



# HAWAI'I ENERGY PY2017 VERIFICATION REPORT

FINAL

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Prepared for:  
HAWAI'I PUBLIC UTILITIES COMMISSION

Energy Solutions. Delivered.

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## EXECUTIVE SUMMARY

This report presents the verified savings and performance results of program year 2017 (PY2017)<sup>1</sup> 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 PY2017 Annual Plan performance targets.<sup>2</sup> The targets span a range of performance indicators, including energy and demand savings, financial benefits to Hawai'i, targets for customer equity and market transformation, and customer satisfaction. Successfully meeting the performance targets leads to a financial reward of up to \$975,330. 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 ES-1 through ES-3, below.

Table ES-1 Resource Acquisition Goals

Key Focus Areas	100 Percent Target	Metric	Percent of Incentive Award
First Year Energy Reduction	130,144,871	kWh	15 %
Peak Demand Reduction	21,640	kW	15 %
Total Resource Benefit	\$327,453,747	\$	40 %

Table ES-2 Customer Equity Goals

Key Focus Areas	100 Percent Target	Metric	Percent of Incentive Award
Economically Disadvantaged	Small Business Direct Install:	Customers served	7 %
	625		
	6,900,000	kWh	
	Multifamily Direct Install:	Customers served	
4,300			
Island Equity	1,300,000	kWh	
	County of Hawai'i:	Target spend; Hawai'i and Maui counties must have their target spends met	10 %
	13 percent		
	County of Maui:		
13 percent			
	City & County of Honolulu:		
	74 percent		

<sup>1</sup> Program Year 2017 began on July 1, 2017 and ended June 30, 2018.

<sup>2</sup> The Verification Team received the Annual Plan in a file entitled "AnnualPlan\_PY2017.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	2,100 participant-hours of training	4 %
	Gamification Campaigns and Competition	200 participants	
	Social Media and Mobile Messaging	3,250 followers/subscribers	
	Transformational Videos	3 videos produced	
Professional Development & Technical Training	Clean Energy Ally Support	8,370 hours of participant training across all categories	4 %
	Targeted Ally Training Opportunities		
	Targeted Participant Training Opportunities		
	Educator Training and Grants		
Energy in Decision Making	Energy Industry Workforce Development		
	Strategic Energy Management	2 cohort participants	1 %
Codes and Standards	Code Adoption – County Level	9 advocacy events	1 %
	Code-Related Training and Compliance	70 participant-hours of training	
	Leading Edge Technologies and Strategies	4 stakeholder meetings; 1 report	
Clean Energy Collaboration	iDSM Pilot Project	1 pilot project	0 %
Customer Satisfaction	Application Processing Customer Experience	>8.5 overall customer satisfaction score	3 %

The goal of the verification is to provide 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 PY2017 Technical Reference Manual were appropriately applied. However, the verification analysis does not involve a review of the validity of those stipulated savings or adjustment factors – only their appropriate use for calculating Resource Acquisition performance.

During the verification process, the AEG team received data and documents from Hawai'i Energy and engaged with the Energy Efficiency Manager (EEM) and Hawai'i Energy to discuss observations, confirm data and approaches, and generally worked collaboratively to develop the verification results. Key sources of data and information included:

- The Hawai'i Energy PY2017 Annual Plan
- The PY2017 Technical Reference Manual (TRM)
- An initial Excel-based database of all tracked measures and claimed savings, considered the “frozen” database from which sampling and initial verification planning and tracking system reviews were made

- A final Excel-based database of all tracked measures and claimed savings, treated as the “final” tracking data from which resource acquisition and other portions of performance target verification results would be derived
- Project and equipment-based documentation, including invoices, specification sheets, custom calculators, and other materials used to support individual projects sampled for desk reviews and site visits
- Background information, reports, and memos on a wide range of topics relevant to the verification process and Hawai'i Energy's PY2017 performance
- Numerous emails and telephone calls with Hawai'i Energy to discuss various observations, creating clarity on data, methods, and other topics germane to the verification. This collaboration was essential to the verification effort and was completed in both a transparent and supportive manner by Hawai'i Energy—essential elements that facilitated the completed verification.

Below we summarize the PY2017 performance targets and the results derived by the AEG team. Overall, Hawai'i Energy met nearly all of its performance targets. The PY2017 verification results indicate that substantial efforts were made to achieve the targets, even for performance metrics that did not meet their target goals.

In the next sections, the AEG team presents its methodology and results for the Resource Acquisition, Customer Equity, Market Transformation, and Customer Satisfaction metrics.

Table ES-4 PY2017 Claimed and Verified Performance Award

Performance Indicator	Milestone*	Target	Metric	Percent of Award	Claimed Results	% of Target	Award**	Verified Results	% of Target	Award
<b>Resource Acquisition</b>										
First Year Energy Reduction	97,608,653	130,144,871	kWh	15%	136,600,252	105%	\$ 146,300	136,619,053	105%	\$ 146,300
Peak Demand Reduction	16,230	21,640	kW	15%	20,726	96%	140,121	20,863	96%	141,047
Total Resource Benefits	\$ 245,590,310	\$ 327,453,747	\$	40%	\$ 333,848,273	102%	\$ 390,132	\$335,480,042	102%	\$ 390,132
<b>Customer Equity</b>										
Economically Disadvantaged										
Small Business Direct Install										
Customers Served	469	625	Customers Served		769	123%		769	123%	
kWh Savings	5,175,000	6,900,000	kWh		9,637,280	140%		9,577,813	139%	
Multifamily Direct Install				7%			\$ 68,273			\$ 68,273
Customers Served	3,225	4,300	Customers Served		5,964	139%		5,970	139%	
kWh Savings	975,000	1,300,000	kWh		1,728,292	133%		1,723,262	133%	
Island Equity										
County of Hawaii		13%	share of incentive \$		13%	100%	\$ 97,533	13.4%	103%	\$ 97,533
County of Maui		13%	share of incentive \$	10%	15%	115%		14.8%	114%	
<b>Market Transformation</b>										
Behavior Modification										
Workshops and Presentation	NA	2,100	participant-hours of training		4,523	met target		4,039	met target	
Gamification Campaigns and Competitions	NA	200	number of participants		3,535	met target		3,535	met target	
			digital engagement (followers/subscribers)	4%	4,328	met target	\$ 39,013	9,632	met target	\$ 39,013
Social Media and Mobile Messaging	NA	3,250								
Transformational Videos	NA	3	Number of videos		3	met target		3	met target	
Professional Development and Technical Training										
Clean Energy Ally Support										
Targeted Ally Training Opportunities										
Educator Training and Grants	NA	8,370	Number of participant-hours of training	4%	10,741	met target	39,013	10,403	met target	\$ 39,013
Energy Industry Workforce Development										
Energy in Decision Making										
Strategic Energy Management (SEM)	NA	2	cohort participants	1%	4	met target	\$ 9,753	5	met target	\$ 9,753
Codes and Standards										
Code Adoption - County Level	NA	9	Advocacy Events		10	met target		10	met target	
Code-Related Training & Compliance	NA	70	Number of participant-hours of training		976.5	met target	\$ 9,753	987	met target	\$ 9,753
Leading Edge Technologies and Strategies	NA	4 / 1	Number of stakeholder meetings / reports	1%	4 / 1	met target		4 / 1	met target	
Clean Energy Collaboration										
iDSM pilot project	NA	1	Number of Pilot Projects	0%	1	met target	\$ -	1	met target	\$ -
<b>Customer Satisfaction</b>										
Application Processing										
Customer Experience	NA	>8.5	Overall customer satisfaction score	3%	>9.0	met target	29,260	9.2	met target	\$ 29,260
<b>Total Performance Award</b>							<b>\$ 969,151</b>			<b>\$ 970,078</b>

\*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.

\*\*Calculated by the AEG Team based on available information. Please see Appendix C for additional notes.

# 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.<sup>3</sup> 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 2017.<sup>4</sup> Projects and savings tracked in this database are what the AEG team used to assess final claimed savings and what will be used by Hawai'i Energy in their PY2017 Annual Report.
- **Tracking System Verification.** For measures that utilized the PY2017 Hawai'i Energy TRM (the TRM)<sup>5</sup> to establish savings, the AEG team developed a spreadsheet that incorporated the TRM savings values and algorithms to develop independent savings calculations, verifying the initial and final databases' claimed savings in comparison to the TRM's savings. The approach was applied to a census of the measures for each program that utilized TRM savings, with the Custom Business Energy Efficiency Measures (CBEEM) and Custom Residential Energy Efficiency Measures (CREEM) being the exception. For Small Business Direct Install Lighting (SBDIL) measures, the final database included data that allowed for verification of custom savings, with the AEG team utilizing this data for the purpose of verifying SBDIL measures.
- **Desk Review Verification.** For the CBEEM and CREEM programs, engineering desk reviews were used to verify installations and savings for a sample of projects. While a typical verification method, these desk reviews were a key activity in verifying the Hawai'i Energy savings, as the tracking database did 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, projects were sampled for engineering desk reviews to verify whether the tracking data accurately reflected the supporting documentation. Desk reviews for the Peer Comparison Group program (Peer program) included an analysis of program documentation, comparing the results to those recorded in the tracking databases. 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 PY2017 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. In the case of the Peer Program desk reviews, verification included documentation of individual program participants and their tenure in the program, as well as when Home Energy Reports were mailed. For market transformation initiatives, the Verification Team received training and event sign-in sheets and other material related to the specific initiatives, and for customer satisfaction results the survey outcomes and methods were shared with the AEG team.

- **Site Visit Verification.** The AEG team conducted site verification for a total of 31 PY2017 participants—20 of these site visits were completed for CBEEM and 11 were completed for BEEM. For CBEEM, the

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<sup>3</sup> The frozen database was provided in an Excel file entitled "EMV Extract 20180713 (FINAL).xlsx".

<sup>4</sup> The final database was provided in an Excel file entitled "EMV Extract UPDATED 20181015.xlsx".

<sup>5</sup> The final version of the PY2017 TRM was provided to the Verification Team in a file entitled "PY17 TRM v1-0 (06272018)\_clean.docx".

results were used to inform desk reviews and adjustments that affected extrapolating CBEEM verified results to the program population. For BEEM, the site visits were used to make adjustments only to the projects that were visited, with qualitative results informing considerations and recommendations for the program. The site visits verified installation and documentation accuracy, with CBEEM site visits also verifying key parameters used in the calculation of custom savings.

- Total Resource Benefit (TRB) 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<sup>6</sup>, along with their associated TRBs. To calculate the TRBs, the AEG team utilized the deemed factors presented in the PY2017 TRM and applied those criteria to each program, sector, and the Hawai'i Energy portfolio for purposes of verifying TRB performance achievement relative to the PY2017 goals.

Below, we summarize the method and sampling details for each of the key PY2017 Hawai'i Energy performance metrics.

## Resource Acquisition Verification Methods

Resource acquisition performance metrics include energy (kWh), demand (kW), and TRB performance. Table 2-1 summarizes the sampling and verification methods for each Hawai'i Energy program.

Table 2-1 Resource Acquisition Sampling and Methods

Program	Tracking System Review	Desk Review Sample Size	Site Visits
Residential Energy Efficiency Measures (REEM) <sup>7</sup>	Yes	96 measures	-
Residential Hard to Reach (RHTR)	Yes	-	-
Residential Energy Service and Maintenance (RESM)	Yes	-	-
Custom Residential Energy Efficiency Measures (CREEM)	N/A	3 projects	
<b>Residential Total</b>	<b>Yes</b>	<b>99</b>	<b>-</b>
Business Energy Efficiency Measures (BEEM)	Yes	50	10
Custom Business Energy Efficiency Measures (CBEEM)	N/A	25	20
Business Hard to Reach (BHTR)	Yes	-	-
Business Energy Services and Maintenance (BESM)	Yes	-	-
<b>Business Total</b>	<b>Yes</b>	<b>75</b>	<b>30</b>
<b>Total PY2017</b>	<b>Yes</b>	<b>177</b>	<b>30</b>

Within the REEM, BEEM, and CBEEM programs, different strata were used for each program to sample projects for desk reviews. Within BEEM and 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.

<sup>6</sup> The Realization Rate is the ratio of verified savings to claimed savings.

<sup>7</sup> Due to its program design, Peer Program savings were verified through a different desk review process and not included in the total.

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

Program	Stratum	Desk Review Sample Size	Site Visit Sample Size
<b>REEM</b>			
	Solar Hot Water	32	N/A
	HVAC	32	N/A
	Refrigerator/Freezer Recycling or Bounty	32	N/A
	<b>Total</b>	<b>96</b>	<b>N/A</b>
<b>BEEM</b>			
	Midstream Lighting	32	4
	Non-Midstream Lighting	11	3
	HVAC	7	3
	<b>Total</b>	<b>50</b>	<b>10</b>
<b>CBEEM</b>			
	<50,001 kWh savings	7	6
	50,001 to 200,000 kWh savings	7	6
	200,001 to 1,000,000 kWh savings	10	9
	Over 1,000,000 kWh savings	1	1
	<b>Total</b>	<b>25</b>	<b>20</b>

To calculate realization rates, programs that only received a tracking system review had the entirety of its tracking system projects analyzed and verified for TRM compliance. In the case of REEM, BEEM, and CBEEM desk reviews, the desk reviews provided an additional source of verification to the sampled strata. The results of the desk reviews were applied at the strata level, weighted by project kWh savings as needed, with adjustments made to savings exclusive of those already developed via the tracking system review. In addition, projects receiving site verification had their savings adjusted by the site visit results in the following manner:

- BEEM site visit adjustments were made only to the specific project and not extrapolated to the program stratum they represented
- 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.

## Customer Equity Verification Methods

Customer Equity is a key element of Hawai'i Energy's PY2017 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:		Database review
	625	Customers served	Documentation review
	6,900,000	kWh	Verified savings
	Multifamily Direct Install:		Database review
	4,300	Customers served	Verified savings
	1,300,000	kWh	Database review
			Verified savings
Island Equity	County of Hawai'i:		Target spend; Hawai'i and Maui counties must have their target spends met
	13 percent		
	County of Maui:		
	13 percent		
	City & County of Honolulu:		Database review
	74 percent		

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 PY2017 performance relative to market transformation, the AEG team utilized documentation provided by Hawai'i Energy. Additionally, the AEG team sent a survey to attendees for which email addresses could be obtained from the available documentation using optical character recognition (OCR) software. The summary of market transformation performance elements, metrics, and verification methods are presented in Table 2-4.

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	2,100 participant-hours of training	Review Hawai'i Energy documentation Verify follower and subscriber counts
	Gamification Campaigns and Competition	200 participants	
	Social Media and Mobile Messaging	3,250 followers/subscribers	
	Transformational Videos	3 videos produced	
Professional Development & Technical Training	Clean Energy Ally Support	8,370 hours of participant training across all categories	Review Hawai'i Energy documentation Web survey with census of participants with tracked email addresses
	Targeted Ally Training Opportunities		
	Targeted Participant Training Opportunities		
	Educator Training and Grants Energy Industry Workforce Development		
Energy in Decision Making	Strategic Energy Management	2 cohort participants	Review Hawai'i Energy documentation
Codes and Standards	Code Adoption – County Level	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	
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 PY2017 targets, the AEG team received satisfaction scores from Hawai'i Energy. These scores were developed by a contractor 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 include 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	130,144,871	kWh	15 percent
Peak Demand Reduction	21,640	kW	15 percent
Total Resource Benefit	\$327,453,747	\$	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	136,600,252	105.0%	136,619,053	105.0%
Peak Demand Reduction	kW	20,726	95.8%	20,863	96.4%
Total Resource Benefit	\$	\$333,848,273	102.0%	\$335,480,042	102.5%

Hawai'i Energy presents savings at three levels, referencing the TRM as the basis.<sup>8</sup> 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 by a “system loss factor” to account for line losses, reflecting savings at the electricity generator.
- Program level savings – system level savings that are adjusted by a NTG ratio, reflecting gross savings that are realized by the program and account for free-ridership or spillover. Hawai'i Energy resource acquisition performance targets are based on program level savings.

<sup>8</sup> Source: Hawai'i Energy PY2017 TRM, page 10.

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 TRM and differ from island to island, reflecting differences in the electrical grid. The system loss factors are presented below, in Table 3-3. The system loss factors were multiplied by the customer-level savings to arrive at system level first year savings.

Table 3-3 *Hawai'i Energy System Loss Factors*<sup>9</sup>

Island	Line Loss Factor
Oahu	1.1117
Hawai'i	1.09
Maui	1.0996
Lāna'i	1.0996
Moloka'i	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 PY2017 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 a 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, below.

Table 3-4 *Hawai'i Energy NTG Ratios*<sup>10</sup>

Program	NTG Ratio
BEEM	0.75
CBEEM	0.75
BESM	0.95
BHTR	0.99
REEM	0.79
CESH (CREEM)	0.65
RESM	0.92
RHTR	1.00

To determine TRBs, the present value of program-level savings was calculated using the avoided costs presented in the 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.<sup>11</sup> 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 Hawai'i accrues due to the savings generated by the energy efficiency measures.

<sup>9</sup> Source: Hawai'i Energy PY2017 TRM, page 10.

<sup>10</sup> Source: Hawai'i Energy PY2017 TRM, page 10.

<sup>11</sup> The measure life, also known as the effective useful life (EUL), represents the 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.

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, 2017, they are inflated by three percent and discounted by six percent, as deemed in the TRM. The detailed TRB calculations for the PY2017 programs and portfolio are presented at the end of this section.

Table 3-5 *Avoided Costs and Key TRB Financial Assumptions*<sup>12</sup>

TRB Metric Description	TRB Metric
kWh avoided cost (2017)	\$0.171 per annual kWh
kW avoided cost	\$ varies per kW per year <sup>13</sup>
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 PY2017 energy and demand savings. The following section of this report details 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 PY2017, 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)

Residential energy and demand savings were dominated by the REEM program, which included a diverse set of energy initiatives. With nearly 95 percent of residential program-level (net) 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).

<sup>12</sup> Source: Hawai'i Energy PY2017 TRM, page 13.

<sup>13</sup> 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.

Table 3-6 PY2017 Claimed Net Residential Savings Summary

Program	Component	Claimed Net First Year MWh	Percent of First Year Net Savings
REEM	Upstream	33,175	58.3%
	Peer Program	13,793	24.2%
	General Residential	6,193	10.9%
	Other <sup>14</sup>	711	1.2%
	<b>Total REEM</b>	<b>53,872</b>	<b>94.7%</b>
RESM		1,377	2.4%
RHTR		1,600	2.8%
CREEM		51	0.1%
<b>Total</b>		<b>56,900</b>	<b>100.0%</b>

The verified program-level (net) results for the residential program are presented below, in Table 3-7.

Table 3-7 Residential Program Verification Results, Program Level

Program	Component	Verified Net First Year MWh	First-Year MWh Realization Rates	Verified First-Year Net Savings (kW)	First-Year kW Realization Rates	Verified Lifetime Net Savings MWh	Lifetime MWh Realization Rates
REEM	Upstream	33,175	100.0%	4,704	100.0%	489,064	99.6%
	Peer Program	13,490	97.8%	4,503	98.0%	13,490	97.8%
	General Residential	6,192	100.0%	877	100.0%	101,253	104.2%
	Other	711	100.0%	330	100.0%	8,670	100.0%
	<b>Total REEM</b>	<b>53,568</b>	<b>99.4%</b>	<b>10,416</b>	<b>99.1%</b>	<b>612,477</b>	<b>100.3%</b>
RESM		1,400	101.7%	252	102.1%	3,759	100.6%
RHTR		1,600	100.0%	451	100.0%	17,333	100.0%
CREEM		44	82.4%	6	89.0%	622	245.2%
<b>Total</b>		<b>56,612</b>	<b>99.5%</b>	<b>11,125</b>	<b>99.2%</b>	<b>634,191</b>	<b>100.4%</b>

Below we describe the verification details for the residential sector programs and verification findings that were used to inform the verified program-level (net) 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.

<sup>14</sup> The "Other" category includes the Online Marketplace and Custom measures found within the REEM program.

- 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 58 million customer-level kWh savings for REEM (nearly 54 million kWh program-level savings) for PY2017, which was nearly 95 percent of the residential sector program savings. The AEG team approached the REEM verification through the following methods:

- Tracking system review for all PY2017 deemed measures to verify that claimed savings accurately followed the TRM
- Desk reviews of three prescriptive measure strata—HVAC, non-Upstream lighting, 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 59 kWh and 0.0197 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.

In the Hawai'i Energy tracking system, savings were claimed on a monthly basis and by island. In February 2018, a refill group<sup>15</sup> added 29,000 participants to the program. 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. The AEG team was able to verify that Hawai'i Energy correctly applied the savings rate to the number of participants from each island and adjusted savings for island-level system loss factors. 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<sup>16</sup>. In short, Hawai'i Energy was found to be correctly applying the savings algorithm to the program population presented in the tracking system.

The AEG team further investigated the participation rates of the program. To do so, the AEG team requested and received:

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<sup>15</sup> The refill group refers to an addition of a large batch of new program participants that corrects for accrued program attrition, helping maintain contractual program participation levels. For example, as the program experiences natural attrition due to utility account closings, new accounts are opened and become program eligible after six months of utility bills have amassed. The use of a refill group brings the newly eligible accounts into the program.

<sup>16</sup> 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.

- Documentation describing the source of claimed participation rates
- A record of which accounts received HERs throughout the year
- Historical participation records that included when accounts entered the program or left the program
- HECO account records to identify the island a given account was located on
- A dataset that linked the program account information to the HECO account information, linking a program participant to an island

This set of data and information enabled the AEG team to confirm which accounts received HERs, the amount of time a given account participated in PY2017, and the island the participant lived on. Through the verification process, Hawai'i Energy described their source of information used to track the number of program participants as presented in the tracking system. The AEG team learned that the participation counts in the tracking system were based on planning estimates for PY2017 and did not reflect actual participation levels. As such, the verification analysis differs from the program claimed savings and island location, with the verified results based on actual participation documentation. Because the AEG team had already verified that Hawai'i Energy correctly applied the TRM savings on a monthly basis, variances of energy savings were driven largely by differences in the length of time each participant was in the program through the year.

In keeping with past verification practice, the AEG team identified the daily participation rate for each program participant. A program participant was defined as an account that had received at least one HER during PY2017. A total of 231,067 unique accounts received HERs during PY2017, from a total of 979,039 individual HERs. Participants entered the program either prior to PY2017 or as part of the February 2018 refill group. However, program attrition occurred throughout the year—either through a request to opt out of the program, or more commonly, due to HECO accounts becoming inactive. Those participants with full year participation levels (365 days) received the full TRM savings. Those with partial year participation had their savings adjusted by the proportion of a full year their days of participation represented. For example, a portion of the refill group received a mailing sent of February 13, 2018. Assuming the individual account stayed in the program through the end of June, they would have participated in the program for 137 days, or 37.5 percent of the year. Their individual contribution to program savings would have been calculated as 37.5 percent of the TRM's full-year savings.

For those accounts that were identified as participants at the start of the program year, they either stayed in the program for the entire year or had an end date based on their HECO account becoming inactive or opting out of the program. For the February 2018 refill group, the AEG team noted that February communications occurred for parts of this group either in the middle of the month or near the end of the month. The AEG team treated their participation as starting at the point they received their first communication, and lasting until the end of the year, the date their HECO account became inactive, or they requested to opt-out of the program.

The distribution of participants across the islands enabled the AEG team to apply a system loss factor to the TRM's customer-level savings. The HECO account data was able to be matched to nearly all PY2017 participants except for 3,909 participants (1.7 percent). Of those without an island match, they were allocated to an island based on the island share of program participants who could be matched to an island. Their length of participation was used to develop a final weighted number of days per participant for each island.

Table 3-8 describes the verified results. The AEG team concludes that Hawai'i Energy's tracked planning numbers were somewhat higher than identified, with the AEG team finding that daily participation levels were approximately 98 percent of what Hawai'i Energy had planned. One factor may be how the February

2018 refill group was treated in the planning data—Hawai'i Energy assumed participation for the entire month of February, while the AEG team began counting participation at the point of the first February HERs.

Table 3-8 Peer Program Verification Results

Island	Island Share of Program Participants	Island Count of Participants	Average Days of Participation	Verified Customer kWh Savings	Verified Customer kW Savings	Verified System and Net kWh Savings	Verified System and Net kW Savings
Oahu	68.77%	158,907	325.4	8,361,981	2,791	9,296,014	3,102
Hawai'i	17.24%	39,829	328.6	2,116,707	706	2,307,211	770
Maui	13.33%	30,808	326.7	1,627,664	543	1,789,779	597
Lāna'i	0.29%	672	357.4	38,864	13	42,735	14
Moloka'i	0.37%	849	354.3	48,670	16	53,517	18
<b>Total</b>	<b>100.0%</b>	<b>231,066</b>	<b>326.3</b>	<b>12,193,886</b>	<b>4,069</b>	<b>13,489,257</b>	<b>4,502</b>

Comparing the verified results to Hawai'i Energy's planning assumptions leads to a realization rate of 98 percent for program savings. Table 3-9 compares Hawai'i Energy's claimed savings to the verified savings.

Table 3-9 Peer Program Savings Comparison

Source	Customer kWh	Customer kW	System/Net kWh	System/Net kW
Hawai'i Energy	12,470,859	4,155	13,793,419	4,595
AEG team	12,193,886	4,069	13,489,257	4,502
<b>Realization Rate</b>	<b>97.8%</b>	<b>98.0%</b>	<b>97.8%</b>	<b>98.0%</b>

### 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 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 measures, no additional verification methods were employed for this program, per the Verification Plan.

Table 3-10 presents the claimed savings and quantities, by major equipment type, of measures found in the Hawai'i Energy Upstream tracking data.<sup>17</sup> Residential LED measures represented over 96 percent of the Upstream initiative savings. That said, over 1,400 appliances were purchased through the Upstream initiative, with over 13,000 consumer electronics measures also being installed as part of this program component. The results show that a substantial number of Hawai'i residents made non-lighting purchases through the Upstream initiative.

<sup>17</sup> In the tracking data, the identification of measures in the Upstream initiative were designated by the Equipment Category field and an entry of "CFLs." The use of the term "CFLs" is a legacy of past tracking and measure focus. Moving forward, this is an opportunity to provide greater specificity and accuracy to the Upstream initiative, as CFLs were phased out of the program offering during PY2017.

Table 3-10 Upstream Initiative Claimed Equipment and Savings

Equipment Type	Measure Quantity	Customer First Year kWh	Customer First Year kW	Customer Lifetime kWh	Net First Year kWh	Net First Year kW	Net Lifetime kWh
Residential LED	1,630,487	36,685,958	5,217.6	550,289,363	32,045,226	4,557.5	480,678,390
Clothes Dryers	571	94,546	18.8	1,323,647	82,705	16.5	1,157,869
Clothes Washers	837	131,261	25.1	1,837,656	114,486	21.9	1,602,797
Residential CFL	3,026	50,534	7.3	303,205	44,113	6.3	264,677
Heat Pumps	15	24,660	3.2	246,600	21,498	2.7	214,976
Consumer Electronics <sup>18</sup>	13,248	988,216	112.8	7,943,993	867,313	99.0	6,971,348
<b>Total</b>	<b>1,648,184</b>	<b>37,975,175</b>	<b>5,384.8</b>	<b>561,944,463</b>	<b>33,175,340</b>	<b>4,704.1</b>	<b>490,890,056</b>

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. The AEG team did find one error in measure life, for smart power strips. The TRM specified a five-year measure life for smart power strips, but the Hawai'i Energy tracking data utilized a 20-year useful life, which resulted in verified lifetime savings being 25 percent of what Hawai'i Energy claimed. For other programs (non-Upstream) that offered smart power strips, the correct five-year measure life was used, suggesting a data tracking error for the Upstream initiative. 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. Table 3-11 summarizes the verified results for the Upstream initiative.

<sup>18</sup> Consumer electronics included smart power-strips, soundbars, and televisions.

Table 3-11 Upstream Verified Net Savings Results

Equipment Type	Claimed Net First Year kWh	Verified Net First Year kWh	Realization Rate	Claimed Net First Year kW	Verified Net First Year kW	Realization Rate	Claimed Net Lifetime kWh	Verified Net Lifetime kWh	Realization Rate
Residential LED	32,045,226	32,045,226	100.0%	4,557.5	4,557.5	100.0%	480,678,390	480,678,390	100.0%
Clothes Dryers	82,705	82,705	100.0%	16.5	16.5	100.0%	1,157,869	1,157,869	100.0%
Clothes Washers	114,486	114,486	100.0%	21.9	21.9	100.0%	1,602,797	1,602,797	100.0%
Residential CFL	44,113	44,113	100.0%	6.3	6.3	100.0%	264,677	264,677	100.0%
Heat Pumps	21,498	21,498	100.0%	2.7	2.7	100.0%	214,976	214,976	100.0%
Consumer Electronics	867,313	867,313	100.0%	99.0	99.0	100.0%	6,971,348	5,145,145	73.8%
<b>Total</b>	<b>33,175,340</b>	<b>33,175,340</b>	<b>100.0%</b>	<b>4,704.1</b>	<b>4,704.1</b>	<b>100.0%</b>	<b>490,890,056</b>	<b>489,063,854</b>	<b>99.6%</b>

**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	PY2017 Count of Rebates	Completed Desk Reviews
Refrigerator/Freezer Bounty/Trade-In	3,936	32
HVAC	1,222	37
Solar Hot Water Heater	1,301	33
<b>Total</b>	<b>6,459</b>	<b>102</b>

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 accuracy of 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 measures and rebates with variances from the TRM, the effects were minor overall. In general, Hawai'i Energy successfully applied the TRM to REEM measures. Below we describe the observations and effects on verified savings by measure.

Table 3-13 REEM Tracking System Adjustments

Measures	Observation	Verification Decision
Solar Attic Fans	201 cases used a measure life of 5 years, not the 20 years in the TRM	Measure useful life verified as 20 years, affecting lifetime savings and TRBs
Faucet Aerators and Showerheads	Via the online marketplace, a total of 26 faucet aerators and showerheads did not have information adequate to verify TRM savings	No adjustment – the AEG team found the savings to be reasonable, though recommends a TRM update to address online marketplace measure details relative to TRM calculation expectations
Smart Powerstrips	Tracking assumed a measure life of 20 years, not the 5 years deemed in the TRM	AEG team reduced the measure life to 5 years for purposes of verifying savings
VRF Outdoor – Large and Small	In 790 cases, a measure life of 9 years was used, but the TRM deemed the measure life at 15 years	Verified savings using a 15-year measure life. The AEG team notes that the 9-year measure life is applicable to air conditioners.
Refrigerator Trade-In	11 instances of the NTG ratio of 0.75 being used, rather than the deemed NTG of 0.79	Net savings verified using a NTG ratio of 0.79

The AEG team notes that two custom rebates were recorded under REEM, rather than the CREEM program. These projects totaled 6,570 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 service performed. Across the 102 desk reviews, one project was found to have a difference between the project documentation and the data recorded in the tracking system. A single rebate for a "VRF Outdoor – Small" system was found to have had a single installation quantity, but the tracking system indicated that two had been installed.

To address the desk review finding for the single VRF project, the AEG team investigated the tracking system to determine whether there were other potential instances of miscounting. In all other HVAC strata cases (1,222 rebates), the quantity being recorded was "1," indicating that overcounting was not a concern or risk among the other rebates. As such, the AEG team only adjusted the single project (50 percent of claimed savings), and not the population of the same measure type. No other desk reviews showed variance from the tracked information, thus no other adjustments were made to the sampled REEM strata based on the desk reviews.

Although not a point for verification adjustment, the AEG team observed that for 23 of the 33 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. In all but one case, the age of the previously installed solar water heater was over 15 years, near the end of its useful life. Given the prevalence of solar water heaters in Hawai'i 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.<sup>19</sup>

### REEM Verified Savings

The AEG team determined the net program 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 verified net savings were slightly less than the claimed savings (99.4 percent and 99.1 percent for net kWh and kW, respectively), the verified lifetime net savings were slightly over 100 percent due to measure life adjustments that increased the measure life for several measures. Table 3-14 through Table 3-16 present the program-level net savings for first year kWh, kW, and lifetime kWh.

First year savings (kWh and kW) were affected by the realization rate for the Peer Program, which was a substantial portion of the first-year savings. However, with a measure life of one year, the effect is mitigated for lifetime savings, which were more heavily weighted to other measures with longer lives.

Table 3-14 REEM Verified Savings Summary, Program-Level First Year kWh

Equipment Category	Claimed Net First Year kWh	Verified Net First Year kWh	Realization Rate
Upstream	33,175,340	33,175,340	100.0%
Peer Program	13,793,419	13,489,963	97.8%
General Residential	6,192,537	6,192,219	100.0%
Online Marketplace	704,826	704,826	100.0%
Custom	5,770	5,770	100.0%
<b>Total</b>	<b>53,871,892</b>	<b>53,568,119</b>	<b>99.4%</b>

Table 3-15 REEM Verified Savings Summary, Program-Level kW

Equipment Category	Claimed Net First Year kW	Verified Net First Year kW	Realization Rate
Upstream	4,704	4,704	100.0%
Peer Program	4,595	4,503	98.0%
General Residential	877.0	876.8	100.0%
Online Marketplace	330.3	330.3	100.0%
Custom	1.8	1.8	100.0%
<b>Total</b>	<b>10,508</b>	<b>10,416</b>	<b>99.1%</b>

<sup>19</sup> Solar water heaters and the measure characterization are being considered as part of the development of the PY2019 TRM.

Table 3-16 REEM Verified Savings Summary, Program-Level Lifetime kWh

Equipment Category	Claimed Net Lifetime kWh	Verified Net Lifetime kWh	Realization Rate
Upstream	490,890,056	489,063,854	99.6%
Peer Program	13,793,419	13,489,963	97.8%
General Residential	97,181,502	101,253,436	104.2%
Online Marketplace	8,583,612	8,583,612	100.0%
Custom	86,551	86,551	100.0%
<b>Total</b>	<b>610,535,140</b>	<b>612,477,416</b>	<b>100.3%</b>

### 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 20 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 a 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.

The AEG team identified one area for further discussion in the context of TRM measure characterizations and program practices. The AEG team found that for three accounts and 194 individual faucet aerator measure installations, solar water heating was identified as the water heating type, but the TRM does not include solar water heating as an eligible water heating type. As a result, Hawai'i Energy's practice was to use the savings for heat pump water heaters. The practice of using heat pump water heaters as a proxy for faucet aerator savings from a dwelling with domestic solar water heating may be reasonable absent a specific TRM algorithm. The efficiency of a heat pump water heater is roughly double that of an electric resistance water heater. Because heat pump water heaters are an emerging technology, their market penetration can be expected to be low, suggesting that an electric resistance water heater may be serving as an auxiliary water heater and also be affected by reduced hot water consumption.<sup>20</sup> As such, actual aerator savings would be split between solar water heater and auxiliary water heater—the use of a heat pump water heater may effectively capture that split of savings, albeit with many implied assumptions. Further discussion on the topic is warranted as part of ongoing TRM updates.

<sup>20</sup> A solar water heater does not typically supply 100% of a home's hot water. Typical sizing optimization will provide between 50 and 75 percent of a home's water heating energy needs.

Table 3-17 RHTR Program Level kWh Savings

Measure	End Use Category	Claimed Net First Year Net kWh	Verified Net First Year kWh	Realization Rate
Lighting	Lighting	612,028	612,028	100.0%
Various	Other	988,390	988,370	100.0%*
<b>Total</b>		<b>1,600,417</b>	<b>1,600,398</b>	<b>100.0%</b>

\*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 difference was minimal.

Table 3-18 RHTR Program Level kW Savings

Measure	End Use Category	Claimed Net First Year Net kW	Verified Net First Year kW	Realization Rate
Lighting	Lighting	87.0	87.0	100.0%
Various	Other	364.2	364.2	100.0%
<b>Total</b>		<b>451.2</b>	<b>451.2</b>	<b>100.0%</b>

Table 3-19 RHTR Program Level Lifetime kWh Savings

Measure	End Use Category	Claimed Net Lifetime kWh	Verified Lifetime kWh	Realization Rate
Lighting	Lighting	9,049,789	9,049,789	100.0%
Various	Other	8,283,215	8,283,119	100.0%*
<b>Total</b>		<b>17,333,003</b>	<b>17,332,907</b>	<b>100.0%</b>

\*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 difference was minimal.

## 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 2.2 percent of residential sector claimed savings and 0.9 percent of overall Hawai'i Energy portfolio 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 for all measures, other than cases in which the NTG ratio varied from the TRM's deemed 0.92— NTG ratios were recorded as 0.75 or 0.79 for 498 air conditioner tune-ups and as 0.95 for six solar water heater tune-ups. As a result, the realization rate for the program is slightly over 100 percent for energy and demand net savings, though were accurate for customer and system savings. Lifetime kWh realization rates were slightly above 100 percent. Table 3-20 through Table 3-22 summarize the results.

Table 3-20 RESM Program Level First Year kWh Savings

Measure	End Use Category	Claimed Net First Year Net kWh	Verified Net First Year kWh	Realization Rate
A/C Tune-up	HVAC	787,007	810,314	103.0%
Solar Water Heater Tune-up	Other	589,697	589,647	100.0%
<b>Total</b>		<b>1,376,703</b>	<b>1,399,961</b>	<b>101.7%</b>

Table 3-21 RESM Program Level kW Savings

Measure	End Use Category	Claimed Net First Year Net kW	Verified Net First Year kW	Realization Rate
A/C Tune-up	HVAC	177.6	182.9	103.0%
Solar Water Heater Tune-up	Other	68.7	68.7	100.0%
<b>Total</b>		<b>246.3</b>	<b>251.6</b>	<b>102.1%</b>

Table 3-22 RESM Program Level Lifetime kWh Savings

Measure	End Use Category	Claimed Net First Year Net kWh	Verified Net First Year kWh	Realization Rate
A/C Tune-up	HVAC	787,007	810,314	103.0%
Solar Water Heater Tune-up	Other	2,948,484	2,948,235	100.0%
<b>Total</b>		<b>3,735,491</b>	<b>3,758,550</b>	<b>100.6%</b>

### 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 PY2017, two efforts comprised the CREEM program. One effort involved working with a builder to have a suite of energy efficiency measures installed across 30 homes in a new housing development. The second included the start of a pilot program (the Sense Pilot) which involved the installation of detailed metering equipment in a home that will provide feedback to the homeowner to drive energy efficient behaviors and possible purchases. For the Sense Pilot, although only a single home had savings claimed for PY2017, additional homes had been enrolled, with equipment installations not yet completed.

Due to the percent of savings, verification activities focused on the new construction project that involved the new home development. 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.<sup>21</sup> 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. Adjustments were made for smart thermostats, as Hawai'i Energy referenced the PY2018 TRM for claiming smart thermostat savings. This was a reasonable approach given that the PY2017 TRM did not include the measure. However, the PY2018 TRM utilizes an assumed air conditioner SEER of 11, reflecting a general population average, rather than the specific SEER of the 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 SEER of the project's air conditioners in place of the TRM SEER assumption.

In addition to the adjustment for the smart thermostats, the AEG team found two additional points for adjusting savings. First, the AEG team found that the 0.73 NTG ratio used by Hawai'i Energy did not match the 0.56 NTG ratio that was documented in the TRM for the Customer Energy Solutions for the Home (CESH) program. The AEG team applied to CESH NTG ratio to the verified customer and system level savings, which resulted in a decrease in net savings. The AEG team also notes that the CESH program did not exist, in name, for PY2017 programs. The TRM NTG ratio for custom residential programs references CESH (with no reference to CREEM). As both program naming conventions reference a custom residential energy efficiency program, the AEG team applied the CESH NTG ratio to CREEM. In addition to the NTG ratio adjustment, the AEG team found that Hawai'i Energy had claimed a useful measure life of five years, less than that associated with the individual measures. To calculate lifetime savings and TRBs, the AEG team applied the TRM measure lives to each of the measures associated with the program, resulting in a substantial increase in lifetime savings.

Although the Sense Pilot was not verified, its small contribution to CREEM and portfolio savings created limited risk to the PY2017 verification result. The AEG team did receive documentation on the Sense Pilot, noting that the savings assumption (6.6 percent of average Hawai'i residential energy consumption) was less than that 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. If the Sense Pilot continues to grow and potentially leads to a 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. The AEG team found that with the measure life adjustments made to the custom new construction project, lifetime kWh realization rates were over 245 percent of that claimed by Hawai'i Energy.

Table 3-23 CREEM Program Level kWh Savings

Measure	End Use Category	Claimed Net First Year Net kWh	Verified Net First Year kWh	Realization Rate
Custom	Other	51,057	42,087	82.43%

<sup>21</sup> 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](https://www.energystar.gov/sites/default/files/asset/document/appliance_calculator.xlsx)

Table 3-24 CREEM Program Level kW Savings

Measure	End Use Category	Claimed Net First Year Net kW	Verified Net First Year kW	Realization Rate
Custom	Other	6.7	6.0	89.0%

Table 3-25 CREEM Program Level Lifetime kWh Savings

Measure	End Use Category	Claimed Net First Year Net kWh	Verified Net First Year kWh	Realization Rate
Custom	Other	251,411	616,489	245.2%

## Business Programs

In PY2017, 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 56 percent of the business sector claimed program (net) savings.

Table 3-26 PY2017 Claimed Net Business Sector Savings Summary

Program	Component	Claimed Net First Year MWh	Percent of First Year Net Savings
BEEM	Midstream	28,192	35.4%
	HVAC	5,701	7.2%
	Lighting	9,678	12.1%
	Other	1,410	1.8%
	<b>Total BEEM</b>	<b>44,981</b>	<b>56.4%</b>
CBEEM		23,061	28.9%
BHTR		11,653	14.6%
BESM		6	0.0%
<b>Total</b>		<b>79,700</b>	<b>100.0%</b>

The verified program level (net) results for the business program are presented below, in Table 3-27.

Table 3-27 Business Program Verification Results, Program Level

Program	Component	Verified Net First Year MWh	First-Year MWh Realization Rates	Verified First-Year Net Savings (kW)	First-Year kW Realization Rates	Verified Lifetime Net Savings MWh	Lifetime MWh Realization Rates
BEEM	Midstream	28,010	99.4%	2,053	98.8%	420,100	99.5%
	HVAC	5,861	102.8%	991	104.2%	95,479	98.1%
	Lighting	9,665	99.9%	1,038	96.9%	143,734	99.8%
	Other	1,447	102.6%	387	101.6%	20,813	101.5%
	<b>Total BEEM</b>	<b>44,982</b>	<b>100.0%</b>	<b>4,468</b>	<b>99.7%</b>	<b>680,125</b>	<b>99.4%</b>
CBEEM		23,431	101.6%	3,482	102.4%	290,456	100.9%
BHTR		11,588	99.4%	1,786	109.5%	161,711	99.5%
BESM		6	100.0%	1.4	100.0%	6	100.0%
<b>Total</b>		<b>80,008</b>	<b>100.4%</b>	<b>9,738</b>	<b>102.4%</b>	<b>1,132,300</b>	<b>99.8%</b>

Below we describe the verification process details for the business sector programs that were used to inform the verified program level (net) 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 60 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 Verification Plan, a subset of these measures—contributing 97 percent of BEEM savings—were allocated to three strata: HVAC, Midstream Lighting, and non-Midstream Lighting (abbreviated as Lighting hereafter). These three strata had projects sampled for desk reviews, and of the projects sampled for desk reviews, a sample of 10 projects were also recruited for site visits. Below, we describe the desk review and site visit sampling for the three BEEM strata.

Table 3-28 BEEM Desk Review and Site Visit Sample Sizes

BEEM Stratum	Total BEEM Strata kWh Savings <sup>22</sup>	Percent Sampled Strata Savings	Unique Rebate Counts	Desk Review Sample	Site Visit Sample
Midstream Lighting	35,874,528	65%	246	32	4
Non-Midstream Lighting	12,420,893	23%	174	11	3
HVAC	6,872,773	12%	158	7	3
<b>Total</b>	<b>55,168,194</b>	<b>100%</b>	<b>578</b>	<b>50</b>	<b>10</b>

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. Per the Verification Plan, the site sample results were not intended to be statistically significant, but to inform qualitative results, with site results and adjustments from claimed savings only applying to the specific projects being visited. The site visits did, however, develop insight into program workings and considerations for program savings calculation approaches going forward.

Below we describe the results from the tracking system reviews, followed by the desk reviews, and then site sample findings.

**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.

- All commercial lighting measures were found to be using the TRM's interactive effects twice, increasing the savings from the TRM. Because the AEG team identified this issue early enough in the process, Hawai'i Energy was able to remove the double counting aspect and update its claimed savings prior to providing the final dataset. The AEG team confirmed that this was completed for all BEEM lighting measures, other than A-lamps. As such, the realization rate reflects the corrected claimed savings, though A-lamps still reflect a lower realization rate due to the double counting of interactive effects. The specific effect varied by building type per the TRM lighting savings algorithm.
- 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 but is reflected in the overall verified results.

<sup>22</sup> The strata savings reflect savings tracked in the initial database provided to the Verification 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.

- The tracking database reflected LED refrigerator case lighting measures with a useful life of five years. The AEG team utilized the TRM’s measure life of 16 years, increasing the lifetime savings and TRBs for these measures.
- For six projects that replaced higher wattage T8s with lower wattage T8s, the verified savings were higher for kWh (3.2 times) but slightly lower for kW (0.991 times). These adjustments affected approximately 0.2 percent of BEEM claimed savings.
- The AEG team found that for measures tracked as packaged and split heat pumps, Hawai'i Energy utilized savings for the relevant “Conventional Air Conditioners and Condensing Units—Packaged/Split” measure found in the TRM. The AEG team found this to be reasonable and accepted Hawai'i Energy’s approach, though it suggests an opportunity to more closely align actual equipment types with TRM measure characterizations.
- For booster pump measures that claimed a combined effect of the installation of a variable speed drive and a reduction in motor horsepower, the initial tracking system provided by Hawai'i Energy did not have enough detail to determine the individual effects of each source of savings, as specified in the TRM. Hawai'i Energy provided the updated information in the final dataset and made going-forward changes to the data tracking structure.
- The AEG team was not able to verify savings for five solar water heaters. The calculation in the TRM requires site-specific data that was not captured in the tracking database. The algorithm in the TRM is reasonable for solar hot water systems. It may be appropriate to record this measure under CBEEM as a “Custom - Solar Hot Water” measure to address the custom nature of the measure.

In general, the tracking system review revealed that Hawai'i Energy correctly used the TRM for BEEM claimed savings. The most substantial change related to energy savings was due to the double counting of lighting interactive effects. However, as most of the cases with this error were identified and corrected prior to the final verification analysis, the effect was mitigated when comparing BEEM verified savings to the claimed savings.

**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

BEEM Stratum	Total BEEM Strata kWh Savings <sup>23</sup>	Percent Sampled Strata Savings	Desk Review Sample
Midstream Lighting	33,926,912	61%	32
Lighting	11,625,654	21%	11
HVAC	6,872,773	18%	7
<b>Total</b>	<b>52,425,339</b>	<b>100%</b>	<b>50</b>

<sup>23</sup> 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.

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.

The AEG team identified desk review adjustments for only a few projects. No desk review adjustments were made to Midstream lighting—all measure types and quantities were verified to the tracked data. One HVAC stratum rebate was adjusted and one Lighting stratum rebate was adjusted. The desk review observations and adjustments were:

- The HVAC rebate for a condominium involved the installation of 1.8 and 2.9 ton mini-split heat pumps. The capacities were adjusted to the AHRI specification for the models of 1.83 and 2.93 tons, which slightly increased savings. Additionally, a 23.4-ton chiller was installed in the condominium. The savings for the chiller were based on the "industrial" building type. The AEG team adjusted the building type to "miscellaneous commercial," aligning with the mini-split heat pump building description. This change resulted in lower energy savings for the chiller. The total effect at the rebate level was a realization rate of 94.1 percent of kWh, 100.5 percent of kW, and 92.6 percent of lifetime kWh, all at the customer level, though carrying through to the system and program (net) savings levels. These realization rates were separate from adjustments based on the tracking system review, which would have impacted all related measures.
- The Lighting rebate adjustment involved the installation of 2x2 and 2x4 LED troffers. While all quantities and measure descriptions were confirmed via the project documentation, the AEG team observed that the savings were based on the "restaurant" building type. The documentation indicated that the customer was a retail clothing store. As such, with the AEG team verified savings using the "retail" building type savings for the lighting measures. These realization rates were separate from adjustments based on the tracking system review, which would have impacted all related measures.

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 at the Customer Level<sup>24</sup>

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
HVAC	158	1,719,660	351	30,533,760	99.45%	100.02%	99.36%
Lighting	174	4,849,717	551	72,557,833	99.22%	99.07%	99.22%
Midstream	246	21,507,941	1,607	322,598,693	100.00%	100.00%	100.00%
<b>Total</b>	<b>578</b>	<b>33,926,912</b>	<b>2,509</b>	<b>425,690,286</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>

<sup>24</sup> The overall sampling of BEEM desk reviews and the results for customer first year kWh, the basis for sampling, was found to be +/-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>

## Site Visit Results

Site visits were completed for a sample of the rebates in the desk review sample. Per the Verification Plan, the site visit sample was not intended to be statistically valid—that is, any savings adjustments from claimed savings would only be associated with the individual project receiving the site visit and not for the entire population of the stratum. For the HVAC and Lighting stratum, the rebates were associated to an individual location. For the Midstream stratum, single rebates were based on batches of invoices from lighting distributors. Those invoices could have included multiple customers and locations. For the HVAC and Lighting stratum, all desk reviewed projects were eligible for site visit recruitment. For Midstream, Hawai'i Energy provided customer-level information that allowed the AEG team to see the individual customers and their measures associated with each Midstream rebate. In consultation with the EEM and Hawai'i Energy, the AEG team selected a sample of customers with individually larger savings associated with a rebate that had received a desk review. The view was that these projects were more likely to be comprehensive in nature (affecting a large portion of a building) and that the buy-down (presented on the customer's invoice) would be more memorable than for small projects.

Table 3-31 describes the final disposition of the site inspections. The AEG team was able to visit one extra HVAC project, increasing the completed BEEM site visits to 11, compared to the original plan of 10.

Table 3-31 BEEM Site Visit Sample

BEEM Stratum	Total BEEM Strata kWh Savings <sup>25</sup>	Percent Sampled Strata Savings	Unique Rebate Counts	Desk Review Sample	Completed Site Visits
Midstream Lighting	33,926,912	61%	246	32	4
Lighting	11,625,654	21%	174	11	3
HVAC	6,872,773	18%	158	7	4
<b>Total</b>	<b>52,425,339</b>	<b>100%</b>	<b>578</b>	<b>50</b>	<b>11</b>

Site visits to BEEM projects verified whether the project documentation matched that of the documentation provided by Hawai'i Energy for the desk review. For the HVAC and Lighting stratum, the projects were able to be confirmed via a census approach in most cases. However, for a larger lighting project an approach that sampled area types within a facility was used. In the case of the four Midstream customers, the site visit projects were all schools.

For Midstream, each site visit involved discussion with a principal or director, a facilities manager, or custodial staff. Three of the four schools had projects with several thousand LED lamps retrofitting existing fixtures. Because the Midstream projects had no description of lamp locations, site inspectors walked through the schools with school staff to discuss the retrofit project and the scale of the effort relative to the indicated lamp sales. In all three cases, all public schools, site staff were able to confirm that the size of the school and scale of the lighting retrofit was reasonable relative to the lamp sale quantities. This was done by counting classrooms, numbers of floors, hallway areas, and other spaces that received a lighting retrofit, extrapolating to the entire school. However, the site inspectors did note that there was often a small number of lamps in storage or that there were areas that had not received a lighting retrofit. Additionally, for the public schools, the site inspectors found that site staff had limited knowledge of the lighting project. The AEG team also learned that the State of Hawai'i Department of Education Facilities Management Branch (FMB) had been responsible for the lighting project purchases and installation. The

<sup>25</sup> The strata savings reflect savings tracked in the final database provided to the Verification Team. Savings differ from the original database due to changes made in lighting savings related to double counting interactive effects.

combination of factors—that the FMB was responsible for the purchase and project installation, with site staff having limited knowledge of the project details, and lack of documentation on the locations for the purchased lamps—meant that the AEG team was not able to verify the full scope of the specific lighting purchase. Indeed, with the FMB purchasing lamps, some of those may have been installed in other schools. No savings adjustments were made to these three projects. For future program or verification planning, coordination with the FMB may provide a better source of verification than local site staff. For the Lighting and HVAC site visits, site inspectors were able to verify that the condition of the rebate, as described in project documentation, was as described. No site-level adjustments were made for the Lighting or HVAC strata.

The fourth Midstream project that received a site visit was a private school that had purchased 512 exit lights. During the site visit, site inspectors found that only 60 of these lights had been installed. Site inspectors verified that a large volume of exit lights were in storage. The site inspectors conducted a walk-through with the facilities director to count the number of installed exit lights and discuss the project. The facilities director had started the position after the exit lights had been purchased and, along with facilities maintenance staff, confirmed that the exit lights in storage were not going to be installed in the near future, or ever. The site inspectors concluded that there were sufficient exit lights in the overall campus facility to potentially use all 512 exits lights. The facilities director could not speak to the reason for the large purchase or why they would not all be installed.

For this Midstream exit light project, the AEG team concluded that only 60 of the 512 exit lights were appropriate to use for verifying savings. As a result, this project received a 12 percent realization rate. However, as it was part of a larger rebate subject to desk review, and BEEM site inspections were only intended to adjust savings specific to the project, the overall effect on the rebate associated with this project was minimal. The resulting realization rate for the Midstream rebate containing the exit light project was 92.7 percent for first year customer kWh, 90.8 percent for customer kW, and 92.7 for lifetime kWh.

Overall, the site visits confirmed that the projects had been installed as expected, other than for the single Midstream project. The structure of the Midstream program somewhat limits the ability for site inspections to verify projects. First, the ability for site staff to recall projects may be limited. Second, the nature of the incentive experienced by the customer was limiting. The rebate only appears as a cost buy-down on the customer's invoice. Depending on who actually purchased the lights, decision makers at a facility may have a limited awareness of the buy-down or may not have actually been involved with the purchase decision (e.g. FMB purchases). Finally, the location of lamps within a facility is not known from project documents. To make a determination of locations, the customer's personnel must be aware of the purchase and where the lights went in, in isolation from any other lighting installations at the facility. The AEG team suggests that further collaboration between Hawai'i Energy and the AEG team on program design, documentation, and customer engagement may benefit both the Hawai'i Energy program and future verification efforts.

### **Summary BEEM Verified Savings**

The AEG team combined the results of the BEEM tracking system review with results from the sample of desk reviews and site visits to arrive at the total verified savings for the BEEM program. Table 3-32 through Table 3-34 summarize the results by major category for program (net) level first year kWh, kW, and lifetime kWh savings.

Table 3-32 BEEM Verified Savings Summary, Program-Level First Year kWh

Equipment Category	Claimed Net First Year kWh	Verified Net First Year kWh	Realization Rate
Midstream	28,191,891	28,009,543	99.4%
HVAC	5,700,894	5,861,138	102.8%
Lighting	9,677,890	9,664,981	99.9%
Other	1,410,264	1,446,787	102.6%
<b>Total</b>	<b>44,980,939</b>	<b>44,982,450</b>	<b>100.0%</b>

Table 3-33 BEEM Verified Savings Summary, Program-Level kW

Equipment Category	Claimed Net First Year kW	Verified Net First Year kW	Realization Rate
Midstream	2,078	2,053	98.8%
HVAC	951	991	104.2%
Lighting	1,071	1,038	96.9%
Other	381	387	101.6%
<b>Total</b>	<b>4,481</b>	<b>4,468</b>	<b>99.7%</b>

Table 3-34 BEEM Verified Savings Summary, Program-Level Lifetime kWh

Equipment Category	Claimed Net Lifetime kWh	Verified Net Lifetime kWh	Realization Rate
Midstream	422,264,876	420,099,693	99.5%
HVAC	97,335,564	95,479,114	98.1%
Lighting	144,049,944	143,733,867	99.8%
Other	20,500,558	20,812,811	101.5%
<b>Total</b>	<b>684,150,941</b>	<b>680,125,485</b>	<b>99.4%</b>

## 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 strata: Custom Lighting, Custom HVAC, and Custom. Custom Lighting measures accounted for approximately two-thirds of the claimed energy savings, while Custom HVAC accounted for approximately 18 percent of CBEEM savings, and Custom accounted for approximately 15 percent of savings.

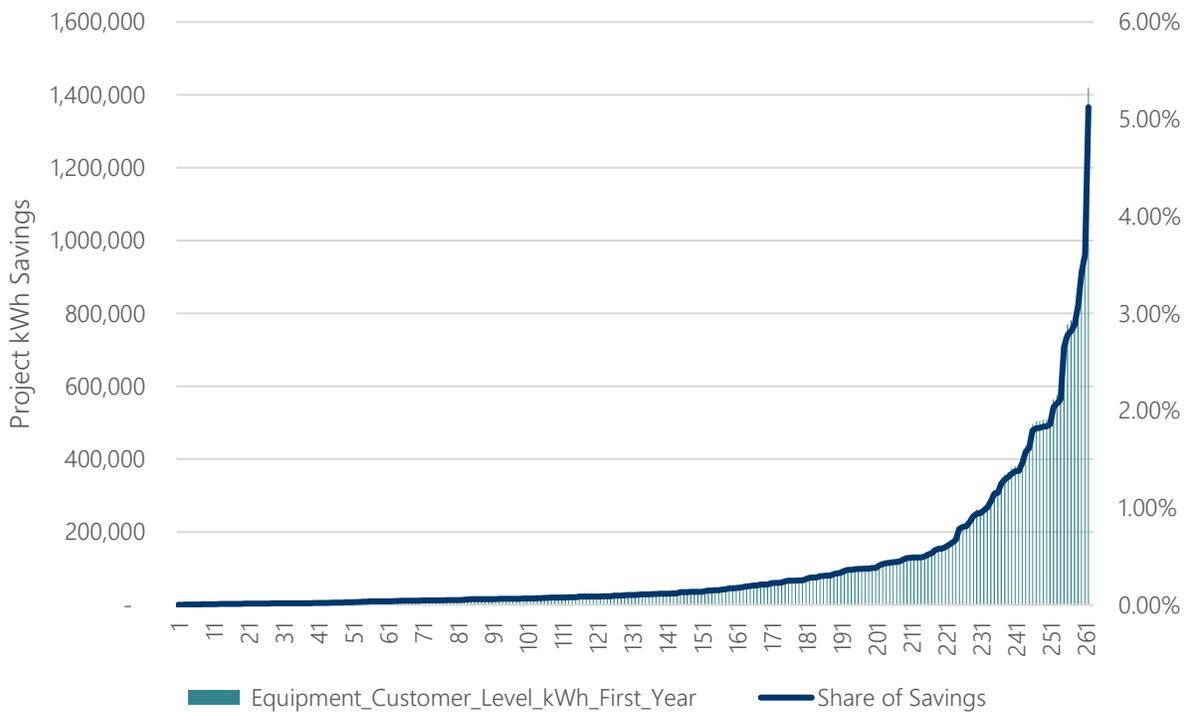
Because CBEEM projects are custom, a tracking system review was not feasible to verify savings. As a result, the AEG team relied on a sample of projects from which engineer desk reviews and site visits were used to verify savings and calculation methods including site-specific calculation key parameters, 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. In several cases, Hawai'i Energy staff directly assisted with making customer contacts and facilitating introductions for the site visits.

### 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. The AEG team developed a sample based on four strata that represented the energy savings at the project level relative to the program total. In this regard, the stratification and sampling approach informed the verification of small, medium, and large saving projects, with the highest savings strata reflecting a "sample with certainty," or census of the largest projects.

The AEG team examined the CBEEM projects in the tracking database to understand the relative contribution each project had toward the overall program savings. Figure 3-1 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 (232 of 262 projects). A relatively small number of projects contributed to the majority of savings—the largest 22 projects contributed approximately half of the program savings.

Figure 3-1 Distribution of Claimed Project Level Savings for CBEEM



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. Engineering desk reviews 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 engineering desk reviews for each stratum. The final desk review and site visit sample design is described in Table 3-35.

Table 3-35 CBEEM Desk Review Stratification and Sample Size<sup>26</sup>

Strata Category	Sampling Approach	kWh range	PY2017 Projects	Percent savings	Population kWh Savings	Desk Review Sample	Site Visit Sample
Low	Random	<50,001	162	9.8%	2,710,026	7	6
Medium	Random	50,001 to 200,000	62	22.7%	6,284,351	7	6
High	Random	200,001 to 1,000,000	37	62.4%	17,300,876	10	9
Certainty	Census	Over 1,000,000	1	5.1%	1,419,816	1	1
<b>Total</b>			<b>262</b>	<b>100.0%</b>	<b>27,715,069</b>	<b>25</b>	<b>20</b>

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. Additionally, the AEG team included other CBEEM projects that had been installed at the customer account during PY2017. This increased the final number of desk reviews to 28, with site visits including those additional projects as applicable.

The final sample count used for desk reviews and site visits, by strata, is presented in Table 3-36.

Table 3-36 Final Sample Count Used for Desk Reviews and Site Visits

Strata Number	kWh range	PY2017 Projects	Percent savings	Population kWh Savings	Final Desk Review Sample	Final Site Visit Sample
Low	<50,001	162	9.8%	2,710,026	9	7
Medium	50,001 to 200,000	62	22.7%	6,284,351	8	6
High	200,001 to 1,000,000	37	62.4%	17,300,876	10	9
Certainty	Over 1,000,000	1	5.1%	1,419,816	1	1
<b>Total</b>		<b>262</b>	<b>100.0%</b>	<b>27,715,069</b>	<b>28</b>	<b>20<sup>27</sup></b>

The final disposition 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 25 sampled projects. The AEG team focused on delivering the 20 site visits, rather than limiting the count to each stratum. This approach allowed for capturing the best available information for each verified project across 20 cases.

### CBEEM Verification Results

The AEG team determined an overall savings verification of:

- 101.6 percent for program level (net) kWh

<sup>26</sup> 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 on a project that was 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>

<sup>27</sup> The number of unique locations is less than the total set of projects that received site visits. A total of 23 projects (rebates) had site visits performed across the 20 locations.

- 102.4 percent of program level (net) kW

The combination of desk reviews and site visits found that 11 projects required no adjustment, while 17 were adjusted to account for desk review or site visit findings. In Appendix A we summarize the results for the 17 cases. The adjustments related to a wide range of verification findings, including the count or type of equipment being installed, using available meter data to calculate savings (not available for the Hawai'i Energy team at the time of project installation), and adjustments to lighting schedules. The aggregate effects on the CBEEM realization rates were minor.

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 the overall CBEEM program, that realization rate informed the total CBEEM verified savings. The program-level (net) savings of each strata are summarized in Table 3-37 through Table 3-39 below for kWh, kW, and lifetime kWh.

Table 3-37 CBEEM Program Level kWh Savings<sup>28</sup>

Strata	Number of Claimed Projects	Claimed Net First Year Net kWh	Verified Net First Year kWh	Realization Rate
Low	162	2,250,032	2,264,038	100.6%
Medium	62	5,222,725	5,336,168	102.2%
High	37	14,403,941	14,647,362	101.7%
Certainty	1	1,183,807	1,183,807	100.0%
<b>Total</b>		<b>23,060,505</b>	<b>23,431,375</b>	<b>101.6%</b>

Table 3-38 CBEEM Program Level kW Savings

Strata	Number of Claimed Projects	Claimed Net kW	Verified Net kW	Realization Rate
Low	162	398.3	418.16	105.0%
Medium	62	763.0	800.13	104.9%
High	37	2,104.3	2,128.89	101.2%
Certainty	1	134.8	134.77	100.0%
<b>Total</b>		<b>3,400.3</b>	<b>3,481.96</b>	<b>102.4%</b>

<sup>28</sup> 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>

Table 3-39 CBEEM Program Level Lifetime kWh Savings

Strata	Number of Claimed Projects	Claimed Lifetime Net kWh	Verified Lifetime Net kWh	Realization Rate
Low	162	25,857,441	25,430,798	98.4%
Medium	62	50,232,370	50,685,651	100.9%
High	37	176,375,805	178,821,680	101.4%
Certainty	1	35,514,213	35,514,213	100.0%
<b>Total</b>		<b>287,979,829</b>	<b>290,452,342</b>	<b>100.9%</b>

### 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 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 SBDIL measure savings, as SBDIL 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. 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.
- A multifamily direct install project tracked 47 faucet aerator savings based on a "system on-demand water heater" implying that a single on-demand water heater was supplying all the hot water to each dwelling unit. The savings were recorded using the TRM's savings for a master metered system boiler. However, the TRM had no entry for a master metered on-demand system water heater. The AEG team used the TRM for master metered multifamily direct install savings related to this set of aerator projects using the multifamily direct install master metered individual on-demand water heater measure savings. The effect was that verified savings were slightly lower than the claimed savings.
- For SBDIL lighting projects, the custom hours of use, baseline wattages, and efficient condition wattages were all accepted by the AEG team. However, the AEG team found a lack of consistency across hours of use, the difference in baseline and efficient wattage, interactive effects, and useful life, which resulted in a large amount of variation in project-level realization rates. The aggregate effect was fairly minor in terms of total savings but suggest an underlying challenge in the tracking system documentation of individual project savings. Additional SBDIL adjustments made by the AEG team include:
  - For projects with an indicated 8,760 hours of operation, the coincidence factor was verified at 1.0

- Due to the lack of information on whether projects were indoors or outdoors, the AEG team applied the TRM interactive effects for energy and demand based on the indicated building type
- It appeared that many of the calculations utilized a custom coincidence factor that could not be explicitly verified. As a conservative approach, the AEG team utilized the TRM coincidence factor based on building type

The AEG team’s BHTR program verified kWh savings were very close to the claimed savings, at 99.4 percent. The kW realization rate was higher, at 109.5 percent, largely due to the adjustments made to address peak kW savings. As 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. 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 we summarize the verified program-level (net) kWh and kW savings for the BHTR program.

Table 3-40 BHTR Program Level kWh Savings

Measure	End Use Category	Claimed Net First Year Net kWh	Verified Net First Year kWh	Realization Rate
SBDIL	Custom	9,637,280	9,577,813	99.4%
Commercial Kitchen	Other	1,534,192	1,534,192	100.0%
Multifamily Direct Install	MDI Lighting	244,420	241,975	99.0%
	MDI Other	236,697	234,131	98.9%
	<b>MDI Total</b>	<b>481,117</b>	<b>476,106</b>	<b>99.0%</b>
<b>Total</b>		<b>11,652,589</b>	<b>11,588,111</b>	<b>99.4%</b>

Table 3-41 BHTR Program Level kW Savings

Measure	End Use Category	Claimed Net First Year Net kW	Verified Net First Year kW	Realization Rate
SBDIL	Custom	1,220	1,377	112.9%
Commercial Kitchen	Other	259	259	100.0%
Multifamily Direct Install	Lighting	35	34	99.0%
	Other	117	116	99.0%
	<b>MDI Total</b>	<b>152</b>	<b>150</b>	<b>99.0%</b>
<b>Total</b>		<b>1,631</b>	<b>1,786</b>	<b>109.5%</b>

Table 3-42 BHTR Program Lifetime Level kWh Savings

Measure	End Use Category	Claimed Net First Year Net kW	Verified Net First Year kW	Realization Rate
SBDIL	Custom	422,264,876	420,099,693	99.5%
Commercial Kitchen	Other	97,335,564	95,479,114	98.1%
Multifamily Direct Install	Lighting	144,049,944	143,733,867	99.8%
	Other	20,500,558	20,812,811	101.5%
<b>MDI Total</b>		<b>684,150,941</b>	<b>680,125,485</b>	<b>99.4%</b>
<b>Total</b>		<b>422,264,876</b>	<b>420,099,693</b>	<b>99.5%</b>

### Business Energy Services & Maintenance

The BESM program has been providing business customers with retrocommissioning, strategic energy management, submetering, or driving non-incentivized efforts. In PY2017 there were 18 BESM projects, all of which were described as “Residential A/C Tune Up.” The AEG team confirmed that all the projects claimed savings based on the PY2017 *residential* air conditioner tune-up measure found in the TRM.

The AEG team utilized the tracking system review to verify BESM savings. The tracking system review found that all 18 projects correctly used the savings from the TRM for the “Central AC Tune Up” measure. In discussion with Hawai'i Energy, the AEG team 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.

Table 3-43 through Table 3-45 summarize the results. Due to the one-year measure life, savings for first year kWh and lifetime kWh are the same.

Table 3-43 BESM Program Level kWh Savings

Measure	End Use Category	Claimed Net First Year Net kWh	Verified Net First Year kWh	Realization Rate
A/C Tune-up	HVAC	6,149	6,149	100.0%
<b>Total</b>		<b>6,149</b>	<b>6,149</b>	<b>100.0%</b>

Table 3-44 BESM Program Level kW Savings

Measure	End Use Category	Claimed Net First Year Net kW	Verified Net First Year kW	Realization Rate
A/C Tune-up	HVAC	1.39	1.39	100.0%
<b>Total</b>		<b>1.39</b>	<b>1.39</b>	<b>100.0%</b>

Table 3-45 BESM Program Level Lifetime kWh Savings

Measure	End Use Category	Claimed Net First Year Net kWh	Verified Net First Year kWh	Realization Rate
A/C Tune-up	HVAC	6,149	6,149	100.0%
<b>Total</b>		<b>6,149</b>	<b>6,149</b>	<b>100.0%</b>

## 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 TRM specifies the calculation approach but presents a summary table of present per-kW and per-kWh factors. The AEG team confirmed its understanding of the TRM's calculation approach by independently calculating the cumulative present values of kWh and kW based on measure life. The results aligned with the TRM and are presented in Table 3-46.

Table 3-46 Cumulative Present Value of kWh and kW Savings by Measure Life

Cumulative Present Value				Cumulative Present Value			
Year	Measure Life	\$/kWh	\$/kW	Year	Measure Life	\$/kWh	\$/kW
2017	1	0.1708	\$-	2030	14	1.9974	\$5,615
2018	2	0.3368	\$-	2031	15	2.1117	\$6,002
2019	3	0.4980	\$-	2032	16	2.2227	\$6,334
2020	4	0.6547	\$759	2033	17	2.3306	\$6,619
2021	5	0.8070	\$1,540	2034	18	2.4355	\$6,619
2022	6	0.9550	\$2,180	2035	19	2.5373	\$6,619
2023	7	1.0987	\$2,708	2036	20	2.6363	\$6,619
2024	8	1.2384	\$3,149	2037	21	2.7325	\$6,619
2025	9	1.3742	\$3,519	2038	22	2.8260	\$6,619
2026	10	1.5061	\$3,831	2039	23	2.9168	\$6,619
2027	11	1.6343	\$4,096	2040	24	3.0051	\$6,619
2028	12	1.7588	\$4,633	2041	25	3.0908	\$6,619
2029	13	1.8798	\$5,163				

The AEG team utilized this table to independently calculate TRBs for all measures in the PY2017 Hawai'i Energy tracking system. The verified savings at the customer, system, and program (net) levels were utilized to develop the companion TRBs at the same levels and are reflected in the results presented for the Residential and Business programs, above. The following tables present the TRBs calculated at the customer, system, and program (net) levels for each program, sector, and entire Hawai'i Energy portfolio.

In terms of meeting TRB targets at the program (net) level, the AEG team verified \$335,480,042 of TRBs for PY2017, 100.5 percent of Hawai'i Energy's claimed TRBs. This indicates that Hawai'i Energy met its TRB performance target for PY2017.

Table 3-47 Customer-Level TRBs by Program

Program	Claimed TRBs	Verified TRBs	Ratio of Verified to Claimed TRBs
<b>Residential Sector</b>			
REEM	\$136,810,414	\$137,407,912	100.4%
CREEM	\$62,837	\$174,091	277.1%
RHTR	\$3,479,890	\$3,478,610	100.0%
BESM	\$706,038	\$705,887	100.0%
<b>Total Residential</b>	<b>\$141,059,180</b>	<b>\$141,766,500</b>	<b>100.5%</b>
<b>Business Sector</b>			
BEEM	\$147,938,432	\$143,676,385	97.1%
CBEEM	\$65,308,110	\$66,707,250	102.1%
BHTR	\$29,148,853	\$29,823,529	102.3%
BESM	\$996	\$994	99.9%
<b>Total Business</b>	<b>\$242,396,390</b>	<b>\$240,208,159</b>	<b>99.1%</b>
<b>Total Portfolio</b>	<b>\$383,455,570</b>	<b>\$381,974,659</b>	<b>99.6%</b>

Table 3-48 System-Level TRBs by Program

Program	Claimed TRBs	Verified TRBs	Ratio of Verified to Claimed TRBs
<b>Residential Sector</b>			
REEM	\$151,318,544	\$151,982,708	100.4%
CREEM	\$69,856	\$193,537	277.1%
RHTR	\$3,835,256	\$3,833,841	100.0%
BESM	\$782,802	\$782,614	100.0%
<b>Total Residential</b>	<b>\$156,006,458</b>	<b>\$156,792,700</b>	<b>100.5%</b>
<b>Business Sector</b>			
BEEM	\$163,878,490	\$162,736,331	99.3%
CBEEM	\$72,430,631	\$73,981,518	102.1%
BHTR	\$32,289,393	\$33,041,176	102.3%
BESM	\$1,107	\$1,105	99.9%
<b>Total Business</b>	<b>\$268,599,621</b>	<b>\$269,760,129</b>	<b>100.4%</b>
<b>Total Portfolio</b>	<b>Total Portfolio</b>	<b>\$424,606,079</b>	<b>\$426,552,829</b>

Table 3-49 Program-Level TRBs by Program

Program	Claimed TRBs	Verified TRBs	Ratio of Verified to Claimed TRBs
<b>Residential Sector</b>			
REEM	\$120,035,331	\$120,550,197	100.4%
CREEM	\$50,995	\$125,799	246.7%
RHTR	\$3,835,256	\$3,833,841	100.0%
BESM	\$716,227	\$720,004	100.5%
<b>Total Residential</b>	<b>\$124,637,808</b>	<b>\$125,229,842</b>	<b>100.5%</b>
<b>Business Sector</b>			
BEEM	\$122,909,030	\$122,052,248	99.3%
CBEEM	\$54,322,973	\$55,486,138	102.1%
BHTR	\$31,977,410	\$32,710,764	102.3%
BESM	\$1,051	\$1,050	99.9%
<b>Total Business</b>	<b>\$209,210,465</b>	<b>\$210,250,200</b>	<b>100.5%</b>
<b>Total Portfolio</b>	<b>\$333,848,273</b>	<b>\$335,480,042</b>	<b>100.5%</b>

Across the TRBs, the AEG team found that kWh savings make up a large majority of the overall TRB value. As shown in Table 3-50, kWh savings represented nearly three quarters of the TRB value. For each program sector, the proportion of kWh to kW TRBs is similar, though kW TRBs are approximately 28 percent of residential sector TRBs compared to 24 percent of business sector programs.

Table 3-50 Program-Level TRBs by Sector and Savings Type

Program Sector	kWh	kW	Total
Residential	\$89,628,307	\$35,601,535	\$125,229,842
Business	\$158,864,269	\$51,385,931	\$210,250,200
<b>Total</b>	<b>\$248,492,576</b>	<b>\$86,987,467</b>	<b>\$335,480,042</b>
<b>Percent</b>	<b>74.1%</b>	<b>25.9%</b>	<b>100.0%</b>

# 4

## 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 Hawai'i 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 4-1 presents the PY2017 Customer Equity performance targets and verification approaches.

Table 4-1 Customer Equity Performance Target and Verification Approach

Key Focus Areas	100 Percent Target	Metric	Verification Approach
Economically Disadvantaged	Small Business Direct Install:		
	625	Customers served	Database review
	6,900,000	kWh	Verified savings
	Multifamily Direct Install:		
	4,300	Customers served	Database review
	1,300,000	kWh	Verified savings
Island Equity	County of Hawai'i:		
	13 percent	Target spend; Hawai'i and Maui counties must have their target spends met	Database and documentation review
	County of Maui:		
	13 percent		
City & County of Honolulu:			
	74 percent		

### Economically Disadvantaged Results

To verify Hawai'i Energy's PY2017 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 PY2017 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 site visit fees, which reflected direct install measures for a unique multifamily dwelling unit (a visit fee is paid per 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 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 4-2 summarizes the AEG team's findings related to Hawai'i Energy PY2017 customer equity performance for MFDI and SBDI. Hawai'i Energy met and exceeded its goals in all four areas related to economically disadvantaged performance.<sup>29</sup>

Table 4-2 PY2017 Verified Economically Disadvantaged Performance Results

Target Segment	Metric	Performance Target Metric	Verified Results	Percent of Target	Met Target?
Small Business	Customers Served	625	769	123.0%	Yes
	kWh savings	6,900,000	9,577,813	138.8%	Yes
Multifamily	Customers Served	4,300	5,970	138.8%	Yes
	kWh savings	1,300,000	1,723,262	133.6%	Yes

## Island Equity Results

To verify Hawai'i Energy's PY2017 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 monthly report from June 2017 that included the full program year-to-date (YTD) spending. 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, Lāna'i, and Moloka'i 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 4-3 presents the island equity performance results. The resource acquisition incentives and island distribution matched between the YTD totals presented in the June 2017 monthly report, though market transformation spending allocations could not be directly verified. The resource acquisition incentives were far higher than market transformation incentives, at 91 percent of the total incentives. The market transformation allocation across the three counties was calculated by subtracting the total incentives from the resource acquisition incentives. In PY2017, Hawai'i Energy met its island equity targets by exceeding incentive spending associated with Hawai'i and Maui Counties.

<sup>29</sup> A portion of the economically disadvantaged performance target associated with multifamily direct installs are associated with single family homes. These participants are credited toward the multifamily direct install count of customers served as are their associated energy savings.

Table 4-3 *Verified Incentive Spending by Geography*

Location	Resource Acquisition Incentives		Market Transformation Incentives		Total Incentives	
	Funds	Percent	Funds	Percent	Funds	Percent
Honolulu County and Honolulu City	\$14,027,216	73.4%	\$1,061,381	55.7%	\$15,088,597	71.8%
Hawai'i County	\$2,426,672	12.7%	\$390,604	20.5%	\$2,817,276	13.4%
Maui County	\$2,647,800	13.9%	\$452,059	23.7%	\$3,099,859	14.8%
<b>Total</b>	<b>\$19,101,689</b>	<b>100.0%</b>	<b>\$1,904,044</b>	<b>100.0%</b>	<b>\$21,005,733</b>	<b>100.0%</b>

## 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 PY2017 performance. Summarized in Table 4-4, Hawai'i Energy met all of the equity performance targets.

Table 4-4 *Customer Equity Results Summary*

Key Focus Areas	Measurement Category	100 Percent Target	Claimed Result <sup>30</sup>	Claimed % of Target	Verification Result	Verified % of Target
Economically Disadvantaged	Small Business Direct Install Customers Served	625	769	123.0%	769	123.0%
	Small Business Direct Install kWh Savings	6,900,000	9,637,280	139.7%	9,577,813	138.8%
	Multifamily Direct Install Customers Served	4,300	5,964	138.7%	5,970	138.8%
	Multifamily Direct Install kWh Savings	1,300,000	1,728,292	132.9%	1,723,262	132.6%
Island Equity Incentive Spending	County of Hawai'i: 13 percent	13.0%	13.5%	103.8%	13.4%	103.1%
	County of Maui: 13 percent	13.0%	13.5%	103.8%	14.8%	113.8%

<sup>30</sup> Economically disadvantaged claimed savings were based on the final tracking database supplied by Hawai'i Energy to the Verification Team. Island Equity Incentive spending claimed results were based on the Hawai'i Energy PY2017 draft Annual Report titled, "PY17 AR 10.19.18\_DRAFT.docx," with verified results developed from a combination of the final tracking database and June 2017 monthly report year-to-date incentive spending results "Hawai'i Energy PY17 Monthly Report June v0.pdf."

# 5

## MARKET TRANSFORMATION RESULTS

The AEG team verified the Market Transformation activities and achievements provided by Hawai'i Energy during PY2017 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. Market Transformation programs are 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. Activities categorized as Clean Energy Collaboration include iDSM pilot programs, which attempt to increase energy savings by providing a portfolio of various customer-focused demand-side management programs. Although these programs may lead to future gains in energy efficiency and conservation, Hawai'i Energy does not set direct energy savings goals for these programs, though 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. These included numbers of participant-hours, number of participants attending, and other metrics identified under the Market Transformation targets for PY2017. Specifically, the AEG team assessed accomplishments by engaging in the following tasks:

- Review of event, presentation, or workshop attendance spreadsheets/sign-up sheets and event flyers (if available),
- Review of event invoices documenting the date and number of participants in attendance,
- Review of data on social media activity and associated metrics, and
- Review of customer satisfaction information provided by Medallia, Hawai'i Energy's survey software.

To verify the performance of social media followers and subscribers, the AEG team reviewed Hawai'i Energy's Facebook, Twitter, and Instagram publicly available pages. For each of these social media platforms, the number of subscribers is indicated on the landing page. The AEG team summed the total across the three social media platforms to verify the total number of subscribers. In addition to verifying the subscriber/follower metric, the AEG team received monthly activity logs for Facebook and Instagram, as well as a description of an online campaign using all three social media platforms. While the results do not directly tie to the annual performance metric, the data indicates Hawai'i Energy actively utilized the three platforms to engage with subscribers.

In addition to reviewing Hawai'i Energy documentation, the AEG team issued its own survey of PY2017 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. In total, 408 unique customers participating in 11 different professional development events were recruited via email to complete the survey. Survey recruits were identified using event sign-in sheets provided by Hawai'i Energy; participants' email addresses were then harvested from these documents, if email addresses were recorded. Email harvesting was limited to email addresses that were typed (i.e. not handwritten).

In total, 91 respondents, approximately 22 percent of participants recruited, completed the survey.<sup>31</sup> Table 5-1 summarizes the number of participants in the sample and the number who completed surveys by training.

Table 5-1 Number of Participants Sampled, and Number of Surveys Completed

Training	Count of Participants in Survey Sample <sup>32</sup>	Count of Survey Respondents (n)	Response Rate
Innovation Symposium	196	44	22%
Clean Energy Ally Breakfast	39	21	54%
ASHRAE Training	48	8	17%
Customized Lighting Training	27	7	26%
Fujitsu Technical Training	25	4	16%
Building Industry Association Event	43	4	9%
HECO Bill Training	25	3	12%
SBDIL / Keith Cronin Training	12	1	8%
HVAC Training	12	1	8%
Building Operator Certification Training	15	4	27%
Tripler Army Training	6	0	0%
<b>Total</b>	<b>448*</b>	<b>97</b>	<b>22%</b>

\*40 participants were listed as having participated in multiple professional development events; these participants were sent a survey invitation for each training they attended. The 97 respondents represent 91 unique training participants, six of which attended more than one training.

## Verification Results

Overall, the AEG team determined that Hawai'i Energy achieved all its Market Transformation target metrics related to the performance award. Table 5-2 shows each category area, the target metrics within each category, and the verified outcome for each metric.

<sup>31</sup> The Verification Team received 97 responses across the survey, however, the response rate is based on the count of unique email addresses that provided at least one response.

<sup>32</sup> The number of participants in the sample refers to the count of email addresses that could be gathered from the various training sign-in sheets and do not reflect the absolute number of participants in any given training.

Table 5-2 Market Transformation Performance Metrics, and Verified Performance

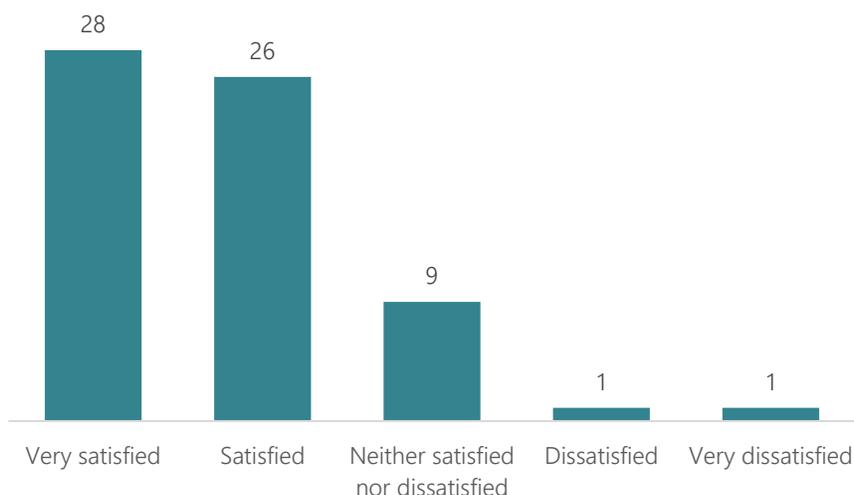
Key Focus Areas	Market Transformation Factor	Performance Indicator Target	Verified Performance	Met Target
Behavior Modification	Workshops and Presentations	2,100 participant-hours of training	4,039 participant hours of training	Y
	Gamification Campaigns and Competition	200 participants	3,535 participants	Y
	Social Media and Mobile Messaging	3,250 followers/subscribers	9,632 followers/subscribers*	Y
	Transformational Videos	3 videos produced	3 videos produced	Y
Professional Development & Technical Training	Clean Energy Ally Support			
	Targeted Ally Training Opportunities			
	Targeted Participant Training Opportunities	8,370 hours of participant training across all categories	10,403 participant-hours of training	Y
	Educator Training and Grants			
	Energy Industry Workforce Development			
Energy in Decision Making	Strategic Energy Management	2 cohort participants	5 cohort participants	Y
Codes and Standards	Code Adoption – County Level	9 advocacy events	10 advocacy events	Y
	Code-Related Training and Compliance	70 participant-hours of training	987 participant-hours of training	Y
	Leading Edge Technologies and Strategies	4 stakeholder meetings; 1 report	4 stakeholder meetings; 1 report	Y
Clean Energy Collaboration	iDSM pilot project	1 pilot project	1 pilot project	Y

\* Includes subscribers/followers on Facebook, Twitter, and Instagram as of November 1, 2018. As the verification activities did not start until after PY2017 ended, verification of total social media subscribers may include some new subscribers in PY2018.

## Professional Training Participant Survey Results

Overall, survey respondents rated their satisfaction with Hawai'i Energy's professional development offerings highly. Of the 97 survey responses, 65 provided responses related to questions about their satisfaction with the training they attended.<sup>33</sup> Twenty-eight of 65 respondents said they were "very satisfied" with the training they attended, and an additional 26 respondents said they were "satisfied." Only two respondents said they were either "dissatisfied" or "very dissatisfied" with the training attended. Both participants, who attended the Customized Lighting training and the Innovation Symposium, respectively, felt that the events were too basic, and did not cover any new concepts or practices. Figure 5-1 illustrates participant satisfaction with the training attended.

Figure 5-1 Participant Satisfaction with Professional Development Training Attended



In addition to reporting high satisfaction, 32 respondents characterized the trainings as "very useful." An additional 18 respondents described the training they attended as "somewhat useful," and two respondents characterized the trainings as either "not very useful" or "not at all useful." The respondents who characterized the trainings as not useful were the same two respondents who reported being dissatisfied with their trainings.

A total of 23 respondents provided recommendations on ways to improve trainings. Individual suggestions ranged from topics (e.g. electric vehicles) to logistical suggestions (e.g. starting trainings at the scheduled time). Ten respondents provided suggestions that were repeated more than once. These included:

- Better tailoring of training opportunities to match participants underlying knowledge on the topics at hand (e.g. ensuring that introductory classes are clearly identified as being for beginners and providing more technical or advanced classes, 5 respondents)
- Providing training focused on end-users/operators/facility managers (three respondents)
- Keep the website up-to-date on event availability and timing (two respondents).

The respondent's recommendations related to training content suggest that there is an appetite for more focused and advanced trainings. Indeed, Hawai'i Energy operates a variety of advanced professional

<sup>33</sup> 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 (97 responses compared to 91 unique individuals).

trainings. However, 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. The recommendation on keeping the website training calendar up-to-date suggests that there is an active group of people interested in training who actively seek information on the website and further suggests an opportunity to improve outreach and training enrollment through the website.

Survey participants also were asked whether they are registered with Hawai'i Energy as a Clean Energy Ally. Of the 97 responses, 73 provided their awareness of whether or not they were registered as a Clean Energy Ally. While many respondents (32 out of 73) confirmed being registered as a Clean Energy Ally, 23 reported not being a Clean Energy Ally and 18 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, suggesting that a diverse set of professionals engaged with energy efficiency are being reached outside of the Clean Energy Ally network.

# 6

## 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 3,158 surveys to customers in PY2017, of which 27 percent responded to the survey. Medallia compiled an overall satisfaction rating of 9.2 out of 10 on average by compiling satisfaction scores across all categories queried, satisfying the target performance metric.

In addition to verifying Hawai'i Energy's customer satisfaction results, 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. Below, the AEG team outlines several approaches:

- 1) 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 that 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 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.

- 2) 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.

- 3) Specific to professional development trainings and events, Hawai'i Energy could consider electronically tracking feedback or conducting event feedback surveys via email.

In verifying the participation rates for Hawai'i Energy's market transformation efforts, the AEG team received documents that included training feedback. Those documents were hand written by the respondents, making tallying challenging or labor-intensive. The feedback can provide valuable information that relate to program delivery across a number of topics, not just the training. By having the results recorded electronically, a systematic and longitudinal analysis could be done to leverage the perspective of professionals who have engaged with Hawai'i Energy, enabling Hawai'i Energy or the AEG team to track feedback over time and for topics that attract specific types of professionals to their respective trainings. Doing so can allow for a critical mass of feedback to be gathered over time or for changes in feedback to be linked to programmatic changes.

# 7

## 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 PY2017 performance targets. Targets for resource acquisition were met and exceeded for kWh and total resource benefits, with kW savings nearly reaching the maximum performance target at 96.4 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 99.5 percent of the maximum, or \$970,078.

### AEG Team Recommendations

Through the verification process, the AEG team had opportunities to engage with Hawai'i Energy and review the TRM measure, program tracking data, and other documentation. Through that process the AEG team developed several 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, potential streamline or clarify approaches or methods for savings verification or mitigate potential sources of verification risk.

Recommendation 1: For the Peer program, consider tracking claimed savings and organizing data in manner that facilitates claiming those savings. Additionally, consider updating the TRM to account for sub-annual savings claims.

During the verification process, the AEG team learned that the tracking data recorded the planning assumptions for savings associated with the PY2017 Peer program. While the AEG team was able to ultimately verify savings based on daily participation rates, Hawai'i Energy has some risk of verification adjustments should planning numbers not align with verifiable performance numbers. By tracking savings in the database based on actual participation rates, Hawai'i Energy can mitigate this risk and is assured that the data the AEG team has available will also be the same data Hawai'i Energy uses.

Secondly, the TRM currently presents Peer program savings as an annual savings number per participant. The AEG team observed that Hawai'i Energy's tracking database participation rates were based on expected monthly participation rates, with savings for each month being one-twelfth of annual savings. The PY2017 AEG team and prior verifications have used daily participation rates, dividing the annual savings by 365 based on the verified daily enrollment status of each participant. While both the monthly and daily approach are practical solutions to address part-year participation, the TRM does not address the issue nor the data that would be expected to conduct the calculation. Updating the TRM may help provide clarity and consistency going forward.<sup>34</sup>

Recommendation 2: For fully deemed measures, Hawai'i Energy should use the savings values from the TRM directly, rather than algorithm-based calculations.

The AEG team found that for many measures, rounding effects caused a minor shift in realization rates, but with potentially large aggregate effects. 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.

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<sup>34</sup> This recommendation will be addressed in the PY2019 TRM.

Measure characterizations in the TRM are inherently general calculations. The precision assumed in an algorithm calculation implies greater precision than is actually present in the TRM measure savings. The use of the TRM 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. In one case, the double counting of interactive effects for a large number of commercial lighting indicates that the potential for errors using database-driven algorithms is not always a minor risk.

Recommendation 3: Continue to collect and retain the documentation for each business sector project.

The AEG team was able to quickly obtain and utilize the project-level documentation for purposes of desk reviews. The practices employed by Hawai'i Energy to store business sector project records in the program data was robust and facilitated the verification, which found very little variance from project documentation and the data tracking system metrics.

Recommendation 4: Consider expanding the timing and methods for gathering customer satisfaction results.

The current practice of gathering customer satisfaction information relies on an email that is sent shortly after a rebate is paid. The AEG team observed that in the data tracking system, email addresses were not always present for customers. Midstream end-use customers (in BEEM) appear to be effectively excluded from the email customer satisfaction system. Additionally, customers who have only experienced a portion of the program (perhaps an energy audit) may never be surveyed for satisfaction or would be asked to reflect on an experience occurring sometime in the past. Expanding the timing and methods may help Hawai'i Energy develop a more comprehensive view of customer satisfaction, informing potential opportunities for program action. This topic is discussed in more detail in the Customer Satisfaction section of this report (Section 6).

Recommendation 5: Consider how programs and delivery methods are aligned, potentially updating tracking or project information to facilitate programmatic goals.

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 water. However, these can be addressed through categories captured in the tracking database and avoid mixing program, project, and customer types who 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.

Recommendation 6: 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.

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 risk.

Recommendation 7: Findings from the verification process should be used to inform TRM updates.

As part of the TRM updating process, the TRM review should assess measure characterizations as well as stipulated assumptions (e.g. NTG ratios and avoided costs). Following a schedule developed through the TRM Framework and with tasks associated with TRM oversight and management, such a process can help ensure that Hawai'i Energy is using up-to-date metrics and practices in alignment with the TRM. The verification process is a key source of information for TRM updates. AEG used findings from the PY17 verification process to help prioritize measures and stipulated assumptions for the review and update performed for the PY19 TRM.

During the verification process, the AEG team found instances of TRM-based measure savings being used in ways that suggested a need for either updating or expanding baseline conditions, or for modifying the deemed savings algorithms. An example noted in this verification report is the baseline condition for residential solar water heaters. A few other examples found during the verification process include the need to update the baseline for chillers to current market conditions, the need for an in-service rate to account for equipment that is stored or removed, and the need for expanding the deemed savings for the residential refrigerator measure to include savings for freezers since freezers are currently rebated through the program. As programs and measures evolve over time, actual conditions in the marketplace or the types of customers that are actually participating can change, suggesting a need for regular TRM measure characterization changes.

Similarly, assumptions related to program or portfolio level metrics, such as program-level NTG ratios or avoided costs, should be reviewed for accuracy relative to new information or program practices. For example, multifamily direct installations were found in both the RHTR and BHTR program. However, the NTG ratio between these programs differs. Another example is the presence of custom projects tracked outside of custom-designated programs (CBEEM and CREEM). Regardless of the reasons for tracking projects in this way, the tight linkage between NTG ratios and program designations creates a potential misalignment between the research behind and intent of the NTG ratios relative to project tracking practices.

Lastly, during the development of verified total resource benefits (TRBs), the AEG team found that TRM descriptions of kW savings appeared higher than might be typically expected. While the TRM results were used to develop verified TRBs, a periodic review and documentation of avoided costs and their appropriate treatment, following a standard schedule based on the TRM framework and as part of a TRM update process will ensure that accurate and transparent avoided costs are utilized for future planning and calculation of TRBs.

Recommendation 8: For performance targets associated with customer equity, market transformation, or customer satisfaction, document the methods for calculating performance, along with data sources and data tracking expectations.

During the course of the verification, metrics associated with customer equity, market transformation, and customer satisfaction were verified by the AEG team. While we verified that Hawai'i Energy met all of its performance targets, the AEG team found inconsistencies with data quality, tracking, and documentation across metrics. For example, documentation related to customers served by multifamily direct installs was inconsistent in how the tracking system was used and how underlying documentation was presented for verification. The AEG team learned that a large portion of the customers were tracked under a mechanism

outside the tracking database and that their recorded participation in the tracking database captured measures and associated savings, but that their individual household participation was recorded differently than other multifamily direct install projects.

As customer satisfaction, market transformation, and/or customer equity performance targets are updated from year to year or new metrics are developed, Hawai'i Energy and other stakeholders will benefit from having clear and transparent approaches to identifying and verifying the performance. To do so, the TRM may be one mechanism for documenting metric types, the data used to measure performance, and how that data would be tracked to document the performance. Another option is developing a separate document, in parallel with the TRM, that establishes these criteria. A potential side benefit may be that Hawai'i Energy is able to work with its staff or program partners to establish data tracking that simplifies or streamlines Hawai'i Energy's performance tracking.



# A

## CBEEM SUMMARY OF PROJECT ADJUSTMENTS

Reporting ID	Stratum	Project Description	Summary Adjustments
1	MEDIUM	Interior warehouse and exterior lighting retrofit project	Adjustments made during the desk review and then further adjusted based on site visit findings. The project documentation listed 8-foot LED fixtures while 4-foot LED fixtures were found installed. There were some small schedule differences. The exterior LED wall pack quantities, fixture types and schedule matched the project documents. No 8' LEDs were found installed on-site, which matched the findings from the invoice during the desk review. The desk review results were updated for on-site fixture counts, which reduced both kW and kWh savings.
6	LOW	Bank parking lot CFL lighting retrofit with LED lighting and controls	Adjustments made during the desk review. A slight adjustment to the wattage of the light was made to match DLC certification. Claimed savings showed these lights dimmed to 50% during certain periods but lighting spec sheets showed these lights could not dim to 50% - only 10%, 30% or 80%. The desk review also adjusted the dim setting of the lights down to 80% of their capacity to match specs sheets included in project documentation. No additional adjustments were made after the site visit.
7	HIGH	Highway LED lighting project which replaced HPS lamps in street lights with LED lighting.	Adjustments made during the desk review. The desk review adjusted the wattage of some lights from the claimed 66W to 67W to match DLC certification documentation. This slightly reduced verified kWh and kW savings. No additional adjustments resulted from the site visit.
9	HIGH	Highway LED lighting project which replaced HPS lamps in street lights with LED lighting.	Adjustments made during the desk review. The desk review adjusted the wattage of some lights from the claimed 67W to 66W to match DLC certification documentation. This slightly increased verified kWh and kW savings. No additional adjustments resulted from the site visit.
11	LOW	A new construction bank that installed interior lighting for the entire facility. The baseline is described by a lighting code maximum 1.5 watts per square foot which is compared to all lights actually installed, including decorative lighting.	Adjustments made during desk review. Adjusted pre and post lighting schedule to reflect email of occupied hours (MF: 7:30pm-7pm, Sa-Su: 8:30am-4pm). This increased pre and post annual operating hours (AOH) and increased energy savings. This also increased peak demand savings across the period 5-9pm. The increased daily runtime reduced measure life to 13.25 years to account for increased AOH of ~3780. $50,000 L70 / 3,780 = \sim 13.25$ years. Overall lifetime savings was slightly higher due to rounding of the adjusted measure life. No additional adjustments made from the site visit.

Reporting ID	Stratum	Project Description	Summary Adjustments
12	MEDIUM	A new construction bank that installed exterior lighting for a parking lot, walkways, and decorative exterior accent lighting. The baseline is described by a lighting code maximum 1.5 watts per square foot which is compared to all lights actually installed, including decorative lighting.	Adjustment made during the desk review. The measure life was adjusted from 12 to 11.4 years to reflect project documentation. This slightly reduced measure life. No additional adjustments made from the site visit
14	HIGH	Highway LED lighting project which replaced HPS and MV lamps in street lights with LED lighting.	Adjustment made during the desk review. The desk review adjusted the wattage of some lights from the claimed 67W to 66W to match DLC certification documentation. This slightly increased verified kWh and kW savings. No additional adjustments resulted from the site visit.
15	MEDIUM	Replacement of exterior parking lot and wall pack lighting with LED lighting at a retail store.	Adjustments made during the desk review. Weekend operating hours adjusted from 9 hours to 5.5 hours. Calculator notes that the lights operate on the weekend from an estimated dusk of 6pm to 9:30pm and then from 4am-6am. This was 5.5 hours instead of the claimed 9 hours. This reduced overall energy savings but did not impact peak demand savings. No additional adjustments were made from the site visit findings.
16	LOW	Replacement of metal halide lights on the exterior of a warehouse with LED lights.	Adjustment made during the desk review. Invoice and post inspection form and notes indicate that only (4) 20W (model BTS-LED WP08A-30) emergency exit doors lights were installed instead of 7 as indicated on the Customized Lighting Incentive Worksheet. EM&V team adjusted verification savings to include (4) pre and post retrofit emergency exit lights. From the inspection form, there are (7) emergency exit door lights at the facility but only (4) were replaced. This reduced energy and demand savings. Model (BTS-LED WP08A-30) was noted as a 20W light in the Customized Lighting Incentive Worksheet but this model number is for a 30W fixture. The invoice and post inspection form indicated that the BTS-LED WP08A-30 was the correct model purchased so the EM&V team adjusted this wattage to 30W to reflect DLC rated wattage. There is a lower 20W model of the same light. The provided DLC certification was for the lower wattage version. This reduced energy and demand savings. Model BTS-LED FL35A-240 was noted in Customized Lighting Incentive Worksheet as 235.6W. This was adjusted to 240W in verifications savings to match DLC listing. This reduced energy and demand savings. No additional adjustments were made from site visit findings.
17	LOW	A partial replacement of LED lights within a warehouse with newer LED lights. Occupancy sensors were installed, and data logging performed to calculate the amount of time the space was occupied.	Adjustment made during the desk review. Measure life adjusted from 14 years to 13.46 years to match project documentation. This reduced lifetime energy savings.

Reporting ID	Stratum	Project Description	Summary Adjustments
18	LOW	Replacement of metal halide street lighting with LED street lighting at a college campus.	Adjustment made during the desk review. Slight demand difference due to rounding. Claimed calculation and tracking system rounded claimed savings to 2 decimals while the verification calculator rounded to 3.
20	LOW	Replacement of mercury vapor and metal halide lights with LED lights on the exterior of an office building and parking lot.	Adjustment made during the desk review. Pre-retrofit wattage of 100W MV lamps adjusted from 122W to 125W. This increased energy and demand savings. Customized Lighting Incentive Worksheet pre-retrofit wattage of 100W mercury vapor lights was listed as 122W after the ballast factor. This is a reasonable assumption but a System Wattage guide for exterior lighting was provided and used in other exterior lighting project's documentation. This guide estimates 100W MV lights consume 125W including the ballast. To remain consistent with other exterior lighting projects, the pre-retrofit MV wattage was adjusted to match this System Wattage Guide which increased pre-retrofit wattage and savings. (4) 79.9W LED lamps (model WL-RTUV-80) were adjusted from 79.9W to 79.95W in verification savings to match the DLC certification sheet. This reduced energy and demand savings by a small amount.
21	HIGH	This project replaced 5 blower filter units with new units and fixed compressed air line leaks at a wastewater treatment plant facility.	Adjustments were made during both the desk review and from further data gathering during the site visit. During the site, the five units were found installed as described in the project documentation. The customer provided daily energy reports through 10/8/2018, which demonstrated a slight increase in kWh savings over the claimed savings. During the desk review, the AEG team found that the claimed peak demand savings were calculated using an assumption of a constant load throughout the day and, consequently, the peak demand period. The site confirmed that the load is constant throughout the day at the facility and that the constant load profile assumption was correct. However, the desk review found a conversion from 3-phase amps to kW was missing from the claimed peak demand savings estimate, which acted to overstate the peak demand savings. The AEG team notes that had the conversion to kW been correct, the realization rate for peak kW would have matched that of the kWh savings.
22	MEDIUM	Replacement of interior metal halide and exterior metal halide and high pressure sodium lighting at a restaurant with LED lighting.	Adjustments made during the desk review. (4) model Hubbell CLED-LL-7-UNV adjusted from 66W to 66.93W to reflect DLC certification wattage (DLC Product ID PYPHTT7S9). This reduced savings. (12) model Hubbell VP-S/36NB-80/5K adjusted from 80W to 81.24W to reflect DLC certification wattage (DLC Product ID PF4Y5D1Q). This reduced savings. (9) model RAB WP1LED30 adjusted from 32W to 31.1W to reflect DLC certification wattage (DLC Product ID PLPVZ1GB9SD7). This increased savings. (7) model Lumark XTOR6B adjusted from 58W to 63.8W to reflect DLC certification wattage (DLC Product ID PWEKQNMV). This decreased savings. (5) model Lumark RAB WPLED26 adjusted from 26W to 28.4W to reflect DLC certification wattage (DLC Product ID P0000171C). This decreased savings.

Reporting ID	Stratum	Project Description	Summary Adjustments
23	HIGH	Chiller plant retrofit project.	Adjustments made during the desk review. Claimed savings did not take into account weather changes between pre and post-retrofit period. The evaluator found the average ambient temperature in the pre-retrofit was 80 degF and the average was closer to 75 degF in the post period. The claimed savings analysis used a simple average reduction between periods, which overstated both kW and kWh savings. Evaluated savings determined temperature dependent trends for both periods and then used TMY3 data to calculate savings from the temperature trends. The peak demand used the difference between the maximum kW values both pre and post instead of averaging the reduction during the peak demand period (5-9pm), which increased the kW savings for the evaluated savings.
24	HIGH	Replacement of interior T8 lights in a large retail store with LED lighting.	Adjustments made during the desk review. The 2015 Customized Lighting Incentive Worksheet did not include any interactive effects into the savings equations to account for the retail space being air conditioned. The documentation does not mention if the space is air conditioned, but it more than likely is. Verification savings included the interactive effects factors for energy and demand from the TRM for a retail building. This increased energy and demand savings.
26	MEDIUM	Replacement of fluorescent, HPS and MH lighting in a grocery store with LED lights with controls.	Adjustments made during the desk review and further adjustments made based on site visit findings. During the desk review, claimed savings is using 7-year measure life while the verified savings calculation showed 6.85 years. Verification savings used 6.85 years which lowered lifetime kWh savings. The site visit resulted in the following changes: The inspection found the light fixtures throughout the facility were changed to LED fixtures, with the exception of the warehouse area. The fixture counts were close for the sales floor, but the back-of-house areas were found to be different from the final savings calculations. In addition, 2x2 and 2x4 troffers were found retrofit in the back-of-house area that were excluded from the claimed savings calculator. The updated counts and the addition of the troffers resulted in an increase in the evaluated savings for both kW and kWh.

# B

## SURVEY INSTRUMENT

### Hawaii Energy Market Transformation – Professional Development Participant Web Survey (PY2017)

This survey instrument will be used for a web survey with participants in Hawaii Energy’s professional development events and/or trainings to support the PY2017 verification effort.

#### Sample Variables

<b>CASEID</b>	Unique case identifier
<b>CONTACT_NAME</b>	Customer contact name listed
<b>EMAIL_ADDR</b>	Participant email address
<b>EVENT</b>	Training event participant attended

#### Survey Questions

1 Let’s get started! Our records indicate that you participated in [EVENT] around [DATE]. Is this information correct?

- 01 Yes
- 02 No [SKIP TO 10]

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

- 01 Yes
- 02 No
- 88 Don't know

3 In your opinion, how useful was the information provided or discussed during the [EVENT] for your work? [SELECT ONE ANSWER]

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

Included as part of 3: Why did you rate the training the way you did?  
[RECORD VERBATIM]

4 How has your participation in the [EVENT] influenced you personally at your organization?  
[SELECT ALL THAT APPLY; RANDOMIZE]

- 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
  - 10 Other [Please describe]
- 5 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.  
[RECORD VERBATIM]
- 6 Did you receive any tuition sponsorship or subsidy to attend this training?
- 01 Yes
  - 02 No [SKIP TO 8]
- 7 To what degree, if any, did the tuition sponsorship or subsidy make a difference in your decision to take part in the training?  
  
[SLIDER: None, I would have attended anyway. → It made a great difference: I would not have attended without it.]
- 8 Would you recommend the [EVENT] to others? [SELECT ONE ANSWER]
- 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 [SPECIFY: What is main reason why you would not recommend the event?]
  - 88 Don't know
- 9 Overall, how satisfied are you with the [EVENT]? [SELECT ONE ANSWER]
- 01 Very satisfied
  - 02 Satisfied
  - 03 Neither satisfied nor dissatisfied
  - 04 Dissatisfied
  - 05 Very dissatisfied
- 10 Which of the following best describes your current occupation?
- 01 Educator
  - 02 Energy efficient equipment installer/ technician
  - 03 Energy efficient equipment sales

- 04 Building operations management
- 05 Business manager
- 06 Consultant
- 07 Other (SPECIFY)

11 On what island do you primarily work? [SELECT ONE]

- 01 O'ahu
- 03 Moloka'i
- 04 Maui
- 05 Lāna'i
- 06 Kaua'i
- 08 Hawai'i

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

- 01 Yes [Specify: In what other Hawai'i Energy events or trainings have you participated?]
- 02 No

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

- 01 Yes [Specify: What recommendations do you have?]
- 02 No

Thank you for your time today.



# C

## NOTES ON CALCULATIONS FOR TABLE ES-4

Note 1: Resource Acquisition Claimed and Reported come from program tracking database "Tracking System Review EMV Extract 20181015.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 "Tracking System Review EMV Extract 20181015.xlsx" Multifamily Direct Install claimed customers served comes from the Hawaii Energy draft annual report "PY17 AR 10.19.18\_DRAFT.docx" Additional Multifamily Direct Install customers served verified through invoices submitted by a channel partner.

Note 3: Island Equity claimed performance comes from the Hawaii Energy draft annual report "PY17 AR 10.19.18\_DRAFT.docx"

Note 4: Island Equity verified performance comes from a combination of "Tracking System Review EMV Extract 20181015.xlsx" and "Hawaii Energy PY17 Monthly Report June v0.pdf"

Note 5: Market Transformation claimed performance comes from the Hawaii Energy draft annual report "PY17 AR 10.19.18\_DRAFT.docx"

Note 6: Market Transformation verified performance comes from multiple documents submitted to the Verification Team by Hawaii Energy

Note 7: Customer Satisfaction claimed performance comes from the Hawaii Energy draft annual report "PY17 AR 10.19.18\_DRAFT.docx"

Note 8: Customer Satisfaction verified performance comes from multiple documents submitted to the Verification Team by Hawaii Energy

Note 9: The calculation for the performance incentive related to peak demand reduction (kW) is based on a rate of \$6.76063/kW as presented in the Hawaii Energy draft annual report "PY17 AR 10.19.18\_DRAFT.docx"

Note 10: 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 Hawaii Energy draft annual report "PY17 AR 10.19.18\_DRAFT.docx"

Note 11: Due to rounding the total verified performance award calculated by the AEG team is \$1.00 higher than the unrounded sum of individual performance award line items.

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