



EVALUATION OF THE HAWAI'I ENERGY CONSERVATION AND EFFICIENCY PROGRAMS

Calendar Year 2019

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HAWAII PUBLIC UTILITIES COMMISSION

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EXECUTIVE SUMMARY

Purpose of Report

The purpose of this report is to present the prior year’s (2019) results of all Evaluation, Measurement and Verification (EM&V) related activities associated with the Hawai’i Energy Conservation and Efficiency Programs (Hawai’i Energy programs). Earlier versions of this report covered activities completed during the prior program year (PY), July-June, and prior calendar year (CY). Starting with this version, the reports are covering only prior CY activities, both initiated and *substantially* completed.¹ Within this report is also a summary of the most important findings from the completed CY19 EM&V activities, with a focus on implications for the Hawai’i Energy programs.

Approach

The EM&V-related research activities for CY19 were determined in consultation with the Hawaii Public Utilities Commission (HPUC) and the Energy Efficiency Manager (EEM). The EM&V Contractor completed three research activities and initiated five activities. The activities completed in CY19 were:

- Verification of impacts for Hawai’i Energy’s PY18 program portfolio
- Mid-year updates to the PY19 Technical Reference Manual (TRM)
- Hawaii Statewide Baseline Energy Use Study (2019 Baseline Study)

The EM&V Contractor used a variety of research and analysis methods to carry out the CY19 EM&V work. Table ES-1 summarizes the primary methods employed for each completed EM&V research activity.

Table ES-1. Summary of EM&V Research Activities and Methods for Work Completed in CY19

EM&V Research Activity	Research and Analysis Methods	
PY18 Verification	<ul style="list-style-type: none"> • Program staff interviews • Documentation reviews • Program tracking system review and analyses • Sample design, selection and extrapolation 	<ul style="list-style-type: none"> • Engineering desk reviews • Site visit verifications • Participant surveys • Total resource benefit (TRB) analysis
Mid-Year PY19 TRM Update	<ul style="list-style-type: none"> • Best practices research & benchmarking 	<ul style="list-style-type: none"> • Measure characterization
2019 Baseline Study	<ul style="list-style-type: none"> • Utility customer data review and analysis • Customer segmentation • Sample design and selection • Research design 	<ul style="list-style-type: none"> • Survey development and testing • Online, phone, and onsite data collection • Data cleaning, weighting, and analysis

¹ From this point forward, “completed” work refers to work that was *substantially* completed during CY19, meaning that the EM&V Contractor completed the research and began drafting final deliverables during CY19. However, final approval of these “completed” activities occurred in CY20.

In addition to the completed activities, the EM&V Contractor initiated five other research activities in CY19:

- PY20 TRM review and update
- LED market transformation attribution study
- Codes and standards (C&S) attribution study
- Baseline supplemental surveys
- Market potential study

Key Findings and Implications

Table ES-2 through Table ES-4 on the following pages summarize some of the key results and findings from the three types of the EM&V research activities completed during CY19. The tables also list the associated outcomes and implications of these findings for the Hawai'i Energy programs.

Findings from the PY18 Verification show that Hawai'i Energy met several of the performance targets (customer equity, market transformation, and customer satisfaction performance targets) and nearly met the resource acquisition targets. The programs are heavily focused on prescriptive measures that use deemed savings from the TRM. Since the verification process is largely an accounting exercise to ensure that savings from the TRM are applied properly, it is critical for the TRM to be as accurate as possible. Ongoing TRM updates, including the Mid-Year PY19 TRM Update, have focused on improving the accuracy of deemed savings estimates and expanding the use of semi-prescriptive calculators to better customize savings for a given measure based on the specific installation characteristics (e.g., program delivery approach, equipment capacity, efficiency, building segment).

Results from the PY18 Verification related to custom measures show opportunities to improve custom savings calculations. This is an area where future TRM updates that focus on providing more detailed guidance on best practices for estimating savings for fully custom measures could be very valuable, particularly as the programs evolve to include more complex measures.

Additionally, as the programs evolve, it will be important to consider whether more robust evaluation approaches should be conducted in addition to, or in the place of, the “accounting-type” verification practices used in recent years. Potential options beyond annual verifications include the following:

- Conducting a more thorough ex post impact evaluation of some high priority or complex program components or measures each year while doing the accounting-type verification for the remainder of the program components / measures.
- Alternating years for evaluating different program components during the triennial period (for example, doing a more thorough ex post impact evaluation for residential programs the first year, business programs the second year, and market transformation programs the third year).
- Conducting an accounting-type verification during the first program year of a triennial period as new program processes ramp up, followed by a more comprehensive evaluation during the second year when the new program processes are well underway to help evaluate what is working and to provide more substantive and quantitative recommendations while allowing sufficient time to inform planning for the next triennial period, and then ending with an accounting-type verification during the last year.

Lastly, results from the 2019 Baseline Study inform future program planning by characterizing the current market, showing how the market has changed in recent years, and highlighting opportunities for certain measures. The results also contribute valuable data on building characteristics and end use equipment for future TRM updates, including the PY20 TRM Update initiated in CY19.

Table ES-2. Key Research Findings and Their Implications/Outcomes: PY18 Verification

Key Result/Finding	Implication/Outcome
<p>Hawai'i Energy came very close to meeting all three resource acquisition targets (97%-98% of goal). Realization rates for verified program impacts relative to claimed program impacts at the program level hovered right at the 100% mark.</p>	<ul style="list-style-type: none"> • Hawai'i Energy is effectively using the TRM for prescriptive measures.² • There is room for improvement in the approaches Hawai'i Energy follows to estimate savings for custom measures, although the realization rates are high, on average.
<p>Lighting measures continued to make up most energy and peak demand impacts, though not in such a dominant way as in the past.</p>	<ul style="list-style-type: none"> • The PY18 numbers reflect the Hawai'i Energy's efforts to achieve goals through a variety of measures and activities, and not rely so heavily on lighting savings.
<p>In PY18, 40% of energy impacts and 41% of demand impacts for the business sector came from custom measures. Lighting projects continue to account for much of the savings for custom measures, and those impacts are estimated using partially deemed savings estimation approaches. For the residential sector, prescriptive measures dominate the influence on energy and demand impacts.</p>	<ul style="list-style-type: none"> • TRM deemed savings values and approaches continue to have a large influence on program results. • Since the verification process simply verifies correct usage of the TRM and does not include a full ex post evaluation, it is very important that the deemed values and approaches in the TRM estimate savings reasonably well.
<p>The EM&V Contractor identified several areas of improvement for custom measure analysis.</p>	<ul style="list-style-type: none"> • For utility billing regressions, increasing the amount of post-implementation billing data and normalizing results would give more accurate results. • For large projects, using site collected data to refine energy savings estimates rather than relying on deemed or partially deemed approaches would improve quality of savings estimates. • Collecting Hawaii-specific data for the Sense pilot rather than exclusively relying on estimates from other jurisdictions may improve accuracy of savings estimates.
<p>Hawai'i Energy met performance targets for island equity and economically disadvantaged markets.</p>	<ul style="list-style-type: none"> • Programs continue to successfully bring energy efficiency to islands other than Oahu, to underserved business markets, and to economically disadvantaged residential customers.
<p>Hawai'i Energy met market transformation targets. Although these Market Transformation activities may lead to future gains in energy efficiency and conservation, Hawai'i Energy did not have direct energy savings goals for Market Transformation in PY18.</p>	<ul style="list-style-type: none"> • For PY18 there was no formal guidance for how to measure, track, or report energy and demand savings impacts from market transformation activities. • EM&V activities initiated in CY19 (i.e., the LED Market Transformation Attribution Study and C&S Attribution Study) are aimed at providing guidance in future program years.
<p>Hawai'i Energy met customer satisfaction targets. The current system continues to solicit customer feedback and emphasizes measuring general satisfaction ratings via email surveys at the time a customer receives a rebate.</p>	<ul style="list-style-type: none"> • Programs have high customer satisfaction (overall satisfaction rating of 9.05 out of 10 on average). • There are opportunities to reach more customers and gain additional insights by modifying the customer satisfaction survey process.

² For measures covered by the TRM, the scope of the verification was limited to assessing whether TRM-stipulated gross savings values and related adjustments that produce net savings were being applied properly, but the scope did not extend to independent calculations of savings estimates or a quantitative evaluation of the TRM's validity.

Table ES-3. Key Research Findings and Their Implications/Outcomes: Mid-Year PY19 TRM Update

Key Result/Finding	Implication/Outcome
Added four new measures: commercial window AC, residential linear LED light, residential security light, and residential holiday string light.	<ul style="list-style-type: none"> TRM additions provide savings estimation approaches for new measures introduced to the program after finalization of the original PY19 TRM.
Expanded four residential measures: central AC, window AC, faucet aerator, and low-flow showerheads.	<ul style="list-style-type: none"> TRM measure expansions provide savings options for a wider range of implementation alternatives.
Clarified the definition of large vs. small lodging for the commercial guest room EMS measure.	<ul style="list-style-type: none"> The clarification promotes proper use of the two levels of deemed savings.
Corrected cell reference errors in the commercial chiller worksheet.	<ul style="list-style-type: none"> Corrections lead to improved accuracy of savings estimates.
Updated the net-to-gross (NTG) ratio for the upstream lighting program to account for market effects.	<ul style="list-style-type: none"> The update attributes a portion of residential lighting market transformation in Hawaii to Hawai'i Energy's upstream lighting program.
Recommended revisiting several of the additions / modifications in a future TRM update to incorporate new information that would improve accuracy (e.g., updated market data from the 2019 Baseline Study and future changes in federal regulations affecting LEDs).	<ul style="list-style-type: none"> TRM measures are subject to a continuous improvement process, whereby annual updates are made to increase the clarity of the measure descriptions and eligibility criteria as well as improve the accuracy of the savings estimates.

Table ES-4. Key Research Findings and Their Implications/Outcomes: 2019 Baseline Study

Key Result/Finding	Implication/Outcome
Results provide a comprehensive description of the building stock and appliance and equipment holdings across five islands (Oahu, Maui, Molokai, Lanai, and Hawaii), for the military, and for various levels of segmentation: sector (residential and commercial), segment (single family home, multifamily home, income level, commercial building type, etc.), building vintage, end use, technology, and efficiency level.	<ul style="list-style-type: none"> • This market characterization data is used to support the Hawaii Statewide Market Potential Study by establishing a baseline from which to measure future program impacts. • It is also used to provide building characteristics and end use data to support the robustness of savings approaches in the TRM.
The 2019 Baseline Study updates a 2014 Baseline Study. ³	<ul style="list-style-type: none"> • Comparison with the 2014 Baseline Study shows how the market is evolving, both naturally and as a result of programs and other types of interventions.
LEDs are installed in 41% of the sockets in an average home. This finding is particularly notable in comparison to the 2014 Baseline Study which showed LEDs filling only 3% of the sockets.	<ul style="list-style-type: none"> • There has been a significant increase in adoption of LED bulbs. • There is still an opportunity to fill the remaining 59% of residential sockets with LEDs.
48% of homes have air conditioning (AC), compared with 41% during the 2014 Baseline Study. Room AC systems are the most common type.	<ul style="list-style-type: none"> • The penetration of air conditioning is growing, as is the potential for energy savings; this is particularly true for homes with solar photovoltaic (PV) systems.
Business facilities have an average of 82 lamps / fixtures. Of this total: 28 are traditional fluorescents, 21 are linear LEDs, 13 are screw-in LEDs, six are traditional incandescent bulbs, and eight are CFLs.	<ul style="list-style-type: none"> • Though LEDs make up a growing sharing of lighting in businesses, there is still an opportunity to replace less efficient commercial lighting with LEDs.
70% of small and medium businesses and all large customers surveyed pay to cool their space, using a variety of technologies.	<ul style="list-style-type: none"> • Due to the high penetration of space cooling systems, there are considerable opportunities to save energy by promoting HVAC measures.

³ Baseline Energy Appliance, Equipment and Building Characteristics Study Report, Prepared for the State of Hawaii Public Utilities Commission, Prepared by Evergreen Economics, Nov. 6, 2013, with errata Feb. 26, 2014.

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1

INTRODUCTION

Purpose of Report

The purpose of this report is to present the prior year's (2019) results of all Evaluation, Measurement and Verification (EM&V) related activities associated with the Hawai'i Energy Conservation and Efficiency Programs (Hawai'i Energy programs). Earlier versions of this report covered activities completed during the prior program year (PY), July-June, and prior calendar year (CY). Starting with this version, the reports are covering only prior CY activities, both initiated and completed. Within this report is also a summary of the most important findings from the completed CY19 EM&V activities, with a focus on implications for the Hawai'i Energy programs.

Research Objectives

The EM&V work conducted for CY19 contributes to three overarching "core" research objectives:

- Verification of accomplishments: Verifying Hawai'i Energy's PY18 impacts.
- Robustness of savings approaches: Updating and improving approaches used to estimate savings for Hawai'i Energy's programs and measures.
- Program planning: Using results from market research to inform future program planning.

EM&V Research Activities

The activities completed in CY19 to meet the core research objectives were:

- Verification of impacts for Hawai'i Energy's PY18 program portfolio
- Mid-year updates to the PY19 Technical Reference Manual (TRM)
- Hawaii Statewide Baseline Energy Use Study (2019 Baseline Study)

In addition to the completed activities, the EM&V Contractor initiated five other research activities in CY19:

- PY20 TRM review and update
- LED market transformation attribution study
- Codes and standards (C&S) attribution study
- Baseline supplemental surveys
- Market potential study

2

PY18 VERIFICATION OF IMPACTS

This chapter summarizes the PY18 verification of impacts for the Hawai'i Energy programs. More detailed information on the verification can be found in the PY18 Verification Report.⁴

Purpose

The chief purpose of the PY18 verification effort was to provide an independent review of Hawai'i Energy's performance relative to the PY18 Annual Plan performance targets.⁵ Specifically, the EM&V Contractor's verification activities determined the extent to which incented projects / measures were appropriately "tracked" in the program database and ensured that estimated savings values and related adjustments were properly applied. For measures covered by the TRM, the scope of the verification was limited to assessing whether TRM-stipulated gross savings values and related adjustments that produce net savings were being applied properly, but the scope did not extend to independent calculations of savings estimates or a quantitative evaluation of the TRM's validity. The TRM in effect for this verification was the Hawai'i Energy PY18 TRM, version 3.0.

Approach

The EM&V Contractor applied the methods shown in Table 2-1 to arrive at verified savings and performance results for PY18. The methods were similar to those used during the PY17 verification, except for two new activities: program staff interviews and quality assurance / quality control (QA/QC) project reviews.

Table 2-1. PY18 Verification Methods

Method	Description
Program Staff Interviews	<ul style="list-style-type: none">Conducted separate interviews with Hawai'i Energy staff representing the residential, business, and market transformation programs.Used interviews to gain a better understanding of program design and delivery, assess Hawai'i Energy's QA/QC procedures, discuss successes and challenges with the programs, and help to identify and prioritize verification tasks.
Tracking System Review	<ul style="list-style-type: none">Reviewed an initial set of project details provided by Hawai'i Energy in September 2019 to assess the close-to-final aggregate savings and to inform the verification plan.Reviewed the final database provided by Hawai'i Energy in October 2019 to assess final claimed savings for PY18.
Tracking System Verification	<ul style="list-style-type: none">For a census of measures that utilized the TRM for claimed savings, used an Excel spreadsheet equipped with TRM savings values and algorithms to develop independent savings calculations for each of the relevant entries from the Hawai'i Energy tracking system.

⁴ Hawai'i Energy PY2018 Verification Report, Prepared by Applied Energy Group and Tetra Tech, Prepared for Hawaii Public Utilities Commission, April 23, 2020.

⁵ Annual Plan, Program Year 2018, Hawai'i Energy, Leidos, https://hawaiienergy.com/files/resources/AnnualPlan_PY18.pdf.

Method	Description
	<ul style="list-style-type: none"> • This analysis allowed verification of the degree to which Hawai'i Energy correctly used the TRM to calculate savings and resource benefits. • It also enabled an assessment of the level and reasonableness of information being tracked by Hawai'i Energy.
Desk Review Verification	<ul style="list-style-type: none"> • Used engineering desk reviews for the Custom Business Energy Efficiency Measures (CBEEM) and Custom Residential Energy Efficiency Measures (CREEM) programs to verify installations and savings for a sample of projects. These desk reviews were a key activity in verifying the Hawai'i Energy savings for CBEEM and CREEM since the tracking database did not record the underlying data used to calculate savings for these custom programs. • For measures recorded in the Business Energy Efficiency Measures (BEEM) and Residential Energy Efficiency Measures (REEM) programs, used engineering desk reviews for a sample of projects to verify whether the tracking data accurately reflected the supporting documentation.
Site Visit Verification	<ul style="list-style-type: none"> • Conducted site verification for nine PY18 CBEEM participants to verify installation and documentation accuracy, as well as key parameters used in the calculation of custom savings. • Selected the sites in a targeted manner based on whether a site visit was likely to provide additional information that would clarify desk review results and conclusions. • The selected sites did not represent the full CBEEM population; therefore, the site visit results were not extrapolated to the CBEEM program population when calculating the verified savings. Instead, the site visit results informed the desk reviews for individual projects.
Documentation Review	<ul style="list-style-type: none"> • Reviewed documentation provided by Hawai'i Energy to verify performance relative to PY18 goals for market transformation initiatives, customer satisfaction performance, and island equity.
QA/QC Project Reviews	<ul style="list-style-type: none"> • During the previous year's (PY17's) verification activities, the EM&V Contractor learned that single rebates for the Midstream program were based on batches of invoices from lighting distributors, and that those invoices could include multiple customers and locations. • Due to this particular program design, the EM&V Contractor conducted QA/QC project file reviews for a sample of 20 projects from the Midstream program to verify that Hawai'i Energy demonstrated sufficient QA/QC practices in the rebate process.
Total Resource Benefit (TRB) Analysis	<ul style="list-style-type: none"> • Developed program and portfolio realization rates (ratio of verified savings to claimed savings) and conducted TRB analysis using results from the tracking system verification, desk review verification, and site visit verification. • Utilized the avoided cost factors presented in the PY18 TRM. • Applied the avoided cost factors at the measure level for each program, and then rolled up to the Hawai'i Energy portfolio to verify TRB performance achievement relative to the PY18 goals.
Verification of Award Claim	<ul style="list-style-type: none"> • Calculated a verified performance award based on the PY18 verification results.

Results

Table 2-2 on the next page summarizes the PY18 performance targets compared with Hawai'i Energy's claimed results and the verified results derived by the EM&V Contractor. Hawai'i Energy met the customer equity, market transformation, and customer satisfaction performance targets, and nearly met the resource acquisition targets (see Figure 2-1 below). The PY18 verification results indicate that substantial efforts were made to achieve the targets, even for performance metrics that did not meet their target goals.

Figure 2-1. Achievement of Performance Targets for PY18

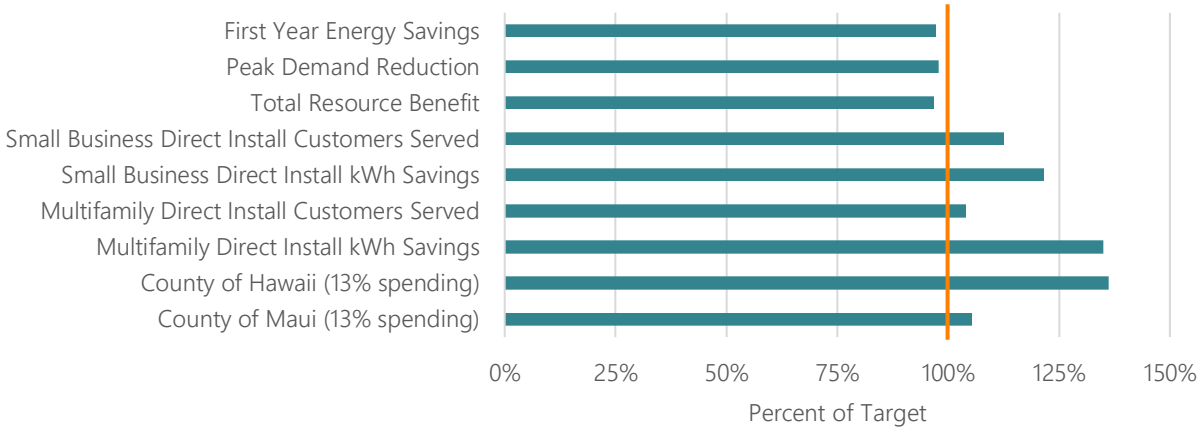


Figure 2-2 and Figure 2-3 (on pages 6 and 7) show more detail for the resource acquisition metrics for the residential and business programs, respectively. The plots show the percentage of the verified savings that each program represents on the left side and the percentage of the end-users on the right side. For REEM, the majority of the "Other" savings are due to the Peer Group Comparison (home energy reports) program, with additional savings for domestic hot water and envelope measures. Overall, most residential savings are from REEM's upstream lighting and Peer Group Comparison program components, while most business savings are from CBEEM custom projects and BEEM lighting measures.

Table 2-2. PY18 Claimed and Verified Performance Award

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

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

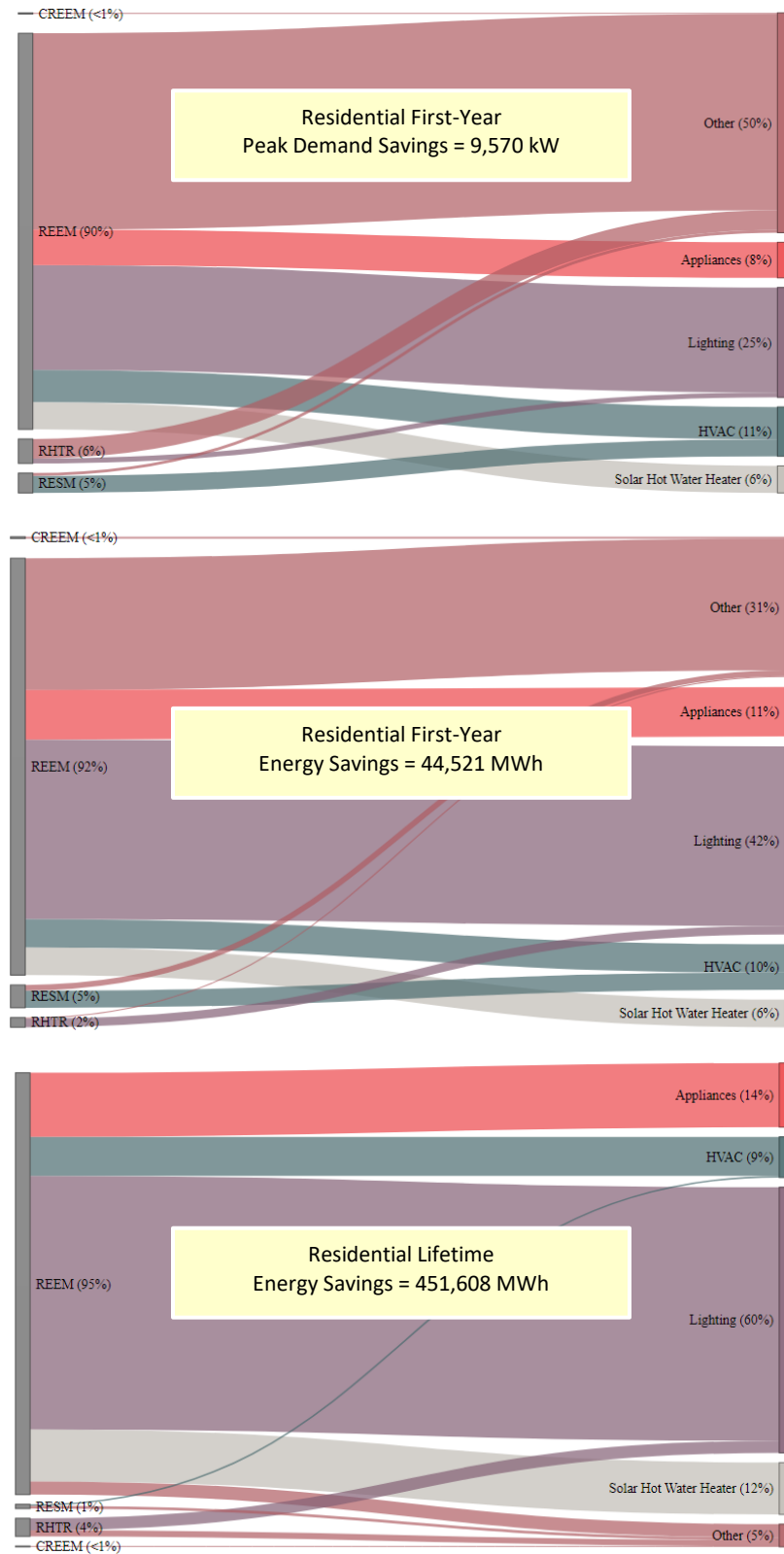


Figure 2-3. Business Verified Net Program-Level Impacts by Program and End-Use



Recommendations

Based on the verification activities, the EM&V Contractor developed a set of recommendations for Hawai'i Energy to consider. Because some of the recommendations were also carryovers from the PY17 verification activities, only those new to PY18 are provided in Table 2-3 table.

Table 2-3. PY18 Verification Recommendations

Area	Recommendation
Site inspections	<ul style="list-style-type: none"> When conducting site inspections during program implementation, ensure the inspections are sufficiently rigorous to catch mistakes made by contractors and installers; this includes carefully checking installation quantities.
Custom project savings analysis	<ul style="list-style-type: none"> Collect detailed information from customer sources, such as control systems, to allow for better accuracy on custom calculations. Improve documentation of all data sources and assumptions used in estimating savings for custom projects. Before conducting utility billing analysis for a given custom project, consider whether billing regressions are the best analysis approach and if there is sufficient pre- and post-implementation data for meaningful and timely results. When billing regression analysis is determined to be the most appropriate analysis approach, but requirements for post implementation billing records extend beyond the given program year, determine a mechanism for crediting savings for the program and for customer incentives. When using utility billing regressions, increase the analysis rigor by including important independent parameters within the regression and normalize the results when appropriate.
Peer program savings	<ul style="list-style-type: none"> Use results from the upcoming Peer Program Stoppage of Treatment study (when they become available) to update the savings approach for the Peer program and to inform decisions related to budgeting for home energy reports versus other energy saving measures.

3

TRM UPDATES AND RELATED RESEARCH

This chapter summarizes CY19 activities related to the review and update of Hawai'i Energy's TRM.

Mid-Year PY19 TRM Update

Purpose

The first approved PY19 TRM (version 1.2) became effective on July 1, 2019, which was the first day of PY19.⁶ In Fall of 2019, Hawai'i Energy provided the EM&V Contractor with lists of requested mid-year modifications and additions to the PY19 TRM.^{7,8} The suggested modifications and additions mainly reflected new program opportunities that Hawai'i Energy identified as being worthy of implementing during PY19 and in subsequent program years. The TRM Framework allows for mid-year additions as long as the requests are submitted and approved prior to implementation of the new or expanded measures.⁹ The purpose of the mid-year PY19 TRM update was to review Hawai'i Energy's requests and then add new and modified measure entries for all opportunities approved by the HPUC into a new version of the PY19 TRM.

Approach

In accordance with guidance provided in the TRM Framework related to mid-year updates, the EM&V Contractor reviewed the mid-year modifications and additions requested by Hawai'i Energy and developed a plan to carry out the updates.¹⁰ For each of the requests, the plan included a description of the request, comments on the level of effort expected to address the request, and a recommendation on how and when to include the new or modified content in the TRM. Specifically, the EM&V Contractor assessed whether to a) accept the new content requested by Hawai'i Energy "as is" and include it in the mid-year PY19 TRM, b) conduct further analysis of the given measure prior to inclusion in the mid-year PY19 TRM, c) address the request during the PY20 TRM update process, or d) reject the request.¹¹ Upon approval of the plan by the Energy Efficiency Manager (EEM) and HPUC, the EM&V Contractor carried out the mid-year TRM updates.

⁶ The TRM in effect at the beginning of the July 1, 2019 through June 30, 2020 program year was the Hawai'i Energy PY19 TRM version 1.2.

⁷ "PY19 TRM Adjustments and Additions Request," Word document and two accompanying Excel files, from Hawai'i Energy, sent to the TRM Administrator (Kelly Parmenter, AEG), October 4, 2019. Filenames: "PY19_TRM_Adjustments," "AC HP Savings Worksheet," and "Residential_Aerator&Showerhead."

⁸ "PY19 TRM - Residential Additions - Draft_20191113," Excel file, from Hawai'i Energy, sent to the TRM Administrator, November 13, 2019.

⁹ Hawai'i Energy Technical Reference Manual Framework, Version 1.1, June 1, 2020, Effective July 1, 2019 (superseded Version 1.0). See Section 3.4 Mid-Program Year Additions and Modifications.

¹⁰ Final Plan for Mid-Year Changes and Additions to the PY19 TRM, Memorandum, Prepared for Hawai'i Energy, Energy Efficiency Manager (EEM), and Hawaii Public Utilities Commission (HPUC), Prepared by Applied Energy Group, December 10, 2019.

¹¹ None of Hawai'i Energy's requests were rejected.

Results and Recommendations

The mid-year updates made to the PY19 TRM included the following:¹²

- Addition of four new measures
- Expansion of four measures to include savings options for a wider range of implementation alternatives
- Clarifications and corrections to the entries for two measures
- Update of the net-to-gross (NTG) ratio for the upstream lighting program

Table 3-1 lists each of the final mid-year updates as well as recommendations to consider in future updates.

Table 3-1. Summary of Mid-Year Updates to the PY19 TRM

Requested Mid-Year Update	Changes Incorporated in PY19 TRM v2.1	Future Recommendations
<p><u>Residential: Central AC</u> Addition of new baseline for retired units with pre-2006 vintage</p>	<ul style="list-style-type: none"> • Updated descriptions of program criteria and baseline equipment. • Added allowance for 11 SEER as the first baseline period efficiency for pre-2006 vintage units that are less than 20 yr old and are still operating upon replacement. • Added additional footnotes and resources. • Updated the calculation worksheet to accommodate the pre-2006 baseline case. 	<ul style="list-style-type: none"> • Monitor the number of projects with pre-2006 vintage baseline units. A limit may be set on the percentage of units that will be eligible for this "special" treatment if they become a significant portion of the retrofits. • Consider re-evaluating the remaining useful life (RUL) in the future to have it be a function of the pre-existing equipment's age.
<p><u>Residential: Faucet Aerator</u> and <u>Residential: Showerhead</u> Add table with deemed savings for online marketplace</p>	<ul style="list-style-type: none"> • Added table showing distribution of water heating by technology for Hawaii. Included source for the data. • Added table with blended savings for units purchased from Online Marketplace. • Clarified that there are distinct products for bathroom vs. kitchen aerators. • Made minor spelling and formatting corrections. 	<ul style="list-style-type: none"> • Conduct a comprehensive review and update of these two measures for the <u>PY20 TRM</u>. • In the PY20 TRM update, use data from the <u>2019 Baseline Study</u>, add lifetime savings, and review the approach and assumptions used to estimate savings for consistency with the solar water heater and heat pump water heater measures. • Consider weighting the blended savings by home type (multifamily and single family) in addition to the current weighting by water heater type.

¹² Mid-Year PY19 TRM v2.1 Update: Summary of Changes Made, Memorandum, Prepared for Hawai'i Energy, Energy Efficiency Manager (EEM), and Hawaii Public Utilities Commission (HPUC), Prepared by Applied Energy Group, June 1, 2020.

Requested Mid-Year Update	Changes Incorporated in PY19 TRM v2.1	Future Recommendations
<p><u>Commercial: Guest Room EMS</u> Define large vs. small lodging</p>	<ul style="list-style-type: none"> Defined large hotel as 100+ rooms. (The building prototype used to estimate savings had 179 rooms.) Defined small hotel/motel as <100 rooms. (The building prototype used to estimate savings had 77 rooms.) 	<ul style="list-style-type: none"> No recommendations at this time.
<p><u>Commercial: Chiller Worksheet</u> Correct cell reference errors</p>	<ul style="list-style-type: none"> Added banner along top of worksheet with measure name. Fixed errors in the cells formerly designated as H5, P6, and P7. (They are cells H6, P7, and P8 in the updated TRM since a row was added for the measure name). 	<ul style="list-style-type: none"> Consider simplifying the calculator. It currently uses a complex set of formulas with nested IF statements, which are difficult to QC.
<p><u>Residential: Dual-inverter Driven Window AC</u> Add new technology</p>	<ul style="list-style-type: none"> Expanded the existing residential window AC measure to include more capacity bins and the ability to cover ENERGY STAR certified dual inverter driven window AC systems. This included adding CEER and EER requirements by capacity bin, for "connected" (i.e., "smart") units and standard units. Updated the R_HVAC_AC_WKST to allow for more capacity bins to cover all standard and connected ENERGY STAR units < 28,000 Btu/h. 	<ul style="list-style-type: none"> No recommendations at this time.
<p><u>Residential/Commercial: Dual-inverter Driven Window AC</u> Add new technology</p>	<ul style="list-style-type: none"> Created a new commercial window AC measure, which covers all ENERGY STAR certified products, including dual inverter driven systems. Created a new calculation worksheet: C_HVAC_WindowAC_WKST. 	<ul style="list-style-type: none"> No recommendations at this time.
<p><u>Residential: Linear LED</u> Review TRM measure sheet provided by Hawai'i Energy for this new technology</p>	<ul style="list-style-type: none"> Linear LED: Added savings for Type A, B, and C installations (Wattages and effective useful lives differ by installation type).¹³ Type A is default if unknown. Updated approach for hours of use (HOU) and interactive effects based on space types applicable to this measure. Clarified program delivery and lamp counts. 	<ul style="list-style-type: none"> Consider reviewing in-service rate in the future. Current in-service rate (ISR) was estimated for screw-in bulbs.

¹³ Type A installation: Ballast left in place; reduced savings due to losses and lifetime reduced to remaining useful life of existing ballast. Type B installation: Bypassing fluorescent ballast and utilizing internal LED driver. Type C installation: Removing fluorescent ballast and utilizing an external driver.

Requested Mid-Year Update	Changes Incorporated in PY19 TRM v2.1	Future Recommendations
	<ul style="list-style-type: none"> • Made minor edits to variables and formulas for consistency. • Added more detailed documentation of assumptions, including list of resources. 	
<p><u>Residential: Security Light</u> Review TRM measure sheet provided by Hawai'i Energy for this new technology</p>	<ul style="list-style-type: none"> • Clarified program delivery and lamp types and counts. • Expanded baseline description and added dual baseline equations for clarity. • Updated coincidence factor (CF) to be applicable to Hawaii's peak demand period. • Added savings for both baseline periods to savings table to assist with TRC calculations. • Made minor edits to variables and formulas for consistency. • Added more detailed documentation of assumptions, including list of resources. 	<ul style="list-style-type: none"> • This measure should be monitored to track final decision on federal standards regarding 45 lm/W backstop.
<p><u>Residential: Holiday String Light</u> Review TRM measure sheet provided by Hawai'i Energy for this new technology</p>	<ul style="list-style-type: none"> • Checked shelf stock of holiday string lights in two home improvement stores in Hawaii during week of Dec. 9, 2019 to confirm incandescent products are still widely available in Hawaii. • Added semi-prescriptive calculator to estimate savings per string light. (Deemed savings are currently per mini bulb.) • Increased coincident factor (CF) to account for greater share of operating hours expected during peak demand period. • Reduced operating hours since not everybody will operate lights from dusk to dawn. • Made minor edits to variables and formulas for consistency. • Added more detailed documentation of assumptions, including list of resources. • Confirmed with Hawai'i Energy that this measure is expected to be offered at least through PY21. 	<ul style="list-style-type: none"> • This measure should be monitored to track pricing differences between incandescent and LED string lights. Prices are changing very rapidly. • Consider reviewing ISR in the future. Current ISR was estimated for screw-in bulbs.
<p><u>Residential: Net-to-Gross (NTG) Ratio for Upstream LED Program</u> Review of Hawai'i Energy's proposed update to the</p>	<ul style="list-style-type: none"> • Performed a literature review of market effects attributable to upstream lighting programs. • Used models and results from other studies to verify the appropriateness of 	<ul style="list-style-type: none"> • Continue to monitor federal regulations related to LED bulbs.

Requested Mid-Year Update	Changes Incorporated in PY19 TRM v2.1	Future Recommendations
upstream LED NTG ratio, which accounts for market effects	Hawai'i Energy's proposed NTG ratio of 0.575. ¹⁴	<ul style="list-style-type: none"> • Revise the NTG ratio as appropriate to account for changing market conditions.

The final mid-year PY19 TRM (version 2.1) was approved for publication on May 20, 2020. The effective dates for applying the mid-year changes to assess the PY19 program impacts will follow the guidance provided in the TRM Framework.¹⁵

¹⁴ See the following memorandum for more information: LED Market Transformation Attribution to Hawai'i Energy, Memorandum, Prepared for Energy Efficiency Manager and Hawaii Public Utilities Commission, Prepared by Applied Energy Group, April 29, 2020.

¹⁵ Hawai'i Energy Technical Reference Manual Framework, Version 1.1, June 1, 2020, Effective July 1, 2019 (superseded Version 1.0). See Section 3.5 Application of TRM Error Corrections and Mid-Year TRM Updates.

PY20 TRM Update (Initiated)

The Hawai'i Energy TRM Framework calls for an annual review and update of TRM content. The workflow includes seven steps, three of which were completed in CY19 :

- Completed in CY19
 - Annual TRM update planning
 - Input on updates
 - Prioritization
- To complete in CY20
 - Draft TRM updates
 - Review and feedback
 - TRM adjustments
 - Final TRM presented for HPUC approval

During CY19, the EM&V Contractor completed the first three steps. After first developing a plan for the PY20 TRM updates, the EM&V Contractor compiled a preliminary list of measures and content to consider in the review and update process. The EM&V Contractor identified these items during the PY19 TRM update, the PY17 Verification, and through previous correspondence with Hawai'i Energy, the EEM, and the HPUC. The EM&V Contractor next requested additional input on the preliminary list of update ideas from the Technical Advisory Group (TAG) and then incorporated all update ideas into a comprehensive list for prioritization. This process resulted in a list of over 90 potential items to review and update. Using four criteria to score each update idea—as well as consideration for the level of effort and time required to conduct the update—the EM&V Contractor recommended a “short list” of roughly one dozen priority items to update for the PY20 TRM.¹⁶ The EM&V Contractor began the update process for the PY20 TRM during the second half of CY19.

LED Market Transformation Attribution Study (Initiated)

The EM&V Contractor initiated a study that involved reviewing available literature on the market effects of upstream lighting programs within the United States and assessing the market effects that may be reasonably attributable to Hawai'i Energy based on the past several years of implementing the upstream lighting program in Hawaii.

Codes & Standards (C&S) Attribution Study (Initiated)

The EM&V Contractor initiated a study to forecast the amount of demand and energy savings expected to result within the State of Hawaii from building code compliance enhancement and from newly adopted state appliance standards and to estimate the portion of those statewide C&S impacts that can be credibly attributed to the influence of Hawai'i Energy's C&S program.

¹⁶ Prioritization of Program Year 2020 Technical Reference Manual Updates: Final Plan, Memorandum, Prepared by Applied Energy Group, Prepared for Energy Efficiency Manager, Hawaii Public Utilities Commission, and Hawai'i Energy, December 10, 2019.

4

MARKET ASSESSMENT

This chapter describes market assessment work that was completed and initiated during CY19.

2019 Baseline Study

The EM&V Contractor completed the core surveys for the 2019 Hawaii Statewide Baseline Energy Use Study (Baseline Study).¹⁷ This work was initiated during 2018.¹⁸

Purpose

The Baseline Study consisted of a series of core surveys used to identify electricity- and gas-using equipment and appliances, building and dwelling characteristics, and descriptive information about households, businesses, institutions, and the military.¹⁹ An important feature of the surveys was the ability to link customer responses about these characteristics to their electricity bills, which allowed the survey results to be used to establish a baseline for estimating changes in energy use of appliances and equipment. Results from the study provided a comprehensive description of the building stock and appliance and equipment holdings across the five islands served by Hawaiian Electric Industries (HEI): Oahu, Maui, Molokai, Lanai, and Hawaii Island. One of the primary purposes of the study was to support the assessment of the State's potential for additional energy-efficiency savings (the [Hawaii Statewide Market Potential Study](#)) and to support measurement of the effectiveness of energy efficiency-related programs over time. The EM&V Contractor also used results from the Baseline Study during the update process for the [PY20 TRM](#).

Approach

Table 4-1 on the next page provides an overview of the four core market research data collection activities performed by the EM&V Contractor during the 2019 Baseline Study. The surveys were conducted with accounts served by HEI.

The EM&V Contractor's residential phone audit survey averaged 45-60 minutes in length and resulted in 403 completed surveys. In parallel with that survey, HECO conducted a Residential Appliance Saturation Survey (RASS) using a mail survey that yielded 3,500 completed surveys. The EM&V Contractor's Baseline Study team had the opportunity to coordinate with the HECO team on the design and implementation of the RASS to ensure that the residential surveys from the two teams mapped to one another as closely as possible. The EM&V Contractor used data from the RASS along with the residential phone audit to help characterize the residential market for the purposes of the [Hawaii Statewide Market Potential Study](#).

The EM&V Contractor conducted two types of surveys with small and medium businesses: 1) a 45-60 min phone audit survey with 372 completes and 2) a mail / online survey (meaning that respondents were invited by physical mail invitation to complete a survey online) with 862 completes. The EM&V Contractor

¹⁷ 2019 Hawaii Statewide Baseline Energy Use Study, Prepared by Applied Energy Group, Prepared for the Hawaii Public Utilities Commission, 2020.

¹⁸ Evaluation of the Hawai'i Energy Conservation and Efficiency Programs, Program Year 2017, Prepared by Applied Energy Group, Prepared for the Hawaii Public Utilities Commission, April 16, 2020, Chapter 6: Market Research.

¹⁹ The EM&V Contractor used additional surveys to investigate attitudinal and behavioral factors. Refer to the [Baseline Supplemental Surveys](#) section.

defined small and medium businesses as commercial accounts with annual electricity use of less than 1 million kWh. Once completed, the EM&V Contractor aggregated the databases from the two surveys to create a single sample representing the small and medium business population.

The last type of survey consisted of in-depth interviews with large customers who were defined as accounts with annual electricity use of greater than 1 million kWh and included the largest military, government, and Association of Apartment Owners (AOAO) accounts. The EM&V Contractor conducted most of the large customer interviews onsite, while a few were over the telephone. There were 93 completed large customer interviews, with each interview ranging from one to four hours in duration due to the size and complexity of the large customers' facilities.

Table 4-1. Overview of the EM&V Contractor's 2019 Baseline Study Methodology²⁰

Sector	Definition	Sampling Universe ²¹	Data Collection Method	Completed Surveys/Interviews
Residential	HEI Residential Accounts	333,775	Phone Audit	403
Small and Medium Businesses	HEI Commercial Accounts < 1M kWh	18,442	Phone Audit	372
			Mail Online	862
Large Customers	HEI Accounts > 1M kWh & largest military, government, and Association of Apartment Owners (AOAO) accounts	972	Onsite and telephone interviews	93

The residential and business phone audit surveys were somewhat unique. The EM&V Contractor designed these surveys to capture more detailed information from customers by having them complete a "guided walk-through audit" of their home (for residential customers) or business (for business customers). Respondents walked through their home or business on a room-by-room or area-by-area basis and responded to questions about energy-using equipment in-place for each room or area. These longer, more detailed surveys made it possible to capture all (or at least most) of the relevant technical information required for the research plan and, in many cases, to capture nameplate information as well.

Key Findings

Table 4-2 summarizes key findings from the Baseline Study. The table shows results for the three market segments surveyed (residential, small and medium businesses, and large customers) and for key building characteristics and end uses.

²⁰ This table does not include HECO's RASS, which was a mail survey of residential accounts that resulted in an additional 3,500 completed surveys.

²¹ The sampling universe represents the eligible pool of customers to survey after cleaning and aggregation of the data based on several criteria. See the full report for more details: 2019 Hawaii Statewide Baseline Energy Use Study, Prepared by Applied Energy Group, Prepared for the Hawaii Public Utilities Commission, 2020.

Table 4-2. Key Findings from 2019 Baseline Study Surveys

Market Segment	Summary of Key Findings from Surveys
Residential	<ul style="list-style-type: none"> • Home type: Single-family detached homes represent 64% of homes, while 9% are single family attached, and 27% are multifamily (e.g., apartments or condos). • Space cooling: 52% of residences do not have air conditioning (AC) or are unsure about this. Individual wall or window AC systems are the most common type of system (29% of all homes), followed by ductless split systems (12% of all homes), and central AC systems (7%). • Water heating: 53% of households report some form of electric water heating system, 26% report some sort of solar thermal system, and 10% report a gas or propane-fired system. • Lighting: The average home has 44 lightbulbs / lamps. LEDs make up the largest portion of these bulbs / lamps, with an average of 18 per household, compared to an average of nine CFLs and nine incandescent or halogen lamps. • Onsite generation: 28% of homes have solar photovoltaic (PV) systems.
Small and Medium Businesses	<ul style="list-style-type: none"> • Business type: The most common business types reported are retail (22%) and offices (21%). Warehouses (11%), restaurants (8%), healthcare facilities (7%), manufacturing establishments (6%), and multifamily properties²² (5%) are the next most common business types reported. • Space cooling: 70% of establishments pay to cool their space. Among those, room AC systems (27%) are the primary form of space cooling, but packaged units (24%) and ductless mini-split systems (20%) are nearly as common, followed by ducted split systems (15%). • Water heating: 45% of establishments pay for water heating as part of their electric bill. Among those, traditional storage tank water heaters are most common (at 53%). • Lighting: On average, facilities have 82 lamps / fixtures present. Of this total: 28 are traditional fluorescents, 21 are linear LEDs (replacing traditional fluorescents), 13 are screw-in LEDs, six are traditional incandescent bulbs, and eight are CFLs. • Onsite generation: 17% of respondents reported having a solar PV system. Interestingly, more respondents reported having PV systems than were indicated as having PV in HEI's database, which may mean there is a self-report error. 4% of facilities reported having onsite generation using a non-PV source (e.g., turbine, engine, fuel cell).
Large Customers	<ul style="list-style-type: none"> • Business type: The most common types of large customers surveyed included retail (19%), lodging (15%), healthcare (11%), grocery (11%), office (7%), and manufacturing (7%). • Space cooling: All facilities interviewed have and pay for cooling. The type of cooling is split amongst several different types of equipment, with rooftop units and chillers being common. • Water heating: Most facilities pay for water heating on their electric bill, with standard storage tanks being the most prevalent type of water heating equipment. • Lighting: Few facilities have traditional incandescent or halogen bulbs, although they are more prevalent in retail and food preparation space. • Onsite generation: Some form of backup generation is common, with 39% of these facilities reporting the presence on onsite generation (other than PV) and 32% reporting the presence of PV generation.

²² Note that multifamily properties in the residential sector represent individual apartments, condominiums, or similar housing units for which unit owners (or renters) are billed for the electricity used in the unit. Multifamily properties in the non residential sector represent electricity use that is billed to a "building" (e.g., electricity used for common area space, or other shared purposes, or electricity used in master-metered buildings).

Baseline Supplemental Surveys (Initiated)

The EM&V Contractor initiated a series of supplemental surveys with residential and nonresidential customers who previously participated in the 2019 Baseline Study to capture additional insight about attitudinal and behavioral factors relevant to understanding customer actions related to energy efficiency.

Market Potential Study (Initiated)

The EM&V Contractor initiated a comprehensive Market Potential Study (MPS) to assess the potential for future savings from energy efficiency and other interventions. The Hawaii MPS builds on and updates the 2014 Potential Study²³ and the 2018 Potential Study Update that was conducted in CY18 as part of the Energy Efficiency Portfolio Standard (EEPS) Review Research.²⁴

²³ State of Hawaii Energy Efficiency Potential Study, Prepared for the Hawaii Public Utilities Commission, Prepared by Applied Energy Group (dba EnerNOC Utility Solutions Consulting), 2014.

²⁴ EEPS Review Research Report, Prepared for the Hawaii Public Utilities Commission, Prepared by Applied Energy Group, February 2019.

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