HAWAIʻI ENERGY PY2018 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 2018 (PY2018)[1] for Hawai'i Energy. The chief purpose of the verification effort was to provide an independent review of Hawai'i Energy's performance relative to the PY2018 Annual Plan performance targets.[2] To this end, the AEG team reviewed Hawai'i Energy's reported program outcomes to verify that incented projects/measures were appropriately "tracked" and that estimated savings values and related adjustments were properly applied.

The targets span a range of performance indicators, including energy and demand savings, financial benefits to Hawaii, targets for customer equity and market transformation, and customer satisfaction. Successfully meeting the performance targets can lead to a financial reward of up to $1,001,669. The performance incentive is separated into categories and outcomes from which Hawai'i Energy can be awarded a portion of the total potential award. The performance targets and incentive award are summarized in Tables Table ES-1 through Table ES-3, below.

Table ES-1 Resource Acquisition Goals

Key Focus Areas	100 Percent Target	Metric	Percent of Incentive Award
First-Year Energy Reduction	127,563,746	kWh	15 percent
Peak Demand Reduction	21,211	kW	15 percent
Total Resource Benefit	$334,761,873	$	40 percent

Table ES-2 Customer Equity Goals

Key Focus Areas	100 Percent Target	Metric	Percent of Incentive Award
Economically Disadvantaged	Small Business Direct Install: 675 7,500,000 Multifamily Direct Install: 3,692 1,357,849	Customers served kWh Customers served kWh	7 percent
Island Equity	County of Hawaii: 13 percent County of Maui: 13 percent City & County of Honolulu: 74 percent	Target spend must be met in Hawaii and Maui Counties for Milestone and Target Award	10 percent

[1] Program Year 2018 began on July 1, 2018 and ended June 30, 2019.

[2] The AEG team received the Annual Plan in a file named "AnnualPlan_PY2018.pdf".

Table ES-3 Market Transformation and Customer Satisfaction Goals

Key Focus Areas	Market Transformation Factor	100 Percent Target and Metric	Percent of Incentive Award
Behavior Modification	Workshops and Presentations	2,500 participant-hours of training	3.9 percent
	Youth Education Workshops and Presentations	1,000 participant-hours of training	
	Youth Event Sponsorships	2 events	
	Enhanced Engagement (Gamification)	1,000 participants	
	Transformational Videos	10 videos produced	
Professional Development & Technical Training	Clean Energy Ally Support Targeted Ally Training Opportunities Targeted Participant Training Opportunities Educator Training and Grants Energy Industry Workforce Development	8,370 hours of participant training across all categories	3.9 percent
Energy in Decision Making	Strategic Energy Management	2 cohort participants	1 percent
	Community Based Energy Efficiency	1 cohort participant	
Codes and Standards	Code Identification and Adoption	9 advocacy events	1 percent
	Code-Related Training and Compliance	70 hours of participant training	
	Leading Edge Technologies and Strategies	4 stakeholder meetings; 1 report	
	Standards Enhancement	3 engagements	
Clean Energy Collaboration	iDSM Pilot Project	1 pilot project	0.2 percent
Customer Satisfaction	Application Processing Customer Experience	>8.5 overall customer satisfaction score	3 percent

The verification process provides an overall verification rate at the program portfolio level. For Resource Acquisition performance targets, the verification effort verified whether incented projects or measures were appropriately recorded in the program tracking database and whether the underlying savings values and related adjustments stipulated in the PY2018 Technical Reference Manual were appropriately applied. The verification effort (and the overall verification rate) is an important indicator of the accuracy of Hawai'i Energy's tracking effort in terms of properly tracking measure installations (and incentives paid) and applying pre-agreed upon savings values and associated adjustments. The verification analysis does not involve a review of the

> Specifically, the AEG team's verification activities determined the extent to which incented projects/measures were appropriately "tracked" in the program database and ensured 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, but the scope did not extend to independent calculations of savings estimates or a quantitative evaluation of the TRM's validity.

validity of those stipulated savings or adjustment factors—only their appropriate use for calculating Resource Acquisition 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. In short, the scope of the verification for measures covered by the TRM was limited to assessing the extent to which TRM gross savings values and related adjustments were being applied properly, and did not extend to independent calculations of savings estimates or a quantitative evaluation of the TRM's validity.[3]

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 work collaboratively to develop the verification results.

Below we summarize the PY2018 performance targets and the results derived by the AEG team. Overall, Hawai'i Energy met nearly all of its performance targets. The PY2018 verification results indicate that substantial efforts were made to achieve the targets, even for performance metrics that did not meet their target goals.

[3] As a separate task, the AEG team is completing in-depth reviews of the Technical Reference Manual.

Table ES-4 PY2018 Claimed and Verified Performance Award

Performance Indicator	Milestone*	Target	Metric	Fraction of Award	Target Award**	Claimed Results**	Claimed Percent of Target or Met Target**	Claimed Award**	Verified Results***	Verified Percent of Target or Met Target***	Verified Award***
Resource Acqusition				**Fraction of Award** 70%							
First Year Energy Reduction	95,672,810	127,563,746	kWh	15%	$150,250.35	123,583,370	96.9%	$145,562.08	123,994,960	97.2%	$146,046.87
Peak Demand Reduction	15,908	21,211	kW	15%	$150,250.35	20,473	96.5%	$145,022.65	20,737	97.8%	$146,890.50
Total Resource Benefits	$243,134,457	$334,761,873	$	40%	$400,667.60	$333,347,497	99.6%	$398,974.77	$324,093,861	96.8%	$387,899.34
Customer Equity				**Fraction of Award** 17%							
Economically Disadvantaged											
Small Business Direct Install (Energy Advantage)											
Customers Served	506	675	Customers Served			760			760		
kWh Savings	5,625,000	7,500,000	kWh			8,441,662			9,121,417		
Multifamily Direct Install				7%	$70,116.83		met target	$70,116.83		met target	$70,116.83
Customers Served	2,769	3,692	Customers Served			3,840			3,840		
kWh Savings	1,018,387	1,357,849	kWh			1,833,699			1,833,694		
Island Equity											
County of Hawaii		13%	Target spend must be met in			17.7%	met target		17.7%	met target	
County of Maui		13%	Hawaii & Maui Counties for	10%	$100,167.00	13.7%	met target	$100,166.90	13.7%	met target	$100,166.90
City & County of Honolulu		74%	Milestone & Target Award			68.6%	met target		68.6%	met target	
Market Transformation				**Fraction of Award** 10%							
Behavior Modification											
Community Workshops (Hard to Reach, Energy Literacy)	NA	2,500	Number of participant-hours of Training			2,865			2,865		
Youth Education Workshops and Presentations	NA	1,000	Number of participant-hours of Training	3.9%	$39,065.00	1,423.50	met target	$39,065.09	1,423.50	met target	$39,065.09
Youth Event Sponsorships	NA	2	Number of events			3			3		
Enhanced Engagement (Gamificiation)	NA	1,000	Number of participants			10,033			10,033		
Transformational Videos	NA	10	Number of videos produced			10			12		
Professional Development and Technical Training											
Clean Energy Ally Support Targeted Ally Training Opportunities Targeted Participant Training Opportunities Educator Training and Grants Energy Industry Workforce Development	NA	8,370	Number of participant-hours of Training	3.9%	$39,065.00	10,462.16	met target	$39,065.09	10,219.16	met target	$39,065.09
Energy in Decision Making											
Strategic Energy Management (SEM)	NA	2	Cohort participants	1%	$10,016.69	15	met target	$10,016.69	13	met target	$10,016.69
Community Based Energy Efficiency	NA	1	Cohort participants			1			1		
Codes and Standards											
Codes Identification and Adoption	NA	9	Advocacy Events			14			14		
Code-Related Training & Compliance	NA	70	Number of participant-hours of Training	1%	$10,016.69	141	met target	$10,016.69	140	met target	$10,016.69
Leading Edge Technologies and Strategies	NA	4 / 1	Number of Stakeholder Meetings / Reports			4 / 1			4 / 1		
Standards Enhancement	NA	3	Number of Engagements			7			7		
Clean Energy Collaboration											
iDSM pilot project	NA	1	Number of pilot projects	0.2%	$2,003.00	1	met target	$2,003.34	1	met target	$2,003.34
Customer Satisfaction				**Fraction of Award** 3%							
Application Processing Customer Experience	NA	>8.5	Overall customer satisfaction score	3%	$30,050.07	9.05	met target	$30,050.07	9.05	met target	$30,050.07
Total Performance Award				**100%**	**$1,001,668.58**			**$990,060.20**			**$981,337.41**

* A "Milestone" is the minimum threshold to earn an incentive for some metrics and is set at 75% of the full target. A "Target" is the 100% goal for each metric.
** Except for Resource Acquisition, the Claimed Results, Claimed Percent of Target, and Claimed Award numbers are reflective of those from the PY2018 Hawai'i Energy Annual Report, page 17.
*** Determined by the AEG Team. Please see Appendix E for additional notes.

In addition to the verification process, a new activity for PY2018 was conducting interviews with Hawai'i Energy program staff. These interviews were conducted to gain a better understanding of the program design and delivery (in particular for the Peer, Midstream Lighting, and Market Transformation programs), assess quality assurance/quality control procedures (QA/QC), discuss successes and challenges, and help to identify and prioritize verification tasks. In particular for the Market Transformation program and Customer Satisfaction, these staff interviews were used to help determine if additional verification work should be completed. Additionally, these interviews provided a forum for staff to suggest ways that the annual verification process could be helpful in making suggestions for improving programs. Separate interviews were conducted with Hawai'i Energy staff representing the Residential, Business, and Market Transformation programs.

Recommendations

Based on the verification activities, the AEG offers the recommendations in Table ES-5 to Hawai'i Energy for consideration. Because some of the recommendations the AEG team made are carryovers from the PY2017 verification activities, only those new to PY2018 are provided in the table below.

Table ES-5 Summary of PY2018 Recommendations

Recommendations
Recommendation 1. Ensure site inspections are sufficiently rigorous to catch good-faith mistakes made by contractors and installers.
Recommendation 2. Collect detailed information from customer sources, such as control systems, to allow for better accuracy on custom calculations. Improve documentation of all data sources and assumptions used in estimating savings for custom projects.
Recommendation 3. Before conducting utility billing analysis for a given custom project, consider whether billing regressions are the best analysis approach and if there is 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.
Recommendation 4. Use results from the upcoming Peer Program Stoppage of Treatment study (when they become available) to update the savings approach for the Peer program and to inform decisions related to budgeting for home energy reports versus other energy saving measures.

Key Findings and Implications

Hawai'i Energy had several PY2018 performance targets related to resource acquisition, customer equity, market transformation, and customer satisfaction. Table ES-6 summarizes key results and findings from the PY2018 verification activities and their outcomes and implications for the Hawai'i Energy programs.

Table ES-6 Key Verification Findings and Their Implications/Outcomes

Key Result/Finding	Implication/Outcome
Hawai'i Energy came very close to meeting all three resource acquisition targets—97 percent of goal was achieved for first-year energy savings, 98 percent was achieved for peak demand reduction, and 97 percent was achieved for total resource benefit. Realization rates for verified program impacts relative to claimed program impacts at the sector level hovered right at the 100% mark, ranging from 99.2%-100.3% for the residential sector and 91.2%-110.4% for the business sector.	• Programs are successful. • Realization rates are high. • Hawai'i Energy is effectively using the TRM for prescriptive measures • Hawai'i Energy is mostly following sound engineering approaches for custom measures, but there is room for improvement. • Variances were more significant for the business sector primarily due to differences in savings for custom projects.
Lighting measures continued to make up the majority of energy and peak demand impacts, though not in such a dominate way as in the past. For example, in the residential sector, PY2018 prescriptive lighting projects accounted for 60% of lifetime savings. In the business sector, PY2018 prescriptive lighting projects accounted for 43% of lifetime savings. Custom lighting projects contribute additional savings.	• Hawai'i Energy has recognized that lighting savings would not be as abundant as in the past due to various influences, including their own contributions to market transformation. The PY2018 numbers reflect the programs' efforts to achieve goals through a variety of measures and activities, and not rely so heavily on lighting savings.
In PY2018 less than half of the energy (40 percent) and demand impacts (41 percent) for the PY2018 business sector came from custom measures, whereas in PY2017, just over three-quarters came from custom measures. Much of the savings for custom measures continues to come from lighting projects, for which impacts are estimated using partially deemed savings estimation approaches. For the residential sector, prescriptive measures dominate the influence on energy and demand impacts.	• TRM deemed savings values and approaches continue to have a large influence on program results. • Since the verification process simply verifies correct usage of the TRM and does not include a full ex post evaluation, it is very important that the deemed values and approaches in the TRM estimate savings reasonably well.
Although custom measures made up a smaller portion of the PY2018 savings, several areas of improvement for custom measure analysis were identified. For the business sector, there were findings around the use of utility billing regressions and the complexity of analysis. For the residential sector, the advanced home energy pilot could use further study for Hawai'i specific savings estimates.	• For utility billing regressions, increasing the amount of post-implementation billing data and normalizing results would give more accurate results. • For large projects, use site collected data to refine energy savings estimates rather than relying on deemed or partially deemed approaches. • Consider conducting additional data collection for the Sense pilot to refine the potential savings for the measure rather than exclusively relying on estimates from other jurisdictions.

Key Result/Finding	Implication/Outcome
Hawai'i Energy met island-equity spend targets for all three counties—the County of Maui (13.7 percent), Hawaii (17.7 percent), and the City and County of Honolulu (68.6 percent). Hawai'i Energy met targets for economically disadvantaged markets in terms of number of customers served and verified energy savings.	• Programs continue to successfully bring energy efficiency to islands other than Oahu, to underserved business markets, and to economically disadvantaged residential customers.
Hawai'i Energy met market transformation targets. Although these market transformation activities may lead to future gains in energy efficiency, conservation, and renewables, Hawai'i Energy did not have direct energy savings goals tied to its market transformation activities in PY2018.	• While there continued to be no formal guidance in PY2018 for how to measure, track, or report energy and demand savings impacts from market transformation activities, efforts are underway to try to provide some guidance in future program years. • Such guidance could be provided in future versions of the TRM and TRM Framework.
Hawai'i Energy met customer satisfaction targets. The current system continues to solicit customer feedback and emphasizes measuring general satisfaction ratings via email surveys at the time a customer receives a rebate. In PY2017, the AEG team recommended that Hawai'i Energy consider adding questions to target specific program delivery experiences, surveying customers with modes other than just email, and soliciting feedback at different times during the project timeline.	• Programs have high customer satisfaction (overall satisfaction rating of 9.05 out of 10 on average). • There are opportunities to reach more customers and gain additional insights by modifying the customer satisfaction survey process.

2

VERIFICATION METHODOLOGIES

The AEG team utilized several methods to arrive at verified savings and performance results:

- Tracking System Review. The AEG team received an initial set of project details from Hawai'i Energy in September 2019. 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 final database was provided to the AEG team in late October 2019.[4] Projects and savings tracked in this database are what the AEG team used to assess final claimed savings and what should be used by Hawai'i Energy in their PY2018 Annual Report.
- Tracking System Verification. For all measures[5] that utilized the PY2018 Hawai'i Energy TRM for claiming savings, the AEG team used an Excel spreadsheet[6] 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 assessed 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, 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 Custom Business Energy Efficiency Measures (CBEEM) and Custom Residential Energy Efficiency Measures (CREEM) 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 Business Energy Efficiency Measures (BEEM) and Residential Energy Efficiency Measures (REEM) programs, a sample of projects received engineering desk reviews to verify whether the tracking data accurately reflected the supporting documentation. Market transformation initiatives and customer satisfaction performance also used a desk review method to analyze information based on the available documentation provided by Hawai'i Energy for the purpose of verifying performance relative to PY2018 goals.

  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. For market transformation initiatives, the AEG team received training and event sign-in sheets and other material

[4] The final database was provided in an Excel file entitled "EMV_2018_Report_20191028141316.xlsx".

[5] 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.

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

related to the specific initiatives, and for customer satisfaction results the survey outcomes and methods were shared with the AEG team.

- Quality Assurance / Quality Control (QA/QC) Project Reviews. QA/QC reviews were completed for a sample of 20 Midstream projects. QA/QC reviews consisted of examining the available project documentation from a qualitative perspective only and determining whether Hawai'i Energy demonstrated sufficient quality assurance and control practices in the rebate process. The QA/QC reviews were not intended to result in adjustments to project or program savings. As a result of the PY2017 verification activities, the AEG team learned that for the Midstream program, single rebates were based on batches of invoices from lighting distributors. Those invoices could have included multiple customers and locations. Due to this particular program design, the AEG team recommended a QA/QC project file review process for a sample of Midstream program projects. This task was new for PY2018 and focused specifically on the QA/QC process completed by Hawai'i Energy for the sampled Midstream program projects.
- Site Visit Verification. The AEG team conducted site verification for a total of nine[7] PY2018 participants—all nine of these site visits were CBEEM projects. The site visits were selected in a targeted manner and as such are not representative of the population. The site visits were selected based on whether a site visit was likely to provide additional information that would clarify desk review results and conclusions. The site visit results were used to inform the desk reviews for individual projects and did not result in realization rate adjustments that were extrapolated to CBEEM verified results to the program population. The site visits verified installation and documentation accuracy, as well as verifying key parameters used in the calculation of custom savings.
- Total Resource Benefits (TRBs) Analysis. Using the results from the tracking system verification, desk review verification, and site visit verification, the AEG team developed program and portfolio realization rates,[8] along with their associated TRBs. To calculate the TRBs, the AEG team utilized the avoided cost factors by measure lifetime presented in the PY2018 TRM and applied those at the measure level for each program, which was then rolled up to the Hawai'i Energy portfolio, for purposes of verifying TRB performance achievement relative to the PY2018 goals.

Below, we summarize the method and sampling details for each of the key PY2018 Hawai'i Energy performance metrics.

Resource Acquisition Verification Methods

Resource acquisition performance metrics include energy (kWh), demand (kW), and TRBs performance. Table 2-1 summarizes the sampling and verification methods for each Hawai'i Energy program.[9] Underpinning the verification of Hawai'i Energy resource acquisition targets was balancing the verification activities and verification breadth with the verification budget, program or measure approaches to claiming savings, and potential for variance on Hawai'i Energy's overall performance. For example, the site visit activity level for PY2018 focused exclusively on CBEEM, where customer-specific data had the largest effect and provided confirmation of the more complex custom projects.

[7] Ten site visits were planned, but due to unknown security requirements with the tenant's landlord, inspection of equipment at the tenth scheduled site visit could not be conducted as planned.

[8] The Realization Rate is the ratio of verified savings to claimed savings.

[9] The PY2018 Detailed Verification Plan includes a more detailed description of the program and logic for the sampling and activity strategy.

Table 2-1 Resource Acquisition Sampling and Methods

Program Name	Number of Projects in Population	Number of Projects Sampled for Desk Reviews	Tracking System Review	Number of Projects Sampled for Site Visits	Number of Projects Sampled for QA/QC Project Reviews
Residential Programs					
Residential Energy Efficiency Measures (REEM)	10,323	96	Yes	-	-
Residential Hard to Reach (RHTR)	2,849	-	Yes	-	-
Residential Energy Service and Maintenance (RESM)	6,907	-	Yes	-	-
Custom Residential Energy Efficiency Measures (CREEM)	21	4	-	-	-
Residential Total	***20,100***	***100***	***Yes***	***-***	***-***
Business Programs					
Business Energy Efficiency Measures (BEEM)[10]	885	47	Yes	-	20
Custom Business Energy Efficiency Measures (CBEEM)	305	30	-	10	
Business Hard to Reach (BHTR)	1,198	-	Yes	-	-
Business Energy Services and Maintenance (BESM)	272	3	Yes	-	-
Business Total	***2,660***	***80***	***Yes***	***10***	***20***
Total PY2018	**22,760**	**180**	**Yes**	**10**	**20**

Within the REEM, BEEM, and CBEEM programs, different strata were used for each program to sample projects for desk reviews. For CBEEM, site visits were conducted within a nested sample of the desk review sample, meaning that any site visits would also have received a desk review. Table 2-2 describes the stratification used for each of the programs along with the strata's sample size.

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

Table 2-2 Desk Review and Site Visit Stratification and Sampling

Program Name	Stratum	Number of Projects Sampled for Desk Reviews	Number of Projects Sampled for QA/QC Project Reviews	Number of Projects Sampled for Site Visits
REEM				
	Solar Hot Water	42	-	-
	HVAC	27	-	-
	Refrigerator/Freezer Recycling or Bounty	27	-	-
	Total	**96**	**-**	**-**
BEEM				
	Midstream Lighting	10	20	-
	Non-Midstream Lighting	12	-	-
	HVAC	25	-	-
	Total	**47**	**20**	**-**
CBEEM				
	<50,001 kWh savings	8	-	2
	50,001 to 200,000 kWh savings	8	-	3
	200,001 to 1,000,000 kWh savings	10	-	3
	Over 1,000,000 kWh savings	4	-	2
	Total	**30**	**-**	**10**

Verification activities largely focused on assessing the extent to which the claimed savings adhered to the Hawaii TRM protocols. Using verified results, the AEG team calculated realization rates. The realization rate is the verified net savings divided by the claimed net 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. CBEEM site visits were used to complete the desk review, with final project level savings (combining desk review and site visit results) extrapolated to the strata-level savings. In all cases, stratum level verifications were weighted by their relative contribution to program kWh savings.

For BESM, 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 that were sampled. Similarly, a very large 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 projects and was excluded from the realization rate calculation. Additional information on the realization rate calculations can be found in Appendix B.

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.

Customer Equity Verification Methods

Customer Equity is a key element of Hawai'i Energy's PY2018 performance goals. A tracking system analysis was performed to verify Hawai'i Energy's performance relative to the goals. The performance goals, metrics, and verification methods are summarized below, in Table 2-3.

Table 2-3 Customer Equity Performance Targets and Verification Methods

Key Focus Areas	100 Percent Target	Metric	Verification Approach
Economically Disadvantaged	Small Business Direct Install: 675 7,500,000 Multifamily Direct Install: 3,692 1,357,849	Customers served kWh Customers served kWh	Database review Verify savings Database review Verify savings
Island Equity	County of Hawaii: 13 percent County of Maui: 13 percent City & County of Honolulu: 74 percent	Target spend; Hawaii and Maui Counties must have their target spends met	Database review

In addition to the tracking system review, Hawai'i Energy provided the AEG team with an explanation and documentation on the approach to calculating the share of program spending associated with each of the three counties.

Market Transformation Verification Methods

To verify PY2018 performance relative to market transformation, the AEG team utilized documentation provided by Hawai'i Energy. Additionally, the AEG team sent a survey to professional development training attendees for which Hawai'i Energy provided email addresses.[11] The summary of market transformation performance elements, metrics, and verification methods are presented in Table 2-4.

[11] Ideally, the AEG team would have preferred to be able to link an email address to an actual training. However, Hawai'i Energy was able to provide an Excel file with email addresses only.

Table 2-4 Market Transformation Performance Targets and Verification Methods

Key Focus Areas	Market Transformation Factor	Target and Metric	Verification Approach
Behavior Modification	Workshops and Presentations	2,500 participant-hours of training	Review Hawai'i Energy documentation Verify follower and subscriber counts
	Youth Education Workshops and Presentations	1,000 participant-hours of training	
	Youth Event Sponsorships	2 events	
	Enhanced Engagement (Gamification)	1,000 participants	
	Transformational Videos	10 videos produced	
Professional Development & Technical Training	Clean Energy Ally Support Targeted Ally Training Opportunities Targeted Participant Training Opportunities Educator Training and Grants Energy Industry Workforce Development	8,370 hours of participant training across all categories	Review Hawai'i Energy documentation
Energy in Decision Making	Strategic Energy Management	2 cohort participants	Review Hawai'i Energy documentation
	Community Based Energy Efficiency	1 cohort participant	
Codes and Standards	Code Identification and Adoption	9 advocacy events	Review Hawai'i Energy documentation
	Code-Related Training and Compliance	70 hours of participant training	
	Leading Edge Technologies and Strategies	4 stakeholder meetings; 1 report	
	Standards Enhancement	3 engagements	
Clean Energy Collaboration	iDSM Pilot Project	1 pilot project	Review Hawai'i Energy documentation

Customer Satisfaction Verification Methods

To verify customer satisfaction performance relative to PY2018 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.

3

RESULTS FOR ENERGY, DEMAND, AND TOTAL RESOURCE BENEFITS

Hawai'i Energy's performance targets have been heavily weighted to resource acquisition targets. The resource acquisition targets included first-year net (program level) savings for kWh and kW, as well as TRB savings that reflect the value of energy and demand savings over the life of the measures that make up the Hawai'i Energy portfolio. Table 3-1 summarizes these targets.

Table 3-1 Resource Acquisition Goals

Key Focus Areas	100 Percent Target	Metric	Percent of Incentive Award
First-Year Energy Reduction	127,563,746	kWh	15 percent
Peak Demand Reduction	21,211	kW	15 percent
Total Resource Benefit	$334,761,873	$	40 percent

The AEG team verified the following results for Hawai'i Energy's resource acquisition goals.

Table 3-2 Resource Acquisition Verified Performance

Key Focus Areas	Metric	Claimed Results	Claimed Results Percent of Target	Verified Results	Verified Results Percent of Target
First-Year Energy Reduction	kWh	123,583,370	96.9%	123,994,960	97.2%
Peak Demand Reduction	kW	20,473	96.5%	20,737	97.8%
Total Resource Benefit	$	$333,347,497	99.6%	$324,093,861	96.8%

The primary reason the "verified results percent of target" for the total resource benefit is lower relative to the "claimed results percent of target," while it is higher than the "claimed results percent of target" for the first year energy savings and peak demand reduction, is that some adjustments were made to the effective useful lives (EULs) during the verification process, resulting in a net downward adjustment in the verified total resource benefit relative to the claimed total resource benefit.

Hawai'i Energy presents savings at three levels, referencing the TRM as the basis.[12] These include:

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

[12] Source: Hawai'i Energy PY2018 TRM, page 10.

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

All savings calculations began with the customer-level first-year savings, were adjusted to account for system line losses to determine system savings, and then were adjusted again to net savings to reflect total program net impacts. The factors used to adjust customer savings to system savings were deemed in the PY18 TRM and differ by County, reflecting differences in the electrical grid. (Note that these values were developed at the island level and were substantially reduced for the PY19 TRM.)

The system loss factors (SLFs) are presented below, in Table 3-3. The system loss adjustment (1+SLF) values were multiplied by the customer-level savings to arrive at system level first-year savings.

Table 3-3 Hawai'i Energy System Loss Factors[13]

County	System Loss Factors (SLF)	System Loss Adjustment (1+SLF)
Honolulu (Island of Oahu)	11.17%	1.1117
Hawaii (Big Island of Hawaii)	9.00%	1.0900
Maui (Islands of Maui, Lanai, and Molokai)	9.96%	1.0996

After calculating system first-year savings, the program (net) savings were adjusted by a net-to-gross (NTG) ratio, also specified in the Hawai'i Energy PY2018 TRM. These were assigned to each program's system savings. One aspect of the REEM program has an exception—the Peer program (described below) uses an NTG ratio adjustment of 1.0, resulting in the program level savings being the system level savings. The TRM's program NTG ratios are described in Table 3-4.

Table 3-4 Hawai'i Energy NTG Ratios[14]

Program Name	Component	NTG Ratio
BEEM		0.75
CBEEM		0.75
BESM		0.95
BHTR		0.99
REEM	Peer Group Comparison	1.00
REEM	Upstream LED	0.575
REEM	All other REEM Measures	0.79
CESH (CREEM)		0.65
RESM		0.92
RHTR		1.00

[13] Source: Hawai'i Energy PY2018 TRM, page 11.

[14] Source: Hawai'i Energy PY2018 TRM, page 11.

To determine TRBs, the present value of program level savings was calculated using the avoided costs presented in the PY18 TRM. (Note that a significant update to avoided costs was also made in the PY19 TRM.) The TRM also assigned each measure or project in the Hawai'i Energy portfolio a measure life, which describes the period of time Hawai'i Energy expects the savings to last.[15] The avoided costs for each year were applied against those annual savings and lives to arrive at the TRBs, a metric of the benefits that the State of Hawaii accrues due to the savings generated by the energy efficiency 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 below, in Table 3-5. From the first year, 2018, they are inflated by three percent and discounted by six percent, as deemed in the TRM. The detailed TRB calculations for the PY2018 programs and portfolio are presented at the end of this section.

Table 3-5 Avoided Costs and Key TRB Financial Assumptions[16]

TRB Metric Description	TRB Metric
kWh avoided cost (2018)	$0.176 per annual kWh
kW avoided cost	$ varies per kW per year[17]
Annual inflation rate	3 percent
Annual discount rate	6 percent
System loss factor	Varies by county; TRM metrics
Net to gross	Varies by program; TRM metrics

Prior to calculating TRBs, the AEG team employed the methods described in the Verification Methodologies section of this report (Section 2) to develop independently verified estimates of Hawai'i Energy's PY2018 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 are included in Appendix B. The following sections of this report detail the verified resource acquisition performance results for both the residential and business energy efficiency programs' net savings. Following the energy efficiency savings is a section detailing the verification of TRBs.

Residential Programs

In PY2018, Hawai'i Energy implemented the following four programs targeted at the residential sector:

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

[15] The measure life, also known as the effective useful life (EUL), is defined in the PY18 TRM as "the number of years after which 50% of the installed measures are inoperable or removed from service." 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.

[16] Source: Hawai'i Energy PY2018 TRM, page 10.

[17] The AEG team notes that the treatment of kW avoided costs in the TRM is different than kWh. Rather than an inflation rate, it presents specific values for avoided kW in each year. Both annual kWh and annual kW values are discounted to the present using the same discount rate.

Residential energy and demand savings were dominated by the REEM program, which included a diverse set of energy initiatives. With roughly 90 percent of residential program level claimed kWh savings stemming from REEM, the program included an upstream initiative, a behavior program that issued periodic Home Energy Reports (HERs) to participants, 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 home maintenance measures (RESM).

Table 3-6 summarizes the allocation of total residential program savings, by program or major component (in the case of REEM).

Table 3-6 Residential Claimed Program Level Results

Program Name	Component	Claimed Program Level First-Year MWh	Percent of First-Year Program Level Savings
REEM	Upstream	18,701	41.9%
	Peer Group Comparison	12,150	27.2%
	Downstream	9,503	21.3%
	Online Marketplace	138	0.3%
	Residential Custom	52	0.1%
	Total	*40,544*	*90.8%*
RESM		2,120	4.8%
RHTR		1,830	4.1%
CREEM		163	0.4%
Total		**44,656**	**100.0%**

The verified program level results for the residential program are presented below, in Figure 3-1 and Table 3-7. The plots in Figure 3-1 show the percentage of the verified savings that each program represents on the left side and the percentage of the end-uses on the right side. For REEM, the majority of the "Other" group savings are due to the Peer program, with additional savings for domestic hot water and envelope measures. As reflected in Table 3-7, residential program component realization rates were either 100 percent or very close to 100 percent. This is expected, given the vast majority of residential program measures were based on deemed savings from the TRM for first year and lifetime impacts and that the purpose of verification is to confirm Hawai'i Energy accurately applied the TRM.

Figure 3-1 Residential Verified Program Level Impacts by Program and End-Use

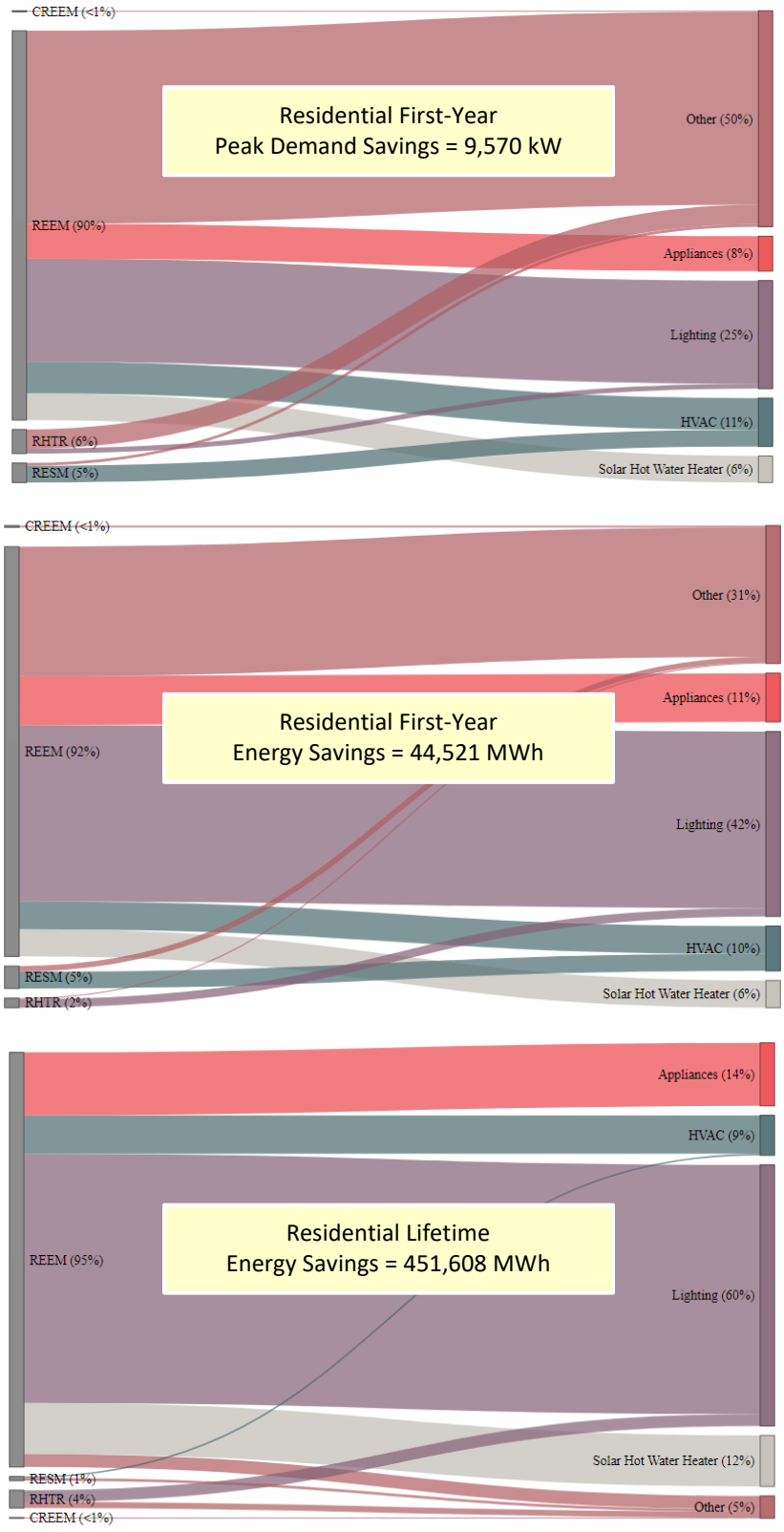


Table 3-7 Residential Verified Program Level Results

Program Name	Verified Program Level First-Year MWh	First-Year MWh Realization Rates	Verified First-Year Program Level Savings (kW)	First-Year kW Realization Rates	Verified Lifetime Program Level Savings MWh	Lifetime MWh Realization Rates
CREEM	162	99.3%	24	106.3%	766	99.2%
REEM	40,404	99.7%	8,604	100.5%	428,751	99.5%
RESM	2,125	100.3%	423	100.3%	4,215	100.2%
RHTR	1,830	100.0%	519	100.0%	17,876	100.0%
Total	**44,521**	**100.0%**	**9,570**	**100.8%**	**451,608**	**100.0%**

Below we describe the verification details for the residential sector programs and verification findings that were used to inform the verified program level kWh and kW results.

Residential Energy Efficiency Measures

The REEM program has delivered energy efficiency measures through the following primary delivery methods:

- Upstream initiative – the upstream initiative 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 – 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 50 million customer-level kWh savings for REEM (over 40 million kWh program level savings) for PY2018, which was nearly 91 percent of the residential sector program savings. The AEG team approached the REEM verification through the following methods:

- Tracking system review for all PY2018 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 subsections below describe the verification activities and findings for each of the major measure and delivery efforts for the REEM program.

Peer Program

The Peer program delivers HERs to Hawaiian Electric Company's (HECO) residential customers. The HERs provide information on how an individual home's energy consumption compares to other similar homes and provides suggestions on 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 three files:

- One file contained customer account numbers, the type of HER sent (paper or email), and the date sent[18]
- Another file contained account numbers, island identification, and various date information (e.g., opt out date, the date the first HER was received, the date the last HER was received, and the last billing date)[19]
- The third file was a summary of the program implementer's (Tendril, now Uplight) savings tracked by Hawai'i Energy.[20]

Hawai'i Energy's practice is to divide the annual savings described in the TRM into a per-month savings rate, with each month being credited with a 1/12 pro rata proportion of the annual rate. Through a review of the Excel savings tracking file provided, the AEG team was able to verify that Hawai'i Energy correctly applied the savings rate to the number of participants from each island. For county-level system loss factors, calculations in this file used an average system loss factor of 10.7%. 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.[21] In short, Hawai'i Energy was found to be correctly applying the savings algorithm, except for using the average system loss factor instead of the county-specific system loss factors.

The data received enabled the AEG team to confirm that at least the number of accounts that were claimed by Hawai'i Energy to have received four or more HERs in PY2018 was correct (Hawai'i Energy claimed 207,000 customers[22]) and that the claimed savings were calculated accurately. Through the verification process, Hawai'i Energy described their source of information used to track the number of program participants as presented in the files received. In analyzing the files, the AEG team found substantially more than 207,000 customers had been sent HERs in PY2018. In discussions with Hawai'i Energy and Uplight, the AEG team learned that due to natural attrition over time with the current treatment group, Uplight and Hawai'i Energy agreed to backfill and pull in any additional eligible customers at the onset of PY2018 to ensure they were treating all customers possible and giving all customers the same service where they could. Hawai'i Energy recognized that this would result in a slight "over treatment" in the initial years but would allow for attrition over time. Given not all customers in the treatment group receive a HER each month due to reasons such as missing meter read or missing historical data, it is a common best practice to always "overtreat" to a certain extent to ensure the target number is hit. The AEG team also learned that there are no additional costs to the program for the larger treatment group, and Hawai'i

[18] File name "HI_sent_HERs_PY18.txt"

[19] File name "All_HI_Customers_HERs_PY18_filtered_w_legacy_flag_edited2.txt"

[20] File name "Tendril Peer Group Island Savings Breakdown FINAL 2018.xlsx"

[21] 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.

[22] Per the PY2018 Hawaii Energy Annual Report, Table 38 on page 72. Additionally, 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.

Energy did not claim any additional savings beyond the 207,000 planned targets, while reaching additional customers to send program messaging.

Table 3-8 describes the verified results. Because the AEG team found that savings were accurately calculated and that Hawai'i Energy did not claim savings for more than 207,000 customers, the AEG team recommended, and the EEM agreed to, using the 207,000 customers as the base for verifying savings. The small difference in claimed compared to verified savings is a result of how the island system loss factor was applied.

Table 3-8 Peer Program Verified Results

Island	Island Share of Program Participants	Island Count of Participants	Verified Customer kWh Savings	Verified Customer kW Savings	Verified Program Level kWh Savings	Verified Program Level kW Savings
Oahu	68.2%	141,174	7,490,692	2,541	8,327,403	2,825
Hawaii	18.1%	37,467	1,987,999	674	2,166,919	735
Maui	13.0%	26,910	1,427,845	484	1,570,058	533
Lanai	0.2%	414	21,967	7	24,155	8
Molokai	0.5%	1,035	54,917	19	60,387	20
Total	**100.0%**	**207,000**	**10,983,420**	**3,726**	**12,148,921**	**4,121**

Comparing the verified results to Hawai'i Energy's planning assumptions leads to realization rates that are very close to 100 percent for both customer level and program level savings. Table 3-9 compares Hawai'i Energy's claimed savings to the verified savings.

Table 3-9 Peer Program Claimed and Verified Savings Comparison

Source	Customer kWh	Customer kW	Program Level kWh	Program Level kW
Hawai'i Energy Claimed	10,984,248	3,661	12,149,837	4,050
AEG team Verified	10,983,420	3,726	12,148,921	4,121
Realization Rate	**99.9%**	**101.8%**	**99.9%**	**101.8%**

Upstream Initiative

The Upstream Initiative has provided retailers with incentives as a means of buying-down the purchase cost of high efficiency equipment often sold through retail channels. Upstream Initiative savings were dominated by LED lamp purchases, though also included home appliances and electronics. For the Upstream Initiative, past verifications have found no variance from projects recorded in the program tracking data. 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 Verification Plan.

Table 3-10 presents the claimed savings and quantities, by equipment type, of measures found in the Hawai'i Energy Upstream Initiative tracking data. Residential LED measures represented over 98 percent of the Upstream Initiative savings. That said, over 4,000 appliances were purchased through the Upstream Initiative, with over 16,000 consumer electronics measures also being installed as part of this program component. The results show that a substantial number of Hawaii residents made non-lighting purchases through the Upstream Initiative.

Table 3-10 Upstream Initiative Claimed Customer and Program Level Equipment and Savings

Equipment Type	Measure Quantity	Customer First-Year kWh	Customer First-Year kW	Customer Lifetime kWh	Program Level First-Year kWh	Program Level First-Year kW	Program Level Lifetime kWh
Appliances							
Clothes Washer Tier 2	1867	292,746	56	3,220,202	255,060	49	2,805,664
Clothes Dryer	1248	206,644	41	2,893,014	180,590	36	2,528,253
Heat Pump (ESTAR)	101	166,064	21	1,660,642	145,039	19	1,450,387
Dehumidifiers	368	158,133	18	1,897,599	137,655	16	1,651,854
Air Purifiers	244	95,282	11	857,538	83,277	10	749,493
Clothes Washer Tier 1	255	29,088	6	319,966	25,350	5	278,848
APS 1	160	9,979	1	49,896	8,669	1	43,344
Dishwasher	136	3,820	0	42,023	3,310	0	36,406
Freezer	64	2,734	0	46,479	2,376	0	40,392
Clothes Washer Tier 3	10	1,764	0	19,401	1,544	0	16,987
Appliances Totals	*4,453*	*966,254*	*155*	*11,006,760*	*842,869*	*136*	*9,601,629*
Lighting							
LED: Omni	837,997	18,888,452	2514	283,326,786	12,012,464	1,599	180,186,967
LED: MR	138,609	3,124,247	416	46,863,703	1,982,946	264	29,744,186
LED: Downlight	85,117	1,918,537	255	28,778,058	1,219,040	162	18,285,602
LED: Candelabra	82,064	1,849,723	246	27,745,838	1,175,628	156	17,634,413
LED: PAR/BR/R	20,650	465,451	62	6,981,765	295,902	39	4,438,530
Lighting Totals	*1,164,437*	*26,246,410*	*3,493*	*393,696,150*	*16,685,980*	*2,221*	*250,289,697*
Electronics							
TV	16,020	1,324,534	160	7,947,202	1,159,630	140	6,957,781
Soundbar	313	13,853	1	96,974	12,162	1	85,133
Electronics Totals	*16,333*	*1,338,387*	*161*	*8,044,175*	*1,171,792*	*141*	*7,042,915*
Total	**1,185,223**	**28,551,051**	**3,810**	**412,747,085**	**18,700,641**	**2,497**	**266,934,241**

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 all Upstream Initiative measures accurately used the TRM values for first-year customer, system, and net kWh and kW. Overall, the verification process of the Upstream Initiative demonstrated accuracy on the part of Hawai'i Energy in terms of capturing measure level savings across a wide range of technologies. The table below summarizes the verified results for the Upstream initiative.

Table 3-11 Upstream Initiative Claimed and Verified Program Level Results

Equipment Type	Claimed Program Level First-Year kWh	Verified Program Level First-Year kWh	Realization Rate*	Claimed Program Level First-Year kW	Verified Program Level First-Year kW	Realization Rate	Claimed Program Level Lifetime kWh	Verified Program Level Lifetime kWh	Realization Rate
Appliances									
Clothes Washer Tier 2	255,060	255,059	100.0%	49	49	100.0%	2,805,664	2,805,645	100.0%
Clothes Dryer	180,590	180,591	100.0%	36	36	100.0%	2,528,253	2,528,269	100.0%
Heat Pump (ESTAR)	145,039	145,039	100.0%	19	19	100.0%	1,450,387	1,450,387	100.0%
Dehumidifiers	137,655	137,655	100.0%	16	16	100.0%	1,651,854	1,651,855	100.0%
Air Purifiers	83,277	83,277	100.0%	10	10	100.0%	749,493	749,495	100.0%
Clothes Washer Tier 1	25,350	25,350	100.0%	5	5	100.0%	278,848	278,848	100.0%
APS 1	8,669	8,669	100.0%	1	1	100.0%	43,344	43,344	100.0%
Freezer	2,376	2,376	100.0%	0	0	100.0%	40,392	40,390	100.0%
Dishwasher	3,310	3,310	100.0%	0	0	100.0%	36,406	36,408	100.0%
Clothes Washer Tier 3	1,544	1,544	100.0%	0	0	100.0%	16,987	16,987	100.0%
Appliances Totals	*842,870*	*842,870*	*100.0%*	*136*	*136*	*100.0%*	*9,601,628*	*9,601,628*	*100.00%*
Lighting									
LED: Omni	12,012,464	12,012,465	100.0%	1,599	1,599	100.0%	180,186,967	180,186,978	100.0%
LED: MR	1,982,946	1,982,947	100.0%	264	264	100.0%	29,744,186	29,744,209	100.0%
LED: Downlight	1,219,040	1,219,040	100.0%	162	162	100.0%	18,285,602	18,285,600	100.0%
LED: Candelabra	1,175,628	1,175,628	100.0%	156	156	100.0%	17,634,413	17,634,415	100.0%
LED: PAR/BR/R	295,902	295,902	100.0%	39	39	100.0%	4,438,530	4,438,532	100.0%
Lighting Totals	*16,685,980*	*16,685,982*	*100.0%*	*2,220*	*2,220*	*100.0%*	*250,289,698*	*250,289,734*	*100.0%*
Electronics									
TV	1,159,630	1,159,634	100.0%	140	140	100.0%	6,957,781	6,957,802	100.0%
Soundbar	12,162	12,162	100.0%	1	1	100.0%	85,133	85,133	100.0%
Electronics Totals	*1,171,792*	*1,171,796*	*100.0%*	*141*	*141*	*100.0%*	*7,042,914*	*7,042,935*	*100.0%*
Upstream Totals	**18,700,641**	**18,700,646**	**100.0%**	**2,497**	**2,497**	**100.0%**	**266,934,241**	**266,934,295**	**100.0%**

Other REEM Prescriptive Measures

The REEM program has included downstream incentives to encourage the purchase of high efficiency equipment through trade allies or 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, in which all measures were verified for savings compliance with the TRM and sampled from three strata for conducting desk reviews. The desk reviews assessed the accuracy of the tracking system measure descriptions, quantities indicated on invoices, equipment capacities, and other factors that would demonstrate a measure had been installed (or removed in the case of refrigerator/freezer recycling/trade-ins) as recorded in the tracking system. Per the Verification Plan, the strata and quantities of desk reviews to verify these downstream prescriptive measures are described in Table 3-12.

Table 3-12 REEM Prescriptive Measure Desk Review Sample

Strata	PY2018 Count of Rebates	Completed Desk Reviews
Refrigerator/Freezer Bounty/Trade-In	4,749	42
HVAC	2,542	27
Solar Hot Water Heater	1,430	27
Total	**8,721**	**96**

The strata were designed to capture large groups of downstream measures that demonstrated fundamentally different technologies and potential differences in trade allies or program delivery. The purpose of the desk reviews was to confirm the reasonableness of savings estimates and the consistency of the project documentation, to inform potential adjustments to claimed savings. The HVAC category included a range of possible measures in the sample, covering variable refrigerant flow heat pumps, window air conditioners, and heat pump water heaters. As a measure, solar hot water heater projects reflected the installation of a new solar water heating system, while refrigerator/freezer bounty/trade-in measures reflected removal of supplemental residential refrigerators or the turn-in of old refrigerators after a new refrigerator had been purchased.

Tracking Review Results

As noted above, the AEG team completed a census analysis of REEM projects tracked in the database to verify conformance of savings to the TRM. While the AEG team did find one measure and rebate with a variance from the TRM, the overall effect was minor. In general, Hawai'i Energy successfully applied the TRM to REEM measures. In Table 3-13 we describe the observation and effect on verified savings for this measure.

Table 3-13 REEM Tracking System Adjustments

Measure	Observation	Verification Decision
Window AC Trade-Up	All cases of the Window AC Trade-Up measures used a deemed savings of 221.16 kWh per unit	The deemed savings for the Window AC measure as indicated in the TRM is 222.16 kWh per unit

The AEG team notes that seven custom rebates were recorded under REEM, rather than the CREEM program. These projects totaled over 52,000 kWh first-year 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 Review Results

The AEG team received from Hawai'i Energy the available documentation for each of the sampled rebates. The documentation included incentive application forms, invoices, and other materials that demonstrated a measure had been installed or a service had been performed. Across the 96 desk reviews, the AEG team found three projects with differences between the project documentation and the data recorded in the tracking system. The adjusted measures were refrigerator trade-up, VRF split system AC <2 tons, and whole house fans. Details for these projects include:

- Ineligible Equipment. RebateID a0h1B00000WIJC8QAN - This project reported the installation of a new refrigerator and recycling of the previous refrigerator in a single family home in Oahu. The age of the previous refrigerator was unknown. During the desk review process, the AEG team found that the purchased refrigerator was not ENERGY STAR certified, which is required to be eligible for this measure. The TRM deemed savings are derived from the assumption that the baseline refrigerator is a new non-ENERGY STAR certified refrigerator and the installed refrigerator is ENERGY STAR certified. The AEG team adjusted the savings resulting in zero percent realization rate due to the ineligibility of the equipment rebated by this project.
- Incorrect Equipment Information. Rebate ID a0h1B00000WQTEyQAP - This project reported the installation of two one-ton 18 SEER VRF units in a multifamily home in Oahu. During the desk review process the AEG team found that the capacity reported in the tracking system data differed from the capacity reported in the documentation. The documentation showed the systems were each two tons instead of one-ton systems, as reported in tracking data. The AEG team adjusted the savings accordingly resulting in a realization rates of 151 percent for both energy and demand savings respectively.
- Incorrect Equipment. RebateID a0h1B00000XkhVxQAJ - This project reported the installation of a whole house fan in a single family home in Oahu. During the desk review process the AEG team found that purchased installed equipment was not a whole house fan. The documentation reported that the fan type installed was a solar attic fan. The AEG team adjusted the savings accordingly resulting in realization rates of 50 percent and zero percent for energy and demand savings respectively. The TRM indicates there are no demand savings for solar attic fans.

All other discrepancies between the claimed and verified savings were due to rounding.

Additional Desk Review Findings

Although not a point for verification adjustment, the AEG team made several observations for different measures as a part of the desk review process.[23] 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, all projects that were reviewed had the correct incentive paid out based on the measure-specific incentive rates.

[23] 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.

- Solar Hot Water Heater Baselines are Not Sufficiently Covered in TRM. As noted in the PY2017 Verification Report and observed again for PY2018, for most 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 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 net savings research to investigate developing an NTG ratio that is customized for the residential solar water heater measure in Hawaii.
- Update Window AC application. The Window AC measure application eligibility conflicts with the PY2018 TRM requirements. The rebate application states that eligible equipment must be a minimum 11.2 EER with no minimum size required by the program. The PY2018 TRM, however, states that the measure is only eligible for equipment that is greater than 11.4 CEER and greater than 8,500 BTU. This means that it was possible to purchase equipment that was eligible for the program according to the application but was not technically eligible for the PY2018 TRM prescriptive energy and demand savings. During the PY2019 TRM update, the program eligibility criteria were updated, and a semi-prescriptive calculator was developed for estimating savings based on the capacity and efficiency of the installed unit. The rebate application for PY2019 should be revised as needed to be consistent with the new PY2019 TRM criteria.
- Measure incorrectly named. The variable refrigerant flow (VRF) measure was misnamed in the PY2018 TRM since the program allows other types of ductless split systems besides just those with variable refrigerant flow. In addition, the capacity criteria were limited to two bins: <2 tons and ≥ 2 tons. The baseline was assumed to be a 10.9 SEER room AC unit of the same average capacity used in the post case. This is appropriate for the lower capacity systems. However, for higher capacity systems, a more appropriate baseline is a central AC system for which the federal standard specifies a minimum rating of 14 SEER effective as of 2015. During the PY2019 TRM update, the measure was renamed to "Ductless Split Systems" and the program eligibility criteria were clarified. In addition, a semi-prescriptive calculator was developed for estimating savings based on the capacity and efficiency of the installed unit.
- Refrigerator Savings Potentially Overstated by TRM. The refrigerator measure savings in the PY2018 TRM were based on a third-party source whose origins are unclear. The Federal Standard for refrigerator energy consumption is dependent on the style and volume of refrigerator, i.e. top-mounted freezer, side by side, or French door style. The PY2018 TRM did not take into account the size or style of the equipment; as a result, the savings estimates may be overstated. The desk review process found that a majority of refrigerators installed had an annual energy consumption greater than the baseline energy consumption assumption in the TRM. The savings approach and efficiency assumptions for this measure were updated in the PY19 TRM.

REEM Verified Savings

The AEG team determined the program level savings for first-year kWh, first-year kW, and lifetime savings based on the tracking system review, desk reviews, and Peer program analysis. While the first-year and lifetime verified program level energy savings were slightly less than the claimed savings (99.7 percent and 99.5 percent for net first-year kWh and lifetime kWh, respectively), the verified demand program level savings were slightly over 100 percent. Table 3-14 through Table 3-16 present the program level savings for first-year kWh, kW, and lifetime kWh.

Table 3-14 REEM Program Level First-Year kWh Claimed and Verified Results

Equipment Category	Claimed Program Level First-Year kWh	Verified Program Level First-Year kWh	Realization Rate
Downstream	9,502,962	9,364,522	98.5%
Online Marketplace	138,022	138,022	100.0%
Peer Group Comparison	12,149,837	12,148,921	100.0%
Residential Custom	52,213	52,213	100.0%
Upstream	18,700,641	18,700,646	100.0%
Total	**40,543,675**	**40,404,324**	**99.7%**

Table 3-15 REEM Program Level kW Claimed and Verified Results

Equipment Category	Claimed Program Level First-Year kW	Verified Program Level First-Year kW	Realization Rate
Downstream	1,957	1,926	98.4%
Online Marketplace	44	44	100.0%
Peer Group Comparison	4,050	4,121	101.8%
Residential Custom	16	16	100.0%
Upstream	2,497	2,497	100.0%
Total	**8,564**	**8,604**	**100.5%**

Table 3-16 REEM Program Level Lifetime kWh Claimed and Verified Results

Equipment Category	Claimed Program Level Lifetime kWh	Verified Program Level Lifetime kWh	Realization Rate
Downstream	149,968,506	147,869,691	98.6%
Online Marketplace	1,327,978	1,327,979	100.0%
Peer Group Comparison	12,149,837	12,148,921	100.0%
Residential Custom	469,918	469,918	100.0%
Upstream	266,934,241	266,934,295	100.0%
Total	**430,850,481**	**428,750,805**	**99.5%**

Residential Hard to Reach

The RHTR program has 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. Savings were largely driven by measures subject to the TRM, though a portion of the savings (approximately eight percent of RHTR kWh) were 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 savings being claimed. An additional check for reasonableness in quantities was also performed. In both cases, the AEG team determined that all claimed savings for the RHTR program were accurate, resulting in 100 percent realization rate. Table 3-17 through Table 3-19 summarize the results for first-year program kWh and kW, and lifetime program savings. Minor differences related to rounding practices were identified, with the AEG team using the unrounded savings from the TRM. Hawai'i Energy used an unrounded calculation that slightly increased overall savings. The differences were minimal.

Table 3-17 RHTR Program Level kWh Claimed and Verified Results

Measure Category	Claimed Program Level First-Year kWh	Verified Program Level First-Year kWh	Realization Rate
Lighting	795,080	795,077	100.0%
Other	155,063	155,063	100.0%
Plug/Process	182,077	182,075	100.0%
Water Heating	697,782	697,782	100.0%
Total	**1,830,003**	**1,829,998**	**100.0%**

Table 3-18 RHTR Program Level kW Claimed and Verified Results

Measure Category	Claimed Program Level First-Year kW	Verified Program Level First-Year kW	Realization Rate
Lighting	106	106	100.0%
Other	25	25	100.0%
Plug/Process	20	20	100.0%
Water Heating	368	368	100.0%
Total	**519**	**519**	**100.0%**

Table 3-19 RHTR Program Level Lifetime kWh Claimed and Verified Results

Measure Category	Claimed Program Level Lifetime kWh	Verified Program Level Lifetime kWh	Realization Rate
Lighting	11,926,199	11,926,159	100.0%
Other	1,550,634	1,550,634	100.0%
Plug/Process	910,385	910,376	100.0%
Water Heating	3,488,912	3,488,911	100.0%
Total	**17,876,130**	**17,876,080**	**100.0%**

Residential Energy Services and Maintenance

The RESM program has incentivized customers to have their existing air conditioners or solar water heaters receive a tune-up from a participating contractor. RESM program savings represented roughly five 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. Based on the AEG team's review of all RESM measure and project savings claimed in the tracking database, Hawai'i Energy correctly applied the TRM algorithms for all measures, with slight differences resulting from rounding of results. As a result, the realization rate for the program is slightly over 100 percent for energy and demand net savings. Lifetime kWh realization rates were slightly above 100 percent. The AEG team also noted a single "Window AC" project tracked under the RESM program, for which no savings were claimed. Table 3-20 through Table 3-22 summarize the results.

Table 3-20 RESM Program Level First-Year kWh Claimed and Verified Results

Measure Category	Claimed Program Level First-Year kWh	Verified Program Level First-Year kWh	Realization Rate
Residential Central A/C Tune Up	1,597,775	1,602,728	100.3%
Residential Solar Water Heater Tune Up	521,941	522,445	100.1%
Residential Window AC	-	-	-
Total	**2,119,716**	**2,125,173**	**100.3%**

Table 3-21 RESM Program Level kW Claimed and Verified Results

Measure Category	Claimed Program Level First-Year kW	Verified Program Level First-Year kW	Realization Rate
Residential Central A/C Tune Up	361	362	100.3%
Residential Solar Water Heater Tune Up	61	61	100.1%
Residential Window AC	-	-	-
Total	**421**	**423**	**100.3%**

Table 3-22 RESM Program Level Lifetime kWh Claimed and Verified Results

Measure Category	Claimed Program Level Lifetime kWh	Verified Program Level Lifetime kWh	Realization Rate
Residential Central A/C Tune Up	1,597,775	1,602,728	100.3%
Residential Solar Water Heater Tune Up	2,609,704	2,612,226	100.1%
Residential Window AC	-	-	-
Total	**4,207,479**	**4,214,953**	**100.2%**

Custom Residential Energy Efficiency Measures

The CREEM program has offered custom incentives for projects in the residential sector that do not fit within the TRM measures or related delivery approaches. In PY2018, the CREEM program included 21 projects. The AEG team conducted four desk reviews for the CREEM program. Three of the desk reviews were sampled from the Sense Pilot for Advanced Home Energy Monitoring installations.[24] The fourth project sampled for desk review included the installation of prescriptive measures in a multifamily new construction project. Desk review details include:

- RebateID a0h1B00000VeVDiQAN - Hawai'i Energy provided a custom incentive across a range of standard measures, including efficient lighting, refrigerators, clothes washers, smart thermostats, air conditioning systems, and dishwashers. TRM-based savings were claimed for each of the measures, other than the air conditioning and dishwashers.[25] The AEG team completed a desk review to verify the savings claims and confirm the purchase of the claimed measures via a review of invoices and other project documents.

  Across the new construction project, the AEG team found that the TRM was accurately used for claiming customer and system savings and that the approach to claiming savings within the custom rebate was reasonable. Further, the approach for the air conditioner and dishwasher measures was reasonable. However, similar to adjustments made in the PY2017 Verification Report, adjustments were made in PY2018 for smart thermostats. The PY2018 TRM utilizes an assumed air conditioner capacity and SEER of 11.9, reflecting a general population average for existing cooling equipment, rather than the specific capacity and SEER of the new air conditioning equipment that was installed as part of the project (SEER of 17). The AEG team verified the smart thermostat savings by using the PY2018 TRM algorithm for smart thermostats but substituted the capacity and SEER of the project's air conditioners in place of the TRM assumptions.

- When conducting the three Sense Pilot desk reviews, the AEG team found that justification for the savings assumption (6.6 percent of average Hawaii residential energy consumption) lacked complete documentation by Hawai'i Energy. However, the AEG team determined the savings percentage was not necessarily unreasonable since it is less than that what was found in a similar pilot operated by Vermont Energy Investment Corporation (VEIC). VEIC press releases cite a pilot effort that found an eight percent savings rate.[26] Nonetheless, the actual savings percentage for Hawai'i could be different from either of these values due to a number of factors. Due to the increased participation in PY2018 and wider promotion of the technology and program delivery, careful attention should be paid to verifying savings, developing TRM-based savings, and monitoring interactions with other measures to avoid double counting sources of savings.

Table 3-23 through Table 3-25 summarize the CREEM program verified savings.

[24] In PY18, Hawai'i Energy continued its home energy monitoring efforts by collaborating with Sense to train local contractors to install their device in Oahu homes. The Program also collaborated with Sense to provide feedback that enhanced their data analytics, especially for Hawaii homes with solar PV installations. Sense is a leading manufacturer of in-home energy monitoring devices that utilizes high-frequency whole-home energy monitoring and advanced learning algorithms to identify unique devices in homes, track energy usage in real-time and over time, and alert customers to notable changes in energy usage through monthly homeowner updates.

[25] Air conditioners used the TRM algorithm but substituted the current minimum federal standard as the baseline and actual SEER of the new air conditioners as the efficient condition. For dishwashers, the TRM does not include the measure, with Hawai'i Energy using the online Energy Star calculator to calculate savings. This calculator can be found at: https://www.energystar.gov/sites/default/files/asset/document/appliance_calculator.xlsx

[26] "Efficiency Vermont and Sense Conduct Pilot Study of Advanced Home Energy Monitoring," Efficiency Vermont, Press Release, July 24, 2018, https://www.efficiencyvermont.com/news-blog/news/efficiency-vermont-and-sense-conduct-pilot-study-of-advanced-home-energy-monitoring

Table 3-23 CREEM Program Level kWh Claimed and Verified Results

Measure Category	Claimed Program Level First-Year kWh	Verified Program Level First-Year kWh	Realization Rate
Residential Custom	162,877	161,673	99.3%

Table 3-24 CREEM Program Level kW Claimed and Verified Results

Measure Category	Claimed Program Level First-Year kW	Verified Program Level First-Year kW	Realization Rate
Residential Custom	23	24	106.3%

Table 3-25 CREEM Program Level Lifetime kWh Claimed and Verified Results

Measure Category	Claimed Program Level Lifetime kWh	Verified Program Level Lifetime kWh	Realization Rate
Residential Custom	771,820	765,801	99.2%

Business Programs

In PY2018, 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 energy and demand savings were dominated by the BEEM program, though CBEEM and BHTR also contributed substantial savings. The business programs delivered a diverse set of programs, enabling business sector customers to participate in several ways. These included prescriptive rebates, buy-down incentives with lighting distributors, direct-install measures, and custom measures.

Table 3-26 summarizes the source of total program savings, by program or major component (in the case of BEEM). BEEM provided over 49 percent of the business sector claimed program (net) savings.

Table 3-26 Business Claimed Program Level Results

Program Name	Component	Claimed Program Level First-Year MWh	Percent of First-Year Program Level Savings
BEEM	HVAC	12,554	15.9%
	Lighting	13,819	17.5%
	Midstream	11,389	14.5%
	Other	1,503	1.9%
	Total	*39,265*	*49.8%*
BESM		637	0.8%
BHTR		9,743	12.4%
CBEEM		29,166	37.0%
Total		**78,811**	**100.0%**

The verified program level results for the business programs are presented below, in Figure 3-2 and Table 3-27. The plots in Figure 3-2 show the percentage of the verified savings that each program represents on the left side and the percentage of the end-uses on the right side. As reflected in Table 3-27, business program component realization rates were very close to 100 percent. This is expected, given the vast majority of business program measures were based on deemed savings from the TRM for first year and lifetime impacts and that the purpose of verification is to confirm Hawai'i Energy accurately applied the TRM.

Figure 3-2 Business Verified Program Level Impacts by Program and End-Use

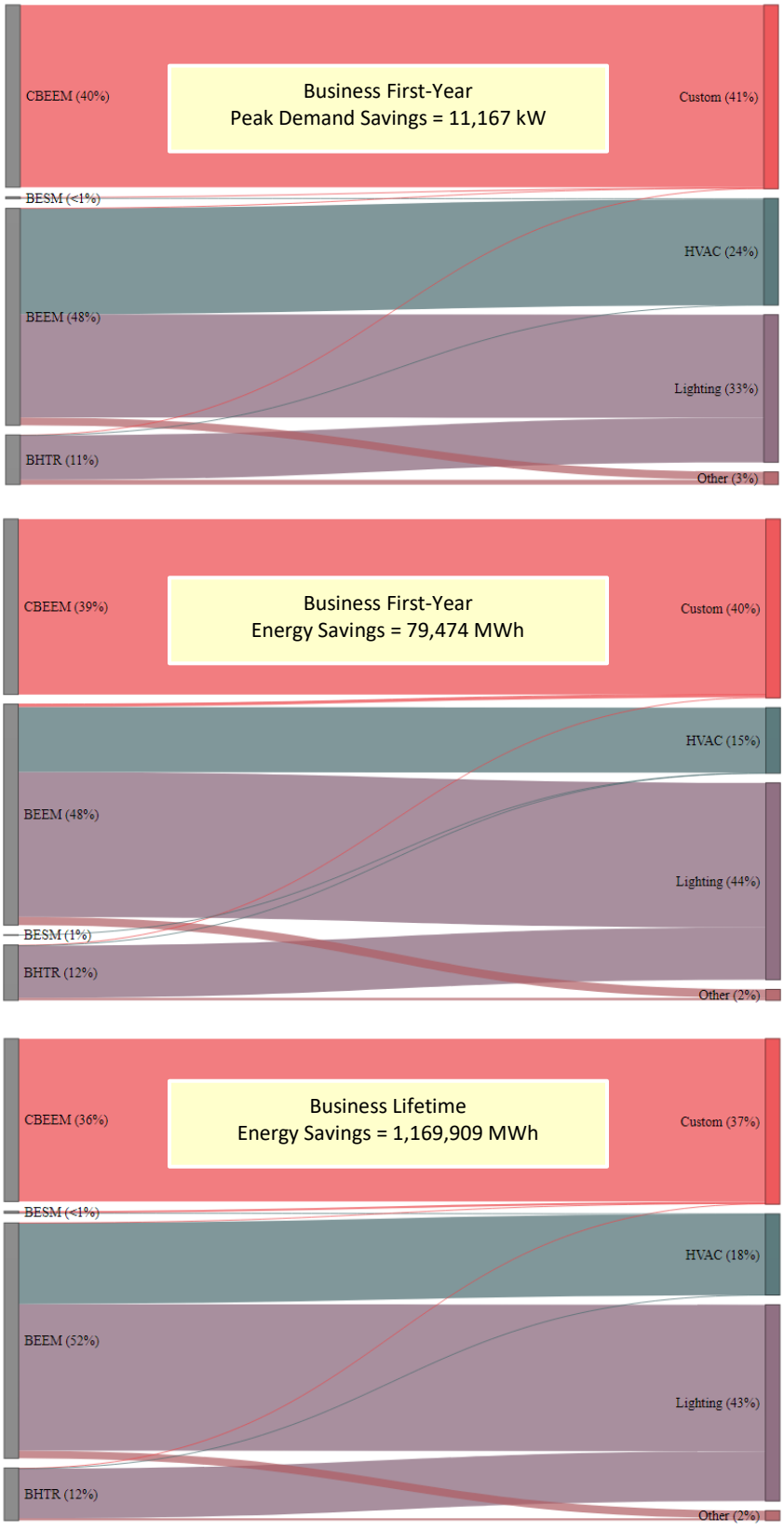


Table 3-27 Business Verified Program Level Results

Program Name	Component	Verified Program Level First-Year MWh	First-Year MWh Realization Rates	Verified First-Year Program Level Savings (kW)	First-Year kW Realization Rates	Verified Lifetime Program Level Savings MWh	Lifetime MWh Realization Rates
BEEM	Lighting	13,888	100.5%	1,712	100.5%	205,776	100.7%
	Midstream	11,528	101.2%	842	104.5%	172,943	101.3%
	HVAC	11,437	91.1%	2,624	92.0%	209,619	92.4%
	Other	1,478	98.4%	195	93.5%	19,888	98.8%
	Total BEEM	*38,331*	*97.6%*	*5,373*	*96.4%*	*608,227*	*97.8%*
BESM		581	91.2%	47	98.2%	5,301	91.5%
BHTR		9,740	100.0%	1,230	99.9%	135,721	100.0%
CBEEM		30,821	105.7%	4,516	110.4%	420,659	96.9%
Total		**79,474**	**100.8%**	**11,167**	**102.1%**	**1,169,909**	**97.7%**

Below we describe the verification process details for the business sector programs that were used to inform the verified program level kWh and kW results.

Business Energy Efficiency Measures

The BEEM program has provided incentives for standard energy efficiency technologies. A range of business-sector measures were offered to drive energy efficiency projects, largely driven by prescriptive incentives and, thus, TRM-based savings. BEEM was a substantial contributor to Hawai'i Energy's business sector programs, representing approximately 50 percent of Hawai'i Energy's business programs' first-year kWh savings. Energy efficiency measures were delivered by several methods, including promotions by trade allies, incentives provided to lighting distributors to buy-down the cost of energy efficiency lighting, and custom projects. End uses included lighting, HVAC, solar water heating, motor controllers, refrigerator recycling, and others.

Because BEEM relied heavily on TRM-based savings, the AEG team conducted a tracking system review of all deemed savings measures. Per the PY2018 Verification Plan, a subset of these measures—contributing 96.2 percent of BEEM savings—were allocated to three strata: HVAC, Midstream Lighting, and non-Midstream Lighting (abbreviated as Lighting hereafter). These three strata had 47 projects sampled for desk reviews. Below, we describe the desk review sampling for the three BEEM strata.

Table 3-28 BEEM Desk Review and Site Visit Sample Sizes at Reported Customer Level

BEEM Stratum	Total BEEM Strata kWh Savings[27]	Percent Sampled Strata Savings	Unique Rebate Counts	Desk Review Sample
Lighting	16,625,442	37%	490	12
HVAC	15,110,583	33%	219	25
Midstream	13,762,224	30%	1,778	10
Total	**45,498,249**	**100%**	**2,487**	**47**

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.

Below we describe the results from the tracking system reviews, followed by the desk reviews results.

Tracking Review Results

As noted above, the AEG team completed a census review of BEEM tracked projects that utilized the TRM to claim savings in order 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 a variety of measures, rounding practices affected realization rates. The AEG team utilized the deemed savings in the TRM, whereas Hawai'i Energy often utilized 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.
- Cross program year adjustment. For one heat pump water heater project, the tracking database indicated that this project was started in PY2017 and used PY2018 deemed savings values for energy and demand. Projects that crossover from one program year into the next are supposed to use the savings algorithms for program year in which they are initiated. The deemed savings values were multiplied by the reported capacity (tons) of the equipment, which is consistent with the PY2018 TRM. The AEG team followed the PY2017 TRM deemed savings values by applying them at the per unit level. This reduced first-year savings, lifetime savings, and TRBs for this measure.
- Chiller IPLV incorrectly entered in tracking data. For two air cooled chiller measures, the tracking database reported a post efficiency (IPLV) of zero which was subsequently used in reported energy and demand savings calculations. The AEG team adjusted the post IPLV to the IECC 2015 Path A default value in the TRM (0.550 kW/Ton). This reduced first-year savings, lifetime savings, and TRBs for these measures.

[27] The strata savings reflect savings tracked in the initial database provided to the AEG team and informed the sample distribution of the 50 desk reviews. Hawai'i Energy updated lighting measure savings prior to providing the final database, based on findings from the tracking system review, shifting the final tracked savings and percentage contribution. Those updated savings are presented in the Desk Review Results section, below.

- Incorrect Deemed Savings for window AC trade-ups. For 18 window AC trade-up (with recycling of old) measures, the claimed savings used a deemed energy savings per unit of 221.16 kWh. The TRM deemed values for this measure is 1 kWh higher (at 222.16 kWh per unit). The AEG team adjusted the savings to the TRM deemed kWh per unit savings value which increased first-year energy and lifetime savings slightly.
- Refrigerated case lighting factors not used. For 10 projects totaling 286 LED refrigerated case lighting measures, the claimed savings used the annual hours of operation by building type rather than the TRM stipulated values of 6,205 annual hours of operation and 1.0 coincident factor used for all LED refrigerated case lighting. Also, the tracking database reported LED refrigerator case lighting measures with a useful life of five years, rather than the TRM stipulated useful life of 16 years. The AEG team used the TRM stipulated values in verification savings which resulted in an increase in energy, demand, and lifetime savings for these measures.
- LED exit sign factors not used. The AEG team found that the claimed savings for 27 LED exit sign projects totaling 384 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 reported 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.
- Some solar water heater savings cannot be verified. The AEG team was not able to verify savings for two solar water heaters. 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.
- Lamp type not available in TRM. Three projects totaling 62 measures were reported as PAR40 style LED lamps, which is not an available lamp type in the TRM. The reported savings were found to be using the algorithms and assumptions consistent with PAR38 lamps. Hawai'i Energy should consider only allowing lamps styles currently listed in the TRM or expanding the TRM to include PAR40 or other in demand style lamps. Ultimately, there were no savings adjustments made to these savings for these measures.

In general, the tracking system review revealed that Hawai'i Energy generally correctly used the TRM for BEEM claimed savings. The most substantial changes related to energy savings were due to LED exit signs using incorrect annual hours of operation and coincidence factors and two air cooled chiller measures which the AEG team found to be using an incorrect IPLV in reported savings.

Midstream QA/QC Project Reviews

QA/QC reviews were completed for a sample of 20 Midstream projects (out of 1,778 projects). As a result of the PY2017 verification activities, the AEG team learned that for the Midstream program, single rebates were based on batches of invoices from lighting distributors. Those invoices could have included multiple customers and locations. Due to this particular program design, the AEG team recommended conducting QA/QC project file review process for a sample of Midstream program projects. This task was new for PY2018 and focused specifically on the QA/QC process completed by Hawai'i Energy for a sample of Midstream program projects. Qualitative findings from the Midstream QA/QC project reviews included:

- All 20 projects included copies of the Excel rebate template, the text rebate template, a submittal email and an approval email. Fifteen of the projects included copies of the final incentive check while five did not.

- Six of the projects included adjustments made by Hawai'i Energy to the original savings amount based on non-qualified fixtures, or cost adjustments. All of these reduced the final incentive and are well-described in the approval emails.
- Two projects reviewed were resubmittals due to issues with the initial submission. One project was revised to clarify model numbers on some fixtures that were initially rejected for incentive during the approval process. The second project was revised for an incorrect zip code in the original transmission from the vendor that could not be mapped to an island for claiming net savings. These revisions indicate there is a good attention to detail by the implementation team.
- For one project, a post inspection was performed by the implementation team to verify the fixture installations. There were no adjustments resulting from the post-installation inspection.

Overall, the Midstream QA/QC project reviews did not yield any concerns about the current process.

Desk Review Results

The purpose of the desk reviews was to compare project documentation to that found in the tracking system. As these measures all utilized the TRM, savings would only be adjusted for variances related to differences related to quantities on incentive applications, invoices, equipment descriptions, or other factors (such as building type) if documentation indicated a difference that would affect TRM savings. Table 3-29 describes the strata level savings, quantities of desk reviews, and percentage savings represented by each stratum.

Table 3-29 BEEM Desk Review Sample and Strata Savings, Customer Level

BEEM Stratum	Total BEEM Strata kWh Savings	Total BEEM Sampled kWh Savings[28]	Percent Sampled Strata Savings	Desk Review Sample
Lighting	16,625,442	3,523,776	42%	12
HVAC	15,110,583	3,261,038	39%	25
Midstream	13,762,224	1,559,894	19%	10
Total	**45,498,249**	**8,344,709**	**100%**	**47**

Through the desk review process, the AEG team found that for a given rebate, several end-use measures were frequently included in both the tracking data and documentation. As such, desk review results were verified at the rebate level, though the aggregate effect of individual measure adjustments informed a given rebate's realization rate. To avoid double counting tracking system adjustments, only variances from the project documentation were used to make further adjustments to realization rates. Additionally, 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. 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 identified desk review adjustments for two lighting projects, one Midstream lighting project and six HVAC projects. The desk review observations and adjustments were:

- Quantity and Fixture Type Adjustment. RebateID 1821001 – An adjustment was made for lighting quantity and lighting type. The AEG team adjusted the reported quantity of (58) 1ft x 4ft LED troffer fixtures in the tracking data to a quantity of (27) 2ft by 2ft LED troffer (model ZR22C-32L-35K-10-FD) and (31) 2ft x 4ft LED troffers (model ZR24C-40L-35K-10V-FD) as reflected in the invoices and

[28] The strata savings reflect savings tracked in the final database provided to the Verification Team. Savings differ from the initial database due to changes made in lighting savings related to double counting interactive effects.

submittal package sheets. This increased energy and demand savings for this project. This adjustment in lighting types indicates that an incorrect, lower incentive amount was issued to the customer.

- Equipment Count Adjustment. RebateID 1821002 – An adjustment was made for lighting occupancy sensor quantity. A quantity of 14 occupancy sensor controls were removed from verified savings. These occupancy controls reported an incentive but no energy or demand savings in the tracking system. The AEG team was not able to determine if these lights were installed due to lack of information in the tracking system, no invoice, and limited details provided in the project documentation such as the audit and post inspection forms. This did not result in a change the verified energy or demand savings. This only impacted the quantity of items reported to be installed and the potential incentive amount of the customer.
- Building Type Adjustment. RebateIDs 1821011 and 1821006 – An adjustment was made to the building type. One participant completed two HVAC VRF mini split projects at the same site. For both projects, the facility type was adjusted from the reported "Office" to "Education." The incentive application and secondary research confirmed this facility's primary function. This reduced energy and demand savings as Education buildings have lower hours of use compared to Offices and are not in use as often during peak demand periods. This did not affect the incentive.
- Efficiency Adjustment. RebateID 1821022 – An adjustment was made to the HVAC motor efficiency. This project consisted of a hotel installing a variable frequency drive on one existing 30HP chilled water pump. The efficiency of the motor used in claimed savings calculations was 93 percent. The AEG team adjusted the motor efficiency from 93 percent to 94.1 percent, which was shown on the motor nameplate data. This reduced energy and demand savings.
- Savings Approach Adjustments. RebateID 1821030 – An adjustment was made for the HVAC measure, from commercial to residential TRM savings approach. This site is a military base that replaced a total quantity of 633 split AC systems and four split VRF systems on single family homes on the base. Claimed savings followed the Commercial TRM approach for AC and split variable refrigerant flow AC systems which bases key factors such as EFLH and coincidence factor on the reported building type of the facility. Tracking data and claimed savings followed the commercial protocols for "Misc. Commercial" building types for all installed units. Project documentation showed the units were installed in single family home, whose operation more closely align with the residential VRF split and central AC retrofit measure. Because of this, the AEG team followed the Residential TRM "Central A/C Retrofit" approach rather than the claimed Commercial "A/C and Heat Pump" measure. This substantially impacted the estimated EFLH and coincidence factor. The Residential TRM also assumes default equipment sizes and efficiencies, which also impacted savings. Overall, this reduced energy and demand savings for these measures.

  For four units, the AEG team followed the Residential TRM "VRF Split" approach rather than the claimed Commercial "VRF" measure, given that all units were installed in single family homes. This also impacted the estimated EFLH and coincidence factor. The Residential TRM assumes default equipment sizes and efficiencies, which impacted savings. Overall, this reduced energy and demand savings for these measures. However, the results from this project were not extrapolated to the population as the uniqueness of this project was not indicative of the larger population. This is the only case in the BEEM program where desk review results were not extrapolated to the population.
- Efficiency Adjustment. RebateID 1821031 – An adjustment was made to the HVAC motor efficiency. This project consisted of a school that installed variable frequency drives on two existing 30HP condenser water pumps. The efficiency of the motor used in claimed savings calculations was 93 percent. The motor efficiency was adjusted to 93.6 percent, which was shown on the motor nameplate data. This reduced energy and demand savings.

- Capacity Adjustment. RebateID 1821036 – An adjustment was made to capacity for split VRF AC systems. This site is an office that installed a quantity of two 10-ton nominal split VRF air conditioning systems. Claimed savings calculated energy and demand savings and incentive amount using the nominal capacity of the AC units (10 tons). Project documentation listed the rated capacity at 115,000 BTU/hr which is equal to 9.583 tons. The AEG team adjusted the capacity to 9.583 tons, which reduced energy and demand savings and incentive amount.
- Efficiency Adjustment. RebateID 1821037 – An adjustment was made to the HVAC motor efficiency. This site is an office building that installed variable frequency drives on one 50HP and one 60HP existing chilled water pumps.
    - The efficiency of the 50HP motor was adjusted from the claimed 94 percent to the TRM value of 94.5 percent. The 94 percent motor efficiency was not listed on motor nameplate data or in spec sheets. The spec sheets noted the enclosure type (TEFC), RPM (1800), HP (50), and efficiency category (NEMA Premium). This information was used to reference the TRM standards for motor efficiencies, which is 94.5 percent for this motor's parameters. This reduced energy and demand savings and had no impact on the incentive amount.
    - The efficiency of the 60HP motor was adjusted from the claimed 94 percent to the TRM value of 95 percent. The 94 percent motor efficiency was not listed on motor nameplate data or in spec sheets. The spec sheets noted the enclosure type (TEFC), RPM (1800), HP (60), and efficiency category (NEMA Premium). This information was used to reference the TRM standards for motor efficiencies, which is 95 percent for this motor's parameters. This reduced energy and demand savings and had no impact on the incentive amount.
- Annual Operating Hours Adjustment. RebateID 1821045 – An adjustment was made to the lighting hours of operation. This is a Midstream lighting project that was completed and submitted by a lighting distributor that sold a total of 2,312 lights through the program, including 103 LED exit signs. For all exit signs (quantity 103), claimed savings did not use the deemed TRM value for energy savings. Additionally, claimed savings did not factor in 24-hour operation for the exit signs into the energy savings calculations and instead used the TRM default annual operating hours (AOH) for a "Misc. Commercial" building of 4,325 hours. The AEG team adjusted the savings to follow the TRM deemed energy savings for an exit sign, which increased energy savings.

The AEG team developed strata level realization rates based on the strata level sample results. Overall, the effects were minor—the Midstream stratum received no adjustment based on the desk reviews and the HVAC and Lighting stratum adjustments reflected the impact of the single rebate adjustments, weighted by the overall sampled stratum savings. Table 3-30 presents the desk review adjustments for each of the three sampled BEEM strata. The desk review adjustment factor is applied to savings verified after the tracking system review.

Table 3-30 Strata Level Adjustments for BEEM Desk Reviews, Customer Level[29]

Strata	Unique Rebate Counts	Claimed Sample Savings - First-Year kWh	Claimed Sample Savings - kW	Claimed Sample Savings - Lifetime kWh	Sample Adjustment Factor – First-Year kWh	Sample Adjustment Factor - kW	Sample Adjustment Factor – Lifetime kWh
Lighting	490	16,625,442	2,048.3	245,805,241	100.3%	100.3%	103.9%
HVAC	219	15,110,583	3,434.7	273,125,174	99.9%	99.9%	99.9%
Midstream	1,778	13,762,224	974.0	206,203,220	101.0%	102.6%	101.0%
Total	**2,487**	**45,498,249**	**6,456.9**	**725,133,635**	**N/A**	**N/A**	**N/A**

Summary of BEEM Verified Savings

The AEG team combined the results of the BEEM tracking system review with results from the sample of desk reviews to arrive at the total verified savings for the BEEM program. Table 3-31 through Table 3-33 summarize the results by major category for program (net) level first-year kWh, kW, and lifetime kWh savings.

Table 3-31 BEEM Program Level First-Year kWh Claimed and Verified Results

Equipment Category	Claimed Program Level First-Year kWh	Verified Program Level First-Year kWh	Realization Rate
Lighting	13,818,803	13,888,483	100.5%
HVAC	12,553,656	11,436,538	91.1%
Midstream	11,389,290	11,527,824	101.2%
Other	1,503,050	1,478,396	98.4%
Total	**39,264,799**	**38,331,241**	**97.6%**

Table 3-32 BEEM Program Level kW Claimed and Verified Results

Equipment Category	Claimed Program Level First-Year kW	Verified Program Level First-Year kW	Realization Rate
HVAC	2,853	2,624	92.0%
Lighting	1,703	1,712	100.5%
Midstream	806	842	104.5%
Other	209	195	93.5%
Total	**5,571**	**5,373**	**96.4%**

[29] The overall sampling of BEEM desk reviews and the results for customer first-year kWh, the basis for sampling, was +/-4.9 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

Table 3-33 BEEM Program Level Lifetime kWh Claimed and Verified Results

Equipment Category	Claimed Program Level Lifetime kWh	Verified Program Level Lifetime kWh	Realization Rate
HVAC	226,917,656	209,619,274	92.4%
Lighting	204,309,344	205,776,498	100.7%
Midstream	170,647,477	172,943,293	101.3%
Other	20,134,186	19,887,671	98.8%
Total	**622,008,663**	**608,226,737**	**97.8%**

Custom Business Energy Efficiency Measures

The CBEEM program provides incentives for energy saving measures not covered by prescriptive incentives. Project-specific calculations were used to estimate the energy savings and determine the incentive that was offered to the customer. CBEEM projects are described as being in one of three measure categories: Custom Lighting, Custom HVAC, and Custom. Custom Lighting measures accounted for approximately 72 percent of the claimed energy savings, Custom HVAC accounted for approximately 13 percent, and Custom accounted for approximately 16 percent of CBEEM savings.

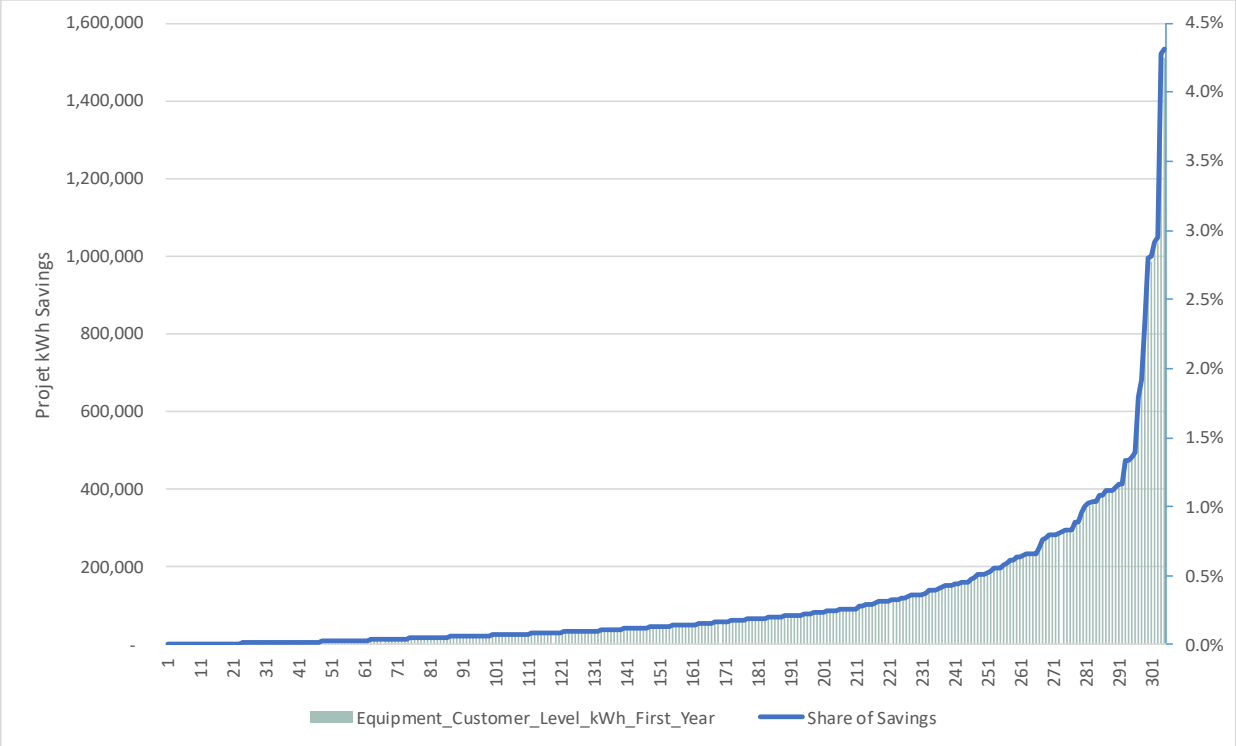
Because CBEEM projects are custom, a tracking system review was not feasible to verify savings. As a result, the AEG team relied on a sample of projects from which engineering desk reviews and site visits were used to verify savings and calculation methods including site-specific calculation key parameters, equipment characterization accuracy, and equipment installation. Hawai'i Energy provided the project documentation necessary to complete the desk reviews and site visits and provided additional assistance to the AEG team related to customer contact information.

Sampling Strategy and Design

The goal of the CBEEM sampling strategy was to enable the sampled projects' verified savings to be applied to the program population. Rather than focusing on project type, the AEG team developed a sample based on the four strata that represent the energy savings contributions to the overall program. In this regard, the stratification and sampling approach informed the verification of small, medium, and large saving projects.

The AEG team examined the CBEEM projects in the tracking database to understand the relative contribution each project has toward the overall program savings. Figure 3-3 illustrates the distribution of project-level savings. As illustrated in the figure, the vast majority of CBEEM projects each contributed less than one percent of program savings (279 of 305 projects). A relatively small number of projects contributed the majority of savings—the largest 31 projects contributed approximately half of the program savings.

Figure 3-3 Distribution of Claimed Project Level kWh Savings for CBEEM



As noted, to efficiently allocate projects for engineering desk reviews, the AEG team stratified the CBEEM projects into four categories based on individual project first-year claimed kWh. Projects were allocated to each stratum with a goal of achieving a sampled project result with no less than +/- 10 percent precision with 90 percent confidence. Site visits were allocated approximately proportionally to the number of desk reviews for each stratum.

The site visits were not treated as their own independent verification element. Rather, they were designed to enhance the accuracy of the desk reviews. In this regard, the strata and population realization rates reflect the best available data from each sampled project. The final sample count used for desk reviews and site visits, by strata, is presented in Table 3-34.

Table 3-34 CBEEM Stratification and Final Sample Counts for Desk Reviews and Site Visits[30]

Strata Category	Sampling Approach	kWh range	PY2018 Projects	Percent Savings	Population kWh Savings[31]	Desk Review Sample	Site Visit Sample
Low	Random	<50,001	160	9.1%	3,197,610	8	2
Medium	Random	50,001 to 200,000	95	27.8%	9,753,403	8	3
High	Random	200,001 to 1,000,000	46	48.6%	17,023,990	10	2
Certainty	Certainty	Over 1,000,000	4	14.4%	5,062,384	4	2
Total			**305**	**100.0%**	**35,037,387**	**30**	**9**

The final distribution of site visits across the strata differed from the original plan primarily due to site visit recruitment. Because the site visits were nested within the desk review sample, a site visit required an accompanying desk review, limiting the potential site recruitment to the original 30 sampled projects. The AEG team focused on delivering the planned 10 site visits, rather than limiting the count to each stratum. This approach allowed for capturing the best available information for each verified project across the 10 cases. In the end, due to landlord restrictions in one case, only nine of 10 site visits were completed.

CBEEM Verification Results

The AEG team determined an overall savings verification of:

- 105.7 percent for program level kWh
- 110.4 percent of program level kW

The combination of desk reviews and site visits completed by the AEG team resulted in three projects that did not require an adjustment and 27 that did require adjustments. Appendix A summarizes the results for the 27 cases. The adjustments included a wide range of verification findings, such as the count or type of equipment being installed, using available meter data to calculate savings (not available to the Hawai'i Energy team at the time of project installation), adjustments to lighting schedule assumptions, and/or inconsistent application of effective useful life for lifetime kWh calculations. The individual project results varied, but the overall effects on CBEEM resulted in aggregate realization rates that were within 10 percent for program level first-year kWh, kW, and lifetime kWh claimed savings.

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. Out of the 30 projects, the AEG team determined that Hawai'i Energy paid the correct incentive at the time of project closeout for 29 projects. For one project, a slightly smaller incentive was paid out than indicated in the project documentation and verified by the AEG team calculations.

The overall verified savings were compared to the claimed savings for each stratum. The realization rate for a stratum's sample was applied to that stratum. Based on the savings contribution of each stratum to

[30] 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

[31] The Population kWh savings presented in the table are Customer-level and do not take into account line loss factors or NTG ratios.

the overall CBEEM program, that realization rate informed the total CBEEM verified savings. The program level savings of each strata are summarized in Table 3-35 through Table 3-37 below for kWh, kW, and lifetime kWh.

Table 3-35 CBEEM Program Level First-Year kWh Claimed and Verified Results[32]

Strata	Number of Claimed Projects	Claimed Program Level First-Year kWh	Verified Program Level First-Year kWh	Realization Rate
Low	160	2,657,183	3,148,970	118.5%
Medium	95	8,122,066	8,787,100	108.2%
High	46	14,165,678	14,297,645	100.9%
Certainty	4	4,220,889	4,587,202	108.7%
Total		**29,165,816**	**30,820,917**	**105.7%**

Table 3-36 CBEEM Program Level kW Claimed and Verified Results

Strata	Number of Claimed Projects	Claimed Program Level kW	Verified Program Level kW	Realization Rate
Low	160	414.7	618.2	149.1%
Medium	95	1,125.0	1,337.5	118.9%
High	46	1,974.9	1,936.8	98.1%
Certainty	4	577.5	623.8	108.0%
Total		**4,092.1**	**4,516.3**	**110.4%**

Table 3-37 CBEEM Program Level Lifetime kWh Claimed and Verified Results

Strata	Number of Claimed Projects	Claimed Lifetime Program Level kWh	Verified Lifetime Program Level kWh	Realization Rate
Low	160	37,729,463	34,787,937	92.2%
Medium	95	122,811,984	122,642,473	99.9%
High	46	219,122,938	178,491,584	81.5%
Certainty	4	54,516,310	84,737,370	155.4%
Total		**434,180,694**	**420,659,366**	**96.9%**

Business Hard to Reach

The BHTR program has provided direct installation of energy efficient measures by program-qualified trade allies. 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 have been based on small business direct

[32] The results were found to have a precision of +/-6.9 percent at a 90 percent confidence level using a ratio estimator. 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

install lighting, though commercial kitchen equipment and multifamily direct install measures were also part of the program.

The AEG team verified savings using a tracking system review. During the verification process, it became apparent that the initial set of tracked data was insufficient to verify Amplify lighting measure savings, as savings were calculated via a custom approach using site-specific hours of use and site-specific baseline equipment. Hawai'i Energy updated the tracked data to include the information needed to verify savings. Additional information related to Amplify can be found in Appendix C. Other BHTR measures directly utilized the TRM measure savings, facilitating the use of the tracking system review to verify savings. The AEG team verified savings and adjusted savings from the claimed savings. The adjustments were as follows:

- Multifamily direct install 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 0.99.
- For one project totaling nine LED A19 measures, Hawai'i Energy reported occupancy sensor controls in the pre and post condition, but no controls factors were used in reported savings calculations. As a result, the AEG team adjusted the control Runtime Reduction factor to 0.33 in the pre and post condition to determine verified savings. This reduced verified energy savings.
- For one project totaling nine LED PAR30 measures, Hawai'i Energy reported occupancy sensor controls in the pre-condition, but no controls factors were used to determine the claimed savings. As a result, the control RTR factor was adjusted to 0.33 in the pre-condition for the verified savings. This reduced verified energy savings.
- For one project totaling two LED exit sign measures, the AEG team found that incorrect interactive effects factors (IFs) for energy and demand were used, based on the reported building type and space conditioning. In the supplemental file, the building type was listed as "Exit Signs" and the lights were documented as being a conditioned space but used an IF of 1.0 for energy and 1.34 for demand, which do not align with the TRM for the reported Retail building type. As a result, the AEG team calculated savings using the TRM IFs for a Retail building type, which are 1.054 for energy and 1.085 for demand which increased energy savings and reduced demand savings.

The AEG team's BHTR program verified kWh savings were very close to the claimed savings, at 100.0 percent. The kW realization rate was also very close, at 99.9 percent, largely due to the adjustments made to the NTG ratio for multifamily direct install measures. Because SBDIL lighting is a major source of savings for the BHTR program, it may be beneficial for Hawai'i Energy to track the details of the full equation used to calculate savings and specify their use in the TRM[33]. Currently, those details are retained in a separate software package used for program implementation. While custom calculations often cannot be presented with all variables in a tracking system, the simplicity of lighting savings calculations may lend itself to making this possible.

Below is the summary of the verified program level kWh and kW savings for the BHTR program.

[33] The AEG team is adding more clarity to the PY2020 TRM.

Table 3-38 BHTR Program Level kWh Claimed and Verified Results

Measure	End Use Category	Claimed Program Level First-Year kWh	Verified Program Level First-Year kWh	Realization Rate
SBDIL	Custom	9,121,417	9,120,112	100.0%
Commercial Kitchen	Other	342,458	342,458	100.0%
Custom Lighting	Lighting	120,490	120,490	100.0%
Multifamily Direct Install	MDI Lighting	44,225	43,783	99.0%
	MDI Other	114,534	113,389	99.0%
	MDI Total	*158,759*	*157,172*	*99.0%*
Total		**9,743,124**	**9,740,232**	**100.0%**

Table 3-39 BHTR Program Level kW Claimed and Verified Results

Measure	End Use Category	Claimed Program Level First-Year kW	Verified Program Level First-Year kW	Realization Rate
SBDIL	Custom	1,095	1,095	100.0%
Commercial Kitchen	Other	60	60	100.0%
Custom Lighting	Lighting	11	11	100.0%
Multifamily Direct Install	MDI Lighting	6	6	99.0%
	MDI Other	59	58	99.0%
	MDI Total	*65*	*64*	*99.0%*
Total		**1,231**	**1,230**	**99.9%**

Table 3-40 BHTR Program Level Lifetime kWh Claimed and Verified Results

Measure	End Use Category	Claimed Program Level First-Year kW	Verified Program Level First-Year kW	Realization Rate
SBDIL	Custom	127,699,832	127,681,569	100.0%
Commercial Kitchen	Other	5,002,626	5,002,626	100.0%
Custom Lighting	Custom	1,813,298	1,813,298	100.0%
Multifamily Direct Install	MDI Lighting	663,376	656,742	99.0%
	MDI Other	572,671	566,945	99.0%
	MDI Total	*1,236,048*	*1,223,687*	*99.0%*
Total		**135,751,804**	**135,721,181**	**100.0%**

Business Energy Services & Maintenance

The BESM program has been providing business customers with retro-commissioning, strategic energy management, submetering, or driving non-incentivized efforts. In PY2018 there were 52 BESM projects, most of which were described as "Residential A/C Tune Up" or "Commercial A/C Tune Up." The AEG team confirmed that all of these tune-up projects claimed savings based on the PY2018 residential air conditioner tune-up measure found in the TRM.

The AEG team utilized the tracking system review to verify the BESM savings for the tune-ups. The tracking system review found that all 46 projects correctly used the savings from the TRM for the "Central AC Tune Up" measure. In previous discussions with Hawai'i Energy, the AEG team had confirmed that this was the approach taken and that these measures were not duplicative of others found in the tracking system under other programs. While the specific nature of the tune-ups was not verified, the use of the residential measure suggests a level of conservatism in terms of developing savings. As a result, the savings for BESM were verified as 100 percent of the claimed savings for the customer, system, and program (net) levels.

The six non tune-up (custom) projects consisted of three rebates that had zero savings, including two retro-commissioning and one energy study grant, and three projects that had non-zero savings; all three non-zero savings projects were selected for desk reviews. As a result, the verified savings represent a census review of the custom projects included in BESM. Adjustments to individual projects from the desk reviews included methodology changes for determining peak demand impacts, effective useful life adjustments, and quantity differences for system leaks that would likely have been fixed without automated detection.

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. Out of the three projects, the AEG team determined that two paid the correct incentive at the time of project closeout. For the third project, the source of the incentive that was paid was not found in the project documentation and it was much greater than indicated by AEG team calculations for typical custom incentive rates.

Table 3-41 through Table 3-43 summarize the results. Due to the one-year measure life for tune-ups, the lifetime savings are affected disproportionately by the custom strata.

Table 3-41 BESM Program Level First-Year kWh Claimed and Verified Results

Measure	End Use Category	PY2018 Projects[34]	Claimed Program Level First-Year kWh	Verified Program Level First-Year kWh	Realization Rate
Custom	Custom	6	546,769	490,891	89.8%
A/C Tune-up	HVAC	46	90,511	90,511	100.0%
Total		**52**	**637,280**	**581,401**	**91.2%**

[34] 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.

Table 3-42 BESM Program Level kW Claimed and Verified Results

Measure	End Use Category	PY2018 Projects[35]	Claimed Program Level kW	Verified Program Level kW	Realization Rate
Custom	Custom	6	27.8	26.9	96.8%
A/C Tune-up	HVAC	46	20.4	20.4	100.0%
Total		**52**	**48.2**	**47.3**	**98.2%**

Table 3-43 BESM Program Level Lifetime kWh Claimed and Verified Results Savings

Measure	End Use Category	PY2018 Projects[36]	Claimed Program Level Lifetime kWh	Verified Program Level Lifetime kWh	Realization Rate
Custom	Custom	6	5,705,092	5,210,778	91.3%
A/C Tune-up	HVAC	46	90,511	90,511	100.0%
Total		**52**	**5,795,603**	**5,301,289**	**91.5%**

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 savings at the customer, system, and program levels were utilized to develop the verified TRBs at the same reporting levels to compare to the claimed TRBs. Table 3-44 presents the TRBs calculated at the program (net) levels for each program, sector, and entire Hawai'i Energy portfolio.

In terms of meeting TRBs targets at the program level, the AEG team verified $324,093,861 of TRBs for PY2018, which is 97 percent of Hawai'i Energy's claimed TRBs and 97 percent of the target TRBs. Therefore, Hawai'i Energy did not meet its TRBs performance target for PY2018.

[35] Ibid

[36] Ibid

Table 3-44 Program Level TRBs by Program

Program Name	Claimed TRBs	Verified TRBs	Ratio of Verified to Claimed TRBs
Residential Sector			
REEM	$92,112,305	$91,940,328	99.8%
RHTR	$4,418,720	$4,419,038	100.0%
RESM	$855,403	$856,845	100.2%
CREEM	$180,816	$183,140	101.3%
Total Residential	*$97,567,244*	*$97,399,350*	*99.8%*
Business Sector			
BEEM	$126,418,957	$121,012,570	95.7%
CBEEM	$80,566,061	$77,178,102	95.8%
BHTR	$27,739,147	$27,531,691	99.3%
BESM	$1,056,087	$972,148	92.1%
Total Business	*$235,780,253*	*$226,694,511*	*96.1%*
Total Portfolio	**$333,347,497**	**$324,093,861**	**97.2%**

Across the TRBs, the AEG team found that lifetime kWh savings make up a large majority of the overall TRBs value. As shown in Table 3-45, kWh savings represent 70 percent of the TRB value. For each program sector, the proportion of kWh to kW TRBs is similar, though kW TRBs are approximately 32 percent of residential sector TRBs compared to 29 percent of business sector programs.

Table 3-45 Program Level TRBs by Sector and Savings Type

Program Sector	kWh	kW	Total
Residential	$66,288,134	$31,111,216	$97,399,350
Business	$161,219,385	$65,475,125	$226,694,511
Total	**$227,507,520**	**$96,586,342**	**$324,093,861**
Percent	**70.2%**	**29.8%**	**100.0%**

4

HAWAI'I ENERGY STAFF INTERVIEWS

A new activity for PY2018 that occurred as part of the verification effort was conducting interviews with Hawai'i Energy program staff. These interviews were conducted to gain a better understanding of the program design and delivery (in particular for the Peer, Midstream Lighting, and Market Transformation programs), assess quality assurance/quality control procedures (QA/QC), discuss successes and challenges, and help to identify and prioritize verification tasks. In particular for the Market Transformation program and Customer Satisfaction, these staff interviews were used to help determine if additional verification work should be completed. Additionally, these interviews provided a forum for staff to suggest ways that the annual verification process could be helpful in making suggestions for improving programs. Separate interviews were conducted with Hawai'i Energy staff representing the Residential, Business, and Market Transformation programs. This section of the Verification Report documents the key messages that came out of the staff interviews.

Residential Programs

During the Residential program staff interviews, the AEG team learned about the key contractors and stakeholders that Hawai'i Energy works with to help deliver the Residential programs—the Clean Energy Allies, or CEAs. Staff called out two main categories of CEAs for the Residential programs: 1) air conditioner contractors; and 2) solar water heating contractors. In order to become a CEA, a contractor has to meet the requirements established and then go through a training webinar. Contractors need to understand the prescriptive nature of the Residential program offerings, including how to earn and process rebates. All of the contractor-based rebates are instant on the invoice, so the customer receives the rebate right away. While this process generally works well, staff did note that sometimes it is not clear to customers that they have received the instant rebate. In addition to the CEAs, Hawai'i Energy transitioned to engaging a channel partner, rather than a subcontractor, for the multifamily program. This change came as a result of need to expand to the neighbor islands and be more nimble in working with the property owners on these islands, and the channel partner was able to bring the resources and flexibility. After working through a transition period, Hawai'i Energy feels the channel partner has been working out well.

Hawai'i Energy staff noted that the Residential program saw few major changes overall, as PY2018 was the last year of a three-year contact. Some of the changes made included:

- Increasing the solar water heater rebate incentive
- Adding a few more measures to the upstream program
- Shuttering downstream rebates

Another change to the Residential program in PY2018 was moving to a new implementer for the Peer program. While transitioning this program to a new contractor was a big lift for Hawai'i Energy, staff felt that the transition went well, and that the new implementer has been easy to work with. One of the key modifications to the Peer program in PY2018 was assigning the stoppage of treatment group.[37] Other changes to this program included updating the look of the report, particularly related to how comparisons

[37] Over the past 12-18 months, Opinion Dynamics Corporation (ODC) and, more recently, the AEG team, have been tasked with proposing ways of resuming measurement of the program in order to potentially move away from deemed values in future program years. As part of that scoping, ODC authored a literature review and a proposal for a "stoppage" group in June 2018, then moved forward with randomly assigning approximately 22,500 households into the stoppage group.

are done. Hawai'i Energy also rolled out electronic versions of the home reports. Customers are now able to receive both an electronic version and a paper version. Customers did not have to self-select to receive the electronic home report; if the customer had an email address, the electronic version was automatically sent to them.

A large portion of the Residential program savings are garnered through the upstream program. Because of this, staff indicated they pay close attention to ensuring they are implementing best practices and offering as many equipment options as possible through this program delivery method. Staff did note that they are grappling with how to replace savings that have historically come through lighting, as Hawaii does not have a need for heat, and thus very little need for envelope measures. One program design option that had been discussed is a "whole home" or comprehensive program. However, this program design is challenging to implement in Hawaii given there is little need for envelope measures and that a whole home program relies on having a central group of contractors that are certified and trained, and in Hawaii, there are very few BPI or Resnet certified contractors.

Business Programs

During the Business programs staff interviews, the AEG team learned that Hawai'i Energy works with key allies and stakeholders to deliver the Business programs, aligning goals across this suite of businesses that are instrumental in helping Hawai'i Energy achieve its goals. The state of Hawaii itself is galvanized around the 100 percent clean energy target, and so partnering—whether through community outreach or providing direct install lighting programs for Lanai—aligns with both the state's and Hawai'i Energy's interest in promoting wellbeing throughout communities.

Hawai'i Energy's partnerships take different forms—in working with some businesses the focus may be purely energy efficiency and in others it may be more community awareness around clean transportation. But for the most part, Hawai'i Energy works to identify contractors and partners whose competencies help Hawai'i Energy to go further in the locations where they may not have as much coverage. Similar to the Residential programs, a key stakeholder group is the CEAs. For the Business programs, it is the CEAs that are a critical driver of project delivery. This means that many of the Hawai'i Energy training and professional development activities target the CEAs. In particular for PY2018, Hawai'i Energy provided some of the technical trainings multiple times throughout the year, such as the building operator certification.

Hawai'i Energy staff noted that one of the key successes for PY2018 was implementing "spot" bonuses, such as: 1) a contractor bonus for the Energy Advantage program;[38] 2) the rapid response increased incentive level on the Island of Hawaii; and 3) an additional incentive for domestic water booster pumps. While the full impact on the number of projects implemented as a result of these bonus programs may not be fully realized in PY2018 due to the lag time for projects to be completed, Hawai'i Energy staff noted the spot bonuses seem to have raised interest level and attention, and that they had received positive feedback from CEAs related to implementing these bonus opportunities. Additionally, staff felt that the Midstream Distributor program has been working well.

One of the biggest challenges that Hawai'i Energy staff discussed during the Business programs interview was addressing the more holistic approach to meeting Hawaii's clean energy targets, as the focus is no longer just energy efficiency. For example, due to the inclusion of technologies such as renewable energy and electric vehicles, working through issues such as capacity values and non-energy benefits has resulted in challenges for the Hawai'i Energy program. Intertwined with this challenge is the concerns being raised about duplication of effort between Hawai'i Energy and the utilities. While this has been inherent in the

[38] See Appendix C for a discussion of the Energy Advantage program.

Hawai'i Energy programs since the beginning, and there is an ongoing collaboration between these two groups, as discussions focus more and more on holistic solutions Hawai'i Energy staff recognizes the need for all parties to pay close attention to this challenge.

Another key challenge is that while Hawai'i Energy has embraced the shift to codes and standards work, how the program is able to claim savings is currently under review. On the surface, implementing a codes and standards program may seem straightforward, but the details around project documentation and influence are not so straightforward. For example, Hawai'i Energy offers a variety of codes and standards related training and support, but determining the level of influence these trainings have on an organization to take the steps to install energy efficient equipment has been challenging, and thus, how the program is able to claim the savings from that project has not been fully determined.[39]

Market Transformation Programs

While market transformation as a program type is not a new concept, we know from years of working in the demand side management industry that results from these types of programs are not easily verified or quantified. This is because market transformation is typically a strategy that intends to induce long-lasting, sustainable changes in the structure or functioning of a market. To achieve this, a program or policy design needs to reduce barriers to the adoption of energy efficient technologies, or markets that sell, distribute, install, or manufacture those technologies to the point where continuation of the same publicly-funded intervention is no longer appropriate in that specific market. Hawai'i Energy staff recognize that the Market Transformation programs are more challenging to implement and to track the success of than other programs (e.g., resource acquisition). To help support and show value for their market transformation efforts, Hawai'i Energy provides detailed narratives in each annual report.

During the Market Transformation programs staff interview, the AEG team learned that Hawai'i Energy has been working to form strategic partnerships with various entities in order to promote and garner a broader awareness of, and participation in, the Hawai'i Energy programs. Key program partnerships mentioned include those focused on community-based energy efficiency. Hawai'i Energy has worked to increase their efforts implementing community focused projects, which has been a comprehensive effort. Projects have included:

- Development of a non-binding agreement with a designated community leader or entity. Hawai'i Energy essentially has put together a list of activities and support they can provide at the community level, and each community selects the items that will work for them. While the consensus was that this effort has been working well, Hawai'i Energy staff also recognize that the impacts, including non-energy benefits, have been hard to quantify but that what has been happening is still really good for the well-being of a community.
- Implementing energy efficiency efforts on the island of Lanai. On Lanai, there is a single entity (Larry Ellison Development Corporation) that owns 95% of the island. Hawai'i Energy worked closely with them during PY2018 to provide energy efficiency services across both residential and business programs. This effort took substantial resources to execute.
- Working with the United Way. Hawai'i Energy staff has been working with the local chapter for some time to get this organization interested and more engaged because they have a defined process of distributing funds to numerous other non-profits. In this way, the United Way is akin to a gatekeeper

[39] The AEG team is working to provide guidance on how Hawai'i Energy might be able to claim savings from their codes and standards activities.

of key resources that could be combined with Hawai'i Energy resources to complete more projects in more communities.

These partnerships have been both beneficial and challenging for staff. Staff noted that key challenges related to these partners include setting clear metrics for each unique partnership (and ultimately market transformation program) to help ensure meaningful results, as well as getting partners to provide clear and concise supporting documentation. Hawai'i Energy staff noted that while progress has been made in these areas, more could still be done.

Hawai'i Energy staff noted that a recent Market Transformation programs success was getting the 13-year old energy conservation code updated at the county-level. In Hawai'i, focusing on the county level is key, as the state rule is for all counties to approve their own amendment(s) to the energy conservation code. Due to the importance of energy efficiency code in helping Hawai'i get to its net zero goal, Hawai'i Energy staff felt it was important for them to advocate for more stringent energy conservation code. Hawai'i Energy's partner, Blue Planet Foundation, provided substantial support and resources to this effort as well. Hawai'i Energy worked with Blue Planet Foundation to set up reporting requirements (e.g., who they met with, what day they met on, etc.), which they would provide to Hawai'i Energy staff with their monthly invoice. Staff mentioned this was a long, arduous process, but that it came to fruition during this past year.

Last, the AEG team asked questions during the interview about three specific Market Transformation sub-programs—building automation systems (BAS), strategic energy management (SEM), and continuous energy improvement (CEI). These programs were selected to target during the interview as they have been included in the Hawai'i Energy program portfolio for a while but have remained in steady state of participation, including a small number of projects. Hawai'i Energy staff confirmed during the interview that they continue to work to find additional projects for each of these sub-programs. For example, during the PY2018 planning phase, Hawai'i Energy hoped to engage with large customers who would participate in BAS, and that would then lead to implementing additional energy efficiency projects, However, none of these projects came to fruition in PY2018. During this process, Hawai'i Energy designed a tiered incentive structure. While no projects were completed, staff thought the tiered incentives for customers who are interested gained some traction and the idea is carrying forward to their current incentive offerings through energy audits and retro-commissioning.

5

CUSTOMER EQUITY RESULTS

Hawai'i Energy's performance goals are meant to 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 on each of Hawaii and Maui counties and that a minimum number of accounts are served by the multifamily and small business direct install programs, with a minimum amount of first-year kWh savings for each group. Table 5-1 presents the PY2018 Customer Equity performance targets and verification approaches.

Table 5-1 Customer Equity Performance Target and Verification Approach

Key Focus Areas	100 Percent Target	Metric	Verification Approach
Economically Disadvantaged	Small Business Direct Install: 675 7,500,000 Multifamily Direct Install: 3,692 1,357,849	Customers served kWh Customers served kWh	Database review Verified savings
Island Equity	County of Hawaii: 13 percent County of Maui: 13 percent City & County of Honolulu: 74 percent	Target spend must be met in Hawaii and Maui Counties for Milestone and Target Award	Database review Verified savings

Economically Disadvantaged Results

To verify Hawai'i Energy's PY2018 customer equity performance related to economically disadvantaged customer segments, the BHTR and RHTR programs play a key role. These programs conducted small business and multifamily direct installs, overcoming market barriers that small businesses and multifamily or economically challenged households have in directly benefiting from energy efficiency measures. To verify Hawai'i Energy's PY2018 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 energy savings.

Hawai'i Energy tracks projects with an Equipment Category that records whether a project was part of a Multifamily Direct Install (MFDI), SBDI, as well as other project type. In discussion with Hawai'i Energy, the AEG team learned that performance for MFDI projects were tracked via installation work orders that tie out to each dwelling unit[40], which reflected direct install measures for that unique multifamily dwelling unit. One channel partner responsible for serving economically challenged and hard to reach customers records data in invoices that were tracked separately from the tracking database, though with project savings recorded in the tracking database. For SBDI projects, distinct customers were tracked at the rebate

[40] Prior to PY2018, MFDI projects were tracked via the site visit fees.

level, with unique rebate IDs reflecting a unique business served by the program. The AEG team verified the energy savings through the general resource acquisition analysis and developed counts of unique customers served through the use of the tracking data and invoices submitted by a channel partner.

Table 5-2 summarizes the AEG team's findings related to Hawai'i Energy PY2018 customer equity performance for MFDI and SBDI. Hawai'i Energy met and exceeded its goals in terms of kWh savings related to economically disadvantaged performance and total customers served.

Table 5-2 Verified Economically Disadvantaged Performance Results

Target Segment	Metric	Performance Target Metric	Verified Results	Met Target?
Small Business	Customers Served	675	760	Yes
	kWh savings	7,500,000	9,121,417	Yes
Multifamily	Customers Served	3,692	3,840	Yes
	kWh savings	1,357,849	1,833,694	Yes

Island Equity Results

To verify Hawai'i Energy's PY2018 results for meeting its island equity goals, the AEG team reviewed documentation provided by Hawai'i Energy and confirmed incentive payments using the tracking database and a customer equity report from 9-10-2019 that included the full program spending by island. Performance goals were framed as incentive spending that was associated with each island across the resource acquisition and market transformation programs. For purposes of tracking spending for Maui County, the islands of Maui, Lanai, and Molokai were combined to reflect the totality of Maui County. Additionally, the AEG team received a document that described previously agreed-to arrangements for how program costs were allocated across the counties.

Table 5-3 presents the island equity performance results. The resource acquisition incentives were far higher than market transformation incentives, at 90 percent of the total incentives. The market transformation allocations were found in the customer equity report. In PY2018, Hawai'i Energy met its island equity targets by exceeding incentive spending associated with Hawaii and Maui Counties.

Table 5-3 Verified Incentive Spending by Geography

	Resource Acquisition Incentives		Market Transformation Incentives		Total Incentives		
Location	Funds	Percent	Funds	Percent	Funds	Percent	Met Target?
Hawaii County	$3,145,691	15.2%	$508,208	2.46%	$3,653,899	17.7%	Yes
Maui County	$2,329,793	11.3%	$500,194	2.42%	$2,829,987	13.7%	Yes
Honolulu County and Honolulu City	$13,192,435	63.8%	$987,965	4.78%	$14,180,400	68.6%	Yes
Total	**$18,667,919**	**90.3%**	**$1,996,367**	**9.66%**	**$20,664,286**	**100.0%**	**Yes**

Customer Equity Results Summary

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 PY2018 performance. Summarized in Table 5-4, Hawai'i Energy met equity performance targets for energy savings, incentive spending per Island, and numbers of customers served.

Table 5-4 Customer Equity Claimed and Verified Results

Key Focus Areas	Measurement Category	100 Percent Target	Claimed Results[41]	Verified Results	Met Target?
Economically Disadvantaged	Small Business Direct Install Customers Served	675	760	760	Yes
	Small Business Direct Install kWh Savings	7,500,000	8,441,662	9,121,417	
	Multifamily Direct Install Customers Served	3,692	3,840	3,840	
	Multifamily Direct Install kWh Savings	1,357,849	1,833,699	1,833,694	
Island Equity Incentive Spending	County of Hawaii: 13 percent	13.0%	17.7%	17.7%	Yes
	County of Maui: 13 percent	13.0%	13.7%	13.7%	Yes
	City and County of Honolulu: 74 percent	74.0%	68.6%	68.6%	Yes

[41] 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 PY2018 final Annual Report (p17), with verified results developed from a combination of the final tracking database and "PY18 MFDI Unit Counts Summary.xlsx."

6

MARKET TRANSFORMATION RESULTS

The AEG team verified the Market Transformation activities and achievements provided by Hawai'i Energy during PY2018 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. The same as from PY2017, the PY2018 Market Transformation programs were categorized into five categories, including: (1) Behavior Modification, (2) Professional Development & Technical Training, (3) Energy in Decision-making, (4) Codes and Standards, and (5) Clean Energy Collaboration. The activity categorized as Clean Energy Collaboration included an iDSM pilot program, which attempted to determine the ability of an aggregated fleet of water heaters to serve as a dispatchable resource that accurately responds to utility signals. This would increase flexibility in system operations and support stability and help evaluate the feasibility and capability of GIWH devices to support grid service requirements. This collaboration effort will continue at scale in PY2019. Although these programs may lead to future gains in energy efficiency and conservation, direct energy savings goals are not set for these programs, though Hawai'i Energy does receive a performance bonus for activities conducted under this category.

Verification Method

Hawai'i Energy provided the AEG team with documentation used to verify the market transformation activities. For PY2018, this largely included number of participant-hours, number of participants attending, and 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.

In addition to reviewing Hawai'i Energy documentation and similar to PY2017, the AEG team issued its own survey of PY2018 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 by which to verify participation in trainings; 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 likely professional development attendees[42]. This list was used to recruit survey respondents. In total, 659 email invitations were sent.

In total, 61 respondents, approximately 9 percent of participants recruited, responded to the survey. About two thirds of those responding (n=39) said they had participated in a professional training or education event over the past year. Table 6-1 summarizes the number of participants by training.

[42] 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).

Table 6-1 Number of Survey Respondents by Training Type

Training	Count of Survey Respondents (n)
Clean Energy Ally Meeting	5
Code Related	4
Professional Development & Technical Training for Trade Allies	1
Professional Development & Technical Training for Participants	17
Hawai'i Energy Sponsored Training*	12
Total	**39**

* This option was provided to survey respondents who could not recall the name of the training or education they participated in.

Verification Results

Overall, the AEG team determined that Hawai'i Energy achieved all its Market Transformation target metrics related to the performance award. Table 6-2 shows each category area, the target metrics within each category, and the verified outcome for each metric.

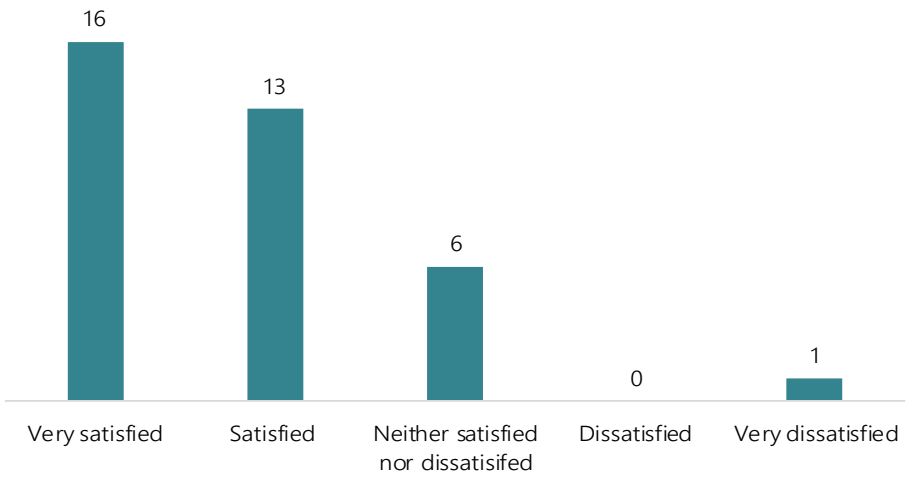
Table 6-2 Market Transformation Performance Metrics, and Verified Performance

Key Focus Areas	Market Transformation Factor	Performance Indicator Target	Verified Performance	Met Target
Behavior Modification	Workshops and Presentations	2,500 participant-hours of Training	2,865 participant-hours of Training	Yes
	Youth Education Workshops and Presentations	1,000 participant-hours of Training	1,423.50 participant-hours of Training	Yes
	Youth Event Sponsorship	2 Events	3 Events	Yes
	Enhanced Engagement (Gamification)	1,000 Participants	10,033 Participants	Yes
	Transformational Videos	10 videos produced	12 videos produced	Yes
Professional Development & Technical Training	Clean Energy Ally Support Targeted Ally Training Opportunities Targeted Participant Training Opportunities Educator Training and Grants Energy Industry Workforce Development	8,370 hours of participant training across all categories	10,219.16 participant-hours of Training	Yes
Energy in Decision Making	Strategic Energy Management	2 cohort participants	13 cohort participants	Yes
	Community Based Energy Efficiency	1 cohort participant	1 cohort participant	Yes
Codes and Standards	Code Identification and Adoption	9 Advocacy Events	14 Advocacy Events	Yes
	Code-Related Training and Compliance	70 participant-hours of Training	140 participant-hours of Training	Yes
	Leading Edge Technologies and Strategies	4 stakeholder meetings; 1 report	4 stakeholder meetings; 1 report	Yes
	Standards Enhancement	3 Engagements	7 Engagements	Yes
Clean Energy Collaboration	iDSM pilot project	1 pilot project	1 pilot project	Yes

Professional Training Participant Survey Results

Overall, survey respondents rated their satisfaction with Hawai'i Energy's professional development offerings highly. Of the 39 survey responses, 36 provided responses related to questions about their satisfaction with the training they attended[43]. Sixteen of 36 respondents said they were "very satisfied" with the training they attended, and an additional 13 respondents said they were "satisfied." Only one respondent said they were either "dissatisfied" or "very dissatisfied" with the training attended. This participant selected the general "Hawai'i Energy Sponsored Training" category and noted that the training description did not match what was actually discussed. Figure 6-1 illustrates participant satisfaction with the training attended.

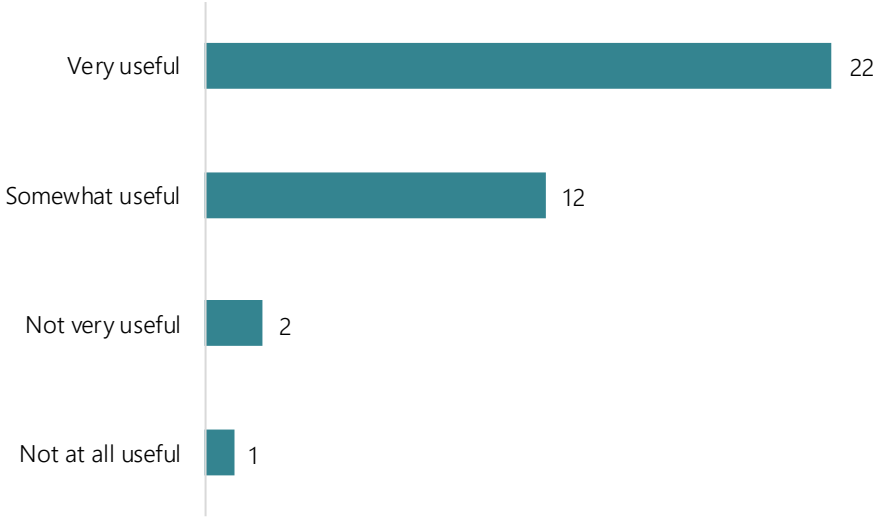
Figure 6-1 Satisfaction with Professional Development Training Attended (n=36)



In addition to reporting high satisfaction, 22 respondents characterized the trainings as "very useful." An additional 18 respondents described the training they attended as "somewhat useful," and three respondents characterized the trainings as either "not very useful" or "not at all useful." The respondent who was "very dissatisfied" with the training also reported it as being "not at all useful."

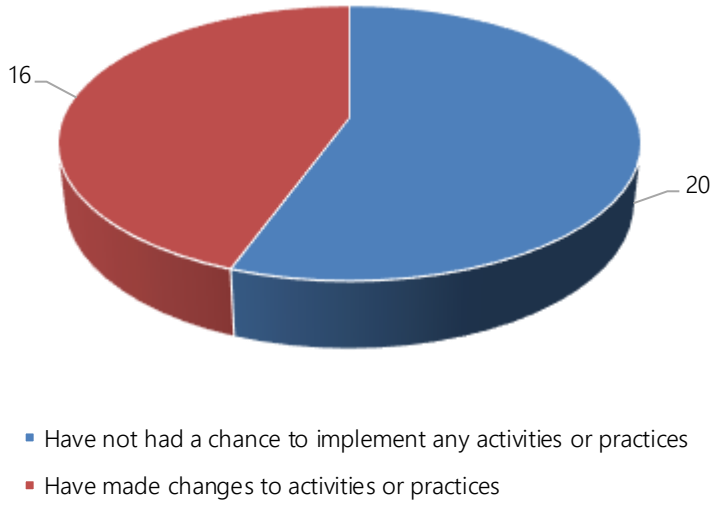
[43] As a unique individual may have participated in more than one training and provided responses for each training, satisfaction results are reported at the response level.

Figure 6-2 Usefulness of Professional Development Training Attended (n=37)



To try to gauge what organizations have done as a result of participating in training, one survey question asked participants what ways, if any, the training event affected their organization's day-to-day activities or practices. Of the 36 respondents answering this question, 16 have made changes to activities or practices.

Figure 6-3 Training Effect on Activities and Practices (n=36)

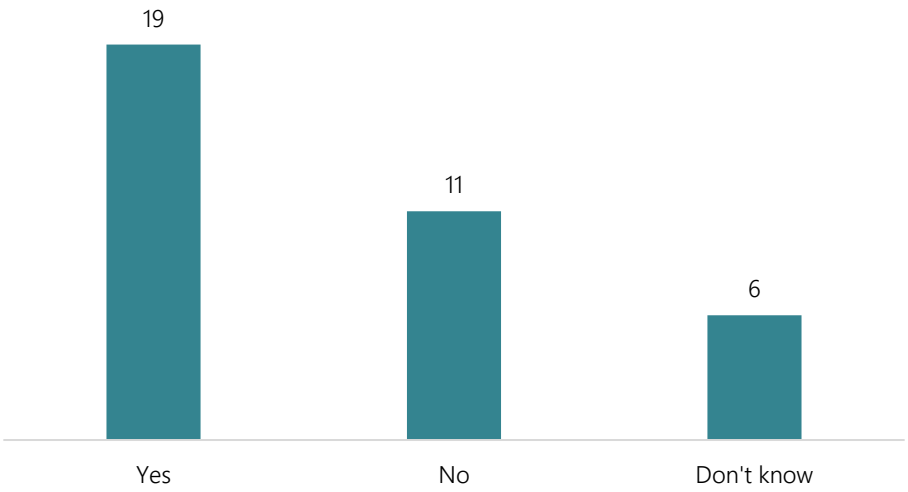


Individual actions included setting goals to reach sustainability targets, having students work on developing a strategic energy plan, and improving tracking of potential rebates for lighting and HVAC equipment. Activities and changes that were mentioned more than once included:

- Launching more education initiatives/ training staff
- Making changes to various equipment to more efficient options
- Developing policies and standards around energy efficiency, renewables, and/or electric vehicles

As a follow-on to this question, survey respondents were asked if their participation led to their organization's participation in an energy efficiency, demand response, storage, or distributed generation program. Of the 36 survey respondents answering this question, 19 answered yes.

Figure 6-4 Did Training Lead to Program Participation (n=36)



A total of 14 respondents provided recommendations on ways to improve trainings. Individual suggestions ranged from topics (e.g. lighting) to logistical suggestions (e.g. offering more trainings on neighbor islands). Notable suggestions included:

- Providing more in-depth explanations of technical content
- Offering more trainings at project sites
- Ensuring objectivity from those that are speaking/leading trainings
- Providing educational messaging around why individuals and communities would want to be energy efficient, how it supports their lives, etc.
- Offer additional tools on the website (e.g. videos and spreadsheets)

Similar to PY2017, respondent's recommendations related to training content continue to suggest that there is an appetite for more focused and advanced trainings. While Hawai'i Energy operates a variety of advanced professional training, information on the level of trainings may not be getting clearly communicated or some training attendees may not be in the right marketing channel to receive the information.

Survey respondents (including those who said they did not participate in a professional training or event this past year) also were asked whether they are registered with Hawai'i Energy as a Clean Energy Ally. Of the 57 responses, 17 confirmed being registered as a Clean Energy Ally, 25 reported not being a Clean Energy Ally and 15 did not know if they were registered as a Clean Energy Ally. However, not all the trainings were focused on topics related to Clean Energy Allies, which continues to suggest that a diverse set of professionals engaged with energy efficiency are being reached outside of the Clean Energy Ally network.

7

CUSTOMER SATISFACTION RESULTS

One of Hawai'i Energy's performance targets relates to customer satisfaction. Hawai'i Energy has an annual target of achieving an overall satisfaction score of 8.5 or greater (out of a possible 10) on overall customer satisfaction. The AEG team received documentation from Hawai'i Energy that described their customer satisfaction feedback system, with output results from their customer experience management tool, Medallia. 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. These included field service experience satisfaction, satisfaction with the rebate process, and overall willingness to recommend Hawai'i Energy's programs. According to program documentation and subsequent discussions with Hawai'i Energy staff, Medallia sent 4,330 surveys to customers in PY2018, of which 22.3 percent responded to the survey. Medallia compiled an overall satisfaction rating of 9.05 out of 10 on average by compiling satisfaction scores across all categories queried, satisfying the target performance metric.

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

- 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 rebate been paid. Additionally, not all customer ultimately complete a project or receive a rebate – collecting information ahead of a rebate may allow for the perspectives of customers who ultimately do not receive a rebate to be captured.

  Secondly, consider using a 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.

Due to the timing of the PY2017 verification activities and subsequent recommendations, Hawai'i Energy was not able to implement these recommendations for PY2018, but they remain a priority.

8

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 PY2018 performance targets. Targets for resource acquisition were nearly met for kWh (97 percent), total resource benefits (97 percent), and kW savings (98 percent). Customer equity goals were all met for economically disadvantaged customers and island equity. Market Transformation targets were verified as having been met as was the customer satisfaction target. Based on the results, the AEG team calculated Hawai'i Energy's performance incentive payment at 98.0 percent of the maximum, or $981,337.41.

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 on a going-forward basis. These recommendations capture many of the elements that led to the final verification results, which if addressed, potentially streamline or clarify approaches or methods for savings verification or mitigate potential sources of verification risk. Because some of the recommendations are carryovers from the PY2017 verification activities, recommendations are categorized as either those that are new based on PY2018 findings or those that remain applicable from PY2017.

PY2018 – New Recommendations

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

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.

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

As part of the 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 can be made for large custom projects.

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 is 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 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 up 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% of the total utility bill. The AEG team also recognizes that below that threshold that are many cases where utility billing regressions are still a valid approach. The AEG team recommends enacting a threshold where 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.

Recommendation 4. Use results from the upcoming Peer Program Stoppage of Treatment study (when they become available) to update the savings approach for the Peer program and to inform decisions related to budgeting for home energy reports versus other energy saving measures.

Upon final approval by the HPUC and under the guidance of the EEM, the AEG team will be conducting a study to estimate the incremental savings from continuing to send reports to Peer participants. Due to the lack of a true control group of customers who have never received a report,[44] the study will compare energy use between the stoppage treatment group (STG) selected by Opinion Dynamics Corporation and a group of customers that will continue to receive reports.[45] The STG consists of a random stratified sample of 22,500 Peer participants who stopped receiving reports as of Fall 2018.[46] The study will also include a benchmarking approach to provide context around stoppage treatment effects and to potentially inform a method to extrapolate the incremental savings to overall program savings based on the experience of other utilities conducting similar analyses with the benefit of a true control group.

Therefore, the intent of the analysis is to provide both an estimate of the incremental benefit of sending reports, and a more accurate picture of the overall program savings based on the experience of other utilities. These two estimates and the associated analysis can be used to update current TRM program savings, inform decisions around program spending and budgeting on Peer reports versus other energy saving measures, and test changes to the reports that make them more impactful for customers.

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.

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 ratings 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.

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 have noted that changes are under way. 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

[44] Most eligible participants are already enrolled in the program, or have been at some point in the past.

[45] Hawaii Peer Comparison Program Stoppage of Treatment Study Sample Selection, Memorandum, Submitted to Steve Schiller, Submitted by Opinion Dynamics Corporation, June 18, 2018.

[46] The STG sample is stratified into six program waves according to month of program enrollment ranging from 2011 through 2016.

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 (Section 6).

Recommendation 7. Consider implementing projects within the most appropriate program. Also, update tracking and project data collection to facilitate program level goal tracking. Finally, allow projects within Business or Residential programs to use algorithms and factors from either section of the TRM when it is most applicable.

This is an ongoing finding from PY2017. The AEG team found a number of inconsistencies related to program structure, reported projects, and reported delivery methods. For example, Multifamily master metered direct install projects were recorded in both RHTR and BHTR programs. Additionally, custom projects and rebates were found throughout non-custom programs. The AEG team understands the need to capture the nature of customer engagement to report on topics related to customer equity or call out specific measures, such as solar hot waters. However, these can be addressed through categories captured in the tracking database and avoid mixing program, project, and customer types that could logically fit into several different programs. Doing so may help provide clarity on "true" program performance. For example, the CREEM program had very few projects and comparatively low savings. However, RHTR and REEM both contained custom residential projects. The AEG team acknowledges the challenge of this recommendation, not the least of which is the need to apply correct NTG ratios to projects. As these are currently assigned at a program level, care should be taken in making any wholesale changes that come into conflict with the underlying programmatic NTG ratio practice, philosophy and policy.

As another example, during the course of the verification, several projects were selected for desk reviews that were claimed under Business programs, because the account types fell under the Business sector (e.g., master-metered multifamily buildings). However, these projects actually installed measures in locations that were Residential in nature such as an individual unit in a multifamily building. The AEG team found these projects were using factors for Misc. Commercial, which were not good values for these buildings and measures. The most accurate accounting of savings for these projects and measures was to utilize the Residential algorithms and assumptions in the TRM, even though the account type is in the other sector.

During the PY20 TRM prioritization process, Hawai'i Energy requested further research into the development of EFLH and CF values for a multifamily facility type to help address this issue. However, this update did not make the high priority short list for the PY20 TRM. Until a comprehensive study can be done to develop customized load shapes for estimating EFLH and CF values for measures installed in individual units in multifamily buildings in Hawaii, the AEG team recommends that Hawai'i Energy use the residential EFLH and CF values for projects involving individually metered *as well as* master-metered multifamily homes.

Recommendation 8. Hawai'i Energy should consider updating the data tracking system to differentiate between different forms of measure quantities recorded at the rebate or measure level.

This is an ongoing finding from PY2017. Through close work with Hawai'i Energy, progress has been made to normalize how quantity is defined across similar measure types. Fields specific to lighting, for example, capture only lamp quantity information, which has helped standardize lighting attributes captured in the tracking data. However, there is still no singular data field used consistently to capture unit quantity across all measure types and programs. The AEG team found that the tracking data's "quantity" field served many purposes. For some measures it referred to actual counts of the measure. For custom projects, the quantity

field recorded the customer-level first-year kWh savings. For HVAC and other measures, quantity was used to identify the metric used to calculate savings (e.g. tons of air conditioning). A separate HVAC quantity field was used to capture the actual number of units being rebated. While the AEG team was able to ultimately utilize the data, the approach to recording quantities with varying definitions creates potential risk. The AEG team understands that there needs to be an approach to capturing measure elements that drive project savings through the TRM or other approach. However, the diverse set of measures in the Hawai'i Energy portfolio have many elements that characterize their savings. A single field to capture the unit quantity separable from those used to calculate savings, across all the measures (not just HVAC) would help mitigate the potential confusion.

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.

A

CBEEM SUMMARY OF PROJECT ADJUSTMENTS

Reporting ID	Stratum	Project Description	Summary of Adjustments
1822001	Medium	Control system optimization in a telecommunications building	Adjustments were made to this project from both the Desk Review and Site Visit. Calculation Methodology - The claimed savings used a simple average of the monthly kWh to estimate the savings based on 12-months of pre-installation data and 7-months of post-installation data. The verified analysis used full 12-month periods for both. The claimed savings also used the average billed demand over those periods while the verified savings used the average demand reduction from 5-9pm year-round. Finally, the verified analysis used a normalized dataset and the regressions were determined from both the pre-installation and post-installation to control for weather differences between the two periods. These differences in approaches combined to reduce the first-year energy and demand savings for the project. EUL Methodology - The verification calculation assumed the standard custom EUL of 13 years because of the range of components of the project. The reported EUL was only 10 years, so this adjustment increased the lifetime kWh savings.
1822003	Certainty	Chilled water plant upgrade at a medical center campus	Adjustments were made to this project from both the Desk Review and Site Visit. Calculation Methodology – A custom calculation for this project was conducted by deriving the relationship between energy consumption and ambient temperature for chiller 1, and then using a normalized weather set to calculate the EFLH and CF. This method resulted in increased first-year kWh savings and decreased demand savings. Effective Useful Life - The effective useful life for the claimed savings used a value of 15 years, however the TRM value for the EUL of a chiller is 20 years. This increased the lifetime energy savings.
1822004	High	Lighting retrofit of a big box retail store	Wattage Adjustment - The base case T5HO fixture wattage was found in the referenced document and the wattage consumed changed slightly. AOH/CF Adjustments - Three holidays were incorporated into the hours of operation, which is typical for a big box store. This slightly reduced the first-year energy savings. The Coincidence Factor on the Garden Center lighting was reduced to 0.75 to match the Exterior TRM values - which best matches the purpose of the lights. EUL Methodology - The verification calculation used the EUL for LED fixtures based on the line item hours of use. This savings approach weighted the EUL based on energy savings and therefore decreased the lifetime savings significantly from the average of the annual hours of use approach. The submitted calculation also rounded the EUL in calculation. The EUL adjustment reduced the lifetime savings.

Reporting ID	Stratum	Project Description	Summary of Adjustments
1822005	High	Lighting retrofit of a big box retail store	This project received both a Desk Review and Site Visit with all adjustments resulting from the desk review. AOH/CF Adjustment - The operating hours for the interior fixtures were updated from 6,570 hours in the claimed savings case to 6,516 in the verification case. The claimed savings analysis did not take closed holidays into account when calculating the custom annual operating hours. This slightly decreased savings but did not affect the lifetime energy savings. EUL Methodology - The verification analysis calculated a 7.7 EUL (50,000 hours / 6,516 EFLH), which was rounded to 8 years, versus the claimed 7 years. This increased the lifetime savings.
1822006	High	Lighting retrofit of a big box retail store	Pre/Post Equipment Ratings - The LED lighting retrofit DLC wattage for the 4 Lamp T5HO retrofits and the high bay lights in the garden center were raised from 108.8, 86, & 69 watts to 114.6, 92.0, & 79.5 respectively. This reduced the energy savings. The base case T5HO fixture wattage was found in the referenced document and the wattage consumed changed slightly. This was adjusted from the fixture wattage being the addition of individual single lamp wattages. AOH Calculation - Three holidays were incorporated into the hours of operation, which is typical for a big box store. EUL Methodology - The verification calculation used the EUL for LED fixtures based on the line item hours of use. This savings approach weighted the EUL based on energy savings and therefore decreased the lifetime savings significantly from the average of the annual hours of use approach. The submitted calculation also rounded the EUL in calculation. The EUL adjustment reduced the lifetime savings but did not affect the first-year savings values.
1822007	High	Lighting retrofit of multiple operations buildings at a military base	Pre/Post Fixture Wattages - The LED lighting retrofit DLC wattage for the T8 fixtures was adjusted to fixture level, which slightly adjusted the base case watts. The biggest retrofit adjustment was the second line item, which submitted a 6 lamp F32T8 fixture with 1 lamp at 37.5 watts each - this was adjusted to a single fixture with 169 watts which significantly increased the base case wattage for 100 fixtures. The remainder of the adjustments were much smaller in magnitude. EUL Calculation Methodology - The verification calculation used the EUL for LED fixtures based on the line item hours of use and assumed 50,000 hours of use for each fixture. This savings approach weighted the EUL based on energy savings and therefore decreased the lifetime savings significantly from the average of the annual hours of use approach. The submitted calculation used a blanket 7 years for the EUL. The EUL adjustment reduced the lifetime savings but did not affect the first-year savings values.
1822008	High	Transformer replacements across multiple buildings at a military base	Quantity Adjustment - The quantity of each size of transformer purchased was adjusted to match the invoice. This increase the number of units from 103 to 123. Non-qualified equipment - The three Single Phase transformers had the savings set to zero because they were not on the CEE Tier 1 QPL. The 120 three phase transformers were on the CEE Tier 1 QPL. The savings was calculated for these units, although they did not meet the requirement of being categorized at Tier 2 that is stated in the TRM. Equipment Rating - The no-load loss of the purchased transformers was adjusted to match the Product Warranty for maximum allowable over 25 years. This increased the no-load loss for the units. EUL Adjustment - The EUL was adjusted from 50 years to the administrative cap of 25 years. A 32-year EUL was used to determine the remaining life of the base case.

Reporting ID	Stratum	Project Description	Summary of Adjustments
1822009	Certainty	Lighting retrofits for an industrial shipping dock	AOH Adjustment - The verification calculations found the same reduction of wattage as the submitted calculation, although the documentation noted Monday to Friday operation. The verification calculations assumed zero hours of operation for the exterior working lots on weekends, where the submitted calculation assumed 7 days a week operation. The verification calculation did not assume light fixture operation for safety during non-operating hours. EUL Methodology - The verification calculation used the EUL for LED fixtures based on the line item hours of use and assumed 50,000 hours of use for each fixture. This increased the EUL to 17 years based on the post install hours of operation. The submitted calculation used 10 years for the EUL. The EUL adjustment reduced the lifetime savings but did not affect the first-year savings values.
1822010	Medium	Guest room occupancy controls at a high-rise hotel	Adjustments were made to this project from both the Desk Review and Site Visit. Calculation Methodology - The verification calculations used the wattage draw from the documentation for the maximum full load consumption of the HVAC units being controlled, where the submitted calculation attempted to calculate it using assumed equipment size and efficiency. This increased the full load slightly. Also, the verification calculation used the full load hours (EFLH) from the TRM entry to convert the full load consumption to annual consumption. This decreased the number of hours. Finally, the verification analysis used the percentage reduction from the Ramada Plaza as the basis for the savings estimation for all units in the project, as most of the units are installed on single rooms rather than suites. This resulted in the largest adjustment to the savings. EUL Methodology - The EUL was increased to 8 years for a control system from 4.7 years. This slightly increased the lifetime savings, offsetting the first-year reduction's effect on the lifetime savings.
1822011	Certainty	Chilled water plant upgrade at a high-rise hotel	Adjustments were made to this project from both the Desk Review and Site Visit. Post Equipment Rating - The reported savings used the minimum target efficiency of 0.4 kW/ton provided for the chillers in email correspondence, rather than the specific value of 0.3243 kW/ton that was provided in the same correspondence. The specific rating was specified as an NPLV initially, but the design engineers confirmed that the operating conditions at the hotel are equivalent to the ARI rating conditions, so the IPLV is identical to the NPLV. The verified savings used the specific rating provided in correspondence, which increased both energy and demand savings. Custom EFLH/CF – The data collected from the site visit was used to calculate a custom EFLH and coincidence factor for the chilled water plant. The analysis found a more than two-fold increase from the EFLH and CF values in the TRM, which greatly increased both energy and demand savings. Sequence of operations – The site visit confirmed that only one chiller is required to operate at any given time. This greatly reduced the energy and demand savings. Baseline Adjustment – The site visit confirmed that the cogeneration plant should be included as present in both the pre and post cases. This adjustment is covered by the Custom EFLH/CF analysis and resulted in a decreased in energy and demand savings. Overall, the verified energy and demand savings were higher than the claimed savings.

Reporting ID	Stratum	Project Description	Summary of Adjustments
1822012	Low	Lighting retrofit at a combined warehouse and retail facility	Pre/Post Fixture Wattages - The base case wattage was adjusted to account for each T8 lamp individually to a fixture wattage based on the Xcel Energy, Input Wattage Guide. Adjustments were made to the interior fixtures, adjusting the 4 lamp T8 fixtures to 117 watts from 110 watts equivalent and the 2 lamp T8 fixtures to 59 watts from 59.2 watts equivalent. AOH Calculation - The verification calculations added three holidays per year to the interior lighting, this reduced the hours of operation from 5,735.7 to 5,688 hours. EUL Methodology - The verification calculation used the EUL for LED fixtures based on the line item hours of use and assumed 50,000 hours of use for each fixture. This savings approach calculated lifetime savings per line item. The submitted calculation used 8 years for the exterior fixtures and 7 years for interior fixtures. The EUL adjustment increased the lifetime savings but did not affect the first-year savings values.
1822013	High	Exterior lighting retrofit at an industrial shipping facility	AOH/CF Adjustment - The verification calculations found the same reduction of wattage as the submitted calculation, although the documentation noted Monday to Friday operation. The verification calculations assumed zero hours of operation for the exterior working lots, where the submitted calculation assumed 7 day a week operation. The verification calculation did not assume light fixture operation for safety during non-operating hours. EUL Adjustment - The verification calculation used the EUL for LED fixtures based on the line item hours of use and assumed 50,000 hours of use for each fixture. This increased the EUL to 17.0 years based on the post install hours of operation. The submitted calculation used 10 years for the EUL. The EUL adjustment reduced the lifetime savings but did not affect the first-year savings values.

Reporting ID	Stratum	Project Description	Summary of Adjustments
1822014	Low	New construction lighting at a retail store	Adjustments were made to this project from both the Desk Review and Site Visit. Pre/Post Fixture Wattages - The equipment wattage of Fixture SP was adjusted to 10 watts from 60 watts based on the invoice purchase of ENERGY STAR A19 lamps. The equipment wattage of Fixture U and UE was adjusted to 40 watts from 38 watts based on the DLC QPL listing for the model number. AOH Adjustment - Three holidays per year were added to the interior lighting; this reduced the hours of operation from 4,223.6 to 4,189 hours. Quantity Adjustments - The quantity of lamps installed was adjusted to match the site inspection counts for area lighting only: o 138 Type U/UE fixtures o 4 Type SP fixtures o 64 Type L5 fixtures installed as area lighting o 8 Type L3 fixtures installed as area lighting o 9 Type EX fixtures o 7 Type EX3 fixtures Equipment Classification - The vast majority of the Type L1 through Type L5 fixtures were found installed in display lighting, which should have been exempted from the area lighting calculations. Removing these fixtures in the verification calculations results in the majority of the first-year energy savings increase. EUL Adjustments - The verification calculation used the EUL for LED fixtures based on the line item hours of use and assumed 50,000 hours of use for each fixture, 12.0 years. This savings approach calculated lifetime savings per line item. The claimed savings calculations used 7 years for interior fixtures. The EUL adjustment increased the lifetime savings but did not affect the first-year savings values.
1822015	High	Refrigeration system replacement at a refrigerated warehouse	Adjustments were made to this project from both the Desk Review and Site Visit. Calculation Methodology - The claimed savings used a simple average of the monthly kWh and peak kW to estimate the savings based on 12-months of pre-installation data and 3-months of post-installation data. The baseline was adjusted based on the increased square footage of the new freezer. The verification analysis used 10-months post-install data, which was the best available information at the time of the site visit. The baseline was adjusted based upon the increase in the exterior wall, roof and floor areas when both refrigerated warehouse areas are included. The verification analysis also used a multi-factor regression analysis that incorporated the average temperatures and the number of days in the consumption regression and the peak temperature and the average demand load in the peak demand regression. The coefficients generated by this analysis were then normalized by TMY3 weather data. The peak demand was then calculated based upon the average peak reduction across the full year. The verification analysis reduced the peak kW baseline from 154 kW to 110 kW but also reduced the post-install peak kW from 79 kW to 71 kW. The net result of that adjustment is a significant reduction in savings. The baseline consumption was reduced slightly for both baseline and post-install, resulting in a minimal increase in annual energy savings.

Reporting ID	Stratum	Project Description	Summary of Adjustments
1822016	Medium	New construction lighting at a mixed use high-rise building	Quantity Adjustments - The area of the Tower Ground Level, Tower mezzanine, Tower Roof, and Exterior were adjusted to match the Building summary table of Sheet GI101 of the submitted plans. The Tower - Typical Floor was adjusted by hand calculation using scaled drawings to remove the balconies that were included in the table. The typical floor had approximately a 901 sqft main hallway, 324 sqft elevator waiting area and two 214 sqft information areas for a total of 1,657 sqft. The number of floors for the parking garage level was adjusted from 1 to 9. The Tower-Typical Floor was adjusted from 1 to 44. The changes were very significant in the calculations, as the inclusion of all the floors increased the savings many times over than the adjustments of square footage and installed watts reduced the savings. The end result is a significant increase, but the project had minimal documentation to be certain of all assumptions. Pre/Post Fixture Wattages - The installed lamp wattage for the Tower-Typical Floor was adjusted from 200.2 watts to 678 watts. The sampled quantities of lamps on all other floors were not significant enough to make adjustments. Only half of the most popular fixtures were identified in the DLC QPL or ENERGY STAR listing. The wattage was adjusted from the plan's claimed value when listed, although the unlisted lamps did not include an adjustment in the verification calculations. Custom EUL - The calculation of 50,000 hours divided by the annual hours of use equaled 10 years, as opposed to the 6 years submitted.
1822017	Certainty	Lighting retrofits at multiple buildings on a military base	Controls Savings Factors - There were five errors associated with controls factors in the claimed savings calculators. Four line items (14, 25, 30, and 34) had controls savings factors applied to them even though the location description did not include controls in either the pre or post case. For one line item (33) there were two savings factors applied even though only one was indicated by the description. Removing these factors resulted in a slight decrease in savings. Unknown Calculation Difference - The claimed savings used the PY2016 and PY2017 calculators. For the PY2016 calculator, the evaluation team was able to replicate the results before applying corrections to deemed factors. For the PY2017 calculator, the evaluation team was not able to replicate the results. Discrepancies were noted on the post-installation energy use for all line items with controls factors applied. Since the calculator was locked, the formula differences could not be determined. The difference resulted in slightly decreased savings using the PY2018 TRM calculator. Interactive Effects - Line items 57 and 70 were reversed from the room-by-room inventory, the effect of which was applying the interactive effects for AC to the wrong line item. Since the correct line item 70 has higher savings, this resulted in a slight increase in energy and demand savings. Incorrect Wattages - The wattages for 48 of the 64 line items in the calculator for lighting without AC did not match the room-by-room inventory. The wattages appeared to have been shifted by several rows while the pre and post installation quantities, new fixture descriptions and hours of use were all consistent with the room-by-room inventory. Correcting these 48 items resulted in an overall decrease in energy and demand use. EUL Adjustment - The claimed savings used a 7 EUL for the entire project while the evaluated savings applied the 50,000 hours / AOH method for all fixtures, for consistency with other custom lighting projects. This resulted in a large increase of the lifetime savings for this project.

Reporting ID	Stratum	Project Description	Summary of Adjustments
1822018	Medium	Lighting retrofit of a combined warehouse and retail facility	Adjustments were made to this project from both the Desk Review and Site Visit. AOH Adjustment - The operating hours for the interior fixtures were updated from 5,710 hours in the claimed savings case to 5,895 in the verification case. This slightly increased savings but did not affect lifetime kWh savings. Pre/Post Fixture Wattages - The installed fixture wattage for the LED wall packs was updated from 55 watts to 55.2 watts, per the DLC certification sheet. This slightly decreased savings for these fixtures. Quantity Adjustment - The number of existing and installed 2' 8-lamp LED fixtures was adjusted to 154 from 179 to reflect the counts found on-site. This decreased first-year kWh, peak demand, and lifetime kWh savings.
1822020	Medium	New construction lighting in hotel common spaces	CF Adjustment - The claimed peak demand savings were calculated by taking the connected load reduction from the room-by-room build up and multiplying by the average of the coincident factors across all floors. The evaluated savings weighted the coincident factor for each floor in the build up by its connected load and calculated a weighted coincident factor. This methodology change resulted in an increase in the peak demand savings. EUL Adjustment - The EUL for the project was claimed as 10 years. The evaluated savings used an estimated 50,000 hours of life for the fixtures divided by the blended AOH from the project of 6,616 hours to derive an EUL of 8 years. This reduced the lifetime savings.
1822021	Low	Exterior lighting retrofit at an industrial facility	EUL Adjustment - The EUL for each line item was set to be 50,000 hours divided by the annual hours of use for that location and allowed a maximum EUL of 25 years.
1822022	Medium	Exterior lighting retrofit at an industrial facility	Pre/Post Fixture Wattages - The difference in savings is due to a discrepancy between the fixtures reported in the customized lighting incentive worksheet and the claimed city contract. Of the 216 55W low pressure sodium bulbs replaced, the contract stated that 208 would be replaced by 31W LED fixtures, while the remaining fixtures would be replaced by 47W LED fixtures. However, the incentive worksheet claimed that all 216 fixtures would be replaced by the 31W fixtures. Replacing this with the values stated by the contract led to a slight reduction in savings. EUL Adjustment - Additionally, the discrepancy in lifetime (a reported 25 years vs an evaluated 12 year EUL) led to the reduction in lifetime savings.
1822023	Medium	Roadway lighting retrofit	EUL Adjustment - 25 years was used as the EUL in the claimed savings. The evaluated savings used the rated life of the fixtures from the product specifications (100,000 hours) divided by the AOH of the fixtures. This resulted in a slight drop in the lifetime savings.
1822024	Low	Exterior lighting retrofit at a hotel	CF Adjustment - The claimed savings listed a total of 2.5 hours for the peak demand operation of the new fixtures, but in the breakouts the operation added up to 3 hours. The evaluated savings reduced this to 2.5 hours based on the percentage of the operational split at the dimming levels (33% at the low settings, 66% at the high settings) to recalculate the demand savings. This resulted in a drop in the peak demand savings. EUL Adjustment - 12 years was used as the EUL in the claimed savings. The evaluated savings used the rated life of the fixtures from the product specifications (290,000 hours) divided by the AOH of the fixtures and capped that at 25 years. This resulted in a large increase in the lifetime savings.

Reporting ID	Stratum	Project Description	Summary of Adjustments
1822025	Low	Control system optimizations at a retail facility	Adjustments were made to this project from both the Desk Review and Site Visit. Calculation Methodology - The claimed savings used a simple average of the monthly kWh to estimate the savings use based on 12-months of pre-installation data and 7-months of post-installation data. The verification analysis used full 12-months for both periods. The claimed savings did not claim a demand reduction while the average demand reduction from 5-9pm across the year was used for the verified demand savings. Finally, the verification analysis used a normalized dataset and the regressions determined from both the pre-installation and post-installation to control for weather differences between the two periods. These differences in approaches combined to reduce the first-year energy savings for the project. EUL Adjustment - The claimed effective useful life was set to 15 years while the verification effective useful life was set to 8 years. The review of the project with the controls vendor indicated the only energy efficiency measures were implemented through the control system, so the effective useful life of 8 years for control systems from the TRM should have been used. This greatly reduced the lifetime savings for the project.
1822026	Low	Transformer replacement at a shipping facility	Adjustments were made to this project from both the Desk Review and Site Visit. Equipment Rating - The verification team identified the warranty performance requirement for the product and utilized that as the no-load losses. This decreased the savings slightly from the calculated. AOH Adjustment - The hours of operation were increased from the Office hours of operation to the hours of operation that the facility consumed energy. This significantly increased annual energy savings by increasing the hours from 2,603 hours to 8,760 hours, but did not affect the peak reduction. EUL Adjustment - The EUL was adjusted to 25 years from 32 years and a dual baseline calculation was applied to the lifetime savings.
1822027	High	Roadway lighting retrofit	Quantity - Total pre and post lighting quantity adjusted from the reported 3,242 to 3,244. Reported savings quantified lights tagged as contract 84 in the "CityData - Contract" field. Evaluated savings quantified lights tagged as contract 84 in the "JCIAudit - Contract" field which contained two additional line items whose "CityData - Contract" field was empty. This added one 100W HPS replaced with one 47W LED lights (ERL1006) and one 70W HPS replaced with one 31W LED light (ERL1004) to verified savings. This increased energy and demand savings. This also would have increased the incentive payment by $76 due to the two additional LED fixtures that were installed. ($38 x 2). New LED lamps type quantities adjusted based on the model numbers reported in the "Install - Fixture Code" column. This adjusted the number of new ERL1006 lights from 8 to 324, and ERL1009 lights from 594 to 279. This increased energy and demand savings. Existing light type quantities adjusted to follow the values reported in the "JCIAudit - Lamp Watt type" field instead of the 'CityData - FixtWatt Field". This adjusted the number of existing 70W HPS from 2,594 to 2,556, 100W HPS from 321 to 363, 150W HPS from 279 to 277. This did not affect the quantity of 48 existing LED lights that were retrofit. This increased energy and demand savings EUL Adjustments - Reported lifetime savings rounded the EUL from 24.5 to 25 for lifetime energy savings calculations. The verification summary used 24 years (rounded down from 24.46 years (100,000/4,088). This reduced lifetime energy savings calculations.

Reporting ID	Stratum	Project Description	Summary of Adjustments
1822029	High	Roadway lighting retrofit	EUL Adjustment - Reported lifetime savings rounded the EUL from 24.5 to 25 for lifetime energy savings calculations despite reporting an EUL of 24.5 years in the tracking data. The verification summary used 24 years (rounded down from 24.46 years (100,000/4,088). This reduced lifetime energy savings calculations.
1822030	High	Roadway lighting retrofit	Quantity - Total pre and post lighting quantity adjusted from the reported 1,016 to 1,024. Reported savings quantified lights tagged as contact 47 in the "CityData - Contract" field. Evaluated savings quantified lights tagged as contract 47 in the "JCIAudit - Contract" field which contained two additional line items whose "CityData - Contract" field was empty. This added six 70W HPS replaced with six 31W LED lights (ERL1004), one 150W HPS replaced with one 47W LED light (ERL1006), and one 250W HPS replaced with one 149W LED light (ERL2019) to verified savings. This increased energy and demand savings. This also would have increased the incentive payment by $304 due to the two additional LED fixtures that were installed. ($38 x 8). New LED lamp quantities adjusted based on the model numbers reported in the "Install - Fixture Code" column. This adjusted the number of new ERL1004 lights from 231 to 237, ERL1009 lights from 117 to 118, and ERL2019 lights from 10 to 11. This increased energy and demand savings. Existing light type quantities adjusted to follow the values reported in the "JCIAudit - Lamp Watt type" field instead of the 'CityData - FixtWatt Field". This adjusted the number of existing 70W HPS from 235 to 238, 100W HPS from 653 to 649, 150W HPS from 124 to 118. Two 55W LPS and 13 250W HPS lights were also added to evaluated savings which were not in reported savings. This increased energy and demand savings Pre/Post Fixture Wattages - A quantity of 238 pre-retrofit 70W HPS lights were adjusted from the reported 91W to 90W based on the system wattages tables included in the project documentation for 70W HPS w/ballast. This reduced energy and demand savings EUL Adjustment - Reported lifetime savings rounded the EUL from 24.5 to 25 for lifetime energy savings calculations. The verification summary used 24 years (rounded down from 24.46 years (100,000/4,088). This reduced lifetime energy savings calculations.

B

REALIZATION RATE CALCULATIONS

Energy efficiency program evaluations routinely employ 90 percent confidence intervals with ±10 percent precision for sampling error as the industry standard ("90/10"). The sampling process for desk reviews was designed to achieve a minimum of 90/10 relative precision for evaluated savings estimates for the large programs at the program level: REEM, BEEM, CBEEM. The sampling process was designed to be informative for BESM and CREEM[47].

The evaluated savings results are based on both the program tracking data review and the sampled project-level adjustments. For the 10 CBEEM projects that received an on-site visit, evaluated savings were also determined based on-site visit findings. The AEG team calculated a realization rate based on the difference between the claimed savings and verified savings. The program tracking data and sampled project-level realization rates were weighted to represent program level realization rates. 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. On-site adjustments incorporated changes based on visual project inspections and discussion with staff at the project site. Desk reviews were completed for all site visit projects.

Each program's realization rate calculation varies somewhat due to how projects were sampled and what was found across the database tracking system review, desk reviews, and on-sites. The table below outlines how realization rates were calculated based on the sampling methodology.

Table B-1 Realization Rate Inputs by Program

Program	Key Verification Activities	Sampling Methodology for Desk Reviews/ On-sites	Number of Sampling Strata	Realization Rate Inputs
REEM	Program data tracking review Desk reviews	Random	3	Program data tracking review Desk reviews
RHTR	Program data tracking review	N/A	N/A	Program data tracking review
RESM	Program data tracking review	N/A	N/A	Program data tracking review
CREEM	Program data tracking review Desk reviews	Random	1	Program data tracking review Desk reviews
BEEM	Program data tracking review Desk reviews	Random	3	Program data tracking review Desk reviews
CBEEM	Program data tracking review Desk reviews On-sites	Random Purposeful/ Certainty	3 Random 1 Certainty	Program data tracking review Desk reviews On-sites
BHTR	Program data tracking review	N/A	N/A	Program data tracking review
BESM	Program data tracking review Desk reviews	Random	1	Program data tracking review Desk reviews

[47] Because sampling for these programs were designed to be informative and not statistically valid, stand-alone project adjustments were made.

The resource acquisition program's realization rate is applied to the Plan goals, which determines the percent of performance incentive Hawai'i Energy is eligible for. Two flow charts of the realization rate calculations are below—one for desk-review only projects and one for projects that also received a site visit.

Figure B-1 Realization Rate Calculation—Projects with Desk Reviews

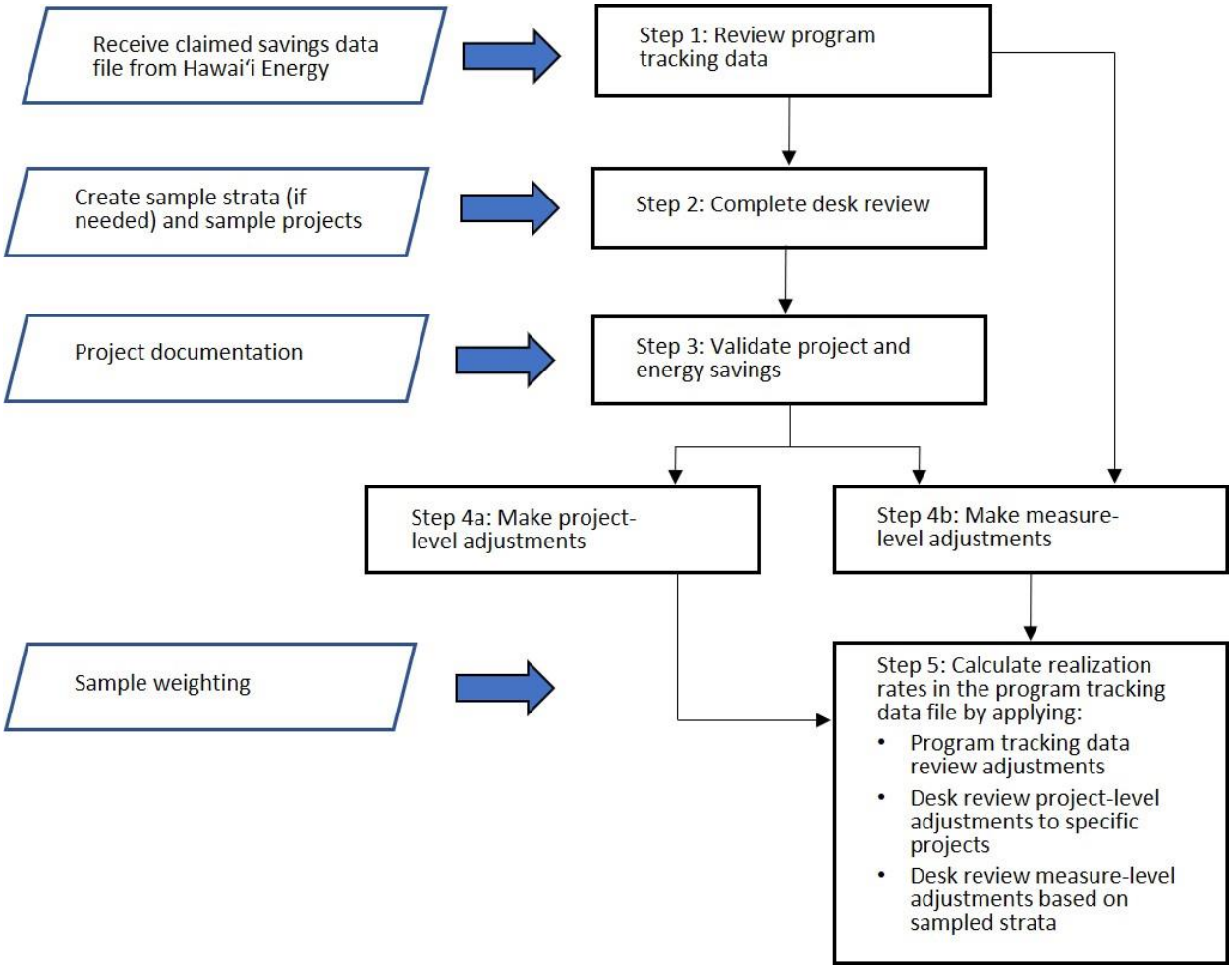
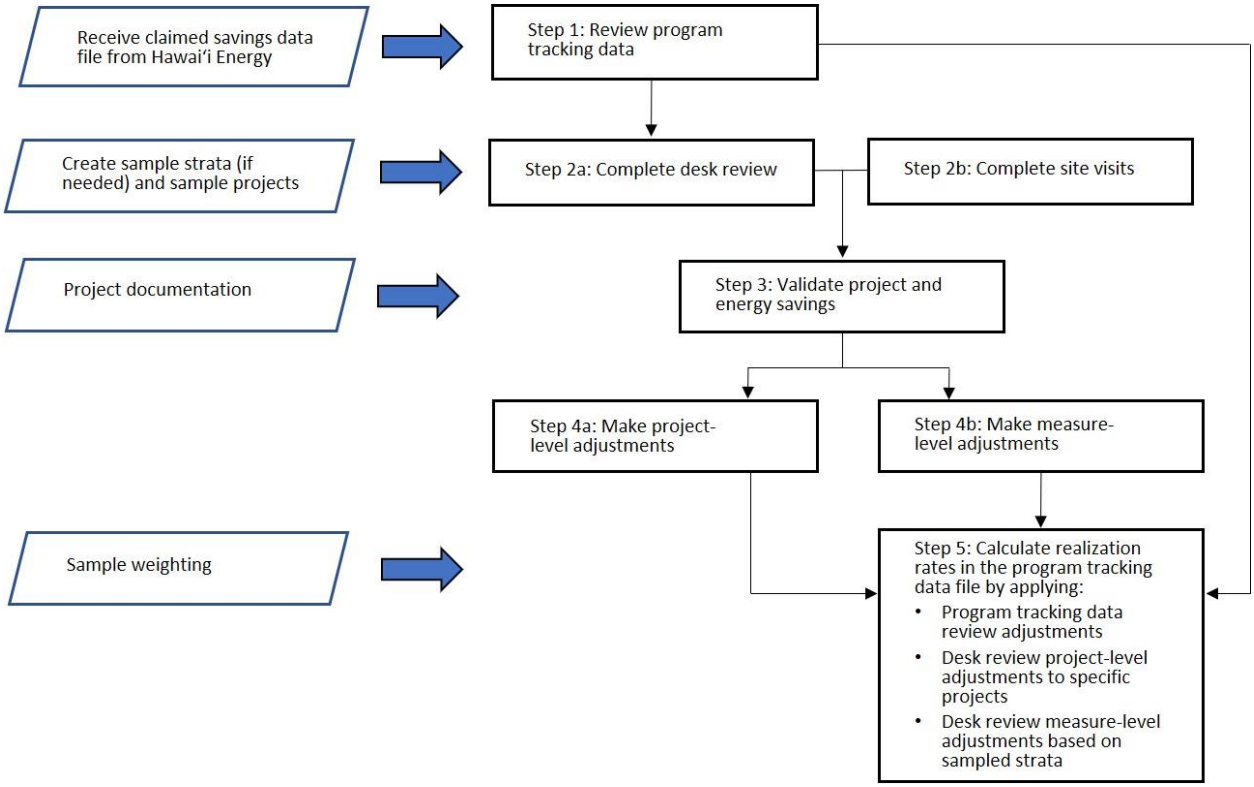


Figure B-2 Realization Rate Calculation—Projects with Desk Reviews and On-sites



C

AMPLIFY/ ENERGY ADVANTAGE LIGHTING VERIFICATION METHODOLOGY

The Energy Advantage program is a component of the overall business portfolio, focusing on small businesses and hard-to-reach efforts. The vast majority of measures implemented through Energy Advantage were lighting. These lighting projects were identified in the Hawai'i Energy tracking database by the tags "Energy Advantage" or "Lighting from Amplify (SBDIL)" in the "Equipment_Category" column. At the start of PY2018, the lighting equipment name reference was "Amplify," but changed to "Energy Advantage" midway through the program year. For consistency, the AEG team references "Energy Advantage." Lighting measures were tracked by the "EquipmentID" variable, and each project could have had multiple measures, or "EquipmentIDs," installed.

In order to be able to verify savings, the AEG team requested and received from Hawai'i Energy supplemental lighting data, which was delivered in the "Hawaii EMV Amplify Supplement with Corrections 20191115.xlsx" file. This file expanded on each piece of the Energy Advantage lighting equipment, organized by EquipmentID. The AEG team was able to append the supplemental file variables to the Hawai'i Energy tracking database by matching on the EquipmentID variable. The supplemental file was helpful because it contained all variables and equations that Hawai'i Energy used to calculate savings. This was crucial to the verification process because Hawai'i Energy used custom equivalent full load hours (EFLHs) and coincident factors (CFs) to calculate savings, which were not recorded in the tracking database. Additionally, projects in the supplemental file were tracked on a room-by-room basis whereas they were tracked at the building level in the Hawai'i Energy tracking database. From the supplemental file, the AEG team appended the following fields for use in energy savings calculations:

- predominant_space_type
- Application_Status__c
- Is_Exterior
- area_cooling_description
- pre_control_factor_type
- post_control_factor_type
- pre_fixture_wattage
- pre_fixture_quantity
- post_fixture_wattage
- post_fixture_quantity
- eflh
- Amplify coincidence_factor
- pre Control Factor
- Post Control Factor
- kWh_Savings (Corrected)

- kW_Savings_Demand (Corrected)

The PY2018 Hawai'i TRM includes a section called "Energy Advantage" that provides guidance on how to calculate EFLHs for lighting in commercial buildings. However, this section of the TRM does not include specific energy or demand formulas for the lighting equipment. To determine claimed savings, it appears as though Hawai'i Energy combined the Energy Advantage TRM guidance (e.g., the custom EFLHs) with other formulas derived from TRM commercial lighting and commercial occupancy sensors equipment. Additionally, Hawai'i Energy used a custom coincidence factor (CF) and reported on the control type to inform the run time reduction (RTR) factor collected for each Energy Advantage lighting project. Hawai'i Energy used the TRM interactive effects factors (IFs) to inform the savings for the Energy Advantage lighting projects as well. These energy and demand savings formulas do align with the energy and demand equations in the "COMMERCIAL: Lighting" section of the TRM. It appears that Hawai'i Energy modified the energy savings (kWh) formula to adjust savings for pre and post-retrofit occupancy sensor lighting controls using the RTR factor from the "COMMERCIAL: Light Occupancy Sensor" section of the TRM. The AEG team believes Hawai'i Energy's approach to calculating energy and demand savings was reasonable, it was just not documented. Additionally, to verify the IFs, the AEG team needed to use both the "Is_Exterior" and "area_cooling_description" data fields.

One main challenge with the Energy Advantage lighting projects was that the Hawai'i Energy tracking database recorded both completed and canceled projects, while the supplemental file recorded only completed projects, though there was no variable to clearly define project status. Upon initial review of the supplemental file, the AEG team found fewer Energy Advantage lighting projects than what was found in the Hawai'i Energy tracking database; we initially could not discern why, as the project status ("Canceled" or "Check Mailed") was not included in the supplemental file. The Rebate tab in the tracking database was the only location where the Application_Status ("Canceled" or "Check Mailed") was identified per RebateID[48]. As a result, the AEG team compared the EquipmentIDs and the RebateIDs between the supplemental file and the tracking database to determine the reason for the difference. This is how the AEG team determined that the supplemental file only contained EquipmentID and RebateID for completed "Check Mailed" projects, while the Hawai'i Energy tracking database contained both canceled and completed projects. Overall, savings adjustments were made to three EquipmentIDs.

- For EquipmentID (a0U1B00000FUbcLUAT), the project reported to have occupancy sensor controls in the pre and post condition, but no controls factors were used in reported savings calculations. As a result, the AEG team adjusted the control RTR factor to 0.33 in the pre and post condition to determine evaluated savings. This reduced verified energy savings.
- For EquipmentID (a0U1B00000H9vMEUAZ), the project reported occupancy sensor controls in the pre-condition, but no controls factors were used to determine the reported savings. As a result, the control RTR factor was adjusted to 0.33 in the pre-condition for the evaluated savings. This reduced verified energy savings.
- For EquipmentID (a0U1B00000HAKj0UAH), the AEG team found that incorrect IFs for energy and demand were used, based on the reported building type and space conditioning. In the supplemental file, the building type was listed as "Exit Signs" and was reported to be a conditioned space but used IFs of 1.0 for energy and 1.34 for demand. Additionally, the source of the IFs for demand was not known and did not align with the TRM. As a result, the AEG team calculated savings using the TRM IF values for a Retail building type, which is 1.054 for energy and 1.085 for demand, because that was

[48] Each piece of equipment was given a unique EquipmentID. When a customer completes a project, all EquipmentIDs in that project are tagged with the same unique RebateID so that all pieces of equipment can be grouped by project. The Rebate tab is only in the Hawai'i Energy tracking database (and not in the supplemental file).

the building type reported in the tracking database. This increased energy savings and reduced demand savings.

D

PROFESSIONAL DEVELOPMENT SURVEY INSTRUMENT

Hawai'i Energy
Market Transformation – Professional Development
Participant Web Survey (PY2018)

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 PY2018 verification effort.

Sample Variables

CASEID	Unique case identifier
CONTACT_NAME	Customer contact name listed
EMAIL	Participant email address
REP	

Survey Questions

EMAIL_Q1 Let's get started!

Our records indicate that you participated in a professional training or education event this past year that was sponsored by Hawai'i Energy.

Is this correct?

01 Yes
02 No

Q1B [SHOW IF EMAIL_Q1 IS BLANK: "Let's get started! Our records indicate that you participated in a training during the past year that was sponsored by Hawai'i Energy."]
From the list below, please select which training you participated in. If you participated in more than one training, please select the most recent training.

(Select one response)

888 I participated in a training, but it is not on the list
999 I did not attend an event this past year [SKIP TO Q13]

Q1	EVENT_NAME	QUARTER	DATE
084	Strategic Energy Management	Q1 2018	February 15, 2018
002	2nd Annual Hawai'i Society of Healthcare Engineering Conference	Q1 2019	February 15, 2019
003	Alexander & Baldwin Continuous Energy Improvement meeting	Q1 2019	March 12, 2019
005	Architects Hawai'i Limited CEI Workshop	Q1 2019	March 27, 2019
006	ASHRAE Technical Workshop	Q1 2019	March 7, 2019
011	Building Owners and Managers Association member luncheon and annual meeting	Q1 2019	February 13, 2019
012	Carrier Engineering	Q1 2019	March 19, 2019
019	CEI Influencer Workshop - Second session	Q1 2019	February 27, 2019
024	Community Association Institute Seminar	Q1 2019	March 7, 2019
025	Continuous Energy Improvement Influencer Workshop - First Session	Q1 2019	February 19, 2019
026	Craigside Board Meeting	Q1 2019	February 11, 2019
028	Electric Vehicle Breakfast n Learn	Q1 2019	March 8, 2019
032	Energy Advantage Contractors Meeting	Q1 2019	March 14, 2019
033	ENGIE Teacher PDE3 Professional Development	Q1 2019	March 18, 2019
034	ENGIE Teacher PDE3 Professional Development	Q1 2019	March 19, 2019
035	ENGIE Teacher PDE3 Professional Development	Q1 2019	March 21, 2019
036	ENGIE Teacher PDE3 Professional Development	Q1 2019	March 22, 2019
049	Green Building tour of Anaha at Ward Village	Q1 2019	February 27, 2019
050	Green Hotel Forum	Q1 2019	January 17, 2019
054	Hawai'i Energy Conference Student Student Sponsorship	Q1 2019	March 28, 2019
056	Hawai'i Gas Continuous Energy Improvement meeting	Q1 2019	January 25, 2019
059	Illuminating Engineering Society Workshop	Q1 2019	February 12, 2019
060	Illuminetix Lunch n Learn	Q1 2019	January 31, 2019
065	Investigative Committee of State Building Code Council Meeting #3	Q1 2019	February 7, 2019
070	Kohala Center Presentation	Q1 2019	March 15, 2019
073	Mid-Pacific Institute Lunch n Learn	Q1 2019	February 20, 2019
077	Powersmiths Lunch n Learn	Q1 2019	February 28, 2019
078	Practical Energy Management for Buildings and Facilities Training	Q1 2019	January 26, 2019
082	Ron Ho & Associates/RHA Energy Partners	Q1 2019	March 4, 2019
097	Strategic Energy Management	Q1 2019	January 1, 2019
100	University of Hawai'i Maui Sustech 101 Class Presentation	Q1 2019	February 26, 2019
001	1133 Waimanu Board Meeting	Q2 2019	April 19, 2019
008	Brand New & Best: Controls Retrofits & Future Impacts	Q2 2019	May 11, 2019
013	CEA Annual Information Meeting - Hilo HVAC Contractors	Q2 2019	April 18, 2019
014	CEA Annual Information Meeting - Hilo SWH Contractors	Q2 2019	April 18, 2019
015	CEA Annual Information Meeting - Maui HVAC Contractors	Q2 2019	April 22, 2019
016	CEA Annual Information Meeting - Maui SWH Contractors	Q2 2019	April 22, 2019
017	CEA Annual Information Meeting - O'ahu HVAC Contractors	Q2 2019	April 26, 2019
018	CEA Annual Information Meeting - O'ahu SWH Contractors	Q2 2019	April 26, 2019
020	Clean Energy Ally Annual Information Meeting - Kona HVAC Contractors	Q2 2019	April 16, 2019
021	Clean Energy Ally Annual Information Meeting - Kona Solar Water Heater Contractors	Q2 2019	April 16, 2019
037	ENGIE Teacher PDE3 Professional Development	Q2 2019	May 1, 2019
038	ENGIE Teacher PDE3 Professional Development	Q2 2019	May 1, 2019
039	ENGIE Teacher PDE3 Professional Development	Q2 2019	June 26, 2019
040	ENGIE Teacher PDE3 Professional Development	Q2 2019	June 26, 2019

042	ENGIE Teacher PDE3 Professional Development - webinars	Q2 2019	April 2019
047	Financing Your Energy Efficiency Project Lunch n Learn	Q2 2019	June 5, 2019
051	Green Realtor Designation	Q2 2019	June 18 & 19, 2019
052	Green Realtor Designation on Hawai'i Island	Q2 2019	June 20 & 21, 2019
055	Hawai'i Energy Innovation Symposium	Q2 2019	April 17, 2019
057	Hawai'i State Association of Counties - Building Best Practices Session	Q2 2019	June 11, 2019
058	Honolulu Japanese Chamber of Commerce Business Solutions Workshop	Q2 2019	April 10, 2019
063	Investigative Committee of State Building Code Council Meeting #1	Q2 2019	August 16, 2019
066	Investigative Committee of State Building Code Council Meeting #4	Q2 2019	June 4, 2019
067	Kapi'olani Community College 'IKE Summer Program	Q2 2019	May 31, 2019
071	Lighting Distributor Instant Rebate Program Training	Q2 2019	April 9, 2019
074	MW Group Ltd. Lunch n Learn	Q2 2019	May 22, 2019
076	Online Building Operator Certification Level 1 - Summer 2019	Q2 2019	June 4 to June 30, 2019
081	Renew Rebuild Hawai'i Forum	Q2 2019	May 8, 2019
102	USGBC HI: Building Tour Out West	Q2 2019	June 28, 2019
103	Waikele Premium Outlet Tenant Meeting	Q2 2019	May 22, 2019
022	Clean Energy Ally Breakfast	Q3 2018	July 26, 2018
027	Department of Health presentation	Q3 2018	September 6, 2018
029	EmPOWER Hawai'i Project Info Session	Q3 2018	July 26, 2018
030	EmPOWER Hawai'i Project Session #1	Q3 2018	September 19, 2018
046	Engineering Intern	Q3 2018	September 2018
053	Habitat for Humanity	Q3 2018	August 7, 2018
068	KCC Commercial Kitchen Training	Q3 2018	September 6, 2018
072	Marine Corp Base Hawai'i Presentation	Q3 2018	September 12, 2018
075	Naval Facilities Engineering Command Hawai'i Presentation	Q3 2018	August 8, 2018
079	Public Utilities Commission Intern	Q3 2018	July 2018
080	PUC intern	Q3 2018	August 2018
085	Strategic Energy Management	Q3 2018	July 11, 2018
086	Strategic Energy Management	Q3 2018	July 11, 2018
087	Strategic Energy Management	Q3 2018	July 24, 2018
088	Strategic Energy Management	Q3 2018	August 29, 2018
089	Strategic Energy Management	Q3 2018	September 6, 2018
090	Strategic Energy Management	Q3 2018	September 7, 2018
099	The Impact of Maintenance on Energy Efficiency	Q3 2018	August 16, 2018
101	USGBC 18th Annual Hawai'i Build + Buy Green Conference	Q3 2018	September 21 & 22, 2018
010	Building Operator Certification Level 1 - Spring 2019	Q3 2019	March - May, 2019
041	ENGIE Teacher PDE3 Professional Development	Q3 2019	September 2019
061	Insynergy Lunch n Learn	Q3 2019	September 7, 2019
098	Sustainability Leadership for Organizations	Q3 2019	May 15 & 17, 2019
007	BOMA Lunch n Learn	Q4 2018	October 17, 2018
009	Build it Green	Q4 2018	November 29 & 30, 2018
031	EmPOWER Hawai'i Project Session #2	Q4 2018	October 19, 2018
043	Engineering Intern	Q4 2018	December 2018
044	Engineering Intern	Q4 2018	November 2018
045	Engineering Intern	Q4 2018	October 2018
048	G70 Design & Architecture Lunch n Learn	Q4 2018	October 11, 2018

062	Interface Engineering	Q4 2018	October 18, 2018
069	KCC Commercial Kitchen Training	Q4 2018	October 30, 2018
091	Strategic Energy Management	Q4 2018	October 9, 2018
092	Strategic Energy Management	Q4 2018	November 13, 2018
093	Strategic Energy Management	Q4 2018	November 14, 2018
094	Strategic Energy Management	Q4 2018	November 20, 2018
095	Strategic Energy Management	Q4 2018	November 28, 2018
096	Strategic Energy Management	Q4 2018	December 6, 2018
104	Zero Net Energy and Codes Workshop	Q4 2018	November 15, 2018
105	Zero Net Energy in Hawai'i: Codes, Tools, and Incentives	Q4 2018	November 14, 2018
004	Alexander & Baldwin Continuous Energy Improvement meeting	Q4 2019	December 7, 2019
023	Clean Energy Ally Lunch n Learn	Q4 2019	December 11, 2019
064	Investigative Committee of State Building Code Council Meeting #2	Q4 2019	November 1, 2019
083	Stakeholder Meeting	Q4 2019	November 9, 2019

*** The EVENT variable used throughout the rest of this survey is outlined in the table at the end of this document.

Q2 How did you hear about the <EVENT>?

(Select all that apply)

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?

(Select one response)

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 your opinion, how useful was the information provided or discussed during the <EVENT> for your work?

(Select one response)

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

Q4a [SHOW ON SCREN 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]

(Select all that apply)

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 resource use or conservation, sales practices, or the type of projects taken on by your organization.

(Select one response)

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?

(Select one response)

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 What is main reason why you would not recommend the event?

[RECORD RESPONSE VERBATIM]

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

(Select one response)

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., a program from Hawai'i Energy offering an incentive for installing efficiency equipment)?

(Select one response)

01 Yes
02 No
88 Don't know

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

(Select all that apply)

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

Q9b [SHOW IF Q9a=03] Which entity?

[RECORD RESPONSE VERBATIM]

Q10 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?

(Select one response)

01 Yes
02 No
88 Don't know

Q11 Have you participated in any other events or trainings organized by Hawai'i Energy?

(Select one response)

01 Yes
02 No

Q11a [SHOW IF Q11=01] In what other Hawai'i Energy events or trainings have you participated?

[RECORD RESPONSE VERBATIM]

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

(Select one response)

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?

(Select one response)

01 Yes
02 No
88 Don't know

Q14 Which of the following best describes your current occupation?

(Select one response)

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 Other (Please specify)

Q15 On what island do you primarily work?

(Select one response)

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

INT99 Mahalo nui loa for your participation!

CP Completed

E

NOTES ON CALCULATIONS FOR TABLE ES-4

Note 1: Resource Acquisition Claimed and Reported come from program tracking database "EMV_2018_Report_20191028141316.xlsx" and the resulting verification activities.

Note 2: Multifamily Direct Install and Small Business Direct Install savings and customers served come from the verification of data from the program tracking database "EMV_2018_Report_20191028141316.xlsx". Multifamily Direct Install claimed customers served comes from the PY18 Hawaii Energy Annual Report (p17).

Note 3: Island Equity verified performance comes from a combination of "EMV_2018_Report_20191028141316.xlsx" and "PY18 Customer Island Equity 9.10.19.xlsx".

Note 4: Market Transformation verified performance comes from multiple documents submitted to the AEG team by Hawai'i Energy.

Note 5: Customer Satisfaction verified performance comes from documents submitted to the AEG team by Hawai'i Energy.

Note 6: The calculation for the performance incentive related to peak demand reduction (kW) is based on a rate of $7.08361/kW as presented in the PY2018 Hawai'i Energy Annual Report.

Note 7: The calculation for the performance incentive related to Economically Disadvantaged targets is based on each of the four metrics accounting for 25% of the total Economically Disadvantaged award claim, as described in the PY2018 Hawai'i Energy Annual Report.

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