive calculations in the TRM, these types of measures should still adhere to TRM guidelines.	The effect of not implementing dual baselines on overall program savings is relatively small; however, savings for some fixtures may be overstated.	**Recommendation 2**. Modify calculations for custom lighting projects in CBEEM to include dual baselines where they are applicable.
3. The AEG team observed inconsistent project documentation and methods for calculating new construction project savings.	Because projects relied on construction documents and architectural estimates for energy savings rather than including information on as-builts, invoice, and purchase orders, these savings estimates are not as robust as they could be.	**Recommendation 3**. Increase the rigor of new construction lighting calculations to increase the confidence in project savings calculations.
4. For multiple HVAC projects, nominal unit capacity was used in the savings calculation rather than rated capacity, whereas TRM algorithms are meant to be used with rated capacity.	In most cases, the rated capacity was slightly lower than the nominal capacity, so using the rated capacity results in slightly lower savings. Nominal capacity adjustments contributed to lowered realization rates in BEEM and REEM.	**Recommendation 4**. Use rated capacity for HVAC calculations.
5. For CBEEM, multiple projects collected invoices where the installed fixture counts and product make/model numbers could not be accurately cross-referenced to the projects.	The overall effect on project savings can be large even for small variations in the number of products installed for a given site, or where make/model numbers differed slightly from those intended for installation.	**Recommendation 5**. Obtain invoices, purchase orders, or submittals for all projects. Seek clarity when these documents cover more than one rebate or customer site.

[5] Average Hawaii passenger car emissions of 2.822 metric tons of greenhouse gas emissions with 7,055 average annual miles driven, https://www.carinsurance.com/Articles/average-miles-driven-per-year-by-state.aspx
https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

[6] https://puc.hawaii.gov/wp-content/uploads/2021/02/Hawaii-2020-Market-Potential-Study-Final-Report.pdf

[7] https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

Verification Finding	Implication/Outcome	Recommendation
6. The AEG team found that Hawai'i Energy consistently used TRM deemed values rather than the provided semi-prescriptive calculations, and mainly relied on "Average" values rather than more granular savings estimates.	Implementing more granular semi-prescriptive calculations or category-specific deemed values would lead to more accurate savings values, and Hawai'i Energy already collects much of this data. The overall effect on program savings is relatively low.	**Recommendation 6**. Determine which semi-prescriptive approaches can be used during the implementation and consider implementing product-specific savings rather than relying on the average category values.

2

CLEAN ENERGY TECHNOLOGIES RESULTS

This chapter summarizes the results and findings for residential and business programs, and then presents the detailed results.

Summary of Results and Key Findings

Clean energy technologies (CET) targets represented 70 percent of Hawaii Energy's total PY2019 incentive payment. Key elements of the CET targets include first-year net (program level) savings for kWh and kW (converted to MWh and MW throughout this report), lifetime savings, and TRB savings. TRB savings reflect the value of energy and demand savings over the life of the measures that make up the Hawai'i Energy portfolio. Additional elements include grid services-ready project targets and greenhouse gas (GHG) emissions targets. Table 2-1 summarizes these targets and Table 2-2 presents the AEG team's verified results[8] as a percent of the target for each of Hawai'i Energy's CET targets.[9]

Table 2-1 Clean Energy Technologies Targets

Key Focus Areas	100 Percent Target	Metric	Percent of Incentive Award
First-Year Energy Reduction	100,931	MWh	15%
Lifetime Energy Reduction	1,149,117	MWh	15%
Peak Demand Reduction	16	MW	15%
Total Resource Benefit	$162,884,010	$	20%
Grid Services Ready	800	Projects	5%
GHG Emissions	107,000	GHG tons	0%
GHG Emissions	180,000	GHG barrels	0%

Table 2-2 Clean Energy Technologies Verified Performance

Key Focus Areas	Metric	Claimed Results	Claimed Results Percent of Target	Verified Results	Verified Results Percent of Target
First-Year Energy Reduction	MWh	103,668	102.7%	102,908	102.0%
Lifetime Energy Reduction	MWh	1,377,416	119.9%	1,204,863	104.9%
Peak Demand Reduction	MW	18.9686	121.1%	18.8366	120.2%
Total Resource Benefit	$	$172,234,065	105.7%	$154,710,054	95.0%
Grid Services Ready	Projects	1,004	125.5%	1,004	125.5%
GHG Emissions[10]	GHG tons	71,169	66.5%	70,647	66.0%
GHG Emissions	GHG barrels	165,488	91.9%	164,275	91.3%

[8] See Appendix D for information related to how sampling methods were applied to determine verified savings and realization rates.

[9] Throughout this analysis the AEG team reports verified results based on program level savings. Program level savings include two adjustments to at-the-meter customer-level savings. First, customer-level savings are adjusted to system level savings to account for line losses. Second, system-level savings are adjusted to program level savings using a net-to-gross factor which accounts for free ridership and spillover. Both adjustment factors are in the TRM, and more detail on each level of savings can be found in Appendix B.

[10] GHG emissions reductions metrics verified by using first-year kWh savings and the eGRID 2018 Summary Tables for total output emission rates (https://www.epa.gov/sites/production/files/2020-01/documents/egrid2018_summary_tables.pdf, page 4)

Hawai'i Energy exceeded the performance targets for first-year energy, peak demand, and lifetime energy reduction. However, Hawai'i Energy only achieved 95 percent of the target for TRBs. In discussions with Hawai'i Energy, the AEG team learned that the lifetime energy reduction target was determined while considering the effect of dual baseline changes to the TRM, while the TRB goal was not. The AEG team recommends reconsidering TRB targets to include dual baseline considerations so that the TRB targets are achievable when the supporting metrics meet, or exceed, 100 percent.

Grid services exceeded the performance target for the total number of projects, while the GHG emissions fell short of targets[11]. With the goal met for first-year energy reduction, the GHG targets may need to better align with the first-year energy reduction.

Below is a list of key findings resulting from the verification activities for CET:

- TRM[12] algorithms were mostly applied correctly for prescriptive measures for first-year energy and demand savings.
- Lifetime savings for some measures were incorrect due to errors in tracking TRM values for the effective useful life (EUL) or deemed lifetime savings.
- Desk reviews confirmed the correct parameters were entered into the tracking system and used in savings calculations for most prescriptive projects in the Residential Energy Efficiency Measures (REEM), Residential Energy Service and Maintenance (RESM), and Business Energy Efficiency Measures (BEEM) programs.
- In the Custom Business Energy Efficiency Measures (CBEEM) program, desk reviews resulted in adjustments to savings for 23 of the 30 custom projects. The most considerable adjustments revolved around lifetime energy savings where EULs were incorrectly calculated from fixture operating hours or applied to measures where the TRM stipulated deemed lifetime savings.
- The Upstream Initiative in the REEM program provided rebates for over one million units in PY2019, including over 20,000 appliances.
- The Peer program achieved more than 100 percent verification rates due to increased customer counts from documentation compared to the tracked data.

Residential Programs

In PY2019, Hawai'i Energy implemented the following four residential sector programs:

- Residential Energy Efficiency Measures (REEM)
- Residential Hard to Reach (RHTR)
- Residential Energy Services and Maintenance (RESM)
- Custom Residential Energy Efficiency Measures (CREEM)

The REEM program continues to dominate residential energy and demand savings, contributing 93 percent of the residential program level claimed MWh savings. Its diverse set of energy initiatives included an upstream initiative, a behavior program that issued periodic Home Energy Reports (HERs), downstream prescriptive programs, and an online marketplace. The other three programs enhanced Hawai'i Energy's services to the residential sector with program-installed measures (RHTR), custom measures (CREEM), and

[11] There is no performance award for these goals, so there is no effect on the monetary performance award for Hawai'i Energy for falling short on these metrics.

[12] PY19 TRM V2.1_PUC signed_final.xlsx.

home maintenance measures (RESM). The table below summarizes the allocation of total residential program savings by program or major component (in the case of REEM).

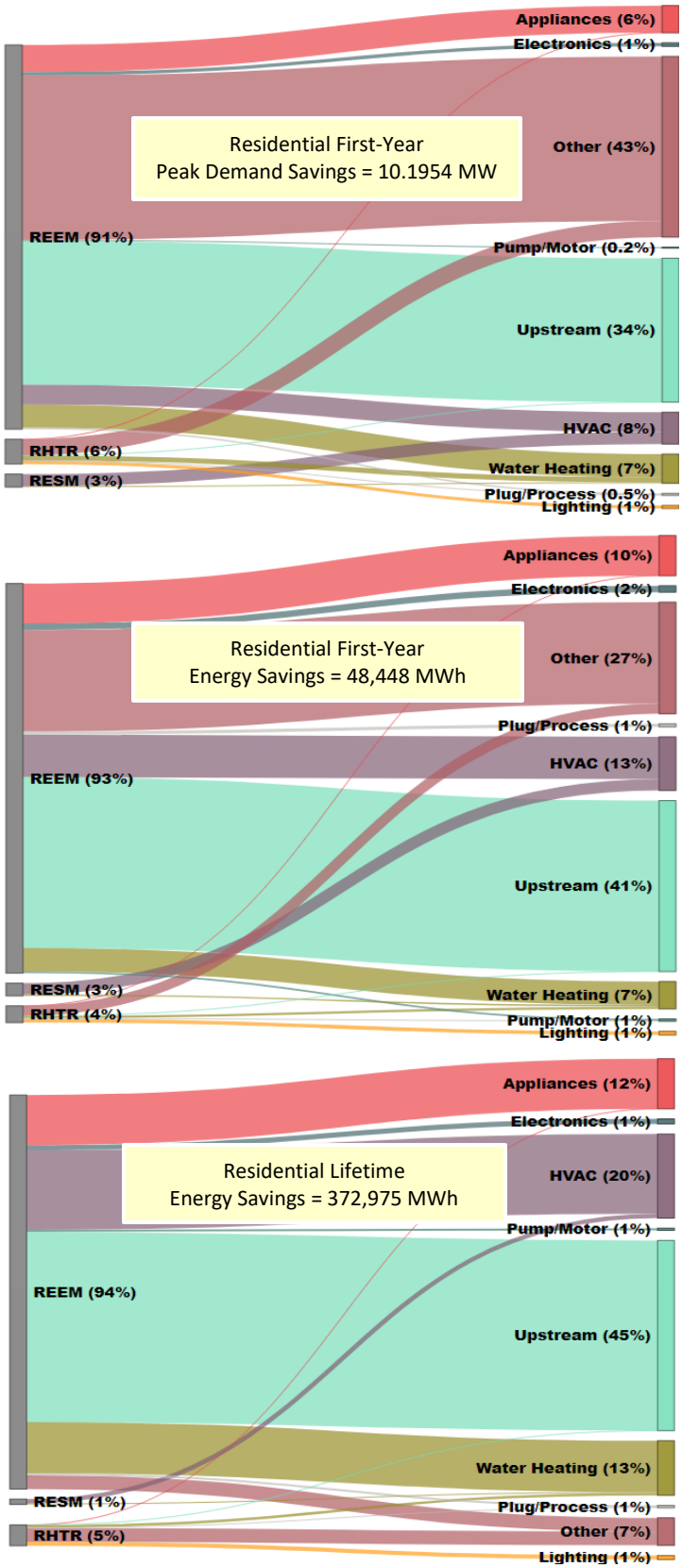
Table 2-3 Residential Claimed Program Level Results

Program Name	Component	Claimed Program Level First-Year MWh	Percent of First-Year Program Level Savings
REEM	Upstream Initiative	22,654	47.1%
	Peer Group Comparison	11,501	23.9%
	Prescriptive/ Downstream	9,711	20.2%
	Online Marketplace	875	1.8%
	Residential Custom	60	0.1%
	Total	*44,801*	*93.2%*
RHTR		1,695	3.5%
RESM		1,461	3.0%
CREEM		131	0.3%
Total		**48,088**	**100.0%**

The verified program level results for the residential programs are presented below, in Figure 2-1 and in Table 2-4. Figure 2-1, on the left side, shows the percentage of the verified savings each program represents, with the percentage of the end-uses on the right side. For REEM, most of the "Other" group savings were due to the Peer program, with additional savings for domestic hot water and envelope measures.

The Upstream Initiative is responsible for nearly 50 percent of the total savings. Incentives for this program were directed at retailers to buy-down the first cost of energy efficient equipment such as: residential lighting, appliances, and electronics.

Figure 2-1 Residential Verified Program Level Impacts by Program and End-Use



As reflected in the table below, residential program component first-year realization rates were either 100 percent or close to 100 percent. REEM, RHTR, and RESM had adjustments to lifetime savings resulting from misapplication of TRM deemed EUL and lifetime savings values, which impacted the lifetime realization rates. The AEG team made a NTG adjustment to the RHTR energy kit measures that also affected the first-year energy and demand savings. Despite these adjustments, the overall realization rates for the residential sector were close to 100 percent for first-year energy and demand savings. This is expected, given the vast majority of residential program measures were based on deemed savings from the TRM and that the primary purpose of verification was to confirm Hawai'i Energy accurately applied the TRM.

Table 2-4 Residential Verified Program Level Results

Program Name	Verified Program Level First-Year MWh	First-Year MWh Realization Rates	Verified First-Year Program Level Savings MW	First-Year MW Realization Rates	Verified Lifetime Program Level Savings MWh	Lifetime MWh Realization Rates
REEM	44,938	100.3%	9.2817	99.1%	349,268	91.4%
RHTR	1,917	113.1%	0.5959	123.5%	18,386	108.8%
RESM	1,461	100.0%	0.3124	100.0%	4,713	222.3%
CREEM	131	100.0%	0.0054	100.0%	608	100.0%
Total	**48,448**	**100.7%**	**10.1954**	**100.3%**	**372,975**	**92.8%**

Next, the AEG team provides a high-level description of each of the residential programs, including each program's verified savings results. Within each program's sub-section, the AEG team also provides a more detailed description of the verification process and findings from the verification activities.

Residential Energy Efficiency Measures

The REEM program delivered energy efficiency measures through the following primary program components:

- Upstream initiative – this program works with retailers to promote residential lighting, appliances, and electronics. Incentives have been directed at the retailer level to buy-down the first cost of energy efficient equipment.
- Peer program – provides HERs that are intended to drive behavior-based energy savings.
- Prescriptive measures – these downstream measures are delivered through traditional retail and trade ally channels, customers can receive rebates for a wide range of end uses, including new refrigerators and refrigerator recycling, water heaters, HVAC equipment, solar attic fans, pool pumps, and solar water heaters.
- Online marketplace – the online marketplace allows customers to directly purchase a select set of measures, including energy efficiency kits.

As a large and diverse program, Hawai'i Energy claimed over 48,000 program level MWh savings through REEM for PY2019, which was over 93 percent of the residential sector program savings. The AEG team approached the REEM verification through the following methods:

- Tracking system review for all PY2019 deemed measures to verify that claimed savings accurately followed the TRM.
- Desk reviews of three prescriptive measure strata - HVAC, solar hot water heater, and refrigerator/freezer trade-in/bounty measures.
- Participation rate verification for the Peer program.

The sub-sections below describe the verification activities and findings for each of the major program components and delivery efforts for the REEM program.

REEM Verified Savings

The AEG team determined an overall savings verification of:

- 100.3 percent for program level MWh
- 99.1 percent of program level MW
- 91.4 percent of program level lifetime MWh

The AEG team determined the program level savings for first-year MWh, first-year MW, and lifetime savings based on the tracking system review, desk reviews, and Peer program analysis. The first-year energy and demand program level savings were close to 100 percent. The lifetime program level savings were 91 percent, which was driven by corrections for tracked EULs and deemed lifetime savings values. Table 2-5 through Table 2-7 presents the program level savings for first-year MWh, MW, and lifetime MWh.

Table 2-5 REEM Program Level First-Year MWh Claimed and Verified Results

Equipment Category	Claimed Program Level First-Year MWh	Verified Program Level First-Year MWh	Realization Rate
Upstream Initiative	22,654	22,624	99.9%
Peer Group Comparison	11,501	11,658	101.4%
Downstream	9,711	9,721	100.1%
Online Marketplace	875	875	100.0%
Residential Custom	60	60	100.0%
Total	**44,801**	**44,938**	**100.3%**

Table 2-6 REEM Program Level MW Claimed and Verified Results

Equipment Category	Claimed Program Level First-Year MW	Verified Program Level First-Year MW	Realization Rate
Peer Group Comparison	3.9016	3.9550	101.4%
Upstream Initiative	4.0285	3.9101	97.1%
Downstream	1.1284	1.1096	98.3%
Online Marketplace	0.2885	0.2885	100.0%
Residential Custom	0.0184	0.0184	100.0%
Total	**9.3654**	**9.2817**	**99.1%**

Table 2-7 REEM Program Level Lifetime MWh Claimed and Verified Results

Equipment Category	Claimed Program Level Lifetime MWh	Verified Program Level Lifetime MWh	Realization Rate
Upstream Initiative	213,465	198,414	92.9%
Downstream	150,690	132,396	87.9%
Peer Group Comparison	11,501	11,658	101.4%
Online Marketplace	6,071	6,256	103.0%
Residential Custom	543	543	100.0%
Total	**382,270**	**349,268**	**91.4%**

Peer Program

The Peer program delivers HERs that provide information on how an individual home's energy consumption compares to other similar homes and suggest opportunities to change energy-consuming behaviors. Savings for the Peer program are described in the TRM and are based on annual savings for a single participating home. Savings of 53.06 kWh and 0.018 kW are based on past studies investigating the percent energy savings from program participants, adjusted to the 2015 average annual electricity consumption of HECO residential customers. The savings are treated with a one-year measure life.

To verify savings, Hawai'i Energy provided the AEG team with two files:

- One file contained customer account numbers, island identification, various date information (e.g., opt-out date and the dates the HERs were sent), and the type of HER sent (paper or email)[13]
- The second file was a summary of the program participation and savings tracked by Hawai'i Energy.[14]

When calculating claimed savings, Hawai'i Energy's practice divides the annual savings described in the TRM into a per-month savings rate. Each month is credited with a 1/12 pro rata proportion of the annual rate. In contrast to other REEM measures, the Peer program utilized an assumed NTG ratio of 1.0, as the savings derivation described in the TRM already accounts for any NTG adjustments.[15]

Through a review of the Excel savings tracking file provided, the AEG team verified that Hawai'i Energy correctly applied the savings algorithm as follows:

- Hawai'i Energy correctly applied the savings rate to the number of participants from each island.
- For county-level system loss factors, calculations in the file correctly used the island-specific system loss factors.
- The number of accounts claimed by Hawai'i Energy to have received four or more HERs in PY2019 was 207,000 customers[16], and the claimed savings for these customers were calculated accurately.

In analyzing the files from Hawai'i Energy, the AEG team found 209,842 customers received four or more HERs in PY2019. From the PY2018 verification, the AEG team learned that there are no additional costs to the program for the larger treatment group. While Hawai'i Energy did not claim any extra savings beyond the 207,000 planned targets, the AEG team validated savings to the actual count (209,482), resulting in a realization rate that exceeds 100 percent. The table below describes the verified results, with the difference between the claimed and verified numbers due to the additional 2,842 customers the AEG team identified.

[13] File name "HI_HER_Data_201912_202005_FINALxlsx"

[14] File name "Peer Group Comparison - Island Savings Breakdown PY19.xlsx"

[15] The study that informed the Peer program percentage savings used a treatment and control group methodology. As the control group accounts for all other factors influencing energy consumption, changes in consumption of the treatment group compared to the control group account for net program savings. Applying the REEM NTG ratio would be an incorrect treatment of the savings due to the treatment/control methodology used to inform program savings.

[16] As part of the PY2018 verification process, the AEG team learned that when Uplight began as the new implementation contractor in PY2018, their scope was to send an "average of four reports to 207,000 customers," with this number coming from the rough number of 230,000 customers already being treated, minus the stoppage group of 22,500 (230,000 - 22,500 = 207,500). In discussions with Hawai'i Energy, the AEG team learned that there are close to 410,000 residential customers total, and that about 25 percent of those will not be eligible for the Peer program largely due to either not having sufficient amount of past data or their usage is too low. This leaves about 307,500 eligible residential customers, of which approximately 90,000 are net energy metered (NEM) customers. Historically, NEM customers were not included in the Peer program, but did get added in PY2018 as Tendril was able to develop specific HER messages for this group. Note that Uplight is the result from the merger of Tendril and Simple Energy, and other acquisitions,

Table 2-8 Peer Program Verified Results

Island	Island Share of Program Participants	Island Count of Participants	Verified Customer MWh Savings	Verified Customer MW Savings	Verified Program Level MWh Savings	Verified Program Level MW Savings
Oahu	67.5%	141,706	7,519	2.5507	7,835	2.6578
Hawaii	18.4%	38,581	2,047	0.6945	2,176	0.7382
Maui	13.6%	28,494	1,512	0.5129	1,588	0.5385
Molokai	0.3%	629	33	0.0113	36	0.0123
Lanai	0.2%	432	23	0.0078	24	0.0081
Total	**100.0%**	**209,842**	**11,134**	**3.7772**	**11,658**	**3.9550**

Comparing the verified results to Hawai'i Energy's planning assumptions leads to realization rates that are over 100 percent for both customer level and program level savings. The table below compares Hawai'i Energy's claimed savings to the verified savings.

Table 2-9 Peer Program Claimed and Verified Savings Comparison

Source	Customer MWh	Customer MW	Program Level MWh	Program Level MW
Hawai'i Energy Claimed	10,983	3.7260	11,501	3.9016
AEG team Verified	11,134	3.7772	11,658	3.9550
Realization Rate	**101.4%**	**101.4%**	**101.4%**	**101.4%**

Upstream Initiative

The Upstream Initiative provided retailers with incentives to buy-down the purchase cost of high-efficiency equipment sold through retail channels. LED lamp purchases dominated Upstream Initiative savings over other equipment that included home appliances and electronics. Past verifications have found no variance from projects recorded in the program tracking data for the Upstream Initiative. While the AEG team did complete a tracking system review of the Upstream Initiative measures, no additional verification methods were employed for this program, per the PY2019 Detailed Verification Work Plan[17].

Table 2-10 presents the claimed savings and quantities, by equipment type, of measures found in the Hawai'i Energy Upstream Initiative tracking data. As noted, LED measures represented a substantial amount of savings, over 89 percent. That said, over 20,000 appliances were purchased through the Upstream Initiative, with over 11,000 consumer electronics measures being installed as part of this program component. The results show that a considerable number of Hawaii residents made non-lighting purchases through the Upstream Initiative. The total number of rebated measures exceeded one million in PY2019, which is larger than the approximately half million households in the state of Hawaii and implies that on average more than one energy-efficient product was purchased per household.

[17] Approved by the HPUC and dated November 25, 2020.

Table 2-10 Upstream Initiative Claimed Customer and Program Level Equipment and Savings

Equipment Type	Measure Quantity	Customer First-Year MWh	Customer First-Year MW	Customer Lifetime MWh	Program Level First-Year MWh	Program Level First-Year MW	Program Level Lifetime MWh
Appliances							
Clothes Washers - Tier I	7,653	873	0.1684	9,601	723	0.1395	7,957
Clothes Washers - Tier II	3,516	551	0.1055	6,064	457	0.0874	5,023
Clothes Dryers	2,859	473	0.0943	6,628	392	0.0781	5,487
Dehumidifiers	809	348	0.0396	4,172	289	0.0329	3,464
Air Purifiers	612	239	0.0275	2,151	198	0.0228	1,782
Heat Pumps	130	214	0.0276	2,138	177	0.0228	1,772
Advanced Power Strip - Tier I	2,500	156	0.0175	780	130	0.0146	651
Dishwasher	2,095	59	0.0063	647	49	0.0052	538
Smart Thermostats	360	50	-	149	41	-	123
Freezer	343	15	0.0017	249	12	0.0014	206
Clothes Washers - Tier III	7	1	0.0002	14	1	0.0002	11
Appliance Totals	***20,884***	***2,978***	***0.4887***	***32,593***	***2,469***	***0.4050***	***27,014***
Lighting							
LED Omni MP	611,738	20,866	3.6704	198,004	12,562	2.2097	119,189
LED MP	145,595	4,966	0.8736	48,922	2,990	0.5260	29,449
LED Candelabra MP	72,001	2,456	0.4320	20,975	1,480	0.2602	12,636
LED Downlight MP	64,020	2,184	0.3841	18,761	1,317	0.2316	11,311
LED String Light	34,176	53	0.2051	267	32	0.1233	160
LED Smart Bulb	24,458	834	0.1467	7,125	502	0.0883	4,286
LED Omni	8,410	287	0.0505	2,450	173	0.0304	1,476
LED	6,249	213	0.0375	1,821	128	0.0226	1,096
LED MR MP	5,368	183	0.0322	1,564	110	0.0194	942
LED Downlight	5,084	173	0.0305	1,481	104	0.0184	892
LED Candelabra	1,931	66	0.0116	563	40	0.0070	339
LED Shop Light	1,484	17	0.0045	278	11	0.0027	168
LED MR	253	9	0.0015	74	5	0.0009	45
Lighting Totals	***980,767***	***32,308***	***5.8801***	***302,283***	***19,454***	***3.5405***	***181,989***
Electronics							
TVs	9,642	797	0.0964	4,783	659	0.0796	3,951
Soundbars	1,992	88	0.0040	617	73	0.0033	511
Electronics Totals	***11,634***	***885***	***0.1004***	***5,400***	***731***	***0.0829***	***4,462***
Grand Total	**1,013,285**	**36,172**	**6.4692**	**340,276**	**22,654**	**4.0285**	**213,465**

As noted above, the AEG team completed a tracking system review to verify whether the Upstream Initiative measure savings were accurately claimed based on the TRM. The AEG team confirmed that most of the Upstream Initiative measures accurately used the TRM values for the first-year customer, system, and net MWh and MW. The AEG team found discrepancies in the estimated EUL for several measures resulting in adjustments to lifetime savings; for details, see the tracking system findings in Table 2-13. Overall, the verification process of the Upstream Initiative demonstrated accuracy on the part of Hawai'i Energy in terms of capturing measure level first-year savings across a wide range of technologies. The table below summarizes the claimed and verified results by equipment type for the Upstream Initiative.

Table 2-11 Upstream Initiative Claimed and Verified Program Level Results

Equipment Type	Claimed Program Level First-Year MWh	Verified Program Level First-Year MWh	Realization Rate	Claimed Program Level First-Year MW	Verified Program Level First-Year MW	Realization Rate	Claimed Program Level Lifetime MWh	Verified Program Level Lifetime MWh	Realization Rate
Appliances									
Clothes Washers - Tier I	723	723	100%	0.1395	0.1395	100%	7,957	7,957	100%
Clothes Washers - Tier II	457	457	100%	0.0874	0.0874	100%	5,023	5,023	100%
Clothes Dryers	392	392	100%	0.0781	0.0781	100%	5,487	5,487	100%
Dehumidifiers	289	289	100%	0.0329	0.0329	100%	3,464	3,464	100%
Air Purifiers	198	198	100%	0.0228	0.0228	100%	1,782	1,782	100%
Heat Pumps	177	177	100%	0.0228	0.0228	100%	1,772	2,658	150%
Advanced Power Strip - Tier I	130	130	100%	0.0146	0.0146	100%	651	651	100%
Dishwasher	49	49	100%	0.0052	0.0052	100%	538	538	100%
Smart Thermostats	41	41	100%	-	-		123	123	100%
Freezer	12	12	100%	0.0014	0.0014	100%	206	206	100%
Clothes Washers - Tier III	1	1	100%	0.0002	0.0002	100%	11	11	100%
Appliance Totals	***2,469***	***2,469***	***100%***	***0.4050***	***0.4050***	***100%***	***27,014***	***27,900***	***103%***
Lighting									
LED Omni MP	12,562	12,562	100%	2.2097	2.2097	100%	119,189	107,289	90%
LED MP	2,990	2,990	100%	0.5260	0.5260	100%	29,449	25,538	87%
LED Candelabra MP	1,480	1,480	100%	0.2602	0.2602	100%	12,636	12,636	100%
LED Downlight MP	1,317	1,317	100%	0.2316	0.2316	100%	11,311	11,245	99%
LED Smart Bulb	502	502	100%	0.0883	0.0883	100%	4,286	4,286	100%
LED Omni	173	173	100%	0.0304	0.0304	100%	1,476	1,476	100%
LED	128	128	100%	0.0226	0.0226	100%	1,096	1,096	100%
LED MR MP	110	110	100%	0.0194	0.0194	100%	942	942	100%
LED Downlight	104	104	100%	0.0184	0.0184	100%	892	892	100%
LED Candelabra	40	40	100%	0.0070	0.0070	100%	339	339	100%
LED Shop Light	11	11	100%	0.0027	0.0027	100%	168	262	156%
LED MR	5	5	100%	0.0009	0.0009	100%	45	45	100%

Equipment Type	Claimed Program Level First-Year MWh	Verified Program Level First-Year MWh	Realization Rate	Claimed Program Level First-Year MW	Verified Program Level First-Year MW	Realization Rate	Claimed Program Level Lifetime MWh	Verified Program Level Lifetime MWh	Realization Rate
LED String Light	32	1	4%	0.1233	0.0050	4%	160	7	4%
Lighting Totals	***19,454***	***19,423***	***100%***	***3.5405***	***3.4221***	***97%***	***181,989***	***166,052***	***91%***
Electronics									
TVs	659	659	100%	0.0796	0.0796	100%	3,951	3,951	100%
Soundbars	73	73	100%	0.0033	0.0033	100%	511	511	100%
Electronics Totals	***731***	***731***	***100%***	***0.0829***	***0.0829***	***100%***	***4,462***	***4,462***	***100%***
Upstream Totals	**22,654**	**22,624**	**100%**	**4.0285**	**3.9101**	**97%**	**213,465**	**198,414**	**93%**

Downstream Prescriptive Measures

The REEM program included downstream incentives to encourage the purchase of high-efficiency equipment through trade allies, as post-consumer rebates, and for removal of older or extra refrigerators and freezers. To assess the savings associated with these measures, the AEG team conducted a tracking system review to verify all measures for compliance with the TRM. Additionally, the AEG team conducted desk reviews for a subset of measures across three strata, shown in the table below[18]. The desk reviews assessed the accuracy of the tracking system measure descriptions, quantities indicated on invoices, equipment capacities, and other factors that would demonstrate installation (or removal in the case of refrigerator/freezer recycling/trade-ins) of a specific measure.

Table 2-12 Downstream Prescriptive Measure Desk Review Sample

Strata	PY2019 Count of Rebates	Number of Completed Desk Reviews
Refrigerator/Freezer Bounty/Trade-In	4,122	12
HVAC	3,825	21
Solar Hot Water Heater	1,319	9
Total	**9,266**	**42**

The AEG team designed the sample stratification to capture large groups of downstream measures that demonstrated fundamentally different technologies and potential differences in trade allies or program delivery. The HVAC category included a range of possible measures covering variable refrigerant flow heat pumps, window air conditioners, and heat pump water heaters. As a measure, solar hot water heater projects reflected a new solar water heating system. In contrast, refrigerator/freezer bounty/trade-in measures reflected the removal of supplemental residential refrigerators or the turn-in of old refrigerators after a new refrigerator purchase.

Tracking Review

As noted above, the AEG team completed a census analysis of REEM projects tracked in the database to verify the conformance of savings to the TRM. In most cases, Hawai'i Energy accurately applied the first-year TRM savings to REEM measures. However, the AEG team found discrepancies for several measures resulting in adjustments to lifetime savings. In Table 2-13, we describe the observation and effect on verified savings for these measures.

[18] Per the PY2019 Detailed Verification Work Plan, the split of desk reviews among measure types was based on contribution of first-year savings.

Table 2-13 REEM Tracking System Adjustments Summary

Measure	Observation	Verification Decision and Result
Measures with Increased Savings		
Residential Faucet Aerator	For 25 RebateIDs, savings were claimed using a 5-year EUL	Verified savings used the 10-year EUL stipulated in the PY19 TRM, which increased lifetime savings
Residential Heat Pump Water Heater	Claimed lifetime savings used a 10-year EUL	Verified savings used the 15-year EUL stipulated in the PY19 TRM, which increased lifetime savings
Residential LED Shop Light	Claimed lifetime savings used a 15-year EUL	Verified savings used the 25-year EUL stipulated in the PY19 TRM, which increased the lifetime savings
Measures with Decreased Savings		
Residential Refrigerator/Freezer	Claimed lifetime savings used a 14-year EUL	Verified savings used the weighted deemed lifetime values stipulated in the PY19 TRM, which decreased lifetime savings
Residential Refrigerator	For 10 RebateIDs, savings were claimed using a previous TRM value	Verified savings used the PY19 TRM deemed values, which decreased first year, peak demand, and lifetime savings
Residential Smart Thermostat	For 13 RebateIDs, savings were claimed using an 11-year EUL	Verified savings used the 3-year EUL stipulated in the PY19 TRM, which decreased lifetime savings
Residential Solar Water Heater	Claimed lifetime savings used a 20-year EUL	Verified savings used the 18-year EUL stipulated in the PY19 TRM, which decreased lifetime savings
Residential LEDs	Claimed lifetime savings used a 15-year EUL	Verified savings used the weighted early retirement deemed lifetime values stipulated in the PY19 TRM, which decreased the lifetime savings
Residential LED String Light	Claimed savings used 1.56 kWh/bulb	Verified savings used 0.065184 kWh/bulb as stipulated in the PY19 TRM, which decreased first year, peak demand, and lifetime savings
Residential VRF Split	Claimed savings for 5 RebateIDs did not use the correct ELFH and coincidence factor for the equipment type	Verified savings used the ELFH and coincidence factor stipulated in the PY19 TRM, which decreased first year, peak demand, and lifetime savings

The AEG team notes that 30 custom rebates were recorded under REEM rather than the CREEM program. These projects totaled over 72 MWh first-year customer savings and were not verified (savings were not adjusted). In the future, it may be beneficial to record all custom residential projects or measures under the CREEM program to ensure consistency with program categories and purposes.

Desk Reviews

The AEG team received the available documentation from Hawai'i Energy for each of the sampled rebates. The documentation included incentive application forms, invoices, and other materials that demonstrated a measure had been installed, or service had been performed. Across the 42 desk reviews, the AEG team found 17 projects with differences between the project documentation, the data recorded in the tracking system, and the TRM. The adjusted measures included refrigerator trade-up and recycling, VRF Split System AC ≥20,000 <30,000 Tier 2, and solar hot water heaters. Details for these projects include:

- Incorrect EUL. For three refrigeration recycling projects, the EUL for the claimed savings was tracked at 14 years, which was also reflected in the lifetime savings calculations. The EUL for refrigeration recycling projects is only eight years. Similarly, for all nine solar hot water heater projects, the EUL was tracked at 20 years, while the TRM value for EUL is 18 years. These adjustments led to decreased lifetime savings and were confirmed as systematic through the tracking system review. The affected

RebateIDs were a0h1B00000YhgMEQAZ, a0h1B00000YhnR7QAJ, a0h1B00000YhzayQAB, a0h1B00000a6AezQAE, a0h1B00000a6GpKQAU, a0h1B00000YhacKQAR, a0h1B00000YhagGQAR, a0h1B00000YhjKuQAJ, a0h1B00000YWYr7QAH, a0h1B00000YWZ6KQAX, a0h1B00000YWZyuQAH, and a0h1B00000YWZz4QAH.

- **Incorrect calculation of lifetime savings.** For refrigeration projects with trade-in, the reported lifetime was calculated by using the full EUL for a refrigerator of 14 years multiplied by the first-year savings, rather than using the deemed lifetime savings from the TRM. The deemed lifetime savings in the TRM accounts for the dual baseline of 8 years for the first period and a total duration of 14 years for the new refrigerator operation. This finding was also part of the tracking system review findings and led to decreased lifetime savings for these projects. The affected RebateIDs were a0h1B00000YhgxFQAR, a0h1B00000YhjX0QAJ, and a0h1B00000YhqAxQAJ.
- **Incorrect equipment efficiency rating.** For RebateID a0h1B00000a6CipQAE, this project reported the installation of a 2-ton variable refrigeration flow (VRF) split system in a single-family home in Oahu. The AEG team found the claimed savings used an energy efficiency ratio (EER) of 14.2 for the unit, while the AHRI certification listed 13.4 for the EER. This adjustment led to a reduction in the demand savings for this project.
- **Incorrect equipment capacity.** For RebateID a0h1B00000YhYdsQAF, this project reported the installation of a 2-ton variable refrigeration flow split system in a single-family home in Hawaii. The AEG team found that the nominal capacity of the unit (24,000 Btuhs) was used in the savings rather than the rated capacity (21,400 Btuhs). The reduction in capacity for the input formulas led to a reduction in first-year energy, demand, and lifetime savings.

All other discrepancies between the claimed and verified savings were due to rounding. The AEG team used the deemed savings in the TRM, whereas Hawai'i Energy's tracking system uses the unrounded output of a measure's TRM algorithm, resulting in minor savings differences. In some cases, the rounding increased savings from the TRM deemed value, and in other cases, it decreased the savings. The aggregate effect of rounding has not been quantified separately but is reflected in the overall verified results.

The AEG team made several observations for different measures as a part of the desk review process that did not result in savings adjustment.[19] Key observations include:

- **The correct incentives were paid.** As part of the desk reviews, the AEG team reviewed whether the correct incentive payments were made by Hawai'i Energy for each of the projects in the desk review sample at closeout. For the REEM program, almost all projects reviewed appeared to have correct incentives paid out based on the program criteria, except for one. One HVAC project documented that it paid out a $250 incentive in the project documentation, while a $150 incentive was tracked in the tracking system. It was unclear whether this project received an increased COVID-19 incentive, which could explain the discrepancy.
- **Solar hot water heater baselines were not sufficiently covered in TRM.** As described in the PY2017 and PY2018 Verification Reports and observed again for PY2019, for some of the solar hot water heater desk reviews, project documentation noted that a solar water heater was the prior water heater type installed on the home. While Hawai'i Energy followed the TRM for purposes of claiming savings, the application form captured the type of water heater in-place prior to the new solar water heater. The TRM assumes an electric resistance water heater is the baseline water heater type. Given the

[19] The AEG team has already addressed these observations, as well as many of those documented in the Business Programs section, as part of the PY2019 (and PY2020) TRM update process. As a result, Hawai'i Energy is aware of these findings via TRM memos. This means the findings presented here are not new recommendations, however, the AEG team felt it was still important to include key observations as part of this Verification Report.

prevalence of solar water heaters in Hawaii and new construction code requirements for homes to have solar water heaters, it may be beneficial for the TRM to address varying potential baseline conditions to more accurately capture general market or customer specific baseline conditions. The AEG team also recommends conducting research to investigate developing an NTG ratio that is customized for the residential solar water heater measure in Hawaii.

- Semi-prescriptive calculations and average deemed values. During the verification activities, the AEG team noted for TRM measures where semi-prescriptive calculations were available, Hawai'i Energy claimed savings using the deemed values. Similarly, while category-specific deemed values were available for some measures, Hawai'i Energy used the "Average" category when available. The AEG team notes that using semi-prescriptive calculations when the inputs are tracked or collected on the application forms would increase the accuracy of the savings for these measures. When the product categorization is sufficiently known, using the product category rather than the "Average" value would also increase accuracy. However, the AEG team notes the use of deemed values and "Average" categories would not significantly affect the savings at the program level.

Overall, the desk review realization rates were near 100 percent. For the lighting and midstream stratums, the sample adjustment factors were 100 percent because all of the findings confirmed through the desk reviews were made as part of the systematic tracking system review. The HVAC sample adjustment factors were slightly lower than 100 percent due to the VRF equipment efficiency ratings and equipment capacity findings. These desk review adjustment factors were applied to savings verified after the tracking system review.

Table 2-14 Strata Level Adjustments for REEM Desk Reviews, Customer Level[20]

Strata	Unique Rebate Counts	Claimed Sample Savings First-Year MWh	Claimed Sample Savings MW	Claimed Sample Savings Lifetime MWh	Sample Adjustment Factor First-Year MWh	Sample Adjustment Factor MW	Sample Adjustment Factor Lifetime MWh
Midstream	4,198	3,183	0.3651	44,562	100.0%	100.0%	100.0%
HVAC	2,644	5,533	0.5604	81,291	98.4%	97.9%	98.3%
Lighting	1,319	2,621	0.3895	52,427	100.0%	100.0%	100.0%
Total	**8,161**	**11,338**	**1.3151**	**178,280**	**N/A**	**N/A**	**N/A**

Residential Hard to Reach

The RHTR program delivered directly installed measures to households that could be hard to reach via other residential program mechanisms. Hawai'i Energy installed measures such as screw-in lamps, faucet aerators, smart power-strips, and showerheads at multifamily dwellings. Additionally, the program offered incentives for refrigerators and solar hot water heaters. Savings were primarily driven by measures subject to the TRM. However, a portion of the energy savings (approximately 27 percent) was driven by custom projects not described in the tracking database. The AEG team focused verification activities on analyzing the accuracy of deemed measures subject to TRM savings relative to the claimed savings. The AEG team also checked quantities for reasonableness. A census analysis of the RHTR projects tracked in the database and desk reviews for a sample of five custom projects was also completed.

[20] The overall sampling of REEM desk reviews and the results for customer first-year kWh, the basis for sampling, was +/-1.2 percent with 90 percent confidence using a ratio estimator. For more information on ratio estimator confidence and precision calculations, please see the Uniform Methods Project Sample Design Cross-Cutting Protocol, Chapter 11: https://www.nrel.gov/docs/fy17osti/68567.pdf

RHTR Verified Savings

The AEG team determined an overall savings verification of:

- 113.1 percent for program level MWh
- 123.5 percent of program level MW
- 108.8 percent of program level lifetime MWh

The AEG team found discrepancies in the tracking data and the desk reviews resulting in realization rates over 100 percent for net energy and demand savings. Additionally, there were minor discrepancies in demand savings for some measures due to rounding. Table 2-15 through Table 2-17 summarizes the results for first-year program MWh and MW, and lifetime program savings.

Table 2-15 RHTR Program Level MWh Claimed and Verified Results

Measure Category	Claimed Program Level First-Year MWh	Verified Program Level First-Year MWh	Realization Rate
Custom	926	1,149	124.0%
Lighting	420	420	100.0%
Water Heating	269	269	100.0%
Plug/Process	73	73	100.0%
Appliances	5	5	100.0%
Upstream	1	1	100.0%
Total	**1,695**	**1,917**	**113.1%**

Table 2-16 RHTR Program Level MW Claimed and Verified Results

Measure Category	Claimed Program Level First-Year MW	Verified Program Level First-Year MW	Realization Rate
Custom	0.2770	0.3904	140.9%
Water Heating	0.1227	0.1227	100.0%
Lighting	0.0740	0.0740	100.0%
Plug/Process	0.0082	0.0082	100.0%
Appliances	0.0006	0.0006	100.0%
Upstream	0.0001	0.0001	100.0%
Total	**0.4826**	**0.5959**	**123.5%**

Table 2-17 RHTR Program Level Lifetime MWh Claimed and Verified Results

Measure Category	Claimed Program Level Lifetime MWh	Verified Program Level Lifetime MWh	Realization Rate
Custom	10,537	12,191	115.7%
Lighting	3,591	3,591	100.0%
Water Heating	2,325	2,195	94.4%
Plug/Process	364	364	100.0%
Appliances	71	40	56.0%
Upstream	6	6	100.0%
Total	**16,894**	**18,386**	**108.8%**

Tracking Review

The AEG team completed a census analysis of RHTR projects tracked in the database to verify the conformance of savings to the TRM. In general, Hawai'i Energy successfully applied the TRM to RHTR measures. However, there were discrepancies in three measures that resulted in adjustments to the savings. The table below describes the observation and effect on verified savings for this measure.

Table 2-18 RHTR Tracking System Adjustments Summary

Measure	Observation	Verification Decision and Result
Energy Kit	Program-level claimed savings used the CREEM NTG ratio of 0.65	Verified program level savings used the RHTR NTG ratio of 1.0, which increased program level savings for all metrics
Residential Refrigerator/Freezer	Claimed lifetime savings used a 14-year EUL	Verified savings used the weighted early retirement deemed lifetime values stipulated in the PY19 TRM, which decreased lifetime savings
Residential Solar Water Heater	Claimed lifetime savings used a 20-year EUL	Verified savings used the 18-year EUL stipulated in the PY19 TRM, which decreased lifetime savings

Desk Reviews

The AEG team received from Hawai'i Energy the available documentation for a sample of five projects labeled as "Res Custom" in the tracking system. The documentation included incentive application forms, invoices, and other materials that demonstrated a measure had been installed or service had been performed. Across the five desk reviews, the AEG team found three projects with differences between the project documentation, the data recorded in the tracking system, and the TRM. The adjusted measures were refrigerator trade-ins. Details for these projects include:

- Incorrect calculation of lifetime savings. For three refrigeration projects with trade-in, the reported lifetimes were calculated by using the full EUL for a refrigerator of 14 years multiplied by the first-year savings, rather than using the deemed lifetime savings from the TRM. The deemed lifetime savings in the TRM accounts for the dual baseline of 8 years for the first period and a total duration of 14 years for the new refrigerator operation. This finding was also part of the tracking system review findings. The affected RebateIDs were a0h1B00000YhgxFQAR, a0h1B00000YhjX0QAJ, and a0h1B00000YhqAxQAJ.

Residential Energy Services and Maintenance

The RESM program incentivized tune-ups, by a participating contractor, for existing air conditioners or solar water heaters. RESM program savings represented roughly two percent of residential sector claimed savings. Because the tune-up measures had savings specified in the TRM, the focus of verification activities was to assess whether the TRM savings were correctly used for the purpose of claiming savings.

RESM Verified Savings

The AEG team determined an overall savings verification of:

- 100.0 percent for program level MWh
- 100.0 percent of program level MW
- 100.0 percent of program level lifetime MWh

Hawai'i Energy successfully applied the first-year TRM values to RESM measures. As a result, the realization rates for the program are 100 percent for energy and demand net savings. However, there was a

discrepancy in the A/C tune-up measure EUL resulting in an overall lifetime MWh realization rate above 200 percent. Table 2-19 through Table 2-21 summarizes the results.

Table 2-19 RESM Program Level First-Year MWh Claimed and Verified Results

Measure Category	Claimed Program Level First-Year MWh	Verified Program Level First-Year MWh	Realization Rate
Residential A/C Tune Up	1,296	1,296	100.0%
Solar Hot Water Heater Tune Up	165	165	100.0%
Total	**1,461**	**1,461**	**100.0%**

Table 2-20 RESM Program Level MW Claimed and Verified Results

Measure Category	Claimed Program Level First-Year MW	Verified Program Level First-Year MW	Realization Rate
Residential A/C Tune Up	0.2925	0.2926	100.0%
Solar Hot Water Heater Tune Up	0.0199	0.0199	100.0%
Total	**0.3124**	**0.3124**	**100.0%**

Table 2-21 RESM Program Level Lifetime MWh Claimed and Verified Results

Measure Category	Claimed Program Level Lifetime MWh	Verified Program Level Lifetime MWh	Realization Rate
Residential A/C Tune Up	1,296	3,889	300.1%
Solar Hot Water Heater Tune Up	825	825	100.0%
Total	**2,120**	**4,713**	**222.3%**

Tracking Review

The AEG team completed a census analysis of RESM projects tracked in the database to verify the conformance of savings to the TRM. Hawai'i Energy successfully applied the first-year TRM values to RESM measures. However, the lifetime savings for the A/C tune-up measure was adjusted for all projects. The table below describes the observation and effect on verified savings for this measure.

Table 2-22 RESM Tracking System Adjustments Summary

Measure	Observation	Verification Decision and Results
Residential A/C Tune Up	Claimed lifetime savings used a 1-year EUL	Verified savings used the 3-year EUL as stipulated in the PY19 TRM, which increased lifetime savings

Custom Residential Energy Efficiency Measures

The CREEM program enables Hawai'i Energy to incentivize energy efficiency projects for measures not included in the TRM. Described in the PY2019 Annual Plan as focusing on new construction, the AEG team found that 17 projects were completed in PY2019, and they were across a single unique account; this is similar to PY2018, where 19 projects were completed across a single unique account. All measures were identified as "Residential Custom – Other Not Listed" or "Residential Custom" measures. These projects at the single unique account level represented 0.3 percent of the total residential first-year MWh savings. Due to the low savings and lack of findings from the previous year's desk reviews, no desk reviews were conducted for PY2019. Also, a tracking system review could not be conducted because the granular data

needed is not available for the equipment under this program. As a result, the realization rates for CREEM were verified at 100 percent. The tables below summarize the CREEM program verified savings.

Table 2-23 CREEM Program Level MWh Claimed and Verified Results

Measure Category	Claimed Program Level First-Year MWh	Verified Program Level First-Year MWh	Realization Rate
Residential Custom	194	194	100.0%

Table 2-24 CREEM Program Level MW Claimed and Verified Results

Measure Category	Claimed Program Level First-Year MW	Verified Program Level First-Year MW	Realization Rate
Residential Custom	0.0079	0.0079	100.0%

Table 2-25 CREEM Program Level Lifetime MWh Claimed and Verified Results

Measure Category	Claimed Program Level Lifetime MWh	Verified Program Level Lifetime MWh	Realization Rate
Residential Custom	898	898	100.0%

Business Programs

In PY2019, Hawai'i Energy operated the following programs targeted at the business sector:

- Business Energy Efficiency Measures (BEEM)
- Business Hard to Reach (BHTR)
- Business Energy Services and Maintenance (BESM)
- Custom Business Energy Efficiency Measures (CBEEM)

Business program energy and demand savings were dominated by the CBEEM program, though BEEM and BHTR also contributed substantial savings. The business programs delivered a diverse set of options, enabling business sector customers to participate in several ways. These included prescriptive rebates, buy-down incentives with lighting distributors (Midstream initiative), direct-install measures, and custom measures.

The table below summarizes the source of total program savings by program or key component (in the case of BEEM). CBEEM provided over 48 percent of the business sector claimed program (net) savings, with BEEM providing another 41 percent. The remainder of the savings is attributed to BHTR at 10 percent and BESM at 0.4 percent.

Table 2-26 Business Claimed Program Level Results

Program Name	Component	Claimed Program Level First-Year MWh	Percent of First-Year Program Level Savings
CBEEM		26,898	48.4%
BEEM	Midstream	10,432	18.8%
	HVAC	6,434	11.6%
	Lighting	4,632	8.3%
	Other	1,313	2.4%
	Total	*22,811*	*41.0%*
BHTR		5,643	10.2%
BESM		228	0.4%
Total		**55,580**	**100.0%**

The verified program level results for the business programs are presented below, in Figure 2-2 and Table 2-27. Figure 2-2, on the left side, shows the percentage of the verified savings that each program represents, with the end-uses percentage shown on the right side. As reflected in Table 2-27, business program component realization rates were close to 100 percent, with the notable exception of the lifetime energy savings for the CBEEM program. This is expected, given the vast majority of business program measures were based on deemed savings from the TRM for the first year and lifetime impacts. The primary purpose of verification is to confirm Hawai'i Energy accurately applied the TRM.

Figure 2-2 Business Verified Program Level Impacts by Program and End-Use

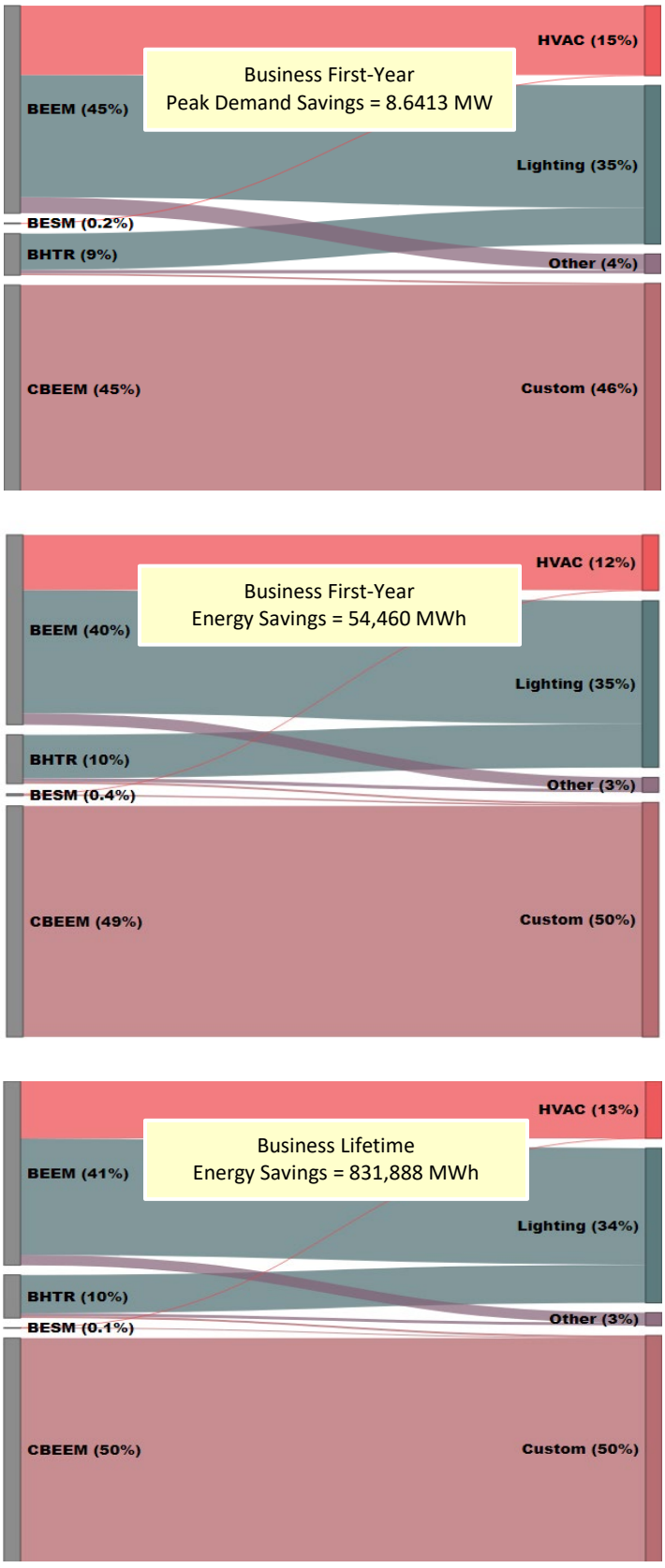


Table 2-27 Business Verified Program Level Results

Program Name	Component	Verified Program Level First-Year MWh	First-Year MWh Realization Rates	Verified First-Year Program Level Savings MW	First-Year MW Realization Rates	Verified Lifetime Program Level Savings MWh	Lifetime MWh Realization Rates
CBEEM		26,674	99.0%	3.9302	95.6%	412,891	71.0%
BEEM	Lighting	4,826	104.2%	0.7222	102.9%	57,889	101.4%
	HVAC	6,368	99.0%	1.3054	99.9%	105,235	99.1%
	Midstream	9,394	90.1%	1.5852	98.2%	156,624	97.7%
	Other	1,312	100.0%	0.3013	99.8%	18,798	98.9%
	Total BEEM	21,900	96.0%	3.9141	99.7%	338,546	98.8%
BHTR		5,658	100.3%	0.7836	100.3%	79,378	100.4%
BESM		228	100.0%	0.0134	100.0%	1,073	100.0%
Total		**54,460**	**98.0%**	**8.6413**	**98.2%**	**831,888**	**85.3%**

Below we describe the verification process and details used to inform the verified program level MWh and MW results for the business sector programs.

Business Energy Efficiency Measures

The BEEM program provided prescriptive incentives for standard energy efficiency technologies and utilized the TRM to claim savings for each project. BEEM savings represented 41 percent of Hawai'i Energy's business programs' first-year MWh savings. Lighting technologies represented 66 percent of those first-year energy savings, and most of the lighting savings originated from the Midstream initiative. Other measure categories included HVAC with about 28 percent of program savings, while water heating, pumps and motors, building envelope, submetering, and appliances (refrigerator trade-in), combined for about six percent of program savings.

BEEM Verified Savings

The AEG team determined an overall savings verification of:

- 96.0 percent for program level MWh
- 99.7 percent of program level MW
- 98.8 percent of program level lifetime MWh

The AEG team combined the BEEM tracking system review results with results from the sample of desk reviews to arrive at the total verified savings for the BEEM program. The tables below summarize the results by major category for program (net) level first-year MWh, MW, and lifetime MWh savings.

Table 2-28 BEEM Program Level First-Year MWh Claimed and Verified Results

Equipment Category	Claimed Program Level First-Year MWh	Verified Program Level First-Year MWh	Realization Rate
Midstream	10,432	9,394	90.1%
HVAC	6,434	6,368	99.0%
Lighting	4,632	4,826	104.2%
Other	1,313	1,312	100.0%
Total	**22,811**	**21,900**	**96.0%**

Table 2-29 BEEM Program Level MW Claimed and Verified Results

Equipment Category	Claimed Program Level First-Year MW	Verified Program Level First-Year MW	Realization Rate
Midstream	1.6148	1.5852	98.2%
HVAC	1.3066	1.3054	99.9%
Lighting	0.7020	0.7222	102.9%
Other	0.3017	0.3013	99.8%
Total	**3.9252**	**3.9141**	**99.7%**

Table 2-30 BEEM Program Level Lifetime MWh Claimed and Verified Results

Equipment Category	Claimed Program Level Lifetime MWh	Verified Program Level Lifetime MWh	Realization Rate
Midstream	160,294	156,624	97.7%
HVAC	106,236	105,235	99.1%
Lighting	57,075	57,889	101.4%
Other	19,010	18,798	98.9%
Total	**342,615**	**338,546**	**98.8%**

Tracking Review

The AEG team completed a census review of BEEM tracked projects that used the TRM to claim savings to assess conformance to the TRM. While the AEG team found measures with variances from the TRM, the effects of those variances were relatively minor overall. In general, Hawai'i Energy successfully applied the TRM to BEEM prescriptive measures. Below we describe observations and effects on verified savings.

- Rounding is creating minor variances. For 1,564 projects totaling 229,887 lighting measures, rounding practices affected realization rates. The AEG team used the deemed savings in the TRM, whereas Hawai'i Energy's tracking system uses the unrounded output of a measure's TRM algorithm, resulting in minor savings differences. In some cases, the rounding increased savings from the TRM deemed value, and in other cases, it decreased the savings. The aggregate effect of rounding has not been quantified separately but is reflected in the overall verified results.
- Some lighting measures did not follow the TRM dual baseline approach. The AEG team identified 545 projects totaling 66,491 lighting measures[21] where claimed savings did not follow the TRM dual baseline stipulated lifetime energy savings. The claimed savings was not in line with the TRM stipulated lifetime energy savings values based on the dual baseline for early replacement measures. The

[21] There were 299,070 lighting measures installed in BEEM, so this finding represented 22 percent of the total lighting measures.

stipulated lifetime energy savings for early replacement lighting measures were used in verification savings, which increased lifetime energy savings.

- **Incorrect equivalent full load cooling hours and coincidence factor for VRFs.** One project totaling one split VRF system was found to be using incorrect equivalent full load cooling hours (EFLH) of 2,528 and coincidence factor (CF) of 0.36 for units less than 30,000 BTU/hr. This unit was documented in the tracking system to be greater than 30,000 BTU/hr, for which the TRM stipulates the use of an EFLH of 1,884 hours and a CF of 0.27. This reduced energy and demand savings for this measure.
- **LED exit sign factors not used.** The AEG team found that the claimed savings for 15 LED exit sign projects totaling 87 measures used the TRM prescriptive annual hours of operation by building type rather than TRM stipulated 8,760 annual hours of operation (24-hour operation) specified for exit signs. The AEG team also found that these measures incorporated interactive effects factors for energy and demand into their claimed savings, which are not incorporated into the TRM methodology for LED exit signs. The AEG team applied the TRM deemed savings per unit for these measures, which increased energy, demand, and lifetime savings.
- **Incorrect EUL for refrigerated case lighting**. Two LED refrigerated case lighting projects totaling 140 measures were found to be using an incorrect EUL of five years instead of the TRM stipulated eight years. A EUL of eight years was used in verification savings, which increased lifetime energy savings.
- **Zero demand savings for VRF measures.** Five projects totaling five residential VRF split system measures (building type is multi-family, master-metered) were found to have zero reported demand savings. For these measures, the TRM baseline EER was found to be higher than the efficient equipment EER. Verification savings used the TRM stipulated EER and EER of the new equipment, which resulted in negative demand verification savings.
- **Some solar water heater savings cannot be verified.** The AEG team was not able to verify savings for one solar water heater. The calculation in the TRM requires site-specific data that was not captured in the tracking database. It may be appropriate to record these as custom measures to separate them from the prescriptive Solar Hot Water projects where savings are fully calculated by TRM algorithms. There were no adjustments made to the savings for these measures.
- **No catalog entry for lighting products in the tracking system.** Nine projects, totaling 601 midstream lighting measures, did not report a lighting type in the "Reporting_Equipment_Type__c" field. This field typically captured detailed lighting descriptions such as lamp type, length, size, and wattage. This information was gathered from other fields in the database. No savings adjustments resulted from this finding.

The tracking system review revealed that, in general, Hawai'i Energy correctly used the TRM for BEEM claimed savings. The most substantial changes related to first-year energy savings were due to LED exit signs using incorrect annual hours of operation and CFs and using unrounded TRM savings for lighting measures instead of rounded TRM stipulated savings.

Desk Reviews

The AEG team selected a sample of projects to receive desk reviews to confirm that parameters and algorithms were successfully applied based on project documentation. In PY2017 and PY2018, the AEG team used three strata for desk review sampling: Midstream Lighting, non-Midstream Lighting, and HVAC. Due to the increased contribution from the other measures in PY2019, at six percent, an "Other" stratum was included. The unit for sampling was the individual rebate, which may include multiple measures.

The 30 desk reviews sample was allocated with a priority to the "HVAC and Other measures" strata due to overall project complexity (HVAC) and increasing savings compared to previous program years (Other). The lighting sample sizes were based on the approximate percentage share each stratum represented of total program savings within the four strata. The table below summarizes the sample design.

Table 2-31 BEEM Desk Review Sample

BEEM Stratum	Total BEEM Strata MWh Savings	Total BEEM Sampled MWh Savings	Percent Sampled Strata Savings	Desk Review Sample
Midstream	13,223	518	45.6%	10
HVAC	8,211	147	28.3%	8
Lighting	5,915	186	20.4%	5
Other	1,674	139	5.8%	7
Total	**29,023**	**991**	**100.0%**	**30**

The desk review realization rates were developed at the stratum level and applied to the program population of the stratum. For example, the HVAC stratum desk review realization rates were applied to the entire BEEM HVAC stratum savings. The desk reviews enabled the AEG team to verify the degree to which tracked savings aligned with project-level details and the completeness of the project documentation collected by Hawai'i Energy. Information on the application of realization rates to the program populations is found in Appendix C. Because all of the measures reviewed used the TRM, savings were only adjusted for variances around quantities on incentive applications, invoices, equipment descriptions, or other factors (such as building type) if documentation indicated a difference that would affect the savings.

The AEG team reviewed the incentive payments made by Hawai'i Energy for each of the projects in the desk review sample. For the BEEM program, the AEG team did not find any cases of an incorrect incentive paid at the time of project closeout. The AEG team also found that for a given rebate, while multiple measures of the same type (i.e., multiple lighting measures) were often included, multiple end-uses were seldom included. This was a change from previous years, where different end uses were often included in the same rebate.

The AEG team identified desk review adjustments for 23 projects. Observations and adjustments were:

- Deemed lifetime savings adjustments. For eight projects, adjustments were made to the lifetime savings for individual measures where the tracking system savings differed from the TRM deemed savings values.
    - RebateIDs a0h1B00000a61A4QAI, a0h1B00000a61AEQAY, and a0h1B00000a66ExQAI – These three rebates were for refrigerator recycling measures at multi-family master-metered facilities. The claimed savings determined lifetime savings by multiplying the EUL (tracked at 14 years) by the annual savings rather than using the TRM deemed value for lifetime energy savings. The deemed lifetime savings for refrigerator recycling has an implied EUL of eight years. Adjusting to the deemed lifetime savings value resulted in reduced lifetime energy savings for these measures.
    - RebateIDs a0h1B00000YhaPGQAZ and a0h1B00000YhZ8sQAF – These two rebates were for refrigerator trade-up measures at multi-family master-metered facilities. The claimed savings determined lifetime savings by multiplying the EUL (tracked at 14 years) by the annual savings rather than using the TRM deemed value for lifetime energy savings. The deemed lifetime savings for refrigerator recycling has an implied EUL of 8.4 years. Adjusting to the deemed lifetime savings value resulted in reduced lifetime energy savings for these measures.

  - RebateIDs a0h1B00000a62BaQAI and a0h1B00000a62BLQAY – These two rebates were for multiple lighting replacements, including refrigerated case lighting kits. For the refrigerated case lighting kits, lifetime savings were verified to the TRM values for the corresponding kit type. The lifetime savings in the tracking data appeared to use an older TRM value. Adjusting these values increased lifetime savings for these measures.
  - RebateID a0h1B00000Yhi7OQAR – For linear LEDs in this project, lifetime savings were verified to the TRM values for the corresponding measure type. The claimed lifetime savings were calculated by multiplying annual savings by the tracked EUL value. Adjusting these values to the deemed lifetime savings increased the lifetime savings for this project.

- **Deemed first-year energy and demand savings adjustments.** There were first-year energy or demand savings adjustments for three projects within the desk review sample where the claimed savings did not match the TRM values.
  - RebateID a0h1B00000a68TBQAY – For measures titled LED: Linear Type A-4 ft. Lamp, LED: Linear Type A-8 ft. Lamp, exit signs, and corn cob LEDs, the savings values used for the claimed savings were different from the deemed values in the TRM. Adjusting to the TRM values resulted in decreased savings for energy, demand, and lifetime energy savings.
  - RebateID a0h1B00000Yhi7OQAR – For PAR30s, the claimed annual energy savings were calculated using a value of 97.7 instead of the TRM-verified 97.2 kWh. Savings were verified using the TRM value of 97.2 kWh per fixture. This adjustment resulted in slightly lower energy savings for this measure.
  - RebateID a0h1B00000YWCZqQAP – For measures titled LED: Linear Type A-4 ft. Lamp, and LED: Linear Type A-8 ft. Lamp, exit signs, and corn cob LEDs, the claimed savings values used values that are different from those in the TRM. Adjusting to the TRM values resulted in decreased savings for energy, demand, and lifetime energy savings.
- **Measure baseline adjustment.** For RebateID a0h1B00000a62BLQAY, the claimed savings for this rebate used a replace-on-burnout baseline for refrigerator light case replacement. The AEG team confirmed that the baseline for these measures was an early retirement. Adjusting to the early retirement baseline led to increased lifetime savings for this measure.
- **Calculation error.** RebateID a0h1B00000YhbylQAB was for a variable frequency drive (VFD) installed on an HVAC supply fan. The AEG team used the Energy Savings Factor from the TRM (49.8%), whereas the claimed savings calculation used a factor of 123 (effectively 12300%). This created a very large savings adjustment to both first-year and lifetime savings. The AEG team reviewed the other VFD measures in the tracking data and determined that this error did not affect any other projects. Therefore, this adjustment was treated as a stand-alone adjustment made only to this individual rebate's savings and was not included in the overall realization rate adjustments for the program.
- **Minor rounding issues.** For 10 rebates, the AEG team used the values as shown in the TRM, which are rounded to three decimal places for kW and two for kWh values, while the tracking system used the individual derivation calculations as shown in the TRM, which are out to at least eight decimal places. These deviations are minor compared to other desk review findings.

The AEG team developed strata level realization rates based on the strata level sample results. First, any duplicate findings from the tracking system were removed from the desk review results to eliminate the double-counting of adjustments. Second, the sample was examined for stand-alone adjustments, which were not representative of the overall population (e.g., the AEG team identified the adjustment to the VFD HVAC measure as a stand-alone measure, and it was not included in the strata level realization rates).

Finally, these realization rates were applied to each measure in their strata in the tracking system for the total program verified savings.

Overall, most of the desk review realization rates were near 100 percent. For the lighting strata, the first-year energy and demand realization rates were 104 percent, resulting from an adjustment to an early retirement baseline from a replace-on-burnout baseline. The realization rates for Midstream first-year and lifetime MWh, 90 percent and 92 percent, were affected by adjustments to deemed values that differed from the TRM values. Similarly, the 99 percent realization rate for lifetime savings for the Other strata was also driven by lifetime savings values that did not match the TRM. The table below presents the desk review adjustments for each of the four sampled BEEM strata. These desk review adjustment factors were applied to savings verified after the tracking system review.

Table 2-32 Strata Level Adjustments for BEEM Desk Reviews, Customer Level

Strata	Unique Rebate Counts	Claimed Sample Savings First-Year MWh	Claimed Sample Savings MW	Claimed Sample Savings Lifetime MWh	Sample Adjustment Factor First-Year MWh	Sample Adjustment Factor MW	Sample Adjustment Factor Lifetime MWh
Midstream	194	13,223	2.0491	202,875	90.0%	100.2%	92.0%
HVAC	147	8,211	1.6674	135,584	100.0%	99.9%	100.0%
Lighting	134	5,915	0.8965	72,862	104.1%	104.2%	100.4%
Other	258	1,674	0.3855	24,259	100.0%	100.0%	98.9%
Total	**733**	**29,023**	**4.9984**	**435,579**	**N/A**	**N/A**	**N/A**

Custom Business Energy Efficiency Measures

The CBEEM program provided incentives for energy saving measures not covered by prescriptive incentives. Project-specific calculations estimated the energy savings and determined the incentive offered to the customer. In PY2019, Hawai'i Energy claimed approximately 34.4 million kWh in customer-level savings from CBEEM, 48 percent of PY2019 business program energy savings. A total of 282 unique customer accounts completed CBEEM projects. CBEEM projects fall into the following three groups: Custom Lighting, Custom HVAC, and Custom. Custom Lighting measures accounted for over 84 percent of the claimed CBEEM energy savings, Custom projects accounted for approximately 11 percent of savings, and Custom HVAC projects accounted for the final four percent of savings.

CBEEM Verified Savings

The AEG team determined an overall savings verification of:

- 99.2 percent for program level MWh
- 96.3 percent of program level MW
- 74.7 percent of program level lifetime MWh

Of the 30 desk reviews completed, the AEG team adjusted savings for 23 projects. The most prominent desk review adjustments were to the lifetime MWh savings. The lifetime MWh savings were verified at 74.7 percent due to adjustments around the application of EULs or deemed lifetime savings. The AEG team made adjustments to lifetime MWh savings for 19 desk reviews. Adjustments were also a result of various other items, such as the count or type of equipment installed, lighting schedule assumptions, or inconsistent application of EULs for lifetime MWh calculations. Appendix C summarizes the results for the 23 projects where adjustments were made.

As part of the desk reviews, the AEG team also assessed whether Hawai'i Energy made the correct incentive payments for each sampled project. The AEG team determined that Hawai'i Energy paid the correct incentive at the time of project closeout for all 30 projects.

Verified savings were compared to the claimed savings for each stratum. The realization rate for a stratum's sample was applied only to that stratum. Then, the verified savings for each stratum were summed to obtain the program's total verified savings. The overall realization rates were then calculated at the program level. The measure and program level savings of each stratum are summarized in Table 2-33 through Table 2-35 below for MWh, MW, and lifetime MWh. While individual project results varied, the aggregate realization rates for CBEEM were within five percent of program level for first-year MWh and MW claimed savings.

Table 2-33 CBEEM Program Level First-Year MWh Claimed and Verified Results

Strata	Number of Claimed Projects	Claimed Program Level First-Year MWh	Verified Program Level First-Year MWh	Realization Rate
Lighting - Medium	89	7,208	6,954	96.5%
Lighting - Certainty	4	6,446	6,449	100.0%
Lighting - High	27	7,194	7,221	100.4%
Custom	26	2,895	2,895	100.0%
Lighting - Low	127	1,956	1,956	100.0%
HVAC	9	1,198	1,198	100.0%
Total	**282**	**26,898**	**26,674**	**99.2%**

Table 2-34 CBEEM Program Level MW Claimed and Verified Results

Strata	Number of Claimed Projects	Claimed Program Level MW	Verified Program Level MW	Realization Rate
Lighting - High	27	1.1012	1.1115	100.9%
Lighting - Certainty	4	1.1092	1.1098	100.1%
Lighting - Medium	89	1.0639	0.9095	85.5%
Custom	26	0.3811	0.3856	101.2%
Lighting - Low	127	0.2982	0.2848	95.5%
HVAC	9	0.1291	0.1291	100.0%
Total	**282**	**4.0828**	**3.9302**	**96.3%**

Table 2-35 CBEEM Program Level Lifetime MWh Claimed and Verified Results

Strata	Number of Claimed Projects	Claimed Lifetime Program Level MWh	Verified Lifetime Program Level MWh	Realization Rate
Lighting - High	27	166,445	137,039	82.3%
Lighting - Medium	89	142,066	94,175	66.3%
Lighting - Certainty	4	141,929	79,656	56.1%
Custom	26	48,461	48,685	100.5%
Lighting - Low	127	32,225	31,698	98.4%
HVAC	9	21,638	21,637	100.0%
Total	**282**	**552,763**	**412,891**	**74.7%**

Desk Reviews

The AEG team designed the CBEEM desk review sample to enable the verified savings of the sampled projects to be applied to the program population. Rather than focusing strictly on project type (the groups mentioned above), the AEG team developed a two-tiered sampling approach. First, the projects were stratified based on the three equipment type groups mentioned above. The lighting strata, which represents over 92 percent of the claimed savings, was further divided into four sub-strata based on project size. Desk reviews were allocated to each stratum with a goal of achieving a sampled project result of no less than +/- 10 percent precision with 90 percent confidence. The desk review samples were distributed in the following manner:

- A total of 30 desk reviews was first distributed based on equipment type strata (Lighting, HVAC, and Custom) by overall kWh savings represented in the strata.
- Due to the complexity of projects, the strata for HVAC and Custom were oversampled[22] at the expense of Lighting. This resulted in three desk reviews for Custom, four for HVAC, and 23 for Lighting.
- The desk reviews for Lighting were then allocated across four sub-strata (Low, Medium, High, Certainty), with a census of the four projects in the Certainty strata.
- Finally, the additional desk reviews for the High, Medium and Low Lighting stratum (19 in total) were allocated by the Neyman allocation[23] proportion for each stratum. The results are described in Table 2-36 below.

Table 2-36 CBEEM Stratification and Final Sample Counts for Desk Reviews[24]

Strata Category	Sampling Approach	MWh Range	Number of Claimed Projects	Percent Savings	Population MWh Savings[25]	Desk Review Sample
Custom	Random	N/A	26	10.8%	3,700	3
HVAC	Random	N/A	9	4.4%	1,523	4
Lighting - Certainty	Certainty	>1,000	4	24.0%	8,248	4
Lighting - High	Random	>200 and ≤1,000	27	26.8%	9,197	8
Lighting - Medium	Random	>50 and ≤200	89	26.8%	9,215	8
Lighting - Low	Random	≤50	127	7.3%	2,493	3
Total			**282**	**100.0%**	**34,376**	**30**

[22] For oversampling, the AEG team first calculated what the ideal distribution of datapoints was given the number of projects and savings for each strata, then adjusted this by adding additional datapoints to the Custom and HVAC strata and removing these datapoints from the Lighting strata. This was to account for the complexity of Custom projects, and potential for variances, for these two populations. The original distribution was only one project for HVAC and two projects for Custom, which was not enough for the AEG team to fully review the projects in either of these two stratas.

[23] Neyman allocation is a sample allocation method that may be used with stratified samples. See: https://stattrek.com/statistics/dictionary.aspx?definition=Neyman_allocation

[24] To allocate the projects, the AEG team assumed an error ratio of 0.25 for each stratum. The number of desk reviews for each stratum were based on a Neyman allocation with a finite population correction, other than for the largest saving strata, which had four projects that were sampled with certainty. For more information on the Neyman allocation, please see the Uniform Methods Project Sample Design Cross-Cutting Protocol, Chapter 11: https://www.nrel.gov/docs/fy17osti/68567.pdf

[25] The population MWh savings presented in the table are customer-level and do not take into account line loss factors or NTG ratios.

Of the 30 desk reviews completed, the AEG team adjusted savings for 23 projects. The major findings from the desk reviews are summarized in the list below, with the full list of project-specific findings available in Appendix C.

- **EUL rounding.** For eight rebates, the EUL that Hawai'i Energy used in the lifetime savings calculations was rounded up from a decimal value in the project documentation. This rounding up of the EUL led to realization rates for lifetime savings between 95 and 99 percent on these projects (i.e., the claimed lifetime savings were slightly higher than the verified savings, leading to a realization rate below 100 percent).
- **Incorrect methodology for residential lifetime savings.** For three large rebates for the same customer, the lifetime savings for the residential portion of the project were calculated using the custom EUL determined for the commercial fixtures in the project. The verified savings adjusted to the deemed lifetime values in the residential section of the TRM, which led to lifetime savings realization rates between 24 and 31 percent.
- **Incorrect methodology for automatic dimming fixtures.** For two rebates for the same customer, the lifetime savings determined from the project calculator included an overestimation of the EUL for the fixtures at 100 percent output. All fixtures for these rebates operate 24 hours per day for safety reasons, and the overall lifetime remains the same. Adjusting to a single lifetime value for all measures at these rebates resulted in lifetime savings realization rates of 28 and 23 percent.
- **Incorrect fixture lifetime ratings.** For two rebates, lifetime hours used in the reported savings calculations were not supported in the project documentation. Adjusting to the highest confidence values displayed in the project documentation (e.g., the order of information by which the AEG team assessed projects when key information was missing[26]) resulted in lifetime savings realization rates of 68 and 79 percent.
- **New Construction lighting savings methodology.** The claimed savings used a lighting wattage table included in the construction documents package. The verified savings used detailed fixture takeoffs from the construction drawings along with the luminaire schedule's listed wattages for each fixture. The lighting takeoffs resulted in a reduction of installed interior lighting power, with a contributing factor being the likely inclusion of exterior lighting in the interior lighting power calculations displayed on the Construction Documents. This adjustment resulted in increased savings for all three buildings in the project.

Business Hard to Reach

The BHTR program provides for the installation of energy efficient measures by program-qualified trade allies and downstream purchasing of energy-efficient commercial kitchen equipment by participants. The program is designed to reach historically underserved markets based on geography and demographics. These include small businesses, restaurants, and lower-income multifamily properties on commercial-rate meters. Most projects and energy savings result from small business direct install lighting, though commercial kitchen equipment and multifamily direct install measures are also part of the program. BHTR measures account for approximately eight percent of Hawai'i Energy's business sector savings.

Within BHTR, measures fall into four categories: small business direct install (SBDI) lighting (Energy Advantage), commercial kitchen, multifamily direct install (MFDI), and custom BHTR. Energy Advantage measures make up approximately 88 percent of BHTR savings. Commercial kitchen and custom BHTR

[26] When there was conflicting information, the AEG team looked first at third-party tested values, then warrantied values, then manufacturers published values and lastly at written specifications from designers.

measures make up approximately six percent and three percent of BHTR savings, respectively. In all cases, besides custom BHTR, measure savings are informed by the TRM.

BHTR Verified Savings

The AEG team determined an overall savings verification of:

- 100.0 percent for program level MWh
- 100.0 percent of program level MW
- 100.0 percent of program level lifetime MWh

The AEG team's BHTR program verified first-year MWh, demand, and lifetime MWh savings all came in at a 100.0 percent realization rate. The MFDI savings for all three metrics were reduced by applying the program NTG ratio, but the effect could not be detected in the overall program realization rates. The tables below summarize the verified program level MWh and MW savings for the BHTR program.

Table 2-37 BHTR Program Level MWh Claimed and Verified Results

Measure	End-Use Category	Claimed Program Level First-Year MWh	Verified Program Level First-Year MWh	Realization Rate
SBDIL	Lighting	5,009	5,008	100.0%
Commercial Kitchen	Other	377	377	100.0%
Custom	Custom Other	139	158	113.7%
Custom Lighting	Lighting	82	82	100.0%
Multifamily Direct Install	MDI Lighting	18	16	91.0%
	MDI Other	19	17	91.0%
	MDI Total	36	33	91.0%
Total		**5,643**	**5,658**	**100.3%**

Table 2-38 BHTR Program Level MW Claimed and Verified Results

Measure	End-Use Category	Claimed Program Level First-Year MW	Verified Program Level First-Year MW	Realization Rate
SBDIL	Lighting	0.6808	0.6806	100.0%
Commercial Kitchen	Other	0.0627	0.0627	100.0%
Custom	Custom Other	0.0202	0.0230	113.9%
Custom Lighting	Lighting	0.0107	0.0107	100.0%
Multifamily Direct Install	MDI Lighting	0.0031	0.0028	91.0%
	MDI Other	0.0041	0.0037	91.0%
	MDI Total	0.0072	0.0065	91.0%
Total		**0.7816**	**0.7836**	**100.3%**

Table 2-39 BHTR Program Level Lifetime MWh Claimed and Verified Results

Measure	End-Use Category	Claimed Program Level First-Year MWh	Verified Program Level First-Year MWh	Realization Rate
SBDIL	Lighting	70,119	70,098	100.0%
Commercial Kitchen	Other	5,353	5,353	100.0%
Custom	Custom Other	2,491	2,834	113.8%
Custom Lighting	Custom	866	866	100.0%
Multifamily Direct Install	MDI Lighting	152	138	91.0%
	MDI Other	93	90	96.7%
	MDI Total	244	228	93.2%
Total		**79,073**	**79,378**	**100.4%**

Tracking Review

For BHTR, the AEG team verified savings primarily using a tracking system review. Verification for Energy Advantage lighting measures reviewed data previously collected on-site and included in the Energy Advantage worksheet from the tracking data extract. Other BHTR measures directly applied the TRM measure savings, facilitating a tracking system review to verify savings. Adjustments to the claimed savings were as follows:

- LED exit sign factors not used – Energy Advantage lighting. The AEG team found that the claimed savings for one LED exit sign project totaling six measures used Energy Advantage reported annual hours of operation for the general building of 3,419 hours rather than the TRM stipulated 8,760 annual hours of operation (24-hour operation) specified for exit signs. The AEG team also found that these measures incorporated interactive effects factors for energy and demand into their claimed savings, which were not incorporated into the TRM methodology for LED exit signs. The AEG team applied the TRM deemed savings per unit for these measures, which increased energy, demand, and lifetime savings.
- LED corn cob lighting type not noted in the tracking system for Energy Advantage lighting. Eight LED corn cob lighting projects totaling 48 measures were installed in interior locations. Of these, seven projects totaling 40 measures used TRM stipulated interactive effects factors for high bay lights, and one project totaling eight measures used TRM stipulated interactive effects factors for omni-directional lights. However, neither lighting style is captured in the tracking system. Because LED corn cob lights may suit a high bay or omni-directional role, the AEG team recommends that the lighting type is captured in the tracking database. No savings adjustments resulted from this finding.
- Occupancy sensor control factors were not used. Five projects totaling 30 Energy Advantage lighting measures were found to have occupancy sensor controls prior to LED retrofit. Of these, one project totaling four measures reported the occupancy sensor controls to have been removed in the retrofit condition, and four projects totaling 26 measures reported occupancy sensor controls to have remained in place in the retrofit condition. Claimed savings did not correctly account for the energy and demand savings runtime reduction factors (RTR) for the occupancy sensor controls. This reduced energy and demand savings for these measures.
- Incorrect EUL for bathroom aerators. Six bathroom aerator projects totaling 18 measures used an incorrect EUL of five years instead of the TRM stipulated 10 years. A EUL of 10 years was used in verification savings, which increased lifetime energy savings.

- Incorrect EUL for kitchen aerators. Two kitchen aerator projects totaling six measures were using an incorrect EUL of five years instead of the TRM stipulated 10 years. A EUL of 10 years was used in verification savings, which increased lifetime energy savings.
- Incorrect NTG ratio. MFDI measures indicated a master metered multifamily condition. Hawai'i Energy applied a 1.0 NTG ratio for the claimed savings, whereas the AEG team used the BHTR NTG ratio of 0.91.
- Incorrect NTG ratio. One measure indicated a Custom-Miscellaneous Reporting equipment type. Hawai'i Energy applied a 0.75 NTG ratio for the claimed savings, whereas the AEG team used the BHTR NTG ratio of 0.91.

Because Energy Advantage lighting is a major source of savings for the BHTR program, it may be beneficial for Hawai'i Energy to track the parameters used to calculate savings based on the PY20 TRM update for Energy Advantage. For PY19, details such as base/new wattages, controls factors, coincidence factors, and interactive factors, reside in a separate software package maintained by Hawai'i Energy for program implementation. These factors are either expressed directly, or their algorithms are defined, within the PY20 TRM, so the AEG team recommends that Hawai'i Energy track all of the necessary parameters within the tracking system.

Desk Reviews

The AEG team conducted desk reviews for a census of the three BHTR projects described as "Custom-Miscellaneous." The AEG team notes that two projects consisted of solar hot water heater installations at multifamily, master-metered facilities, and one project was a commercial dishwasher. The commercial dishwasher project resulted in verification adjustment:

- Incorrect calculation methodology. For RebateID a0h4v00000Yi218AAB, the claimed savings calculation used the Energy Star calculation for Energy Star dishwasher savings. The TRM provides guidance to use the California Energy Wise calculator developed by Fishnick. Changing the methodology to the California Energy Wise calculator resulted in a small increase in first-year and lifetime energy savings.

Business Energy Services & Maintenance

The BESM program provided business customers with retrocommissioning, strategic energy management, submetering, and energy audits. In PY2019, BESM completed 196 projects—the majority of the measures were "Commercial A/C Tune-Up." However, 74 percent of the savings came from a single "Custom-BESM" measure. The total first-year savings for BESM contributed 0.3 percent to the total business sector savings.

BESM Verified Savings

The AEG team determined an overall savings verification of:

- 100.0 percent for program level MWh
- 100.0 percent of program level MW
- 100.0 percent of program level lifetime MWh

The tables below summarize the results. All metrics were verified at 100 percent for this program.

Table 2-40 BESM Program Level First-Year MWh Claimed and Verified Results

Measure	End-Use Category	Number of Claimed Projects[27]	Claimed Program Level First-Year MWh	Verified Program Level First-Year MWh	Realization Rate
Custom	Custom	1	169	169	100.0%
A/C Tune-up	HVAC	53	59	59	100.0%
Other[28]	Other	10	0	0	N/A
Total		64	**228**	**228**	**100.0%**

Table 2-41 BESM Program Level MW Claimed and Verified Results

Measure	End-Use Category	Number of Claimed Projects[29]	Claimed Program Level MW	Verified Program Level MW	Realization Rate
Custom	Custom	1	0.0000	0.0000	N/A
A/C Tune-up	HVAC	53	0.0134	0.0134	100.0%
Other[30]	Other	10	0.0000	0.0000	N/A
Total		**64**	**0.0134**	**0.0134**	**100.0%**

Table 2-42 BESM Program Level Lifetime MWh Claimed and Verified Results Savings

Measure	End-Use Category	Number of Claimed Projects[31]	Claimed Program Level Lifetime MWh	Verified Program Level Lifetime MWh	Realization Rate
Custom	Custom	1	1,013	1,013	100.0%
A/C Tune-up	HVAC	53	59	59	100.0%
Other[32]	Other	10	0	0	N/A
Total		**64**	**1,073**	**1,073**	**100.0%**

Tracking Review

The AEG team used the Hawai'i Energy tracking system to verify the BESM savings for the tune-ups. The tracking system review found that all 185 projects correctly used the TRM savings for the "Central AC Tune-Up" measure. All of the tune-ups conducted under BESM were for the "multifamily, master-metered" building, so the use of the residential savings parameter is valid. As a result, the savings for BESM were verified as 100 percent of the claimed savings for the customer, system, and program levels.

[27] Tune-up measures were found to have a unique RebateID for each individual unit. The count of Projects for BESM consists of unique AccountIDs across the measure type.

[28] The Other category includes energy audit and retro commissioning measures with no claimed savings.

[29] Tune-up measures were found to have a unique RebateID for each individual unit. The count of Projects for BESM consists of unique AccountIDs across the measure type.

[30] The Other category includes energy audit and retro commissioning measures with no claimed savings.

[31] Tune-up measures were found to have a unique RebateID for each individual unit. The count of Projects for BESM consists of unique AccountIDs across the measure type.

[32] The Other category includes energy audit and retro commissioning measures with no claimed savings.

Desk Review Results

The AEG team completed a desk review for the single BESM equipment ID named "Custom-Miscellaneous." The AEG team verified that the project consisted of installing remote water leak detection loggers to conserve water use throughout a municipal water system. The project was verified at 100 percent.

Total Resource Benefits

Total Resource Benefits (TRBs) reflect the present value of energy and demand savings over the life of the measures in Hawai'i Energy's portfolio. The verified customer level savings were used to develop the verified TRBs to compare to the claimed TRBs. Table 2-43 presents the TRBs calculated at the net customer levels (i.e., customer level savings with the net-to-gross ratios applied) for each program, sector, and entire Hawai'i Energy portfolio.

The AEG team verified $154,710,054 of TRBs for PY2019, or 90 percent of Hawai'i Energy's claimed TRBs. The adjustments to TRBs resulted mainly from lifetime savings adjustments for dual baseline measures (REEM and BEEM) and adjustments to measure effective useful lives (CBEEM and RESM). Details on the resulting CET incentives calculations for the TRBs can be found in Appendix A.

Table 2-43 Program Level TRBs by Program

Program Name	Claimed TRBs	Verified TRBs	Ratio of Verified to Claimed TRBs
Residential Sector			
REEM	$51,249,111	$47,242,150	92.2%
RHTR	$2,876,613	$2,849,050	99.0%
RESM	$340,965	$763,084	223.8%
CREEM	$78,592	$78,592	100.0%
Total Residential	*$54,545,281*	*$50,932,876*	*93.4%*
Business Sector			
CBEEM	$61,564,898	$49,714,000	80.8%
BEEM	$46,177,643	$43,687,702	94.6%
BHTR	$9,804,471	$10,233,703	104.4%
BESM	$141,772	$141,772	100.0%
Total Business	*$117,688,784*	*$103,777,177*	*88.2%*
Total Portfolio	**$172,234,065**	**$154,710,054**	**89.8%**

3

ACCESSIBILITY AND AFFORDABILITY RESULTS

Hawai'i Energy's performance goals ensure that program services and benefits are equitably allocated across eligible geographies and underserved demographics. These performance targets require that 13 percent of program spending occurs in each of the Hawaii and Maui counties and that a minimum number of accounts are served by the Energy Advantage and single- and multifamily direct install programs, with a minimum amount of customer bill savings for each group.

Verification Results

Based on the combination of economically disadvantaged customers and the geography of incentive spending, the AEG team was able to verify Hawai'i Energy's PY2019 performance. Summarized in the table below, Hawai'i Energy met most of the equity performance targets for energy savings, incentive spending per island, numbers of customers served, participating non-profits, and communities served.

Table 3-1 Accessibility and Affordability Claimed and Verified Results[33]

Key Focus Areas	Measurement Category	100 Percent Target	Claimed Results[34]	Verified Results	Met Target?
Economically Disadvantaged	Energy Advantage Customers served	650	403	403	No
	Energy Advantage Customer bill savings*	$1,500,000	$1,511,084	$1,510,641	Yes
	Single & Multifamily Direct Install Customers served	1,934	2,019	2,019	Yes
	Single & Multifamily Direct Install Customer bill savings*	$10,089,930	$1,674,146	$1,674,146	No
	Community-Based Energy Efficiency Number of communities served	2	2	2	Yes
	EmPOWER Hawaii Project Number of participating non-profits	7	7	7	Yes
Island Equity Incentive Spending	County of Hawaii: 13 percent	13.0%	16.4%	16.4%	Yes
	County of Maui: 13 percent	13.0%	15.4%	15.4%	Yes
	City and County of Honolulu: 74 percent	74.0%	68.3%	68.3%	N/A

* These two key focus areas for economically disadvantaged use different metrics for bill savings. Customer bill savings for Energy Advantage are first-year savings while customer bill savings for Single and Multifamily Direct Install are lifetime savings.

[33] In the Hawai'i Energy Monthly Performance Report for February 2020, Hawai'i Energy notified the Commission that, "MFDI target value for lifetime customer bill savings was actually lifetime kWh (not bill savings)." Hawai'i Energy has clarified that the correct bill savings target for PY19 should have been $3,430,577 instead of $10,089,930, based on lifetime energy savings. Because the PBFA contract's stated goal has not been updated to reflect this proposed correction, the AEG team verified the metric based on the contracted amount. Current reporting values include both lifetime kWh and lifetime customer bill savings.

[34] Economically disadvantaged claimed savings were based on the final tracking database supplied by Hawai'i Energy to the AEG team. Island Equity Incentive spending claimed results were based on the Hawai'i Energy PY2019 Annual Report, with verified results developed from a combination of the final tracking database and "PY19 Customer Island Equity_10.01.20.xlsx."

Economically Disadvantaged Results

The BHTR and RHTR programs play a crucial role for Hawai'i Energy in achieving their accessibility and affordability performance targets related to economically disadvantaged customer segments. These programs conducted small business and single- and multifamily direct installs to overcome market barriers that economically disadvantaged and hard to reach small businesses and households face in directly benefiting from energy efficiency measures.

To verify Hawai'i Energy's PY2019 performance, the AEG team reviewed the tracking data for project counts (measuring customers served) and utilized the verified savings at the first-year customer level to verify customer bill savings. For Energy Advantage projects, distinct customers were tracked at the rebate level, with unique RebateIDs reflecting a unique business served by the program. The AEG team developed counts of unique customers served through the tracking system review for CET verification and examined invoices submitted by channel partners. For the EmPOWER Hawaii Project, the AEG team reviewed the list of participating non-profits.

Hawai'i Energy tracks projects with an "Equipment Category" that records whether a project was part of a multifamily direct install (MFDI), small business direct install (SBDI), or another project type. For PY2019, individual rebates were tracked for each dwelling within the tracking system for all MFDI projects, and the channel partner invoices were reviewed to corroborate the counts in the tracking system.

The table below summarizes the AEG team's findings related to Hawai'i Energy PY2019 accessibility and affordability performance for Energy Advantage, Direct Install, Community Based Energy Efficiency, and EmPOWER Hawaii. Hawai'i Energy either met or exceeded its targets for four of the categories. The categories where targets were not met included the number of customers served and customer bill savings for single and multifamily direct install.

The PY2019 goals for customer bill savings used different target metrics; the Energy Advantage target is first-year bill savings while the target for SFDI and MFDI is lifetime bill savings. The value for the SFDI and MFDI lifetime bill savings target was incorrect in the triennial plan. The target was the lifetime kWh savings rather customer bill savings. Hawai'i Energy began correcting the metric in their monthly reporting starting in February 2020.

Table 3-2 Verified Economically Disadvantaged Performance Results

Target Segment	Metric	Performance Target Metric	Verified Results	Met Target?
Energy Advantage	Customers served	650	403	No
	Customer bill savings	$1,500,000	$1,510,641	Yes
Single & Multifamily Direct Install	Customers served	1,934	2,019	Yes
	Customer bill savings	$10,089,930	$1,674,146	No
Community-Based Energy Efficiency[35]	Number of communities served	2	2	Yes
EmPOWER Hawaii Project	Number of participating non-profits	7	7	Yes

Island Equity Results

To verify Hawai'i Energy's PY2019 results for meeting its island equity goals, the AEG team reviewed documentation provided by Hawai'i Energy. It confirmed incentive payments using the tracking database

[35] Community Based Energy Efficiency targets were confirmed as part of the Economic Development and Market Transformation project documentation review.

and a customer equity report from 10-1-2020, which included the full program spending by island. Performance goals were framed as incentive spending associated with each island across the resource acquisition and market transformation programs. The islands of Maui, Lanai, and Molokai were combined to reflect the totality of Maui County.

The table below presents the island equity performance results. The resource acquisition incentives were far higher than market transformation incentives, at 87 percent of the total incentives. The market transformation allocations reside in the customer equity report. In PY2019, Hawai'i Energy met its island equity targets by exceeding incentive spending associated with Hawaii and Maui Counties.

Table 3-3 Verified Incentive Spending by Geography

	CET Incentives		Market Transformation Incentives		Total Incentives		
Location	**Funds**	**Percent**	**Funds**	**Percent**	**Funds**	**Percent**	**Met Target?**
Hawaii County	$2,576,394	12.8%	$726,378	3.6%	$3,302,773	16.4%	Yes
Maui County	$2,405,112	11.9%	$703,955	3.5%	$3,109,067	15.4%	Yes
Honolulu County and Honolulu City	$12,649,824	62.6%	$1,134,297	5.6%	$13,784,121	68.3%	N/A[36]
Total	**$17,631,330**	**87.3%**	**$2,564,631**	**12.7%**	**$20,195,960**	**100.0%**	**Yes**

[36] Note that there is no target for this metric, only the 13 percent targets on Hawaii and Maui. This is a line item within the Triennial Plan, and thus is included here as well.

4

ECONOMIC DEVELOPMENT AND MARKET TRANSFORMATION RESULTS

The AEG team verified the Economic Development and Market Transformation activities and achievements provided by Hawai'i Energy during PY2019 relative to the program year's performance target categories and metrics. These programs seek to identify and overcome market barriers that prevent residential and business customers from becoming energy efficient by engaging in energy-saving behavior or investing in energy-saving equipment. In particular, these programs[37]:

- Work to raise the level of energy literacy at every level in our communities;
- Support policies and workforce training that make it easier for industries to adopt clean energy practices;
- Stay at the cutting-edge of new technology developments; and
- Establish strong relationships that help grow the movement's capacity and reach.

As in PY2017 and PY2018, the PY2019 programs were categorized as follows: (1) Behavior Modification, (2) Professional Development & Technical Training, (3) Energy in Decision Making, (4) Codes and Standards, and (5) Clean Energy Innovation Hub (new for PY2019). The activity categorized as Clean Energy Innovation Hub included a focused effort to explore emerging technologies and future program concepts. A great effort was placed on relationship building and strategic planning with *Elemental Excelerator* leveraging their evaluation process to help Hawai'i Energy identify startup companies that align with their clean energy goals[38]. Through this process, Hawai'i Energy has identified a few emerging technologies and services that they plan to move forward with to incentivize and fill the pipeline for future Hawai'i Energy offers.

Verification Results

Overall, the AEG team determined that Hawai'i Energy achieved all its economic development and market transformation target metrics. The table below shows each category area, the target metrics within each category, and the verified outcome for each metric.

Table 4-1 Economic Development and Market Transformation Performance Metrics, and Verified Performance

Key Focus Areas	Performance Indicator Target	Verified Performance	Met Target
	Behavior Change		
Workshops and Presentations:			
STEM-based student workshops	1,200 participant-hours of training	1,350 participant-hours of training	Yes
Adult learning	2,750 participant-hours of training	3,191 participant-hours of training	

[37] Per the Hawai'i Energy PY19 Annual Report, page 10.

[38] Per the Hawai'i Energy PY19 Annual Report, page 27.

Key Focus Areas	Performance Indicator Target	Verified Performance	Met Target
Gamification Campaigns and Competitions	1,000 participants	1,399 participants	Yes
Exhibit Educational Resources	2 events	2 events	Yes
Sustained Outreach	1 agreement	1 agreement	Yes
Behavioral Insights	1 program intervention	1 program intervention	Yes
Professional Development & Technical Training			
Clean Energy Ally Support	10,000 participant-hours of training	12,298 participant-hours of training	Yes
Targeted Ally Training Opportunities			
Targeted Participant Training Opportunities			
Educator Training and Grants			
Degree Program Support			
Vocational Training			
Energy in Decision Making			
Strategic Energy Management (SEM)	6 new participating institutions	4 new participating institutions	No
Codes and Standards			
Appliance Standards Advocacy (new)	5 events	12 events	Yes
Improving Code Compliance	1 compliance roadmap	1 compliance roadmap	
Code-Related Training	100 participant-hours of training	158 participant-hours of training	
Leading Edge Technologies and Strategies	4 meetings and a report	4 meetings and a report	
Clean Energy Innovation Hub			
Innovation and Emerging Technologies	1 company supported	0 company supported	No

Verification Methods

Hawai'i Energy provided the AEG team with documentation used to verify activities. The documentation primarily included the number of participant-hours, the number of participants attending, and the number of events. Specifically, the AEG team assessed accomplishments through the following activities:

- Review of event, presentation, or workshop attendance spreadsheets/sign-up sheets and event flyers (if available), and
- Review of event summaries documenting the date and number of participants in attendance.

Besides reviewing Hawai'i Energy documentation, the AEG team issued a survey of PY2019 professional training attendees. The participant survey, which was administered as a web survey via an embedded email link, served two primary purposes: (1) it provided a secondary mechanism to verify participation in training sessions; and (2) elicited qualitative information about Hawai'i Energy's professional development offerings. The AEG team received a file of emails from Hawai'i Energy of professional development attendees linked to the specific training sessions attended[39]. This list was used to recruit survey respondents. In total, 776 email invitations were sent. In total, 90 respondents, approximately 12 percent of participants recruited, responded to the survey. The table below summarizes the number and percent of participants by training category.

Table 4-2 Number of Survey Respondents by Training Category

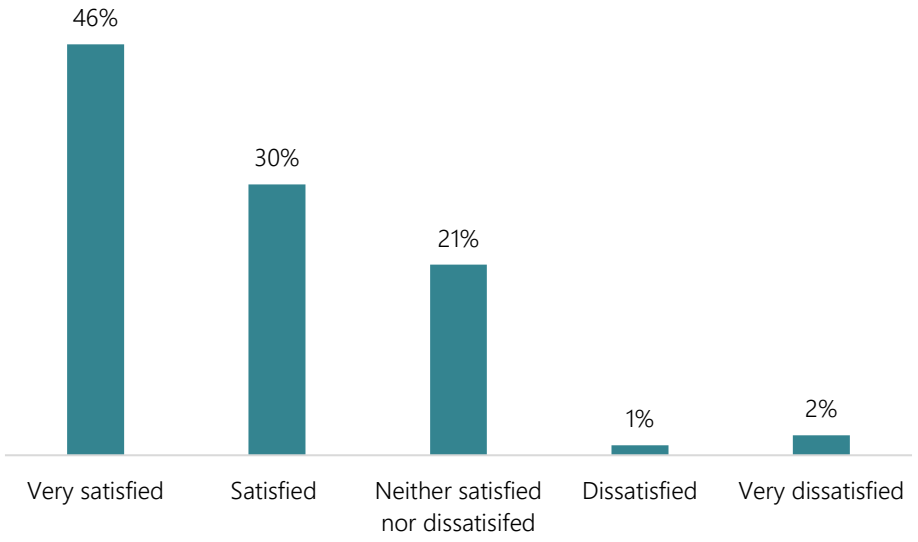
Training Category	Count of Survey Respondents (n)	Percent of Survey Respondents
Code/Modeling Code	48	53%
Energy Management	6	7%
Technology/ Equipment	25	28%
Professional Development	11	12%
Total	90	100%

Professional Training Participant Survey Results

Overall, survey respondents rated their satisfaction with Hawai'i Energy's professional development offerings highly. Of the 90 survey respondents, all provided responses related to their satisfaction with the training they attended. Almost half of the 90 respondents (46 percent) said they were "very satisfied" with the training they attended, and an additional third (30 percent) said they were "satisfied." Only three percent of respondents said they were either "dissatisfied" or "very dissatisfied" with the training attended. The figure below illustrates participant satisfaction with the training attended.

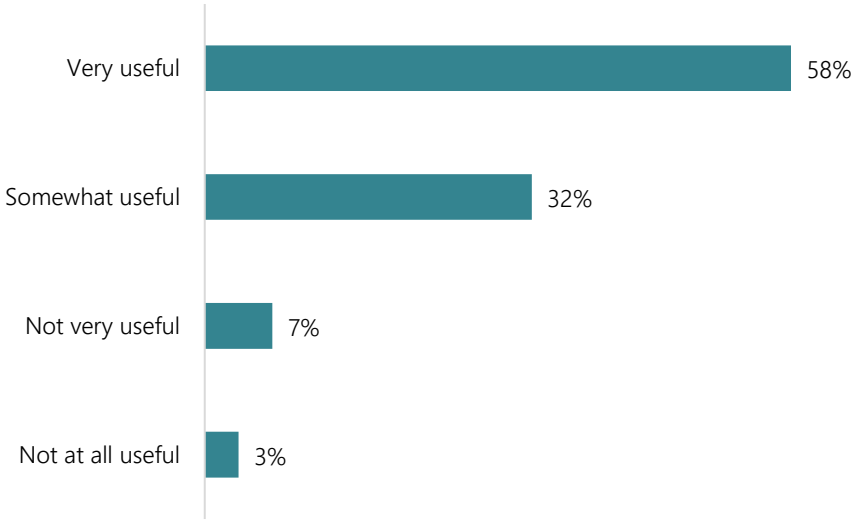
[39] Over the past three years, Hawai'i Energy has improved their data collection for training participants. In PY2017, the AEG team transposed, where we could, the contact information from sign-in sheets to build the sample file for which to email the web survey. In PY2018, the AEG team received an Excel file containing 659 email addresses. No other contact or training information was included in the file (which meant we could not accurately associate an email with a specific training). In PY2019, the AEG team received emails linked to trainings in an Excel file. Participants in trainings geared towards the general public or K-12 were not included in the list of recruited participants.

Figure 4-1 Satisfaction with Professional Development Training Attended (n=90)



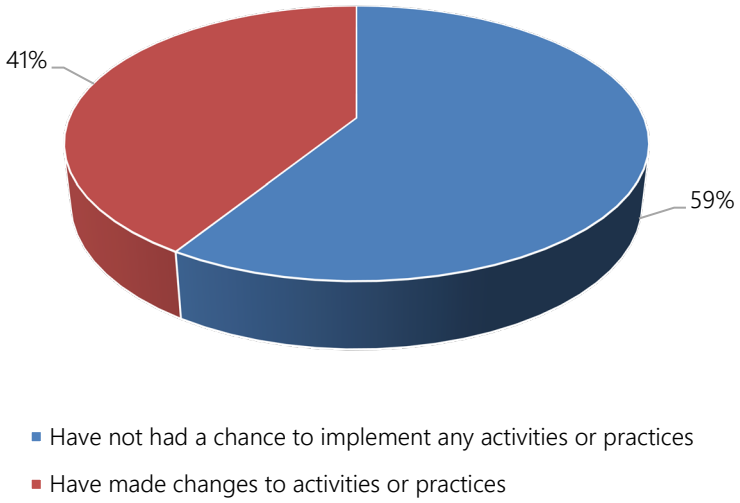
In addition to reporting high satisfaction, over half of the respondents (58 percent) characterized the training as "very useful." Another third (32 percent) described the training they attended as "somewhat useful," and 10 percent of respondents characterized the training as either "not very useful" or "not at all useful." Two respondents who were "very dissatisfied" with the training also reported their training to be "not at all useful." Of those that recorded "not very useful" or "not at all useful" scores, most noted they scored the training this way because the training ended up not being geared towards their specific industry, they were looking for more details than what was provided, or more suggestions on real-world applications (e.g., not what the energy code is, but how to apply the energy code).

Figure 4-2 Usefulness of Professional Development Training Attended (n=90)



One survey question asked participants what ways, if any, the training event affected their organization's day-to-day activities or practices. Of the 90 respondents answering this question, 40 percent have made changes to activities or practices.

Figure 4-3 Training Effect on Activities and Practices (n=90)

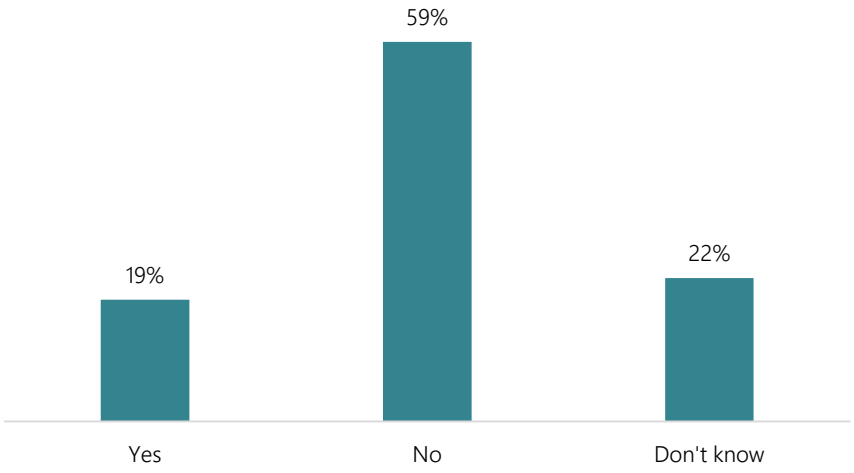


Individual actions included changes to driving habits, community engagement, and sharing lessons learned with facility managers to make broader energy efficiency improvements. Activities and changes mentioned more than once included:

- Increased awareness of new building codes and ensuring they are captured in the design of new buildings, including types of equipment and net-zero energy specifications.
- Increased awareness of the impact that LEDs can have on energy consumption.
- Respondents making updates to marketing materials and websites to promote energy efficiency and renewables.

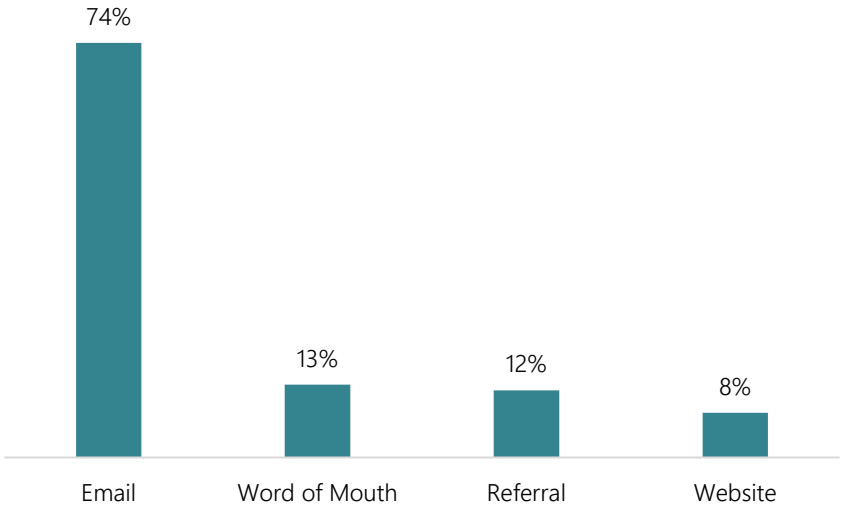
As a follow-on to this question, survey respondents were asked if their training participation led to their organization's participation in energy efficiency, demand response, storage, or distributed generation programs. Of the 90 survey respondents answering this question, 19 percent answered yes.

Figure 4-4 Did Training Lead to Program Participation (n=90)



The vast majority of respondents heard about the training through email (74 percent). Word of mouth and referrals were the next most common method of hearing about training sessions (13 percent and 12 percent, respectively), followed by the website (8 percent). Only two people said they heard about the training through social media.

Figure 4-5 How Participants Heard about Training (n=90)



A quarter (26 percent) of respondents provided recommendations on ways to improve training. Individual suggestions varied quite a bit, including providing a certificate of completion, offering regular monthly training, and providing more Hawaii-specific training. Other notable suggestions included:

- Offer training for varying levels of experience (beginner, intermediate, advanced).
- Continue to offer virtual training.
- Provide more energy modeling training.
- Offer training to code officials/ county permit personnel.

Similar to PY2017 and PY2018, the respondent's recommendations related to training content suggest an appetite for more focused and advanced training. While Hawai'i Energy operates various advanced professional training sessions, information on the training level may not be clearly communicated, or some training attendees may not be in the right marketing channel to receive the information.

Survey respondents were asked whether they registered with Hawai'i Energy as a Clean Energy Ally. Across the 90 respondents, 21 percent said yes, and about a third (36 percent) said they did not know if they were registered as a Clean Energy Ally. However, not all the training sessions focused on topics related to Clean Energy Allies, which suggests that a diverse set of professionals engaged with energy efficiency is being reached outside of the Clean Energy Ally network.

5

CUSTOMER SATISFACTION RESULTS

Similar to PY2017 and PY2018, one of Hawai'i Energy's performance targets relates to customer satisfaction. For PY2019, Hawai'i Energy's annual target was to achieve an overall satisfaction score greater than 9.0 (out of a possible 10) on overall customer satisfaction for each of the residential and business sectors[40]. The AEG team received the output results from their customer experience management tool, Medallia, for the residential sector programs. For the residential sector programs, when a customer receives a rebate from Hawai'i Energy, Medallia sends this customer an automated email survey soliciting feedback on their experience with a variety of program interaction elements. For residential participants, these included satisfaction with the rebate experience, likelihood to recommend, and field service experience. For the business sector, Hawai'i Energy created a manual survey based on the Medallia survey. According to Hawai'i Energy, they "send out monthly surveys to new program participants, timed approximately with receiving their rebate check to maximize recognition and awareness. Hawai'i Energy's survey procedures minimized outreach duplication and maximized the number of recipients." Business sector participants were asked about their satisfaction with the rebate experience, likelihood to recommend, and communications.

Verification Results

According to program documentation and subsequent discussions with Hawai'i Energy staff, Medallia sent 4,651 surveys to residential customers in PY2019, of which 28.9 percent responded to the survey. Hawai'i Energy staff also administered 411 surveys to business customers. Fifty customers, or 12 percent, responded to the business survey. Hawai'i Energy compiled an overall satisfaction rating of 9.0 out of 10 on average for business sector participants, and Medallia compiled an overall satisfaction rating of 9.3 for residential sector participants by compiling satisfaction scores across all categories queried. This resulted in Hawai'i Energy, satisfying the residential target performance metric but not the business sector target.

Process Findings

As part of the PY2017 verification activities, the EEM requested that the AEG team considered the current process by which Hawai'i Energy measures customer satisfaction and offers considerations or recommendations on potential adjustments to the process. The AEG team provided the following two suggestions in PY2018, which continue to hold true into PY2019:

- Consider soliciting customer satisfaction via different modes and times in the customer experience. The current system emphasizes measuring satisfaction via email surveys at the point a customer receives a rebate. While the presence of a rebate can be a useful trigger to help with recall, some details of engagement may not be as well-remembered if there is a substantial gap in time from the start of a project through to the end. Collecting information soon after key milestones in a project may provide greater clarity on their experience related to a key milestone. For example, if a customer receives an energy audit, contacting the customer soon after the completion to gather information on their energy audit experience may provide better information about that particular program element than some time after a project has moved forward and a rebate been paid. Additionally, not all customers ultimately complete a project or receive a rebate – collecting information ahead of a

[40] Previously, the customer satisfaction target was an overall target, and not separate for the residential and business sectors.

rebate may allow for the perspectives of customers who ultimately do not receive a rebate to be captured.

Secondly, consider using another mode in conjunction with emails. In the tracking system, not all customers had email addresses recorded, and it is not clear if that is a typical condition or not. As such, relying solely on feedback from customers who provide an email address may create a bias in terms of responses. Expanding the survey method to include a random sample of telephone or paper mail surveys may capture a wider range of program participants and allow for a more diverse set of participants to be surveyed.

- **Consider coordinating with the AEG team to develop survey questions related to general satisfaction or program-specific elements.** The AEG team notes that the Medallia satisfaction questions are designed to capture general satisfaction ratings across the Hawai'i Energy portfolio, driving inherently general results. These general results are useful, but adjusting or emphasizing questions based on program delivery experiences may provide greater insight into more focused areas for Hawai'i Energy to target for program adjustments. Working with the AEG team would help align questions for consistency and approach while also supporting future verification efforts or other evaluation activities.

In discussions with Hawai'i Energy, the AEG team learned that these recommendations remain a priority.

6

CONCLUSIONS

As noted in the Executive Summary and with detail in this report, the AEG team was able to verify that Hawai'i Energy met nearly all of its PY2019 performance targets. Targets for CET were met for first-year energy (102 percent), lifetime energy (105 percent), total resource benefits (95 percent), and peak demand reduction (120 percent). Accessibility and affordability goals were mostly met for economically disadvantaged customers and island equity. The AEG team also verified that Hawai'i energy met its economic development and market transformation targets and the customer satisfaction target. Based on the results, the AEG team calculated Hawai'i Energy's performance incentive payment at 71 percent of the maximum, or $534,987.

AEG Team Recommendations

Through the verification process, the AEG team had opportunities to engage with Hawai'i Energy and review the TRM measures, program tracking data, and other documentation. Through that process, the AEG team developed some broad recommendations for Hawai'i Energy to consider going forward. These recommendations capture many of the elements that led to the final verification results, which, if implemented, could increase the accuracy of savings estimates, streamline approaches for savings verification, or mitigate potential sources of verification risk. Because some recommendations are carryovers from PY2017 and PY2018 verification activities, recommendations are either categorized as new (based on PY2019 findings) or still applicable (from PY2017 PY2018.) The PY2019 recommendations are listed in order of importance.

PY2019 – New Recommendations

Recommendation 1. To maximize incentives, ensure all changes to TRM deemed measures are implemented in the tracking system calculations.

The AEG team found multiple measures in PY2019 that calculated different lifetime savings values from the deemed value shown in the TRM. Typically, the claimed savings were calculated using the measure's first-year energy savings and full measure lifetimes as shown in the TRM and did not account for a dual baseline approach. This finding affected some commercial and residential lighting measures, as well as refrigerator recycling and trade-up measures. The adjustments to lifetime savings for these measures account for the bulk of the adjustments and lowered realization rates for lifetime savings in REEM and BEEM. Ensuring that all TRM changes flow through to the tracking system is the number one recommendation for improving verification percentages.

Recommendation 2. Modify calculations for custom lighting projects in CBEEM to include dual baselines where applicable to increase accuracy.

During desk reviews, the AEG team noted that individual lighting measures installed for custom lighting projects might qualify for dual baselines. The team recommends that for custom calculations, the initial baseline period compared to an existing product should match the defined first-period effective useful lifetimes in the TRM. In contrast, the second-period baseline should be reset to a code-compliant baseline as defined in the TRM. This approach yields the most accurate estimates of savings. While there may be fixtures where savings are overstated due to this issue, the AEG team notes the overall effect on the program savings is likely small.

The AEG team did not make any adjustments to project savings for dual baselines in the CBEEM program. Because the projects are not prescriptive one-to-one replacements and may include substantial renovation or lighting plan changes, the application of dual baselines is not as straightforward as it is for the prescriptive projects in BEEM. The AEG team hopes to continue a dialog about dual baselines in the CBEEM program and work with Hawai'i Energy to define when dual baselines are required for custom lighting projects and review how to implement the calculations best. The AEG team hopes to incorporate an agreed-upon dual baseline methodology for custom projects into a Custom Projects Guidance document. Additionally, the AEG team acknowledges that due to the timing of this report, changes related to dual baselines in custom lighting projects will likely not be implemented until PY2021 by Hawai'i Energy.

Recommendation 3. Increase the rigor of new construction lighting calculations to increase the confidence in project savings calculations.

The AEG team conducted desk reviews for several new construction lighting projects under the CBEEM program and observed inconsistent project documentation and savings calculation methods. For example, the team identified one project where the savings estimate relied on architectural estimates for energy savings. In this example, the estimates likely included exterior fixtures in the fixture counts for interior lighting savings. Analyzing the exterior lighting savings separately would have likely increased the project savings and customer incentive.

Recommendation 4. Use rated capacity for HVAC calculations to improve realization rates.

The AEG team found multiple HVAC projects where the unit's nominal capacity was used in the savings calculation rather than the rated capacity listed in product specifications or on AHRI datasheets. The TRM algorithms are meant to be used with rated capacity rather than nominal capacity, and the TRM will be updated to make that explicit. In most cases, the rated capacity is slightly lower than the nominal capacity, so using the rated capacity results in slightly lower savings. Using the more accurate rated capacity as intended in the TRM would have improved realization rates in the BEEM and REEM programs.

Recommendation 5. To facilitate verification activities, obtain invoices, purchase orders, or submittals for all projects. In addition, seek clarity when these documents cover more than one rebate or customer site.

The AEG team found multiple projects in CBEEM that collected invoices where the installed fixture counts and product make/model numbers could not be accurately matched to the projects. These included several large lighting projects at a military base where the invoice included many times the number of fixtures installed for the project, and some of the shipping addresses were on the mainland. For another set of rebates at the same customer, rebates were paid in phases, while the collected invoices included fixtures from more than one phase in the project.

For multi-phase projects, the AEG team suggests attempting to reconcile the invoices for all processed rebates at each stage of the project to ensure there is no overpayment of incentives or overclaiming of savings. For projects where invoices cannot be reconciled, increased rigor for site inspections can be used to gain confidence in the overall project's savings values. Hawai'i Energy did conduct site visits for all CBEEM projects where the AEG team could not use invoices to verify fixture counts. However, it was hard to tell from the site visit how rigorous the sampling process was for site inspections.

The AEG team notes that even small variations in the number of products installed for a given site, or where make/model numbers differed slightly from those intended for installation, the overall effect on project savings and program savings could be large due to the size and complexity of some of the projects observed through the desk reviews.

Recommendation 6. Review TRM measures where semi-prescriptive calculators are included, and determine which semi-prescriptive approaches can be used during implementation. Consider implementing product-specific savings rather than relying on the average category values.

During the verification effort, the AEG team noted the TRM includes semi-prescriptive calculators for many measures alongside tables of deemed values. In addition, many measures include deemed savings values by building type or product category, in addition to "Average" values. In all cases throughout the verification, the AEG team found that Hawai'i Energy used deemed values rather than semi-prescriptive calculations and mainly relied on "Average" values rather than more granular savings estimates.

For some deemed measures, Hawai'i Energy already tracks the necessary data for semi-prescriptive calculations. For other measures, the data is collected on the application but is not tracked. The AEG team notes that implementing more granular semi-prescriptive calculations or category-specific deemed values would lead to more accurate savings values; however, the overall effect on program savings is expected to be low.

PY2018 – Recommendations that Remain Relevant

Recommendation 1. Ensure site inspections are sufficiently rigorous to catch mistakes made by contractors and installers.

In the PY2018 evaluation, the AEG team conducted nine site visits as part of the evaluation of the CBEEM program, and for one of those site visits, found discrepancies between the project documentation and Hawai'i Energy's implementation inspection. The AEG team discovered a substantial quantity of fixtures that appeared on the project application, the invoice and were verified by the implementation inspection. In communicating with the lighting installer about the discrepancy, the AEG team discovered that the installer had mistakenly billed the customer for 25 fixtures that were not used on the project. The error was based on a poor inspection diagram developed during the middle of the project, which did not match the final project drawings.

In conducting the site inspection during the implementation process, it is important to verify quantities, whenever feasible, to ensure the best accuracy for incentive payments and claimed savings. Based on the results of this site visit and a review of the other implementation site inspection reports, the AEG team raises a concern that installation quantities are not being sufficiently scrutinized during the implementation site inspections and recommends increasing focus on them in the future program years.

PY2019 update: the AEG team found that site inspection documentation does appear to have more detail than in the past but could be updated more for additional clarity (note the PY2019 recommendations related to this).

Recommendation 2. Collect detailed information from customer sources, such as control systems, that allows for better accuracy on custom calculations.

In the PY2018 evaluation site visits, the AEG team was able to collect interval data for several projects that led to adjustments of the claimed savings. For these particular projects, the revised savings were increased relative to the claimed savings and also would have enabled higher incentives to the customer. In most cases, these adjustments were made to projects where deemed savings were used, while the scope and size of the projects should lend themselves to more rigorous data collection in custom calculations, which would create more precise savings estimates and incentive amounts.

The AEG team recommends Hawai'i Energy investigate sources of data that can lead to custom calculations for parameters such as annual operating hours and coincident factors so more accurate incentive payments and claimed savings could be made for large custom projects.

PY2019 update: as part of the PY2019 verification, the AEG team did not review any projects similar to this. As a result, the AEG teams was unable to determine if improvements were made.

Recommendation 3. Increase the rigor for projects using utility billing regressions and address whether regressions are the best analysis approach. Use utility billing regressions only when appropriate, include important independent parameters within the regression, and normalize results when appropriate.

Before conducting utility billing analysis for a given custom project, consider whether billing regressions are the best analysis approach and if there are sufficient pre-and post-implementation data for meaningful and timely results. When billing regression analysis is determined to be the most appropriate analysis approach, but requirements for post-implementation billing records extend beyond the given program year, determine a mechanism for crediting savings for the program and for customer incentives. When using utility billing regressions, increase the analysis rigor by including important independent parameters within the regression and normalize the results when appropriate.

As part of the desk review and site visits for the PY2018 CBEEM program, a number of utility billing regressions were reviewed, with several of the projects receiving site visits. For projects with site visits, the AEG team was able to obtain additional utility data that was previously unavailable due to the post-installation timing. This additional information added increased accuracy to the savings estimates that resulted from the regression analysis. Also, for most projects that used regression analysis, the AEG team added parameters for cooling degree days to capture the climatological dependence of the measures, or suite of measures, within the project.

The AEG team recognizes that waiting a full year to obtain 12-months of post-installation data can be difficult for both the customer and Hawai'i Energy. The AEG team suggests conducting a "true-up" of project savings after 12-months of post data is available. This can be achieved by paying a split incentive based on the estimated savings for the project at closeout in the current program year and then following up in the subsequent program year. The split incentives would pay a percentage of the estimated savings at project closeout, then true-upped the savings after 12-months of data have been obtained with a final incentive payment for the trued-up savings amount. Alternatively, Hawai'i Energy could assume the full risk for the project by paying out the entire incentive for the estimated savings and truing up the savings claim once 12-months of data have been collected.

The AEG team also recommends considering thresholds for when utility billing regressions are appropriate. The IPMVP recommends Option C for utility billing regression when the savings expected from the measures exceeds 10 percent of the total utility bill. The AEG team also recognizes that below that threshold are many cases where utility billing regressions are still a valid approach. The AEG team recommends enacting a threshold where an additional review of alternative savings approaches should be conducted before approving the use of billing regressions.

Finally, utility billing regressions should take into account the independent parameters that affect the monthly energy use. For HVAC projects, this typically includes cooling degree day or cooling enthalpy day factors. For some projects, the use of other factors, such as occupancy rates or school days, may be necessary to properly regress the data. The final results of pre-and post-regressions should also consider using normalized datasets for first-year savings in order to account for climatological or operational outliers during the data periods.

PY2019 update: as part of the PY2019 verification, the AEG team did not review any projects similar to this. As a result, the AEG teams was unable to determine if improvements were made.

PY2017 – Recommendations that Remain Relevant

Recommendation 5. For fully deemed measures, Hawai'i Energy should use the TRM methodology and eligibility criteria, including rounding the savings values in the same way as it is done in the TRM.

In the PY2017 evaluation, the AEG team found some measures that were incented even they should not have been incented per the TRM guidelines. In particular, this applied to measures with different rating tiers for new equipment from a rating authority where one tier was eligible in the TRM, and the lower tier was not.

In addition, the AEG team found that for many measures, rounding effects caused a minor shift in realization rates. In discussion with Hawai'i Energy, the AEG team learned that Hawai'i Energy uses database-driven algorithms to calculate savings, with rounding extending to many decimal places. In the TRM, the kW savings are rounded to three decimal places, and the kWh savings are rounded to two decimal places.

Measure characterizations in the TRM are inherently general calculations. The precision assumed in an unrounded algorithm calculation implies greater precision than is actually present in the TRM measure savings. The use of the TRM's rounding approach can avoid verification risk and aligning measure savings to those presented directly in the TRM will help mitigate potential verification risk or potential errors in database-driven algorithms. This recommendation was first reported in PY2017 and persisted in PY2018.

PY2019 update: in discussing similar findings with Hawai'i Energy, they noted that their tracking system is undergoing a comprehensive update, which, once completed, will allow them to better align measure tracking to the TRM (including dual baselines).

Recommendation 6. Consider expanding the timing and methods for gathering customer satisfaction results, as the current method likely creates bias in the results.

This is an ongoing finding from PY2017, and in discussions with Hawai'i Energy, they noted during the PY2018 verification that changes are underway. The current practice of gathering customer satisfaction information relies on an email that is sent shortly after a rebate is paid. The AEG team observed that in the data tracking system, email addresses were not always present for customers. Midstream end-use customers (in BEEM) appear to be effectively excluded from the email customer satisfaction system. Additionally, customers who have only experienced a portion of the program (perhaps an energy audit) may never be surveyed for satisfaction or would be asked to reflect on an experience occurring sometime in the past. Expanding the timing and methods may help Hawai'i Energy develop a more comprehensive view of customer satisfaction, informing potential opportunities for program action. Additionally, consider coordinating with the AEG team to develop survey questions related to general satisfaction or program-specific elements. This topic is discussed in more detail in the Customer Satisfaction section of this report (Chapter 5).

PY2019 update: based on documentation received as part of the PY2019 verification, it appears as though these recommendations remain relevant.

Recommendation 9. Findings from the verification process should continue to be used to inform TRM updates.

The verification process is a key source of information for TRM updates. AEG used findings from the PY2017 and PY2018 verification processes to help prioritize measures and stipulated assumptions for the review and update performed for the PY2019 and PY2020 TRMs.

PY2019 update: this is a standing recommendation, as the verification process should be used to inform TRM updates on an ongoing basis.

A

PERFORMANCE AWARD DETAILS

As noted earlier, the chief purpose of the verification effort was to provide an independent review of Hawai'i Energy's performance relative to its PY2019 annual targets. The targets spanned a range of performance indicators, including energy and demand savings, financial benefits to Hawaii, targets for accessibility and affordability, economic development, market transformation, and customer satisfaction. Hawai'i Energy's performance incentive is separated into categories and outcomes from which Hawai'i Energy can be awarded a portion of the total potential award. A portion of Hawai'i Energy's total award will come through meeting shared-savings goals, which is determined outside of the verification process and is therefore not covered in this report.[41] Details for the performance targets and incentive awards are presented in the sub-sections below.

Clean Energy Technologies Award Details

For PY2019, the awards for the CET metrics of first year energy reduction, lifetime energy reduction, peak demand reduction, and TRBs were divided into categories by sector and incentive type. This resulted in 20 separate financial performance awards. The programs were divided into categories as follows:

- Business Prescriptive: BEEM, BESM
- Business HTR: BHTR
- Business Custom: CBEEM
- Residential Incentives: REEM, RESM, CREEM
- Residential HTR: RHTR

The highest amount that could be earned for any particular category was 115 percent of the base performance award. Also, in order to receive the minimum award, the performance of that category must meet or exceed 95 percent of the target metric. Table A-2 summarizes the performance targets, base performance awards, and the achieved performance awards calculated from the claimed savings.[42]

[41] The EEM team will apply the final verification results to obtain shared-savings incentives, add it to the $534,987 included in this report, and present the full incentive award to the HPUC via a memo.

[42] CET claimed savings come from program tracking database "EMV_PY2019_20210115.xlsx."

Table A-2 Claimed Clean Energy Technologies Performance Awards Details

Key Performance Metrics	Claimed Results	PY2019 Targets	PY2019 Claimed % of Target	Metric Meets 95% Minimum Target	Base Peformance Award	% of Base Peformance Award	Achieved Performance Award
First Year Energy Reduction (kWh)	103,667,855	100,930,855	102.7%	Yes	$112,500.00	92.0%	$103,456.08
Business Prescriptive	23,038,774	23,614,037	97.6%	Yes	$26,320.78	76.0%	$20,003.80
Business HTR	5,643,193	10,413,329	54.2%	No	$11,606.95	0.0%	$0.00
Business Custom	26,897,895	24,910,048	108.0%	Yes	$27,765.35	108.0%	$29,986.58
Residential Incentives	46,393,435	40,623,894	114.2%	Yes	$45,280.39	114.2%	$51,710.20
Residential HTR	1,694,558	1,369,546	123.7%	Yes	$1,526.53	115.0%	$1,755.51
Lifetime Energy Reduction (kWh)	1,377,415,952	1,149,116,865	119.9%	Yes	$112,500.00	79.1%	$89,004.42
Business Prescriptive	343,687,485	361,338,592	95.1%	Yes	$35,375.51	51.0%	$18,041.51
Business HTR	79,072,521	155,360,657	50.9%	No	$15,210.01	0.0%	$0.00
Business Custom	552,763,430	308,958,471	178.9%	Yes	$30,247.43	115.0%	$34,784.54
Residential Incentives	384,998,313	306,640,883	125.6%	Yes	$30,020.53	115.0%	$34,523.61
Residential HTR	16,894,203	16,818,261	100.5%	Yes	$1,646.53	100.5%	$1,654.76
Peak Demand Reduction (kW)	18,969	15,666	121.1%	Yes	$112,500.00	106.5%	$119,840.49
Business Prescriptive	3,938	3,378	116.6%	Yes	$24,260.74	115.0%	$27,899.85
Business HTR	782	1,155	67.7%	No	$8,290.88	0.0%	$0.00
Business Custom	4,083	2,491	163.9%	Yes	$17,888.23	115.0%	$20,571.47
Residential Incentives	9,683	8,294	116.7%	Yes	$59,562.92	115.0%	$68,497.35
Residential HTR	483	348	138.8%	Yes	$2,497.23	115.0%	$2,871.81
Total Resource Benefit ($)	$172,234,065	$162,884,010	105.7%	Yes	$150,000.00	67.3%	$100,898.82
Business Prescriptive	$46,319,415	$48,516,767	95.5%	Yes	$44,980.17	55.0%	$24,739.09
Business HTR	$9,804,471	$19,249,740	50.9%	No	$17,515.78	0.0%	$0.00
Business Custom	$61,564,898	$39,178,616	157.1%	Yes	$35,070.74	115.0%	$40,331.35
Residential Incentives	$51,668,668	$53,488,688	96.6%	Yes	$49,938.64	66.0%	$32,959.50
Residential HTR	$2,876,613	$2,450,198	117.4%	Yes	$2,494.67	115.0%	$2,868.87
Total					**$487,500.00**	**84.8%**	**$413,199.81**

The results of the verification activities for each program were used to derive the verified CET performance awards. The verified CET performance awards are shown in Table A-3. The total verified performance award is $317,486.76, which is substantially lower than the claimed performance award. The minimum targets were not met for business prescriptive for both first year energy and lifetime energy reductions due to adjustments for deemed values not matching the TRM. The business prescriptive and residential incentives also fell short of the minimum target for TRBs due to adjustments for dual baselines.

Table A-3 Verified Clean Energy Technologies Performance Awards Details

Key Performance Metrics	Verified Results	PY2019 Targets	PY2019 Verified % of Target	Metric Meets 95% Minimum Target	Base Peformance Award	% of Base Peformance Award	Achieved Performance Award
First Year Energy Reduction (kWh)	102,907,723	100,930,855	102.0%	Yes	$112,500.00	74.1%	$83,338.24
Business Prescriptive	22,128,530	23,614,037	93.7%	No	$26,320.78	0.0%	$0.00
Business HTR	5,657,524	10,413,329	54.3%	No	$11,606.95	0.0%	$0.00
Business Custom	26,673,720	24,910,048	107.1%	Yes	$27,765.35	107.1%	$29,736.69
Residential Incentives	46,531,052	40,623,894	114.5%	Yes	$45,280.39	114.5%	$51,846.04
Residential HTR	1,916,896	1,369,546	140.0%	Yes	$1,526.53	115.0%	$1,755.51
Lifetime Energy Reduction (kWh)	1,204,862,879	1,149,116,865	104.9%	Yes	$112,500.00	63.2%	$71,107.81
Business Prescriptive	339,618,537	361,338,592	94.0%	No	$35,375.51	0.0%	$0.00
Business HTR	79,378,031	155,360,657	51.1%	No	$15,210.01	0.0%	$0.00
Business Custom	412,891,002	308,958,471	133.6%	Yes	$30,247.43	115.0%	$34,784.54
Residential Incentives	354,589,215	306,640,883	115.6%	Yes	$30,020.53	115.0%	$34,523.61
Residential HTR	18,386,095	16,818,261	109.3%	Yes	$1,646.53	109.3%	$1,799.66
Peak Demand Reduction (kW)	18,837	15,666	120.2%	Yes	$112,500.00	106.5%	$119,840.49
Business Prescriptive	3,927	3,378	116.3%	Yes	$24,260.74	115.0%	$27,899.85
Business HTR	784	1,155	67.9%	No	$8,290.88	0.0%	$0.00
Business Custom	3,930	2,491	157.8%	Yes	$17,888.23	115.0%	$20,571.47
Residential Incentives	9,599	8,294	115.7%	Yes	$59,562.92	115.0%	$68,497.35
Residential HTR	596	348	171.4%	Yes	$2,497.23	115.0%	$2,871.81
Total Resource Benefit ($)	$154,710,054	$162,884,010	95.0%	Yes	$150,000.00	28.8%	$43,200.22
Business Prescriptive	$43,829,474	$48,516,767	90.3%	No	$44,980.17	0.0%	$0.00
Business HTR	$10,233,703	$19,249,740	53.2%	No	$17,515.78	0.0%	$0.00
Business Custom	$49,714,000	$39,178,616	126.9%	Yes	$35,070.74	115.0%	$40,331.35
Residential Incentives	$48,083,826	$53,488,688	89.9%	No	$49,938.64	0.0%	$0.00
Residential HTR	$2,849,050	$2,450,198	116.3%	Yes	$2,494.67	115.0%	$2,868.87
Total					**$487,500.00**	**65.1%**	**$317,486.76**

Notes for Performance Award, Table ES-1-2

Note 1: Clean Energy Technologies Claimed and Reported come from program tracking database "EMV_PY2019_20210115.xlsx" and the resulting verification activities.

Note 2: Greenhouse gas emissions metrics verified by using first-year kWh savings and the eGRID 2018 Summary Tables for Hawaii's total output emission rates (https://www.epa.gov/sites/production/files/2020-01/documents/egrid2018_summary_tables.pdf, page 4)

Note 3: Multifamily Direct Install and Energy Advantage savings and customers served come from the verification of data from the program tracking database "EMV_PY2019_20210115.xlsx". Energy Advantage claimed customers served comes from the PY19 Hawaii Energy Annual Report and are verified through the program tracking database. Additionally:

- In the Hawai'i Energy Monthly Performance Report for February 2020, Hawai'i Energy notified the Commission that, "MFDI target value for lifetime customer bill savings was actually lifetime kWh (not bill savings)." Hawai'i Energy has clarified that the correct bill savings target for PY19 should have been $3,430,577 instead of $10,089,930, based on lifetime energy savings. Because the PBFA contract's stated goal has not been updated to reflect this proposed correction, the AEG team verified the metric based on the contracted amount. Current reporting values include both lifetime kWh and lifetime customer bill savings. When asked by the EEM if this affected only the PY19 targets or if both the PY20 and PY21 targets were also off, Hawai'i Energy confirmed that only the PY19 targets were off.

Note 4: Island Equity verified performance comes from a combination of "EMV_PY2019_20210115.xlsx" and " PY19 Customer Island Equity_10.01.20.xlsx".

Note 5: Market Transformation verified performance comes from multiple documents submitted to the AEG team by Hawai'i Energy.

Note 6: Customer Satisfaction verified performance comes from documents submitted to the AEG team by Hawai'i Energy.

B

VERIFICATION METHODOLOGY

The AEG team implemented a variety of methodologies to verify Hawai'i Energy's claimed savings and activities. This appendix summarizes the key verification approaches implemented by the AEG team, which align with the approved approaches in the PY2019 Detailed Verification Work Plan. As noted in the main report, the AEG team received data and documents from Hawai'i Energy and engaged with the EEM, HPUC, and Hawai'i Energy to discuss observations, confirm data and approaches, and generally worked collaboratively to develop the verification results. The table below is a matrix of which verification method was applied to each program or metric (e.g., customer satisfaction).

Table B-1 Verification Methods Applied to Each Program or Metric

Program Name or Metric	Tracking System Review	Tracking System Verification	Desk Reviews	TRB Analysis	Training/ Professional Development Documentation Review
REEM: non-Peer	X	X	X	X	
REEM: Peer		X		X	
RHTR	X	X	X	X	
RESM	X	X	X	X	
CREEM	X	X	X	X	
BEEM	X	X	X	X	
CBEEM	X	X	X	X	
BHTR	X	X	X	X	
BESM	X	X	X	X	
Economic Development and Market Transformation					X
Customer Satisfaction					X

Types of Savings

Hawai'i Energy presents savings at three levels, referencing the TRM as the basis.[43] These include:

- **Customer-level savings** represent measure savings without respect to system line losses or net effects. The TRM describes these as "gross customer level."
- **System-level savings** are customer-level savings adjusted up by a "system loss factor" to account for line losses, reflecting savings at the electricity generator.

[43] Historical definitions.

- **Program-level savings** are system-level savings adjusted down by an NTG ratio, reflecting net savings realized by the program that account for free-ridership and, to a lesser degree, spillover.

The factors used to adjust customer savings to system savings were deemed in the PY19 TRM and differ by Island, reflecting differences in the electrical grid. The system loss factors (SLFs) are presented in the table below. The AEG Team multiplied the system loss adjustment (1+SLF) values by the customer-level savings to arrive at system-level first-year savings.

Table B-2 Hawai'i Energy System Loss Factors[44]

Island	System Loss Factors (SLF)	System Loss Adjustment (1+SLF)
Hawaii	6.3%	1.063
Lanai	4.3%	1.043
Maui	5.0%	1.050
Molokai	8.5%	1.085
Oahu	4.2%	1.042

After calculating system-level first-year savings, the AEG Team applied the NTG ratio specified in the Hawai'i Energy PY19 TRM to calculate program level savings. Two of the REEM programs are exceptions—the Peer program (described below) uses a NTG ratio adjustment of 1.0, resulting in the program level savings equal to the system-level savings, and Upstream LEDs have a NTG ratio adjustment of 0.575. The table below presents the TRM's program NTG ratios.

Table B-3 Hawai'i Energy NTG Ratios[45]

Program Name	Component	NTG Ratio
BEEM		0.75
CBEEM		0.75
BESM		0.95
BHTR		0.91
REEM	Peer Group Comparison	1.00
REEM	Upstream LED	0.575
REEM	All other REEM Measures	0.79
CREEM		0.65
RESM		0.92
RHTR		1.00

Total Resource Benefit Calculations

To determine TRBs, the present value of net-customer level savings was calculated using the avoided costs presented in the PY19 TRM, which included a significant update to avoided costs. The TRM also assigned each measure or project in the Hawai'i Energy portfolio a measure life, which describes the period of time

[44] Source: Hawai'i Energy PY2019 TRM, "Key Metrics" worksheet.

[45] Source: Hawai'i Energy PY19 TRM, "Key Metrics" worksheet.

Hawai'i Energy expects the savings to last.[46] New for PY2019 was the introduction of dual baselines for certain measures in the TRM. In order to calculate the TRBs, the lifetime energy reduction must be divided among all of the years in the measure EUL to calculate avoided costs. The avoided costs are a metric of the benefits that the State of Hawaii accrues due to the savings generated by the energy efficiency measures. This is the methodology the AEG team followed for calculating total resource benefits for individual measures from their verified savings values:

- Full measure EULs were determined from the TRM for deemed measures or by dividing the lifetime energy reduction by the first-year energy reduction for non-TRM measures.
- Next, first baseline EULs were assigned for measures with dual baseline approaches from the TRM. This mostly included refrigeration measures with trade-in and some lighting measures.
- The TRBs were calculated by applying the avoided cost table from the TRM using the verified first-year energy reduction and peak demand savings and either the first baseline EUL for dual baseline measures or the full measure EUL for non-dual baseline measures.
- Finally, for dual baseline measures, the remaining TRBs were calculated by determining the avoided costs between the full measure EUL and the first baseline EUL. To accomplish this accurately, the remaining verified lifetime energy reduction was apportioned equally over the remaining EUL period for the dual baseline measures.

The AEG team applied the financial assumptions presented in the TRM to the verified savings developed for the residential and business sectors. The key financial factors underpinning the TRB calculation are presented in the table below. From the first year, 2019, they are inflated by three percent and discounted by six percent, as deemed in the TRM.

Table B-4 Avoided Costs and Key TRB Financial Assumptions[47]

TRB Metric Description	TRB Metric
kWh avoided cost (2019)	$ varies by island
kW avoided cost (2019)	$ varies by island
Annual inflation rate	3%
Annual discount rate	6%
Net to gross	Varies by program

Prior to calculating TRBs, the AEG team employed the methods described further in this section to develop independently verified estimates of Hawai'i Energy's PY2019 energy and demand savings, within the limitations described. A description of how the results of the verification activities were applied to calculate realization rates and a flowchart of this process is included in Appendix D.

Clean Energy Technologies Verification Methods

Underpinning the verification of the CET targets was balancing the verification activities and verification breadth with the verification budget, program or measure approaches to claiming savings, and potential

[46] The measure life, also known as the EUL, is defined in the PY19 TRM as "The median number of years that a measure is in place and operational after installation. This definition implicitly includes equipment life and measure persistence but not savings persistence. (Definition is from the Uniform Methods Project.) See also "Savings Persistence" definition." For the purposes of lifetime savings and TRB calculations, it represents the estimated number of years measure savings are expected to last. At the end of the EUL, no additional savings are assumed to result from the program, even if the end-user replaces the efficient equipment with equivalent or more efficient equipment.

[47] Source: Hawai'i Energy PY2019 TRM, "Key Metrics" worksheet.

for variance on Hawai'i Energy's overall performance. The AEG team utilized several methods to arrive at verified savings and performance results for the CET programs, including:

- **Tracking System Review.** The AEG team received an initial set of project details from Hawai'i Energy in August 2020. This initial database was reviewed across all programs to assess the close-to-final aggregate savings and inform the verification plan and was used to inform the options for verification methods and their applicability for each program. A second database was provided to the AEG team in late October 2020 and was the basis of the initial tracking system review. The AEG team raised questions and presented findings to Hawai'i Energy on the tracking system at multiple points during the evaluation, with Hawai'i Energy generating new database extracts for verification—one in late November 2020 and one on January 15, 2021[48], which was the final database the AEG team used for verifying claimed savings.
- **Tracking System Verification.** For all measures[49] that utilized the PY2019 Hawai'i Energy TRM for claiming savings, the AEG team used an Excel spreadsheet[50] method that replicated the project measures and types from the Hawai'i Energy tracking system in order to independently confirm accuracy in terms of utilizing TRM inputs to calculate customer, system, and program savings and resource benefits. This analysis allowed for verifying the degree to which Hawai'i Energy correctly used the Hawai'i Energy TRM, as well as assessing the level and reasonableness of information being tracked. This review included activities such as confirming the applicability of TRM values to the indicated measures and assessing the reasonableness of the measures (e.g., reasonable measure counts per site, the applicability of the reported measures for the site, dates are realistic).

  The tracking system verification allowed for a census of TRM-based projects recorded in the tracking data to be analyzed. To the degree there were variances found in the tracking system data, those variances were identified and discussed with Hawai'i Energy during the course of the verification activities, with the results included in this report.

  Desk Review Verification. For the CBEEM, RHTR, BHTR, and BESM programs, engineering desk reviews were used to verify key input parameters and savings methodologies for a sample of projects. This is a typical verification method, and these desk reviews were a key activity in verifying the Hawai'i Energy claimed savings, as the tracking database does not record the underlying data used to calculate savings. For measures recorded in the BEEM and REEM programs, a sample of projects received engineering desk reviews to verify whether the tracking data accurately reflected the supporting documentation. Across these programs, the AEG team received a variety of documentation from Hawai'i Energy to support the desk review verification process. The nature of the documentation spanned project-specific calculators, invoices, applications, and equipment specification sheets.

The table below summarizes the sampling and verification methods for each Hawai'i Energy CET program.[51]

[48] The final database was provided in an Excel file entitled "EMV_PY2019_20210115.xlsx".

[49] This was completed for all projects. If measures have inadequate tracking data to determine TRM savings, a reasonableness check was done, but the measure itself was removed from the formal analysis. Where this occurred, it is included as a finding in this report.

[50] The AEG team created a spreadsheet as part of the PY2017 and PY2018 verifications and updated it for the PY2019 verification to reflect changes in the PY2019 TRM.

[51] The PY2019 Detailed Verification Work Plan includes a more detailed description of the program and logic for the sampling and activity strategy.

Table B-5 Clean Energy Technologies Sampling and Methods

Program	Desk Review Sample Size	Tracking System Review
	Residential Programs	
REEM	42	Yes
RHTR	5	Yes
RESM	-	Yes
CREEM	-	N/A
Residential Total	***47***	***Yes***
	Business Programs	
BEEM[52]	30	Yes
CBEEM	30	N/A
BHTR	3	Yes
BESM	1	Yes
Business Total	***64***	***Yes***
Total PY2019	**111**	**Yes**

Within the REEM, BEEM, and CBEEM programs, different strata were used for each program to sample projects for desk reviews. The table below describes the stratification used for each of the programs, along with the number of projects sampled for desk reviews by stratum.

Table B-6 Desk Review Stratification and Sampling

Program Name	Stratum	Number of Projects Sampled
REEM		
	Solar Hot Water	9
	HVAC	21
	Refrigerator/Freezer Bounty/Trade-In	12
	Total	**42**
BEEM		
	Midstream Lighting	10
	Non-Midstream Lighting	5
	HVAC	8
	Other Measures	7
	Total	**30**
CBEEM		
	Custom Lighting > 1,000,000 kWh savings	4
	Custom Lighting from 200,001 to 1,000,000 kWh savings	8
	Custom Lighting from 50,001 to 200,000 kWh savings	8
	Custom Lighting < 50,000 kWh savings	3
	Custom HVAC (all)	4
	Customer Other (all)	3
	Total	**30**

[52] These were sampled at the rebate level, allowing for multiple measures to be reviewed within a single sample point.

Using verified results, the AEG team calculated realization rates. The realization rate is the verified program savings divided by the claimed program savings. To calculate realization rates, each program that only received a tracking system review had the entirety of its tracking system projects analyzed and verified for TRM compliance. In the case of REEM, BEEM, and CBEEM desk reviews, the desk reviews provided an additional source of verification to the sampled strata. The results of the desk reviews were applied at the strata level, weighted by project kWh savings as needed, with adjustments made to savings exclusive of those already developed via the tracking system review. In all cases, stratum level verifications were weighted by their relative contribution to program kWh savings.

For BESM and BHTR, due to the unique projects in the program, the results of the individual desk reviews were not extrapolated to the population and were only used to adjust the results for the individual projects, independent of the tracking system review. Similarly, a project in BEEM, which had a unique finding among the desk and tracking system reviews, was used to only adjust the results for that individual project and was excluded from the realization rate calculation. Additional information on the realization rate calculations can be found in Appendix D.

Sampling across all programs was conducted based on the customer level savings, which do not take into account line loss factors by island and net-to-gross ratios. The sampling was done at the customer level because the adjustments arising from desk reviews and site visits affect savings estimates at the customer level directly, and the line loss factors and net-to-gross ratios are considered in the program and portfolio roll-ups after realization rates are applied.

Accessibility and Affordability Verification Methods

Accessibility and Affordability is a key element of Hawai'i Energy's PY2019 performance targets. A tracking system analysis was performed to verify Hawai'i Energy's performance relative to the targets. In addition, documentation was provided by Hawai'i Energy for portions of the customer equity targets that could not be verified sufficiently through the tracking system review. The performance targets, metrics, and verification methods are summarized in the table below.

Table B-7 Accessibility and Affordability Performance Targets and Verification Methods

Key Focus Areas		100 Percent Target	Metric	Verification Approach
Economically Disadvantaged	Energy Advantage	650 $1,500,000	Customers served Customer bill savings	Tracking System Review
	Single & Multifamily Direct Install	1,934 $10,089,930	Customers served Customer bill savings	Tracking System Review & Contractor Invoices
	Community-Based Energy Efficiency (new)	2	Number of communities served	
	EmPOWER Hawaii Project (new)	7	Number of participating non-profits	List of participating non-profits
Island Equity	County of Hawaii	13%	Target spend must be met in Hawaii & Maui Counties for Milestone and Target Award	Tracking System Review & Market Transformation Spend by Island
	County of Maui	13%		
	City & County of Honolulu	74%		

The two key focus areas for economically disadvantaged use different metrics for bill savings. Customer bill savings for Energy Advantage are first-year savings while customer bill savings for Single and Multifamily Direct Install are lifetime savings.

For the MFDI and SFDI metrics, Hawai'i Energy confirmed they estimated lifetime bill savings using the same rate across the EUL; Hawai'i Energy uses the average rate by rate schedule and island for all counties for the previous program year. This is applied to the first-year savings for each rebate by island and then multiplied by the EUL. For example, PY20 used the averages from PY19 rates.

Economic Development and Market Transformation Verification Methods

To verify PY2019 performance relative to economic development and market transformation, the AEG team utilized documentation provided by Hawai'i Energy. The AEG team received a variety of documentation from Hawai'i Energy to support this verification process, including training and event sign-in sheets and other material related to the specific initiatives. Additionally, the AEG team sent a survey to professional development training attendees for which Hawai'i Energy provided email addresses linked to training. The summary of economic development and market transformation performance elements, metrics, and verification methods are presented in the table below.

Table B-8 Economic Development and Market Transformation Performance Targets and Verification Methods

Key Focus Areas	Market Transformation Factor	Target and Metric	Verification Approach
Behavior Change	Workshops and Presentations:		Review Hawai'i Energy documentation
	STEM-based student workshops	1,200 participant-hours of training	
	Adult learning	2,750 participant-hours of training	
	Gamification Campaigns and Competitions	1,000 participants	
	Exhibit Educational Resources	2 stakeholder collaboration events	
	Sustained Outreach	1 participation agreement	
	Behavioral Insights	1 program intervention	
Professional Development & Technical Training	Clean Energy Ally Support Targeted Ally Training Opportunities Targeted Participant Training Opportunities Educator Training and Grants Degree Program Support Vocational Training	10,000 hours of participant training across all categories	Review Hawai'i Energy documentation
Energy in Decision Making	Strategic Energy Management	6 cohort participants	Review Hawai'i Energy documentation
Codes and Standards	Appliance Standards Advocacy	5 advocacy events	Review Hawai'i Energy documentation
	Improving Code Compliance	1 compliance roadmap and tracking savings	
	Code-Related Training	100 participant-hours of training	
	Leading Edge Technologies and Strategies	4 meetings and one report	
Clean Energy Innovation Hub	Innovation and Emerging Technologies	1 company supported	Review Hawai'i Energy documentation

Customer Satisfaction Verification Methods

To verify customer satisfaction performance relative to PY2019 targets, the AEG team received satisfaction scores from Hawai'i Energy. These scores were developed from Hawai'i Energy's customer experience management tool, Medallia, via email surveys of program participants. Background documentation on the survey practices and questions were also provided by Hawai'i Energy, further expanding the verification effort and informing considerations and recommendations.

C

CBEEM SUMMARY OF PROJECT ADJUSTMENTS

For the CBEEM projects, desk review results were presented to Hawai'i Energy prior to drafting of the Verification Report. A project workbook containing the qualitative findings and observations was provided along with the quantitative calculation of project savings, and a summary of the adjustments made to the project. Hawai'i Energy and the AEG team then had several email exchanges and conference calls discussing the verification of these projects, until consensus was reached for all project adjustments presented in this Appendix.

Reporting ID	Stratum	Project Description	Summary of Adjustments
1922001	Custom Lighting	This project consisted of replacing 251 high-intensity discharge exterior lighting with 112 similar wattage LED fixtures at a military airfield maintenance and parking area.	Effective Useful Life: The claimed savings used a 25-year effective useful life for the lifetime savings calculation. The incentive worksheet included a value of 100,000 hours per fixture; however, the approved construction documents listed life span as ">81,000 hours". The verified savings calculations used 81,000 as the lifetime for all fixtures, which resulted in a blended EUL for the project of 19.8 years. This resulted in a 79 percent realization rate for lifetime energy savings.
1922004	Custom Lighting	This project consisted of replacing the exterior walkway and common area lighting of a retail mall center.	LED fixture wattage: The EnergyStar certificate for the C8R24840UNVW fixture stated 24 input watts versus 22.4 claimed. The DLC certificate for the SLIM37NW found that the fixture wattage was 34.2 input watts versus 34.6 watts claimed. This reduced savings slightly to a 98 percent realization rate. EUL Rounding: The EUL listed in the tracking data was 12.6, and the claimed savings used a rounded figure of 13 for the savings calculation. The verified savings estimated the blended EUL as 12.96 years. This caused a very minor decrease in the lifetime savings, with the vast majority of the lifetime savings adjustment resulting from the first-year energy reduction.
1922005	Custom Lighting	This project consisted of replacing roadway lighting in the City and County of Honolulu. The project was managed and constructed through a master contract with JCI.	Effective Useful Life: The effective useful life was calculated and tracked as 24.5 years in the documentation; however, the lifetime savings value indicates that the effective useful life was rounded up to 25 years. The verification calculation used the unrounded value of 24.5, creating a lifetime kWh savings realization rate of 98 percent.
1922006	Custom Lighting	This project consisted of replacing roadway lighting in the City and County of Honolulu. The project was managed and constructed through a master contract with JCI.	Effective Useful Life: The effective useful life was calculated and tracked as 24.5 years in the documentation; however, the lifetime savings value indicates that the effective useful life was rounded up to 25 years. The verification calculation used the unrounded value of 24.5, creating a lifetime kWh savings realization rate of 98 percent.

Reporting ID	Stratum	Project Description	Summary of Adjustments
1922008	Custom Lighting	This project consisted of replacing existing 250 watt high-pressure sodium and 175 watt metal halide streetlights with newer LED fixtures and controls.	Installed fixture adjustment: One exterior light fixture initially planned for installation was replaced fixture with increased wattage, the LL-SL1-SM-100-40K-T3 (100 watt) fixture replaced the JLS68103 (58 watt). This decreased savings by approximately 2 percent. EUL adjustment: The verification calculation used the LM-80 test results for the MPB-AF lighting fixture (60,000 hours) to determine the EUL. The submitted documentation used 100,000 hours. This reduced the project EUL from 23.5 to 16.7 years.
1922009	Custom Lighting	This project consisted of replacing existing incandescent and fluorescent lighting in the interior or exterior of army personnel barracks with newer LED lamps and fixtures. The buildings are single-family homes and duplexes. This project is a portion of a larger project with more lighting and other equipment.	Exterior Wall Pack Fixture Wattage: The verification calculator used the DLC wattage for the 15 watt wall pack because the purchase order and specification identified the 15 watt wall pack. The submitted calculator used the 25 watt wall pack DLC certification. Lifetime Savings: The residential fixture's lifetime savings used the calculated commercial custom EUL (25 years) and the residential first-year energy savings. The verified savings used the commercial EUL for the commercial savings and the residential lifetime savings for each measure, as prescribed in the TRM. The resultant weighted average EUL was 6.1 years. This significantly reduced lifetime savings.
1922010	Custom Lighting	This project consisted of replacing roadway lighting in the City and County of Honolulu. The project was managed and constructed through a master contract with JCI.	Effective Useful Life: The effective useful life was calculated and tracked as 24.5 years in the documentation; however, the lifetime savings value indicates that the effective useful life was rounded up to 25 years. The verification calculation used the unrounded value of 24.5, creating a lifetime kWh savings realization rate of 98 percent.
1922011	Custom Lighting	This project consisted of replacing 582 high-pressure and low-pressure sodium streetlights with newer LED models for the City of Honolulu. Baseline lamp sizes ranged from 55-250W, and retrofit fixtures ranged from 31-149W.	EUL Rounding: The reported lifetime savings were calculated using a rounded EUL of 25 multiplied by the first-year energy savings. The verified savings used the calculated EUL of 24.5, which resulted in a small decrease in the verified lifetime savings and a realization rate of 98 percent.
1922012	Custom Lighting	This project consisted of replacing existing 32W u-tube fluorescent, and 100W decorative soffit can interior fixtures, and a combination of low and high-pressure sodium exterior fixtures, with new LED products. The facility type is multi-sport Athletic venue with locker rooms, multiple courts/athletic areas, and exterior parking lot and walkways.	DLC/ES Fixture Wattage: The report savings calculations used a nominal wattage of 24 W for a linear LED retrofit kit, while DLC listed the input wattage as 24.06. This caused a minor reduction in the demand and energy savings.

Reporting ID	Stratum	Project Description	Summary of Adjustments
1922013	Custom Lighting	This project consisted of new construction lighting for kindergarten and first grade classrooms and support spaces, and a student dormitory. The baseline for the kindergarten and first grade facilities were set to School/University while the baseline for the student housing was set to Dormitory.	Quantities: The verified savings used detailed fixture takeoffs from the Construction drawings along with the luminaire schedule's listed wattages for each fixture. The lighting takeoffs resulted in a reduction of installed interior lighting power, with a contributing factor being the likely inclusion of exterior lighting in the interior lighting power calculations displayed on the Construction Documents. This adjustment resulted in increased savings for all three buildings. AOH/CF Adjustments: The claimed savings used the deemed hours of use for Education and Hotel/Motel. No changes were made to the hours of use for the education buildings, however the deemed coincident factor was used for the verified savings rather than the 0.0 CF used in the report savings. This resulted in increased demand savings. For the Student Housing, the verified savings used the Hotel/Motel hours of use adjusted by the 10 weeks per year that the school is closed. This resulted in decreased energy savings. Similarly, the deemed peak coincidence factor was adjusted from the Hotel/Motel factor of 0.6 to account for the 10 weeks that the school is closed. This adjustment led to decreased demand savings. Overall, these adjustments led to decreased savings across all three metrics.
1922014	Custom Lighting	This project consisted of renovating the lighting in an existing Warehouse from High-Bay fluorescent fixtures to newer LED fixtures.	EUL Rounding: The reported lifetime savings were calculated using a rounded EUL of 14 multiplied by the first-year energy savings. The verified savings used the calculated EUL of 13.7, which resulted in a small decrease in the verified lifetime savings, and a realization rate of 98 percent for the lifetime savings.
1922015	Custom Lighting	This project consisted of replacing high-output high pressure sodium fixtures with newer LED fixtures on an exterior fuel canopy.	AOH/CF Mismatch: The annual hours of use per day was reported at 11.5 hours per day, which roughly corresponds to the average civil twilight hours[53] during the year. The reported peak demand runtime of 3.0 in the 5-9pm timeframe does not match the 11.5 hours based on civil twilight. Using minimum and maximum twilight times of 6:11pm and 7:25pm, respectively, the peak demand runtime was calculated at an average of 2.2 hours for the verified savings, which corresponds to a coincident factor of 0.63. This reduced the demand savings.

[53] https://www.timeanddate.com/astronomy/civil-twilight.html

Reporting ID	Stratum	Project Description	Summary of Adjustments
1922016	Custom Lighting	This project consisted of replacing fluorescent strip and metal halide fixtures with newer LED fixtures on a loading dock and parking garage. The parking garage lighting operates 24/7, while the new loading dock fixtures include integrated photocell sensors to operate only at night. All of the fixtures LED strip fixtures included motion sensors to operate at 10 percent power when no motion is detected, and then operate at 100 percent when motion is detected.	Minor Rounding: The input wattages for the LED strip fixtures at 10 percent dimming were rounded in the reported calculations to the nearest whole decimal. They were not rounded in the verified savings calculations, resulting in a slight increase in first-year energy and demand savings. Effective Useful Life: The claimed savings used a 25-year effective useful life for the lifetime savings calculation. The incentive worksheet included a value of 36 years. The source of the 36-year value could not be found in the project documentation. The LED strip fixtures listed their hours of operation at 50,000, and the wall packs listed life span as ">50,000 hours" with a 5-year warranty. The verified savings calculations used 50,000 as the lifetime for all fixtures, which resulted in a blended EUL for the project of 6.9 years due to the high amount of fixtures with 8,760 operation. This resulted in a 28 percent realization rate for the lifetime energy savings. AOH/CF Mismatch: The reported peak demand operating hours in the Enhanced Case were 4 hours per day for the fixtures at 10 percent dimming. The peak demand operating hours for the 10 percent dimming line items were decreased to 75 percent, while the 100 percent operating time in the peak window was increased from 0 to 25 percent to match the distribution of AOH, and assuming random operation within the peak period. These two changes resulted in decreased demand savings.
1922017	Custom Lighting	This project consisted of replacing fluorescent strip fixtures with newer LED fixtures in parking garage stairwells. The parking garage lighting operates 24/7. All of the fixtures LED strip fixtures included motion sensors to operate at 10 percent power when no motion is detected, and then operate at 100 percent when motion is detected.	Minor Rounding: The input wattages for all fixtures were rounded in the reported calculations to the nearest whole decimal. They were not rounded in the verified savings calculations, resulting in a slight increase in first-year energy and demand savings. Effective Useful Life: The claimed savings used a 25-year effective useful life for the lifetime savings calculation. The incentive worksheet included a value of 114 years. The source of the 114-year value could not be found in the project documentation. The LED strip fixtures listed their hours of operation at 50,000 hours. The verified savings calculations used 50,000 as the lifetime for all fixtures, which resulted in a blended EUL for the project of 5.7 years due to the high amount of fixtures with 8,760 operation. This resulted in a 23 percent realization rate for the lifetime energy savings. AOH/CF Mismatch: The reported peak demand operating hours in the Enhanced Case were only 2 hours per day, even though the fixtures operate 24/7. The peak demand operating hours for the 10 percent dimming line items were increased to 92 percent, while the 100 percent operating time in the peak window was increased from 0 to 8 percent to match the distribution of AOH. These two changes resulted in decreased demand savings.

Reporting ID	Stratum	Project Description	Summary of Adjustments
1922019	Custom Lighting	This project included replacing linear fluorescent lighting with LED strip products throughout an existing Retail and Warehouse facility.	AOH Adjustment: The number of holidays were not factored into the claimed savings calculations. The corporate website for this facility listed 2 full holidays (Thanksgiving and Christmas) with a half day operation on Christmas Eve. This reduced the operating hours and the first-year energy savings. Space Conditioning IEF Factors: The desk review was unable to determine the space conditioning factors used in the claimed savings. The verified savings used 1.36 for IEd and 1.15 for IEe, corresponding to Retail with troffers, which resulted in increased first-year energy, demand, and lifetime energy savings.
1922020	Custom Lighting	This project consisted of replacing high pressure sodium streetlights with newer LED fixtures.	EUL Rounding: The reported lifetime savings were calculated using a rounded EUL of 25 multiplied by the first-year energy savings. The verified savings used the calculated EUL of 24.46, which resulted in a small decrease in the verified lifetime savings, and a realization rate of 98 percent.
1922021	Custom	This project consisted of an incentive for the third phase of LED lighting upgrades, refrigerator, and clothes washer replacements at master-metered apartment buildings.	Calculation Error: The reported peak demand savings calculation for each LED line item did not include the quantity in the formula. This led to all apartments being claimed at 0.006 kW rather than 0.006 kW/lamp. This was corrected in the verified savings calculation, which resulted in a realization rate of 208 percent for demand savings. EUL: The EUL in the claimed savings was 5 years for all three measures. For the verified savings, the lifetime savings for LED lamps, and refrigerators from the TRM was used, and for the clothes washers, the lifetime savings was calculated based on the 11-year EUL from the TRM. This change in lifetime savings methodology resulted in a 177 percent realization rate, and a blended EUL of 8.9 for the project.
1922022	Custom Lighting	This project included replacement of metal halide high-bay fixtures with new LED products in a college gymnasium.	EUL Rounding: The reported lifetime savings were calculated using a rounded EUL of 11 multiplied by the first-year energy savings. The verified savings used the calculated EUL of 10.9, which resulted in a small decrease in the verified lifetime savings, and a realization rate of 99 percent.

Reporting ID	Stratum	Project Description	Summary of Adjustments
1922023	Custom Lighting	This project included replacement of fluorescent, metal halide, and halogen lighting for the interior and exterior of a uniform cleaning business.	Fixture Wattages: There were minor adjustments made from the claimed savings calculations to the verified savings calculations for fixture wattages. For the SNC-FL fixtures, the claimed savings used 29W for the installed fixtures, and was adjusted to 29.01W based on the DLC listing. For the AL-TP70 fixtures, one line item in the interior inventory was using 68.6 input watts, which was changed to 68.55W for the verified savings based on the DLC listing. Overall, these minor wattage adjustments caused a negligible increase in first-year energy, demand, and lifetime savings. EUL Rounding: The EUL in the tracking data was listed as 11.2 years, while the claimed savings used a rounded up figure of 12 for the lifetime savings calculations. The verified savings calculated an 11.4 value for the EUL on the project, which is higher than the tracking system value, but lower than the rounded value used in the claimed savings. This adjustment resulted in a decrease of the lifetime savings. Interactive Effects Factors: For the interior fixtures in the claimed savings, it was not clear which factor were used for the interactive effects based on the project documentation. "Misc.Commercial" was selected in the incentive calculator, and the derived values were 1.075 for demand and 1.056 for energy savings. The verified savings used the "Average" values for non-omni directional fixtures of 1.26 for demand and 1.13 for energy. This adjustment increased first-year energy, demand, and lifetime savings.
1922024	Custom Lighting	This project consisted of replacing pre-existing incandescent and fluorescent lighting in the interior and exterior of army personnel barracks with newer LED projects. The project was split into two separate equipmentIDs, with one representing the prescriptive lighting (A-lamp, PAR30/38, and 4' LED replacements) and a smaller custom lighting calculation for hallways and exterior spaces.	EUL Methodology: The EUL for the claimed savings was set at 25, with the lifetime savings calculated by multiplying the first-year energy savings by the 25-year EUL. The verified savings used 25 years as the EUL for the custom portion, based on the hours of use from product specifications, and the prescriptive portion used the lifetime savings outlined for the applicable fixture type from the TRM. Those prescriptive EULs were lower than 25 years, averaging 6.8 years, which reduced the overall EUL on the project to 6.9 years. This resulted in a 27 percent realization rate for the lifetime savings.
1922025	Custom Lighting	This project consists of replacing metal halide exterior lighting with newer LED products for exterior lighting.	EUL Rounding: The EUL in the tracking data was listed as 11.4 years, while the claimed savings used a rounded-up figure of 12 for the lifetime savings calculations. The verified savings used 11.4 for the lifetime savings calculations, which resulted in a decrease of the lifetime savings.

Reporting ID	Stratum	Project Description	Summary of Adjustments
1922026	Custom Lighting	This project consisted of replacing pre-existing incandescent and fluorescent lighting in the interior and exterior of army personnel barracks with newer LED projects. The project was split into two separate equipmentIDs, with one representing the prescriptive lighting (A-lamp, PAR30/38, and 4' LED replacements) and a smaller custom lighting calculation for hallways and exterior spaces.	EUL Methodology: The EUL for the claimed savings was set at 25, with the lifetime savings calculated by multiplying the first-year energy savings by the 25-year EUL. The verified savings used 25 years as the EUL for the custom portion, and the prescriptive portion used the lifetime savings outlined for the applicable fixture from the TRM. The prescriptive EULs were lower than 25 years, averaging 7.7 years, which reduced the overall EUL on the project to 7.8 years. This resulted in a 31 percent realization rate for the lifetime savings.
1922030	Custom Lighting	This project consisted of replacing exterior lighting, including street lighting, security walkway lighting, wallpacks and parking lot lighting, on a US Naval base. The existing lighting was a combination of high-impact discharge, compact fluorescent, incandescent/halogen, and linear fluorescent technologies. The new lighting consists of LED products.	EUL Rounding: The reported lifetime savings were calculated using a rounded EUL of 25 multiplied by the first-year energy savings. The verified savings used the calculated EUL of 24.46, which resulted in a small decrease in the verified lifetime savings, and a realization rate of 98 percent.

D

VERIFIED SAVINGS CALCULATIONS

For the most part, the AEG team applied a ratio adjustment method[54] when moving results from within a sample to the population. An example is shown below for energy savings.

$$MWh_{VP} = \frac{MWh_{VS}}{MWh_{CS}} \times MWh_{CP}$$

Where:

MWh_{VP} = Verified population MWh savings

MWh_{VS} = Verified sample MWh savings

MWh_{CS} = Claimed sample MWh savings

MWh_{CP} = Claimed population MWh savings

There were a few instances when the AEG team did not apply this method to a sample. This occurred mostly when the sample was never planned to be used at the population level (i.e., the sampling process was designed to be informative for BESM, BHTR, and RHTR). Because sampling for these programs were designed to be informative and not statistically valid, the AEG team made adjustments only to the sampled projects and did not extrapolate the verified savings adjustment back to the full population. Additionally, one project in BEEM received a project-only adjustment and was excluded from the sample adjustment factor calculation. (This project had a calculation error, but a review of the tracking system revealed there were no other measures that could have had a similar error and so it was incorrect to apply an adjustment for this one project to other, dissimilar projects.)

Three programs included a sample design that incorporated multiple strata (REEM, BEEM, and CBEEM) and the AEG team applied the ratio adjustment algorithm to each sampling strata before adding up the savings to the program level. The ratio adjustment algorithm above was used to develop the sample adjustment factors, which reflect adjustments from the desk reviews that are independent of the tracking system review and should be extrapolated to the population savings.

The table below summarizes the type of sample design, number of sampling strata, and application of the ratio adjustment algorithm across the six programs with desk reviews.

[54] Cochran, William G. (1977). Sampling Techniques. New York: John Wiley & Sons.

Table D-1 Desk Review sample design, number of strata and realization rate application

Program Desk Review Verification Efforts	Sample design	Number of Sampling Strata
Programs that applied Sample Adjustment Factors (using the ratio adjustment algorithm)		
REEM	Random	3
BEEM	Random	4
CBEEM	Random Purposeful/ Certainty	5 Random 1 Certainty*
Programs that applied project-only adjustments (no application of ratio adjustment algorithm)		
RHTR	Random	1
BHTR	Purposeful/ Certainty	1*
BESM	Purposeful/ Certainty	1*

Note: The AEG team verified RESM through program tracking only and so is not included in the table. CREEM also had no sampling as during development of the PY19 Detailed Verification Work Plan, the AEG team and EEM team discussed that no verification activities were needed for this program in PY19 due to the 100 percent realization rate for CREEM measures in PY18 and the similarity of measures for PY19. As a result, the realization rate for CREEM measures was deemed at 100 percent.

**The AEG team did not apply the ratio adjustment algorithm in the certainty strata as the analysis adjusted all projects in this strata individually.*

For analyses on a population - The ratio adjustment method is not applicable when analysis occurs on a census of projects. The AEG team performed analysis on all projects/measures within the program tracking database, so AEG directly applied any adjustments found during this analysis to each single project/measure with no extrapolation required.[55]

Adding adjustments together for verified savings - When estimating the savings for the program, the AEG team first applied any adjustments to the program tracking database and then applied the sample adjustment factors based on the ratio adjustment algorithm. As such, no projects had double counting of adjustments.

Below are two graphics that visually depict this process. The first graphic is a generic flowchart of how verification activities lead to data adjustments from the program level claimed savings to the program level verified savings. Following that is a visualization of how these adjustments were made for REEM.

[55] Program tracking data and project-level adjustments incorporated any changes related to items such as incorrect application of deemed savings values from the Hawaii TRM and any project documentation inconsistencies.

Figure D-1 Generic Program Level Savings Adjustments Flowchart

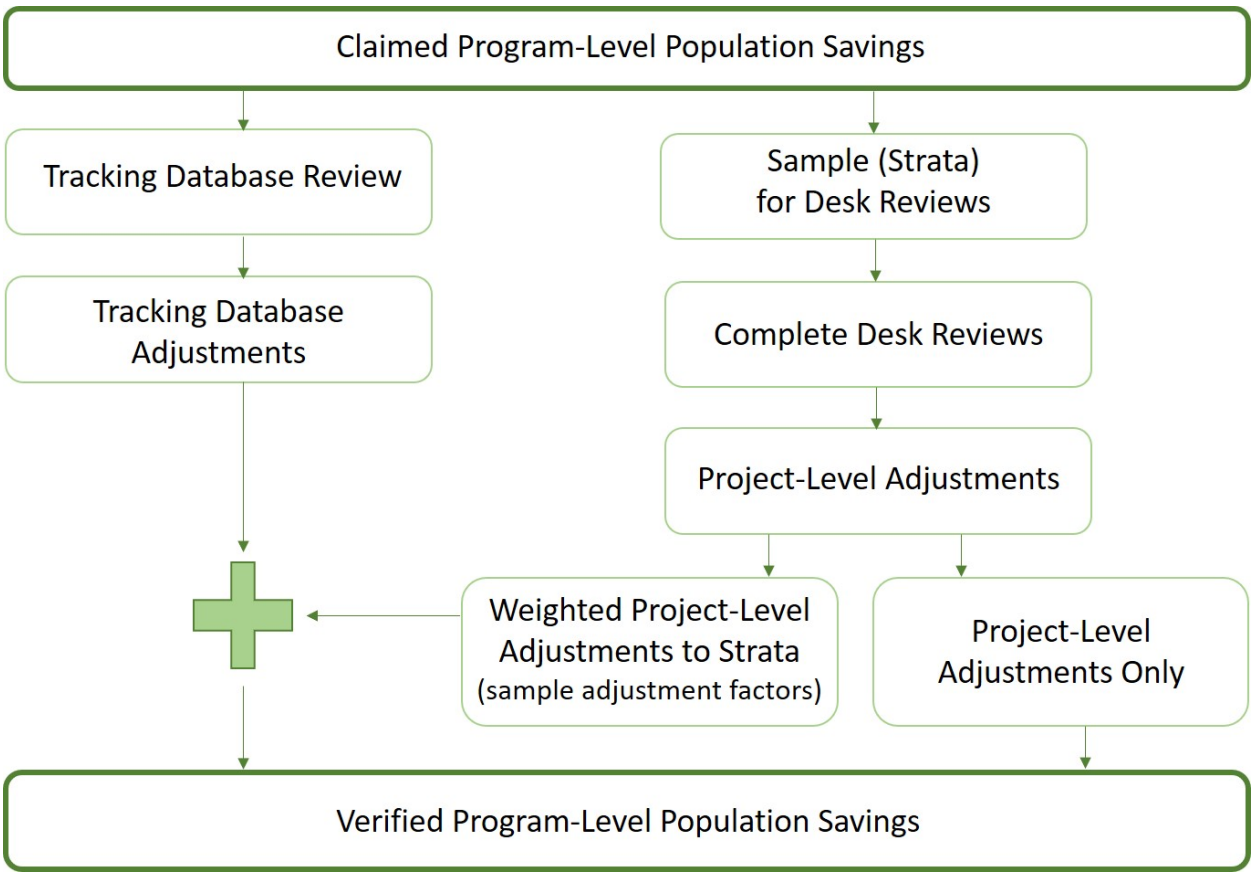
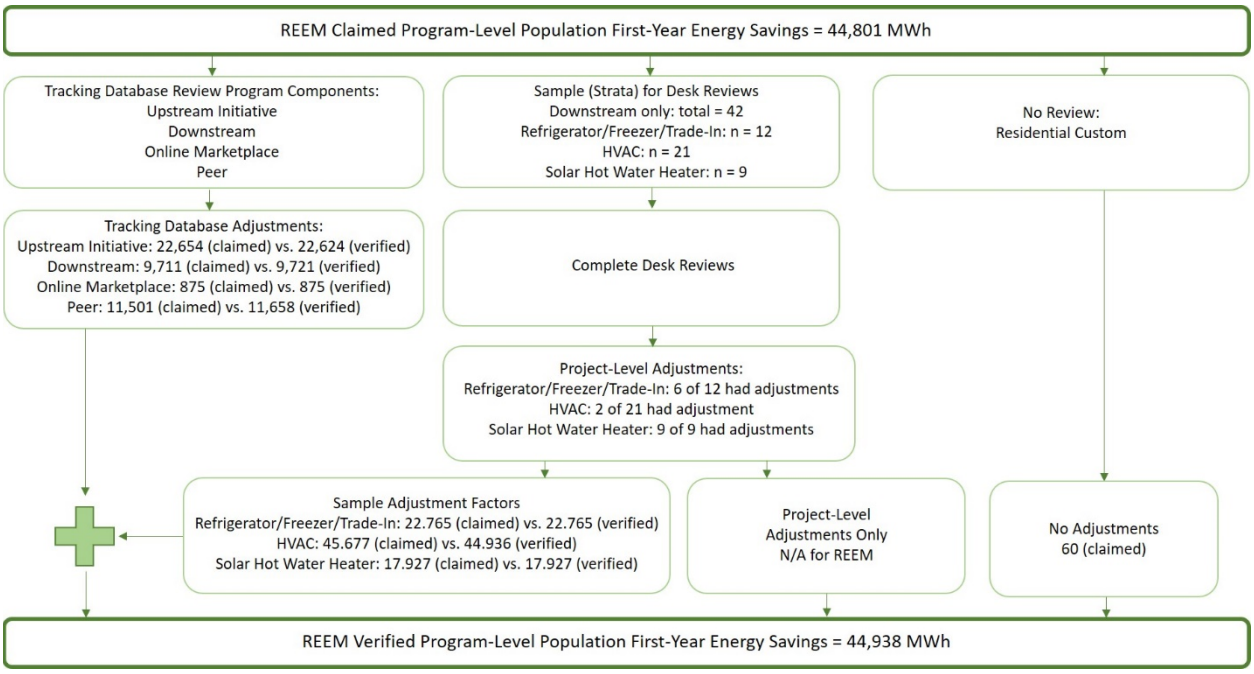


Figure D-2 REEM Program Level Savings Adjustments Flowchart



The realization rates are simply the ratio of the verified population savings to the claimed population savings. The algorithm below presents the equation for the first-year energy realization rate.

$$RR_{MWh} = \frac{VPS_{MWh}}{CPS_{MWh}}$$

Where:

RR_{MWh} = MWh realization rate

VPS_{MWh} = Verified Program MWh savings

CPS_{MWh} = Claimed Program MWh savings

Below are the first-year MWh realization rates for the REEM program example, depicted in the flowchart above.

Table D-2 REEM Program Level First-Year MWh Claimed and Verified Results

Equipment Category	Claimed Program Level First-Year MWh	Verified Program Level First-Year MWh	Realization Rate
Upstream Initiative	22,654	22,624	99.9%
Peer Group Comparison	11,501	11,658	101.4%
Downstream	9,711	9,721	100.1%
Online Marketplace	875	875	100.0%
Residential Custom	60	60	100.0%
Total	**44,801**	**44,938**	**100.3%**

Total Resource Benefit Calculation Examples

This section presents two example calculations for TRBs for typical adjustments made during the verification process. For the TRBs, the Avoided Costs are listed by year in the TRM, including an annual inflation rate of 3 percent and annual savings discount rate of 6 percent. Both of these examples are from the REEM program, which has an NTG ratio of 0.79.

Table D-3 presents an example of the TRB calculation for a refrigerator measure with a dual baseline in Maui County. The total lifetime kWh savings from the TRM for this measure is 6,449 kWh, with a 14-year EUL. The first-year energy savings are 768 kWh with a first-period EUL of 8 years. For the claimed savings, the first-year energy savings was continued for years 9 through 14, which resulted in an overstatement of both the lifetime kWh savings and the TRBs. This project resulted in a realization rate of 60 percent for lifetime kWh and 66 percent for TRBs, with 100 percent realization rates for first-year energy and peak demand savings.

Table D-3 Example TRB Calculation for Refrigerator Trade-Up (with recycling of old) in Maui County

Measure Year	Avoided Costs		NTG Ratio	Claimed Savings			Verified Savings			TRB Difference
	$/kWh	$/kW		Annual kWh Savings	kW Savings	Total Resource Benefit	Annual kWh Savings	kW Savings	Total Resource Benefit	
1	$0.153	$580	0.79	768	0.088	$133	768	0.088	$133	$0
2	$0.149	$547	0.79	768	0.088	$128	768	0.088	$128	$0
3	$0.145	$516	0.79	768	0.088	$124	768	0.088	$124	$0
4	$0.141	$487	0.79	768	0.088	$119	768	0.088	$119	$0
5	$0.137	$459	0.79	768	0.088	$115	768	0.088	$115	$0
6	$0.133	$433	0.79	768	0.088	$111	768	0.088	$111	$0
7	$0.129	$409	0.79	768	0.088	$107	768	0.088	$107	$0
8	$0.125	$386	0.79	768	0.088	$103	768	0.088	$103	$0
9	$0.122	$364	0.79	768	0.088	$99	51	0.006	$7	-$93
10	$0.118	$343	0.79	768	0.088	$96	51	0.006	$6	-$89
11	$0.115	$324	0.79	768	0.088	$92	51	0.006	$6	-$86
12	$0.112	$306	0.79	768	0.088	$89	51	0.006	$6	-$83
13	$0.108	$288	0.79	768	0.088	$86	51	0.006	$6	-$80
14	$0.105	$272	0.79	768	0.088	$83	51	0.006	$6	-$77
Total				**10,751**		**$1,485**	**6,449**		**$977**	**-$508**

Table D-4 presents an example of the TRB calculation for a solar water heater measure with a single baseline in Oahu County. This project received an EUL adjustment from the claimed value of 20 years to the TRM value of 18 years. The total lifetime kWh savings from the TRM for this measure is 35,854 kWh for the 18-year EUL. The first-year energy savings are 1,992 kWh. For the claimed savings, the first-year energy savings was continued for years 19 and 20, which resulted in an overstatement of both the lifetime kWh savings and the TRBs. This project resulted in a realization rate of 90 percent for lifetime kWh and 93 percent for TRBs, with 100 percent realization rates for first-year energy and peak demand savings.

Table D-4 Example TRB Calculation for Solar Water Heater Incentive In Oahu County

Measure Year	Avoided Costs		NTG Ratio	Claimed Savings			Verified Savings			TRB Difference
	$/kWh	$/kW		Annual kWh Savings	kW Savings	Total Resource Benefit	Annual kWh Savings	kW Savings	Total Resource Benefit	
1	$0.134	$198	0.79	1,992	0.296	$257	1,992	0.296	$257	$0
2	$0.130	$187	0.79	1,992	0.296	$249	1,992	0.296	$249	$0
3	$0.126	$176	0.79	1,992	0.296	$240	1,992	0.296	$240	$0
4	$0.123	$166	0.79	1,992	0.296	$232	1,992	0.296	$232	$0
5	$0.119	$157	0.79	1,992	0.296	$224	1,992	0.296	$224	$0
6	$0.116	$148	0.79	1,992	0.296	$217	1,992	0.296	$217	$0
7	$0.113	$140	0.79	1,992	0.296	$210	1,992	0.296	$210	$0
8	$0.110	$132	0.79	1,992	0.296	$203	1,992	0.296	$203	$0
9	$0.107	$124	0.79	1,992	0.296	$197	1,992	0.296	$197	$0
10	$0.104	$117	0.79	1,992	0.296	$190	1,992	0.296	$190	$0
11	$0.101	$111	0.79	1,992	0.296	$184	1,992	0.296	$184	$0
12	$0.097	$104	0.79	1,992	0.296	$178	1,992	0.296	$178	$0
13	$0.095	$98	0.79	1,992	0.296	$172	1,992	0.296	$172	$0
14	$0.092	$93	0.79	1,992	0.296	$167	1,992	0.296	$167	$0
15	$0.090	$88	0.79	1,992	0.296	$162	1,992	0.296	$162	$0
16	$0.087	$83	0.79	1,992	0.296	$157	1,992	0.296	$157	$0
17	$0.085	$78	0.79	1,992	0.296	$151	1,992	0.296	$151	$0
18	$0.082	$74	0.79	1,992	0.296	$146	1,992	0.296	$146	$0
19	$0.080	$69	0.79	1,992	0.296	$142	0	0.000	$0	-$142
20	$0.078	$65	0.79	1,992	0.296	$138	0	0.000	$0	-$138
Total				**39,838**		**$3,816**	**35,854**		**$3,536**	**-$279**

E

PROFESSIONAL DEVELOPMENT SURVEY

Hawai'i Energy
Market Transformation – Professional Development
Participant Web Survey (PY2019)

This survey instrument will be used for a web survey with participants in Hawai'i Energy's professional development events and/or trainings to support the PY2019 verification effort.

Sample Variables

CASEID Unique case identifier

Survey Questions

EMAIL_Q1 Let's get started!

Our records indicate that you participated in the <EVENT> on <DATE> that was sponsored by Hawai'i Energy.

Do you recall participating in this training or event?

01 Yes
02 No

Q1_EXIT [SHOW IF EMAIL_Q1 = 2] Mahalo nui loa for your participation!

01 Exit survey

Q2 How did you hear about the <EVENT> on <DATE>?

{i}(Select all that apply){/i}

01 Email
02 Website
03 Social media
04 Word of mouth
05 Referral
06 Other [Please describe]

Q3 How easy or difficult was the registration process?

{i}(Select one response){/i}

01 Very easy
02 Somewhat easy
03 Neither easy nor difficult
04 Somewhat difficult
05 Very difficult
88 Don't know / I did not register myself for the event

Q4 In thinking about the work you do, in your opinion, how useful was the information provided or discussed during the <EVENT>?

{i}(Select one response){/i}

01 Very useful
02 Somewhat useful
03 Not very useful
04 Not at all useful

Q4a **[SHOW ON SCREEN WITH Q4]** Why did you rate the training the way you did? [RECORD RESPONSE VERBATIM]

Q5 How has your participation in the <EVENT> influenced you personally at your organization? [PROGRAMMER NOTE: RANDOMIZE ORDER]

{i}(Rank all that apply 1-most influence to 9-least influence){/i}

01 Taught me the basics about energy efficiency
02 Improved my understanding of energy efficient principles and programs
03 Provided me with a professional certification or credential
04 Helped me to do my job better
05 Helped me to get a promotion/pay increase
06 Helped me to get more responsibility or recognition within my organization
07 Has encouraged me to be an advocate for energy efficient improvements within my organization
08 This training has not had any impact on my work
09 Other [Please describe]

Q6 In what ways, if any, has the <EVENT> affected your organization's day-to-day activities or practices? As an example, the decisions made about equipment settings or purchases, workplace policies about energy use or conservation, sales practices, or the type of projects taken on by your organization.

{i}(Select one response){/i}

00 Have not had a chance to implement any activities or practices
01 Have made changes to activities or practices

Q6a **[SHOW IF Q6 = 01]** What changes have been made?
[RECORD RESPONSE VERBATIM]

Q7 Would you recommend the <EVENT> to others?

{i}(Select one response){/i}

01 Yes, I have already recommended it
02 I have not recommended it yet, but I would
03 No, I would not recommend this to others
88 Don't know

Q7a **[SHOW IF Q7 = 3]** What is main reason why you would not recommend the event?
[RECORD RESPONSE VERBATIM]

Q8 Overall, how satisfied are you with the <EVENT>?

{i}(Select one response){/i}

01 Very satisfied
02 Satisfied
03 Neither satisfied nor dissatisfied
04 Dissatisfied
05 Very dissatisfied

Q9 Did participation in this <EVENT> lead to your organization's participation in an energy efficiency, demand response, storage, or distributed generation program (e.g., participation could have resulted in your organization either receiving an incentive from a program offering an incentive for installing efficiency equipment or offering services to an organization that received an incentive)?

{i}(Select one response){/i}

01 Yes
02 No
88 Don't know

Q9a **[SHOW IF Q9 = 1]** Was the program your organization participated in offered by Hawai'i Energy, HECO, or some other entity?

{i}(Select all that apply){/i}

01 Hawai'i Energy
02 HECO
03 Other entity
04 Don't know

Q9b **[SHOW IF Q9a = 03]** Which entity?
[RECORD RESPONSE VERBATIM]

Q10 **[SHOW IF Q9 = 2, 88]** Does participation in this <EVENT> make you or your organization more likely to participate in energy efficiency, demand response or related programs in the next 12 months?

{i}(Select one response){/i}

01 Yes
02 No
88 Don't know

Q12 Do you have any recommendations for how Hawai'i Energy could improve its energy efficiency training and/or educational opportunities?

{i}(Select one response){/i}

01 Yes
02 No

Q12a **[SHOW IF Q12 = 01]** What recommendations do you have?
[RECORD RESPONSE VERBATIM]

Q13 Are you registered with Hawai'i Energy as a Clean Energy Ally?

{i}(Select one response){/i}

01 Yes
02 No
88 Don't know

Q14 Which of the following best describes your current occupation?

{i}(Select one response){/i}

01 Educator
02 Energy efficient equipment installer/ technician
03 Energy efficient equipment sales
04 Building operations management
05 Business manager
06 Consultant
07 Architect/ design professional
08 Engineer
09 College student
10 Other (Please specify)

Q15 On what island do you primarily work?

{i}(Select one response){/i}

01 O'ahu
03 Moloka'i
04 Maui
05 Lāna'i
07 Hawai'i

INT99 Mahalo nui loa for your participation!

CO Completed

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