



# EVALUATION OF THE HAWAI'I ENERGY CONSERVATION AND EFFICIENCY PROGRAMS

Calendar Year 2020

July 13, 2021 – Final

Prepared for:  
HAWAII PUBLIC UTILITIES COMMISSION

Energy Solutions. Delivered.

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## 2020 Energy Efficiency Evaluation, Measurement & Verification



### Provided Market Intelligence

From the 2020 Market Potential Study in Hawaii and the supplemental baseline surveys, the EM&V Contractor learned:

- Efficiency is a main driver in purchasing behavior for both residential and C&I customers with two-thirds purchasing LEDs and the vast majority purchasing ENERGY STAR appliances
- Grid optimization options exist across end uses, especially in HVAC, water heating, and EV
- Solar water heaters account for the greatest savings potential
- Residential EV ownership is expected to grow - 16% of Hawaiians own an EV now, but over half say they will buy one in the future



### Assessed Market Effects

Through two studies, the EM&V Contractor team:

- Found evidence to support an increased influence of the use of LEDs today based on past Hawaii Energy efforts. (*LED NTGR to 0.545 from 0.50*)
- Found evidence that Hawaii Energy's efforts influenced code enhancement activities around the state. (*25% of savings from these activities due to Hawaii Energy*)
- Did not find evidence indicating that Hawaii Energy's efforts influenced state appliance standards.



### Guided the Hawaii Energy Programs

The updated Technical Reference Manual (TRM):

- Enabled about 400 additional air conditioners (under 5 tons) to pass through the program by removing an efficiency specific requirement
- Increased first year savings for residential LED measures with subsequent 10% increase in portfolio savings
- Added commercial refrigeration measures so that walk-in coolers, refrigerated cases, and refrigeration systems can now obtain deemed savings



### Verified the Hawaii Energy Program Achievements & Performance Metrics

EM&V activities verified the following achievements:

- Hawaii Energy rebated more than one million energy-efficient items
- Hawaii Energy saved economically disadvantaged customers nearly \$22 million
- Program savings offset the use of more than 180,000 barrels of oil and avoided 107,000 metric tons of GHG emissions

Hawaii Energy Programs met nearly all of their performance metrics in PY2019, however the new performance metrics resulted in a few bumps related to both the COVID-19 pandemic and program tracking difficulties.

- The residential programs performed particularly well bringing in more savings than targeted and continuing to meet direct install participation objectives.
- Business prescriptive and hard-to-reach programs did not reach the required thresholds. For the first time in three years, Hawai'i Energy failed to bring in sufficient customers to their Energy Advantage program (the program seeks savings for small- and medium-sized businesses).
- PY19 included dual baselines for TRM measures for the first time and the program tracking database could not be updated quickly enough to apply dual baseline savings consistently with subsequent loss of lifetime savings and total resource benefits.

# EXECUTIVE SUMMARY

## Purpose of Report

The purpose of this report is to present the prior year's (2020) 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 the CY19 version, the reports are covering only prior CY activities, both initiated and *substantially* completed.<sup>1</sup> Within this report is also a summary of the most important findings from the completed CY20 EM&V activities, with a focus on implications for the Hawai'i Energy programs.

The EM&V work conducted for CY20 contributes to three overarching "core" research objectives:

- Verification of accomplishments: Verifying Hawai'i Energy's PY19 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.

## Approach

The EM&V-related research activities for CY20 were determined in consultation with the Hawaii Public Utilities Commission (HPUC) and the Energy Efficiency Manager (EEM). The EM&V Contractor completed seven research activities and initiated one activity. The activities completed in CY20 were:

- Verification of impacts for Hawai'i Energy's PY19 program portfolio
- Mid-year updates to the PY20 Technical Reference Manual (TRM)
- LED market transformation attribution study
- Codes and standards (C&S) attribution study
- Peer stoppage of treatment study
- 2019 Baseline supplemental surveys
- Market potential study

In addition to the completed activities, the EM&V Contractor initiated one other research activity in CY20:

- PY21 TRM review and update

The EM&V Contractor used a variety of research and analysis methods to carry out the CY20 EM&V work. Table ES-1 summarizes the primary methods employed for each completed EM&V research activity.

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<sup>1</sup> From this point forward, "completed" work refers to work that was *substantially* completed during CY20, meaning that the EM&V Contractor completed the research and began drafting final deliverables during CY20. However, final approval of these "completed" activities may have occurred in CY21.

Table ES 1. Summary of EM&amp;V Research Activities and Methods for Work Completed in CY20

EM&V Research Activity	Research and Analysis Methods	
PY19 Verification	<ul style="list-style-type: none"> <li>Documentation reviews</li> <li>Program tracking system review and analyses</li> <li>Sample design, selection and extrapolation</li> </ul>	<ul style="list-style-type: none"> <li>Engineering desk reviews</li> <li>Participant surveys</li> <li>Total resource benefit (TRB) analysis</li> </ul>
Mid-Year PY20 TRM Update	<ul style="list-style-type: none"> <li>Best practices research &amp; benchmarking</li> </ul>	<ul style="list-style-type: none"> <li>Measure characterization</li> </ul>
LED Market Transformation Attribution Study	<ul style="list-style-type: none"> <li>Data collection</li> <li>Literature review</li> </ul>	<ul style="list-style-type: none"> <li>Best practices research &amp; benchmarking</li> </ul>
C&S Attribution Study	<ul style="list-style-type: none"> <li>Data collection</li> <li>Literature review</li> </ul>	<ul style="list-style-type: none"> <li>Best practices research &amp; benchmarking</li> </ul>
Peer Stoppage of Treatment Study	<ul style="list-style-type: none"> <li>Data collection</li> <li>Data validation and cleaning</li> <li>Experimental design validation</li> </ul>	<ul style="list-style-type: none"> <li>Regression model development</li> <li>Power analysis</li> </ul>
2019 Baseline Supplemental Surveys	<ul style="list-style-type: none"> <li>Sample design and selection</li> <li>Research design</li> </ul>	<ul style="list-style-type: none"> <li>Survey development and testing</li> <li>Online data collection</li> <li>Data cleaning, weighting, and analysis</li> </ul>
Market Potential Study	<ul style="list-style-type: none"> <li>Stakeholder engagement</li> <li>Market characterization</li> <li>Measure characterization</li> </ul>	<ul style="list-style-type: none"> <li>Baseline energy use projection</li> <li>Savings potential estimation</li> <li>Intervention assessment</li> </ul>

## Key Findings and Implications

The EM&V Contractor completed three major types of EM&V research activities during CY20. They include PY19 verification of impacts, TRM updates and special studies, and market assessment activities. The key findings and implications of these findings for the Hawai'i Energy programs for each type of research activity are presented below.

### PY19 Verification of Impacts

Figure-ES 1 and Figure-ES 2 show that Hawai'i Energy met nearly all of its PY19 performance targets for clean energy technologies, and accessibility and affordability, respectively. Because the programs are heavily focused on prescriptive measures that use deemed savings from the TRM, the verification process is largely an accounting exercise to ensure that savings from the TRM are applied properly. Results from the PY19 Verification show opportunities to improve savings calculations for lighting measures with dual baselines, new construction projects, HVAC measures, and measures with semi-prescriptive calculations or category-specific deemed values (see Table ES 2).

Figure-ES 1. Achievement of Performance Targets for Clean Energy Technologies for PY19

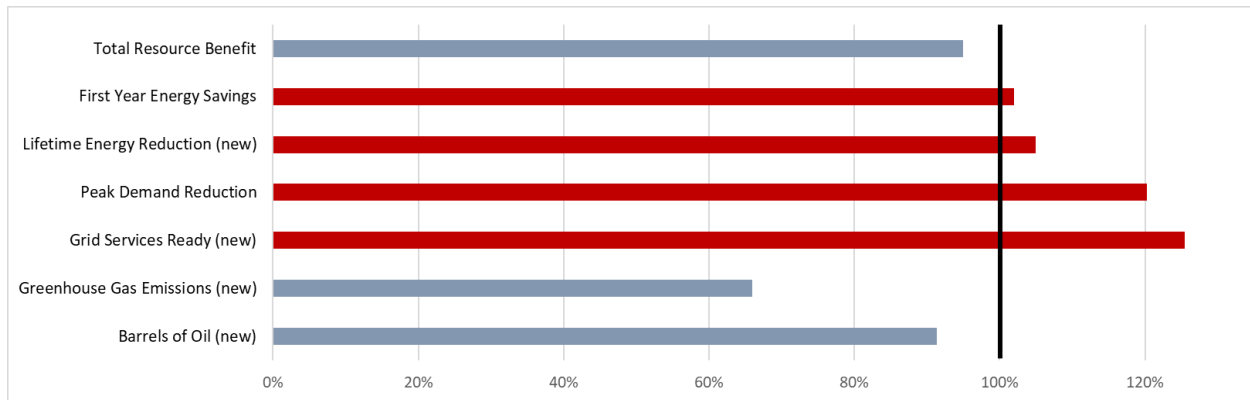


Figure-ES 2. Achievement of Performance Targets for Accessibility & Affordability for PY19

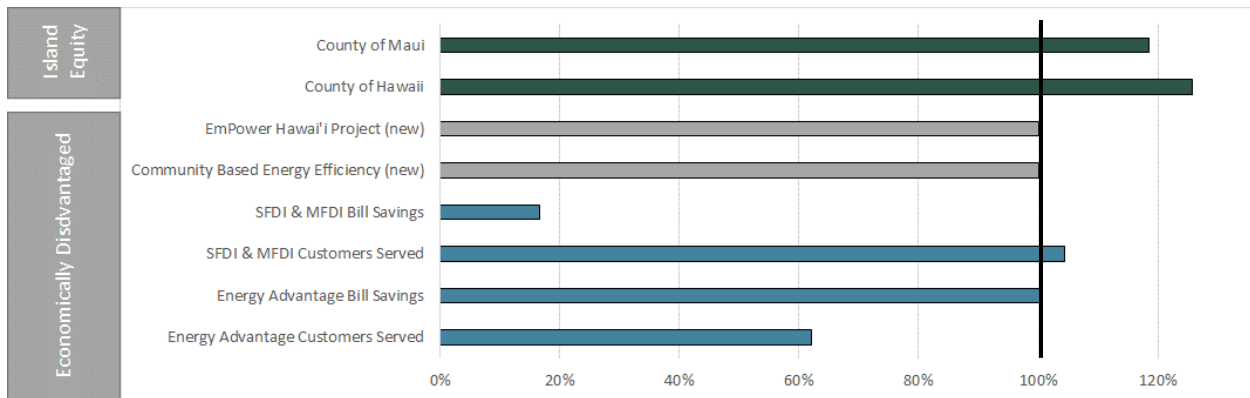


Table ES 2. Key Research Findings and Their Implications/Outcomes: PY19 Verification

Key Result/Finding	Implication/Outcome
Lifetime savings estimates did not consistently align with TRM deemed savings values. Typically, this misalignment affected measures that did not appropriately account for the dual baseline approach.	Verification-based adjustments to lifetime savings for these measures accounted for the bulk of the adjustments and lowered realization rates for lifetime savings in REEM and BEEM.
For CBEEM custom projects, lighting measures installed may qualify for dual baselines. Even though custom measure calculations are not following the prescriptive calculations in the TRM, these types of measures should still adhere to TRM guidelines.	The effect of not implementing dual baselines on overall program savings is relatively small; however, savings for some fixtures may be overstated.
The EM&V Contractor team observed inconsistent project documentation and methods for calculating new construction project savings.	Because projects relied on construction documents and architectural estimates for energy savings rather than including information on as-builts, invoice, and purchase orders, these savings estimates are not as robust as they could be.
For multiple HVAC projects, nominal unit capacity was used in the savings calculation rather than rated capacity, whereas TRM algorithms are meant to be used with rated capacity.	The overall effect on project savings can be large even for small variations in the number of products installed for a given site, or where make/model numbers differed slightly from those intended for installation.
The EM&V Contractor team found that Hawai'i Energy consistently used TRM deemed values rather than the provided semi-prescriptive calculations, and mainly relied on "Average" values rather than more granular savings estimates.	Implementing more granular semi-prescriptive calculations or category-specific deemed values would lead to more accurate savings values, and Hawai'i Energy already collects much of this data. The overall effect on program savings is relatively low.

### TRM Updates and Special Studies

The EM&V Contractor conducted three special studies during CY20 along with the typical mid-year TRM update activity. Table ES 3 to Table ES 6 summarizes the key results by research activity. The outcomes from the special studies range from informing the TRM update to informing program attribution to planning support of programs. The TRM update provides improved savings estimates.

Ongoing TRM updates, including the Mid-Year PY20 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).



*Table ES 3. Key Research Findings and Their Implications/Outcomes: Mid-Year PY20 TRM Update*

Key Result/Finding	Implication/Outcome
Added three new commercial refrigeration measures: evaporator motor controls, adding doors to refrigerated cases, and floating head pressure.	TRM additions provide savings estimation approaches for new measures introduced to the program after finalization of the original PY20 TRM.
Corrected cell reference errors in the commercial chiller worksheet.	Corrections lead to improved accuracy of savings estimates.
Added new baseline conditions and modified program criteria for two HVAC measures: residential HVAC and commercial HVAC.	The clarification promotes proper use of the equipment qualifications.
Clarified the savings and baseline periods in the deemed savings tables and the semi-prescriptive calculators for two measures: residential lighting and commercial lighting.	The clarification promotes proper use of the Tier 1 and Tier 2 baselines.

*Table ES 4. Key Research Findings and Their Implications/Outcomes: LED Market Transformation Attribution Study*

Key Result/Finding	Implication/Outcome
Results indicate it is reasonable to increase the NTG ratio from 0.5 to 0.575 for the 2019-2021 Triennial Plan period to account for market effects from previous program years.	Informs the update of the TRM.

*Table ES 5. Key Research Findings and Their Implications/Outcomes: Codes & Standards Attribution Study*

Key Result/Finding	Implication/Outcome
Insufficient evidence to make a recommendation to keep or modify the preliminary estimate of 50% attribution for the influence on state appliance standards for the PY19-21 Triennial Plan.	<ul style="list-style-type: none"> <li>• Informs the attribution of market transformation to C&amp;S program.</li> <li>• Supports planning for future C&amp;S programs.</li> </ul>
Sufficient evidence to make a recommendation to keep the current estimate of 25% attribution for the influence on energy code enhancements for the PY19-21 Triennial Plan.	<ul style="list-style-type: none"> <li>• Informs the attribution of market transformation to C&amp;S program.</li> <li>• Supports planning for future C&amp;S programs.</li> </ul>

*Table ES 6. Key Research Findings and Their Implications/Outcomes: Peer Stoppage Treatment Study*

Key Result/Finding	Implication/Outcome
Unable to detect a statistically significant incremental savings impact associated with continuing to send Peer reports.	Informs the Peer program's implementation and evaluation going forward.

## Market Assessment Activities

The EM&V Contractor conducted two market assessment activities in CY20. They include: 2019 baseline supplemental surveys and a 2020 market potential study.

Table ES 7 summarizes the key research findings from the 2019 baseline supplemental surveys. The results support planning for future energy efficiency and renewable policies and programs, and also provides information useful for marketing purposes.



Table ES 7. Key Research Findings and Their Implications/Outcomes: 2019 Baseline Supplemental Surveys

Key Result/Finding	Implication/Outcome
<ul style="list-style-type: none"> <li>Most residential respondents are aware of rebate programs and more than a third of them report that they have participated.</li> <li>Less than half of SMB respondents are aware of rebate programs and a little less than a quarter have participated.</li> </ul>	<ul style="list-style-type: none"> <li>Provides insights into support, awareness, and participation in existing energy efficiency and renewable programs.</li> <li>Provides information useful for marketing purposes.</li> </ul>
<ul style="list-style-type: none"> <li>More than two-thirds of residential and two-thirds of commercial respondents report they typically purchase LEDs.</li> <li>The vast majority of those who have purchased LEDs have also purchased ENERGY STAR® appliances/equipment</li> </ul>	<ul style="list-style-type: none"> <li>Provides insights into the drivers and impacts of energy-efficient products and appliances.</li> <li>Supports planning for future energy efficiency policies and programs.</li> <li>Provides information useful for marketing purposes.</li> </ul>
<ul style="list-style-type: none"> <li>The two main drivers for the purchase of solar PV systems for both residential and commercial customers are saving money and environmental considerations.</li> <li>The majority of residential respondents with solar PV systems report that they use their air conditioning systems more often.</li> </ul>	<ul style="list-style-type: none"> <li>Provides insights into the drivers and impacts of PV products and appliances.</li> <li>Supports planning for future energy efficiency policies and programs.</li> <li>Provides information useful for marketing purposes</li> </ul>
<ul style="list-style-type: none"> <li>Sixteen percent (16%) of residential respondents currently have an EV but a little more than half say they will buy an EV in the future. For SMB respondents, the shares are 6% and 11%, respectively.</li> <li>Eleven percent (11%) of SMB respondents report have a charging station with 15% planning to have one or more in the future.</li> </ul>	<ul style="list-style-type: none"> <li>Provides insights into EV saturation.</li> <li>Supports planning for future PV policies and programs.</li> <li>Provides information useful for marketing purposes.</li> </ul>
<p>There is clear interest in solar water heaters and smart thermostat technologies among SMB respondents.</p>	<ul style="list-style-type: none"> <li>Provides insights into the interest in solar water heaters and smart thermostat technologies.</li> <li>Supports planning for future solar water heater and smart thermostat policies and programs.</li> <li>Provides information useful for marketing purposes.</li> </ul>

Table ES 8 shows the key findings from the 2020 Market Potential Study. While no major changes are required to Hawai'i Energy's programs, the results indicate that the programs could benefit from measure diversification, planning for future standards, and program integration. Also, there are opportunities for non-battery technologies in grid-service program and dynamic rates.

Table ES 8. Key Research Findings and Their Implications/Outcomes: 2020 Market Potential Study

Key Result/Finding	Implication/Outcome
<ul style="list-style-type: none"> <li>• EEPS goals are achievable under the Business-as-Usual (BAU) scenario.</li> <li>• Energy-efficiency potential is highly concentrated in cooling, lighting, and water heating across both residential and commercial sectors. <ul style="list-style-type: none"> <li>○ Lighting will be a key component of future EEPS savings but the portion of programmatic savings versus savings from codes and standards is unknown.</li> </ul> </li> </ul>	<p>No major changes are needed to Hawai'i Energy's portfolio</p> <ul style="list-style-type: none"> <li>• There is a likely benefit from measure diversification.</li> <li>• With respect to future standards, programs will need to plan for various future states.</li> </ul>
Cooling, electric vehicles and water heating show substantial potential for grid services in both sectors.	There are technology options, outside of batteries, that are good targets for grid-service programs.
Critical peak pricing rates show significant savings and load-shaping potential.	Variable or dynamic rates should be tested in Hawaii to confirm their savings potential.
<ul style="list-style-type: none"> <li>• Integrated programs allow Hawaii to hit several targets at once including energy efficiency and grid services.</li> <li>• HVAC and water heating are the most cost-effective target end uses for integrated programs.</li> </ul>	Hawaii should evaluate the appetite for integrated programs and future rate-based options.

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# 1

## INTRODUCTION

### Purpose of Report

The purpose of this report is to present the prior calendar year's (2020) 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 the CY2019 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 CY20 EM&V activities, with a focus on implications for the Hawai'i Energy programs.

### Research Objectives

The EM&V work conducted for CY20 contributes to three overarching "core" research objectives:

- Verification of accomplishments: Verifying Hawai'i Energy's PY19 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 CY20 to meet the core research objectives were:

- Verification of impacts for Hawai'i Energy's PY19 program portfolio
- Mid-year updates to the PY20 Technical Reference Manual (TRM)
- LED market transformation attribution study
- Codes and standards (C&S) attribution study
- Peer stoppage treatment study
- 2019 Baseline supplemental surveys
- Market potential study

In addition to the completed activities, the EM&V Contractor initiated one other research activity in CY20:

- PY21 TRM review and update

## 2

# PY19 VERIFICATION OF IMPACTS

This chapter summarizes the PY19 verification of impacts for the Hawai'i Energy programs. More detailed information on the verification can be found in the Hawai'i Energy PY19 Verification Report.<sup>2</sup>

## Purpose

The chief purpose of the PY19 verification effort was to provide an independent review of Hawai'i Energy's performance relative to the Triennial Plan performance targets.<sup>3</sup> 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 PY19 TRM, version 2.1.

## Approach

Verification activities spanned a wide range, including tracking database reviews and replication, engineering desk reviews, ensuring that Technical Reference Manual (TRM) gross savings values and related adjustments were correctly applied, reviewing additional documentation regarding equity and engagement with hard-to-reach communities, and surveys.<sup>4</sup> The EM&V Contractor applied the methods shown in Table 2-1 to arrive at verified savings and performance results for PY19. The methods were similar to those used during the PY18 verification, with some modifications. Program staff interviews, quality assurance / quality control (QA/QC) project reviews, and customer site verification were not conducted for the PY19 verification.

Table 2-1. PY19 Verification Methods

Method	Description
Tracking System Review	<ul style="list-style-type: none"><li>Reviewed an initial set of project details provided by Hawai'i Energy to assess the close-to-final aggregate savings and to inform the verification plan.</li><li>Reviewed the final database provided by Hawai'i Energy to assess final claimed savings for PY19.</li></ul>
Tracking System Verification	<ul style="list-style-type: none"><li>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.</li></ul>

<sup>2</sup> Hawai'i Energy PY2019 Verification Report, Prepared by Applied Energy Group and Tetra Tech, Prepared for Hawaii Public Utilities Commission, April 6, 2021.

<sup>3</sup> Annual Plan, Program Year 2019-2021, Hawai'i Energy, Leidos, [https://hawaiienergy.com/images/about/information-and-reports/annual-plans/Annual-Plan\\_PY19-21\\_Triennial-Plan.pdf](https://hawaiienergy.com/images/about/information-and-reports/annual-plans/Annual-Plan_PY19-21_Triennial-Plan.pdf).

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



Method	Description
	<ul style="list-style-type: none"> <li>• This analysis allowed verification of the degree to which Hawai'i Energy correctly used the TRM to calculate savings and resource benefits.</li> <li>• It also enabled an assessment of the level and reasonableness of information being tracked by Hawai'i Energy.</li> </ul>
Desk Review Verification	<ul style="list-style-type: none"> <li>• 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.</li> <li>• 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.</li> </ul>
Documentation Review	<ul style="list-style-type: none"> <li>• Reviewed documentation provided by Hawai'i Energy to verify performance relative to PY19 goals for clean energy technologies, accessibility &amp; affordability, economic development &amp; market transformation, and customer satisfaction.</li> </ul>
Total Resource Benefit (TRB) Analysis	<ul style="list-style-type: none"> <li>• 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.</li> <li>• Utilized the avoided cost factors presented in the PY19 TRM.</li> <li>• 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 PY19 goals.</li> </ul>
Verification of Award Claim	<ul style="list-style-type: none"> <li>• Calculated a verified performance award based on the PY19 verification results.</li> </ul>

## Results

Table 2-2 (on next page) summarizes the PY19 performance targets compared with Hawai'i Energy's claimed results and the verified results derived by the EM&V Contractor. Hawai'i Energy met nearly all of its performance targets. Even for areas where Hawai'i Energy did not achieve its target, the PY19 verification results show evidence of substantial effort on Hawai'i Energy's part. Hawai'i Energy exceeded most of the Clean Energy Technologies performance targets (see Figure 2-1). Hawai'i Energy also meet or exceeded most of the Accessibility & Affordability performance targets (see Figure 2-2).

Table 2-2. PY19 Claimed and Verified Performance Award by Performance Indicator

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

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

\*\* Determined by the AEG team.

Figure 2-1. Achievement of Performance Targets for Clean Energy Technologies for PY19

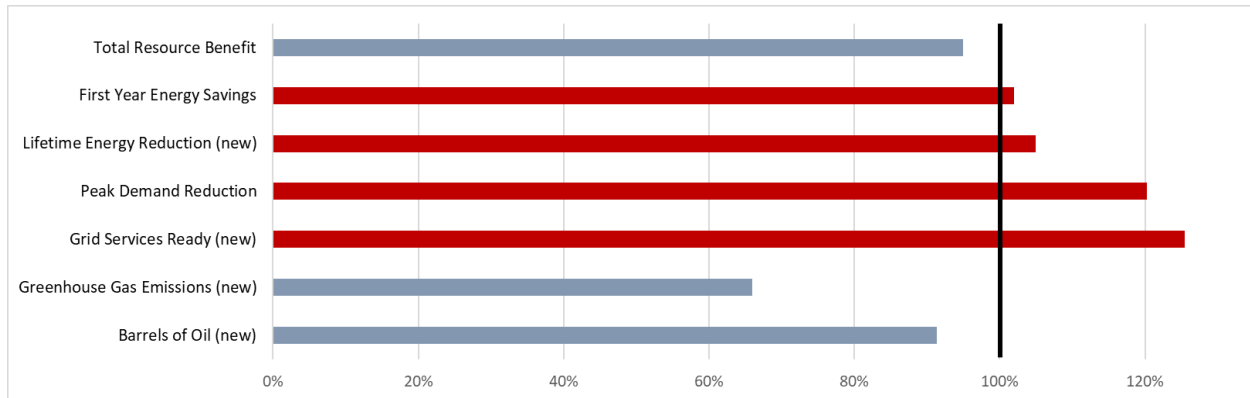


Figure 2-2. Achievement of Performance Targets for Accessibility & Affordability for PY19

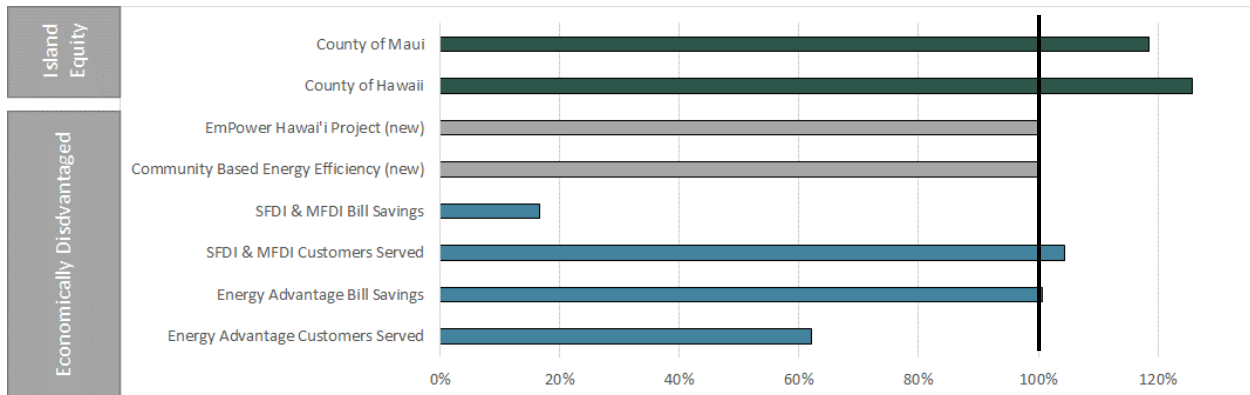


Figure 2-3 and Figure 2-4 show more detail for the Clean Energy Technologies metrics for the residential and business programs, respectively. The plots show the percentage of the verified savings that each program represents on the left side and the percentage of the end-uses on the right side. For REEM, 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.

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

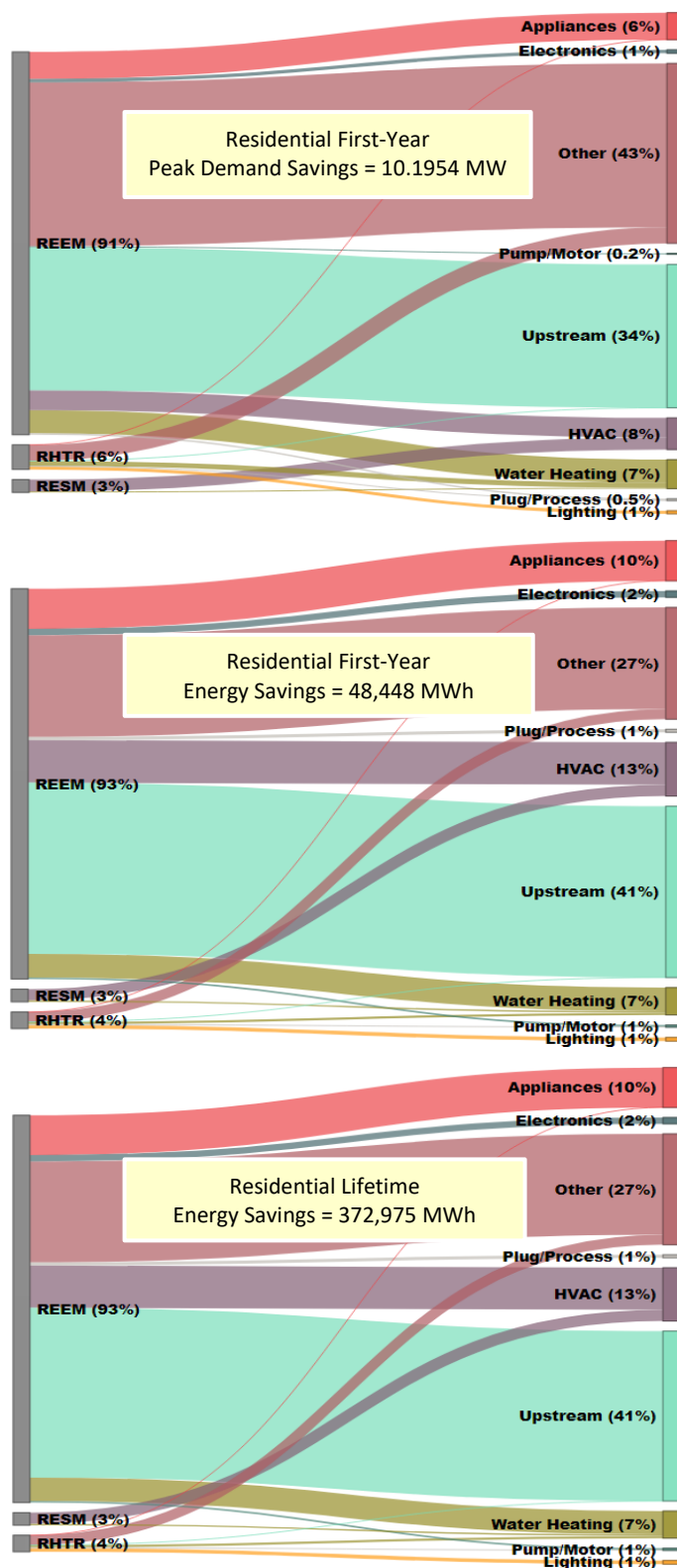
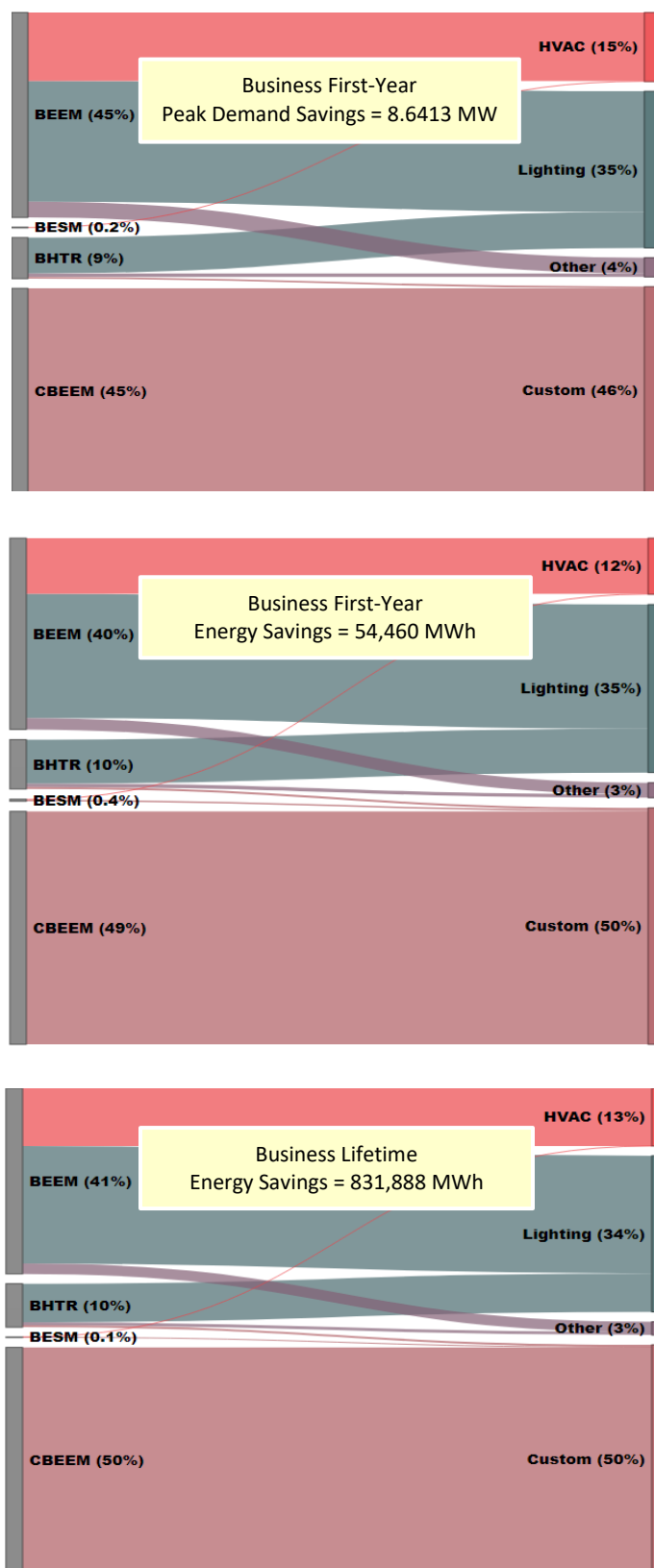


Figure 2-4. Business Verified Program Level Impacts by Program and End-Use



Through the verification activities, the following important achievements by Hawai'i Energy during PY19 were identified:

- Hawai'i Energy rebated more than one million energy-efficient items which are now installed in homes and business throughout the state
- The Hawai'i Energy programs, primarily through hard-to-reach efforts, saved economically disadvantaged customers nearly \$22 million on their utility bills
- Savings from Hawai'i Energy's programs offset the use of more than 180,000 barrels of oil and avoided 107,000 metric tons of GHG emissions

## 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 PY18 and PY17 verification activities, only those new to PY19 are provided in Table 2-3 table.

*Table 2-3. PY19 Verification Recommendations*

Area	Recommendation
Incentives	<ul style="list-style-type: none"> <li>• To maximize incentives, ensure all changes to TRM deemed measures are implemented in the tracking system calculations</li> </ul>
Custom lighting calculations	<ul style="list-style-type: none"> <li>• Modify calculations for custom lighting projects in CBEEM to include dual baselines where applicable to increase accuracy</li> </ul>
New construction lighting calculations	<ul style="list-style-type: none"> <li>• Increase the rigor of new construction lighting calculations to increase the confidence in project savings calculations</li> </ul>
HVAC calculations	<ul style="list-style-type: none"> <li>• Use rated capacity for HVAC calculations to improve realization rates</li> </ul>
Verification	<ul style="list-style-type: none"> <li>• To facilitate verification activities, obtain invoices, purchase orders, or submittals for all projects. In addition, seek clarity when these documents cover more than one rebate or customer site.</li> </ul>
TRM measures with semi-prescriptive savings	<ul style="list-style-type: none"> <li>• Review TRM measures where semi-prescriptive calculators are included and determine which semi-prescriptive approaches can be used during implementation. Consider implementing product-specific savings rather than relying on the average category values.</li> </ul>

# 3

## TRM UPDATES AND RELATED RESEARCH

This chapter summarizes CY20 activities related to the review and update of Hawai'i Energy's TRM.

### Mid-Year PY20 TRM Update

#### Purpose

The first approved PY20 TRM (version 1.0) became effective on July 1, 2020, which was the first day of PY20.<sup>5</sup> In Fall of 2020, the TRM Administrator presented recommendations for mid-year updates to the PY20 TRM.<sup>6</sup> The recommendations reflect input from Hawai'i Energy, the EEM, and the HPUC, and include additions or modifications for new or changed measure content, new baseline conditions, and corrections to errors.<sup>7</sup> 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.<sup>8</sup> The purpose of the mid-year PY20 TRM update was to review the recommendations and then add new and modified measure entries for all opportunities approved by the HPUC into a new version of the PY20 TRM.

#### Approach

In accordance with guidance provided in the TRM Framework related to mid-year updates, the EM&V Contractor reviewed the recommended mid-year TRM updates. Because all recommended updates fit within the budget currently set aside for mid-year additions, EM&V Contractor granted all requests. Upon approval by the Energy Efficiency Manager (EEM) and HPUC, the EM&V Contractor carried out the mid-year TRM updates.

#### Results and Recommendations

The mid-year updates made to the PY20 TRM included the following:<sup>9</sup>

- Addition of three new measures
- Revised baseline conditions and modified program criteria for two measures
- Revised the effective dates for the Tier 2 baseline for two measures
- Corrections of errors for one measure

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<sup>5</sup> The TRM in effect at the beginning of the July 1, 2020 through June 30, 2021 program year was the Hawai'i Energy PY20 TRM version 1.0.

<sup>6</sup> The current TRM Administrator is Kelly Parmenter, AEG.

<sup>7</sup> Mid-Year Changes and Additions to the PY20 TRM: AEG's Recommendations, Memorandum, Prepared for Energy Efficiency Manager (EEM), Hawaii Public Utilities Commission (HPUC), and Hawai'i Energy. Prepared by Applied Energy Group, October 16, 2020.

<sup>8</sup> 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.

<sup>9</sup> Mid-Year PY20 TRM v2.0 Update: Summary of Additions and Changes, Memorandum, Prepared for Energy Efficiency Manager (EEM), Hawaii Public Utilities Commission (HPUC), and Hawai'i Energy, Prepared by Applied Energy Group, December 15, 2020.



Table 3-1 lists each of the final mid-year updates.

Table 3-1. Summary of Mid-Year Updates to the PY20 TRM

Mid-Year Update	Key Changes Made for the PY20 TRM v2.0	Effective Date
<u>Commercial Refrigeration:</u> Evaporator Motor Controls <i>New measure</i>	<ul style="list-style-type: none"> <li>Added an "Update Status" section</li> <li>Clarified program criteria and unit of measure</li> <li>Removed unused terms from algorithm and added motor efficiency and motor capacity</li> <li>Revised compressor duty cycle assumptions to include separate values for coolers and freezers</li> <li>Revised bonus factor for coolers</li> <li>Added a semi-prescriptive savings calculator</li> <li>Added an EUL and lifetime savings</li> <li>Added a "Resources" section</li> </ul>	<ul style="list-style-type: none"> <li>When the new measure is/was first implemented during PY20</li> </ul>
<u>Commercial Refrigeration:</u> Adding Doors to Refrigerated Cases <i>New measure</i>	<ul style="list-style-type: none"> <li>Added an "Update Status" section</li> <li>Clarified program criteria and unit of measure</li> <li>Added interactive effects between the refrigeration system and the AC system to the algorithm and simplified the loss factor</li> <li>Revised compressor duty cycle assumptions based on benchmarking</li> <li>Added a semi-prescriptive savings calculator</li> <li>Added an EUL and lifetime savings</li> <li>Added a "Resources" section</li> </ul>	<ul style="list-style-type: none"> <li>When the new measure is/was first implemented during PY20</li> </ul>
<u>Commercial Refrigeration:</u> Floating Head Pressure Controls <i>New measure</i>	<ul style="list-style-type: none"> <li>Added an "Update Status" section</li> <li>Clarified program criteria and unit of measure</li> <li>Revised the linear regression approach to appropriately adjust for Hawaii's weather and Hawaii's peak demand period<sup>10</sup></li> <li>Developed separate models for four different types of refrigeration systems in addition to providing a model for an "unknown" system type</li> <li>Added a semi-prescriptive savings calculator</li> <li>Added an EUL and lifetime savings</li> <li>Added a "Resources" section</li> </ul>	<ul style="list-style-type: none"> <li>When the new measure is/was first implemented during PY20</li> </ul>

<sup>10</sup> In the draft measure entry, there was an issue in the linear fit approach that was used to adjust savings data obtained from the Regional Technical Forum (RTF) for the Pacific Northwest to Hawaii's weather conditions and peak demand period. AEG used the RTF savings data along with Portland TMY3 dry bulb temperature data to develop simple linear regression models; then AEG applied Honolulu TMY3 dry bulb temperature data to the models to estimate annual kWh savings for Hawaii during a typical year and to estimate kW savings during the 5-9 pm peak demand period.

Mid-Year Update	Key Changes Made for the PY20 TRM v2.0	Effective Date
<u>Commercial HVAC:</u> Chiller Chiller Savings Calculator <i>Corrections to errors</i>	<ul style="list-style-type: none"> <li>Corrected a cell reference error in cell H6, which previously caused the qualification of Tier 2 savings to always displays "fail" for Path B, regardless of the efficiency of the new equipment</li> </ul>	<ul style="list-style-type: none"> <li>July 1, 2019 (first day of PY19)</li> </ul>
<u>Residential HVAC:</u> Ductless Split Systems Central AC Retrofit HVAC Savings Calculator <i>New baseline conditions and modified program criteria</i>	<ul style="list-style-type: none"> <li>Removed language in the measure entries related to EER qualification for AC and heat pump systems of &lt; 65 kBtu/h in capacity</li> <li>Updated the HVAC Savings Calculator to remove the EER qualification requirement</li> <li>Revised the baseline EER values from 11.5 to 11.0 for 14 SEER systems and from 11.0 to 10.0 for 13 SEER systems. The updated values reflect the minimum EER ratings associated with 14 SEER and 13 SEER systems, based on product inventory data from AHRI.<sup>11</sup></li> </ul>	<ul style="list-style-type: none"> <li>July 1, 2020 (first day of PY20)</li> </ul>
<u>Commercial HVAC:</u> AC & Heat Pump AC & Heat Pump Savings Calculator VRF VRF Savings Calculator <i>New baseline conditions and modified program criteria</i>	<ul style="list-style-type: none"> <li>Revised language in the measure entries related to EER qualifications</li> <li>Updated the AC &amp; Heat Pump and VRF Savings Calculators to remove the EER qualification requirement</li> <li>Revised the baseline EER value from 11.5 to 11.0 for 14 SEER systems to reflect the minimum EER rating associated with 14 SEER systems per AHRI</li> </ul>	<ul style="list-style-type: none"> <li>July 1, 2020 (first day of PY20)</li> </ul>
<u>Residential Lighting:</u> LED (Omni-directional) Occupancy Sensor Security Light	<ul style="list-style-type: none"> <li>Updated the baseline equipment description</li> <li>Revised effective dates for the Tier 2 baseline</li> <li>Updated the share of homes with electric cooling using findings from the 2019 Baseline Study<sup>12</sup></li> <li>Clarified the savings and baseline periods in the deemed savings tables and the semi-prescriptive calculators</li> <li>Provided separate sets of EULs and lifetime savings for PY20 and PY21 (only needed for the Occupancy Sensor and Security Light measures)<sup>13</sup></li> </ul>	<ul style="list-style-type: none"> <li>July 1, 2020 (first day of PY20)</li> </ul>

<sup>11</sup> Air-Conditioning, Heating, & Refrigeration Institute (AHRI), Database of Certified Products, accessed Oct. 2018 and Nov. 2020, available here: <<http://www.ahrinet.org/Contractors-Specifiers/Certified-Products>>.

<sup>12</sup> 2019 Hawaii Statewide Baseline Energy Use Study, Final Report, Prepared for Hawaii Public Utilities Commission, Prepared by Applied Energy Group, 2020.

<sup>13</sup> For PY20, the first baseline period assumes the EISA Tier 1 baseline lamps for the occupancy sensor and security light measures will need to be replaced once prior to the EISA Tier 2 baseline taking effect on June 30, 2022. For PY21, the first baseline period assumes the EISA Tier 1 lamps will not reach the end of their useful life until after June 30, 2022. For the omni-directional LED measure, the savings are the same for PY20 and PY21 since the EUL of the omni-directional halogen lamps in the first baseline period is 2 years for military housing and 3 years for non-military housing and, therefore, we assume the halogens will not reach the end of their useful life until after June 30, 2022.

Mid-Year Update	Key Changes Made for the PY20 TRM v2.0	Effective Date
<u>Commercial Lighting:</u> Decorative LEDs Directional and Screw-Base Omni-Directional LEDs <sup>14</sup>	<ul style="list-style-type: none"> <li>Updated the baseline equipment description</li> <li>Revised effective dates for the Tier 2 baseline</li> <li>Clarified the savings and baseline periods in the deemed savings tables</li> <li>Provided separate sets of EULs and lifetime savings for PY20 and PY21<sup>15</sup></li> </ul>	<ul style="list-style-type: none"> <li>July 1, 2020 (first day of PY20)</li> </ul>

The final mid-year PY20 TRM (version 2.0) was approved for publication on February 1, 2021. The effective dates for applying the mid-year changes to assess the PY20 program impacts will follow the guidance provided in the TRM Framework.<sup>16</sup>

<sup>14</sup> The savings for directional and screw-base omni-directional LEDs appear in two TRM worksheets: C\_Light\_General and C\_Light\_Dimmable (Nonlinear LED).

<sup>15</sup> For PY20, the length of the first baseline period is set at a minimum of 2 years since the Tier 2 baseline will not take effect until PY22. For PY21, the first baseline period equals the EUL of the Tier 1 baseline lamp, which ranges from 1 to 3 years depending on the lamp type and building type.

<sup>16</sup> 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.

## PY21 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 CY20 :

- Completed in CY20
  - Annual TRM update planning
  - Input on updates
  - Prioritization
- To complete in CY21
  - Draft TRM updates
  - Review and feedback
  - TRM adjustments
  - Final TRM presented for HPUC approval

During CY20, the EM&V Contractor completed the first three steps. After first developing a plan for the PY21 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 PY20 TRM update, the PY18 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 80 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 a short list of three standard updates, two new measures, and one special study for the PY21 TRM update.<sup>17</sup> The EM&V Contractor began the update process for the PY21 TRM during the second half of CY20.

## LED Market Transformation Attribution Study

### Purpose

The LED lighting market has changed rapidly over the past decade, driven by declining costs, improving quality, updates to federal standards, and utility or third-party energy efficiency programs. As LED market adoption has increased, the share of bulbs that can be directly attributed to utility or third-party program influence has tended to decline, as is the case in Hawaii, where Hawai'i Energy's upstream lighting net-to-gross (NTG) ratio decreased from 0.65 to 0.5 in mid-2018.

In its 2019-2021 Triennial Plan, Hawai'i Energy increased the NTG ratio from 0.5 to 0.575 (halfway between the current and former NTG ratio) to effectively quantify the amount of LED market transformation that should be attributed to the upstream lighting program over the three years. To validate the reasonableness of these estimates, the HPUC engaged the EM&V Contractor to review the available literature and data on the effects of upstream lighting programs and to provide a recommendation for the market effects that may be attributable to Hawai'i Energy's past upstream lighting market effects.

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<sup>17</sup> Prioritization of Program Year 2021 (PY21) Technical Reference Manual Updates: Proposed Plan, Memorandum, Prepared by Applied Energy Group, Prepared for Energy Efficiency Manager (EEM), Hawaii Public Utilities Commission (HPUC), and Hawai'i Energy, November 27, 2020.

## Approach

The EM&V Contractor leveraged a significant amount of data on the lighting market from the geographic region of interest and from comparison states, including full category sales data, the share of LEDs that were ENERGY STAR-certified, and lighting retailer square footage.<sup>18</sup> Unfortunately, most of this information was not available for Hawaii. Because of this, the EM&V Contractor was unable to develop Hawaii-specific models or develop new data-driven NTG ratios. Instead, the EM&V Contractor developed a simplified analysis designed to use the models and results of two studies in particular to validate the reasonableness of Hawai'i Energy's proposed NTG ratio of 0.575.

## Results and Recommendations

The EM&V Contractor determined that it is reasonable to increase the NTG ratio from 0.5 to 0.575 for the 2019-2021 Triennial Plan period to account for market effects from the existence of an upstream lighting program over many years. The results from the LED market transformation attribution study informed the TRM update.

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

### Purpose

Codes and Standards (C&S) programs are increasingly garnering interest across the country as energy efficiency (EE) program administrators (PAs) are seeking new opportunities to capture additional energy savings beyond traditional EE programs. Because the support of C&S development and advocacy raises the baseline from which traditional EE programs' energy and demand savings are derived, some states allow PAs to claim savings for their C&S efforts.

In its 2019-2021 Triennial Plan, Hawai'i Energy estimated the amount of market transformation that should be attributed to its C&S program over the three years. These market effects were calculated by estimating the energy savings from state appliance standards and energy code compliance enhancements in non-residential new construction and then attributing a share of these savings to Hawai'i Energy. To assess the reasonableness of these preliminary savings estimates (which can be considered ex-ante estimates), the HPUC engaged the EM&V Contractor to review the available literature and data on the effects of C&S program activities in other states. The EM&V Contractor was also tasked with recommending both short-term and long-term activities to develop more robust savings estimates, including identifying the next steps for carrying out an ex-post evaluation of C&S savings attributable to Hawai'i Energy.

### Approach

The EM&V Contractor performed a literature review of C&S program market effects and used the results of approximately thirty-five studies to review the appropriateness of Hawai'i Energy's proposed attribution scores.<sup>19</sup> The EM&V Contractor also collected and reviewed the evidence of Hawai'i Energy's activities to support the adoption of state appliance standards and to enhance building code compliance. Figure 3-1 is a plot of multiple attribution scores for state appliance standards and code compliance enhancement used in other states compared with Hawai'i Energy's proposed values. The California values represent weighted averages for six different groupings of Title 20 state appliance standards across different

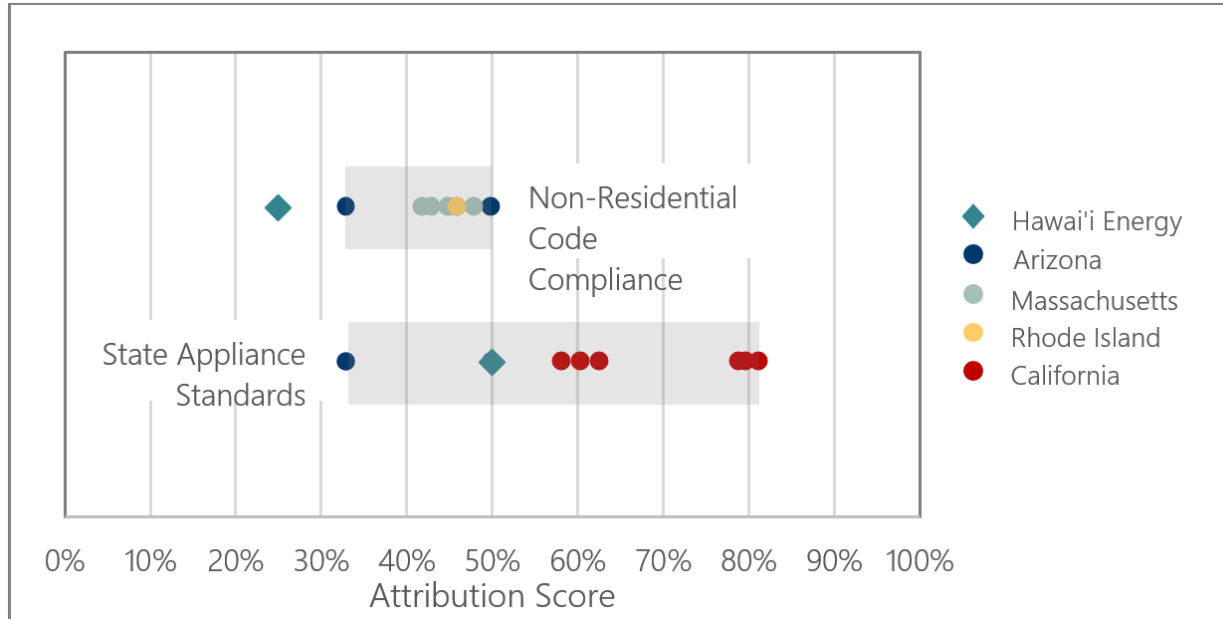
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<sup>18</sup> LED Market Transformation Attribution to Hawai'i Energy, Memorandum, Prepared by Applied Energy Group, Prepared for Energy Efficiency Manager (EEM) and Hawai'i Energy, April 29, 2020.

<sup>19</sup> C&S Market Transformation Attribution to Hawai'i Energy, Memorandum, Prepared by Applied Energy Group, Prepared for Energy Efficiency Manager and Hawaii Public Utilities Commission, June 9, 2020.

program year periods.<sup>20</sup> It is important to point out that California IOUs are heavily involved in equipment testing and standards development, so the attribution scores tend to be higher in California than in other states.

Figure 3-1. Comparison of C&S Attribution Scores Among States



## Results and Recommendations

The EM&V Contractor found that Hawai'i Energy provided some evidence of influence on state appliance standards, but the documentation is insufficient to allow the EM&V Contractor to make a recommendation to keep or modify the preliminary estimate of 50% attribution for the PY19-21 Triennial Plan. However, for the case of code compliance enhancement, Hawai'i Energy provided considerably more detailed evidence of influence, so the EM&V Contractor recommends keeping the current attribution score of 25% for the PY19-21 Triennial Plan.

For both state appliance standards and code compliance, the EM&V Contractor recommends that additional research activities be carried out before the end of the current triennial period to develop the final Hawaii-specific attribution scores that will be used in the verified (ex-post) savings attributed to the program. Additional research activities should include interviews with other entities in Hawaii with firsthand knowledge of Hawai'i Energy's and others' influence on state appliance standards and code compliance. The proposed C&S Phase 2 work<sup>21</sup> was proposed, but ultimately did not occur.

## Peer Program Stoppage Treatment Study

### Purpose

Hawai'i Energy sent the first Peer Comparison home energy report (HER) Program (Peer Program) reports in 2011 as part of a pilot study targeting the high energy usage 'Ewa region of O'ahu. Data collected from the pilot was evaluated using a traditional randomized control trial (RCT) approach. The results of the 2011

<sup>20</sup> Each *grouping* of California standards contains multiple *individual* appliance standards.

<sup>21</sup> Work Plan for Codes and Standards Attribution Phase 2, Prepared by Applied Energy Group, Prepared for Hawaii Public Utilities Commission. July 28, 2020.

pilot were used to develop a deemed savings estimate to quantify annual program savings. The participation in the Peer Program has since expanded to include nearly all of Hawaii's population. Without a true control group, it is not possible to reliably estimate the overall savings effect of the Peer Program from 2011. However, one can attempt to estimate the incremental benefits of continuing to send Peer reports, and this was the intention of the Peer stoppage treatment study.

## Approach

The Peer stoppage treatment study was implemented in two phases: a 2018 design phase and a 2020 analysis phase. In the design phase, the previous EM&V contractor randomly selected a group of participants who would no longer receive Peer reports. These participants, referred to as the stoppage treatment group (STG), were compared to those that continued to receive Peer reports, or the continued treatment group (CTG), in the analysis phase.<sup>22</sup> The analysis was based on a comparison of the randomly assigned STG to the CTG using a regression-based approach. This comparison allows the EM&V Contractor to determine whether there is an incremental effect of continuing to send reports.

## Results and Recommendations

The EM&V Contractor could not detect a statistically significant incremental savings impact associated with continuing to send Peer reports. The sample selected by the previous EM&V contractor in the design phase was too small to detect the expected small incremental effect (0.15%<sup>23</sup>) and would only be able to detect an incremental effect of approximately 0.8%, which is the size of the existing deemed savings.

The EM&V Contractor recommends three options for the Peer program. They are not mutually exclusive and there may be value in moving forward with all three:

- Option 1. Add a Decay Rate. The program could continue with a deemed savings approach but assume that the savings decay at a rate equal to the expected incremental effect for the STG group beginning in 2021. The decay would reduce the savings an additional 10% each year, from 0.8% to 0.7% to 0.6% of annual consumption, and so on.
- Option 2. Adjust Program Design. Acknowledge that the incremental energy and demand savings benefit of the program continuing as is, is likely limited. However, also acknowledge that while the program may not provide incremental energy and demand savings, the program can still be very valuable as a medium- to long-term market transformation program. As such, we recommend that Hawai'i Energy / Uplight revamp the program starting in PY21. Some considerations for future program designs include:
  - Use the program to drive targeted adoption of measures with much higher savings and longer measure life. A focus on longer life measures can help the program drive market transformation and achieve EEPs goals.
  - Use the program to drive targeted adoption of equipment that can provide a range of grid services.
  - Use the program to educate customers on the time-based value of energy, encourage load shifting, and (eventually) adopt time-variant pricing.

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<sup>22</sup> Hawai'i Energy Peer Program Stoppage Treatment Study Report, prepared by Applied Energy Group, Prepared for Hawaii Public Utilities Commission, March 15, 2021.

<sup>23</sup> A 10% decay rate was the rate assumed by the previous EM&V Contractor during the development of the stoppage treatment analysis, the 0.15% incremental effect represents the total decay in savings over 18 months of stoppage of treatment. This assumed decay rate is consistent with other HER persistence studies conducted within the industry.



- Revamp the program for more targeted information at different categories of residential customers (e.g., high versus low energy users, renters versus owners).
- Option 3. Request Implementer to Estimate Program Effects. Request that Hawai'i Energy and Uplight take responsibility for documenting the impacts of the Peer program. The Commission (through the EEM and AEG) took on the responsibility of estimating the program's effects even though this is more typically the responsibility of the administrator or implementer, where for behavior-type programs, implementers typically have multiple protocols for assessing and optimizing performance.

# 4

## MARKET ASSESSMENT

This chapter describes market assessment work that was completed and initiated during CY20.

### 2019 Baseline Study Supplemental Surveys

The EM&V Contractor completed a series of Supplemental surveys with residential and nonresidential customers who previously participated in the 2019 Hawaii Statewide Baseline Energy Study (Baseline Study).<sup>24</sup> The Baseline Study was initiated during 2018.<sup>25</sup>

#### Purpose

Since the Core surveys of the 2019 Baseline Study focused almost exclusively on technical questions about buildings / residences and appliances / equipment, the team recommended that separate surveys should be used to explore additional information about attitudinal, behavioral, or similar issues. The team determined that the most efficient way to capture this information would be to conduct a series of Supplemental surveys that could be implemented as smaller, standalone data collection efforts. One of the primary purposes of the 2019 Baseline 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

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. In total, six supplemental surveys were conducted. For each sector, three separate 10-12-minute online surveys were conducted. Customers in the sample were randomly assigned to a survey (depending on the survey or surveys for which they qualified) and were invited by email to complete a survey online. Given the relatively small total sample pool, respondents were given the opportunity to complete two surveys (if they qualified for both). The target sample sizes for each survey were 100 respondents. The team was able to complete nearly that number of interviews for five of the six surveys but fell short for the nonresidential PV survey due to the smaller number of eligible respondents. Details are as follows:

- Residential energy efficiency issues survey had a total of 97 valid respondents.
- Residential PV issues survey had a total of 92 valid respondents.
- Residential market potential survey had a total of 90 valid respondents.
- Nonresidential energy efficiency issues survey had a total of 109 valid respondents.
- Nonresidential PV issues survey had a total of 24 valid respondents

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<sup>24</sup> 2019 Hawaii Statewide Baseline Energy Use Study, Volume 1: Survey Research Findings, Prepared by Applied Energy Group, Prepared for the Hawaii Public Utilities Commission, April 27, 2020.

<sup>25</sup> 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.

## Key Findings

Key findings from the Supplemental surveys with residential customers include:

- Support for energy efficiency and renewables is very high. The majority of customers are aware of rebate programs and more than a third of the survey respondents report that they have participated.
- Energy efficiency is the main driver in purchasing behavior. More than two-thirds of respondents report they typically purchase LEDs and almost all of those who have purchased LEDs (91%) have purchased ENERGY STAR® appliances.
- The two main drivers for the purchase of solar PV are saving money and environmental considerations. The majority of respondents with solar PV systems report that they use their air conditioning systems more often.
- Electric vehicle (EV) saturation is likely to grow. Sixteen percent (16%) of respondents currently have an EV but a little more than half say they will buy an EV in the future.
- There is a clear interest in the solar water heater, refrigerator, smart lamps, and smart technology programs, as well as direct load control (DLC) programs aimed at water heating.

Key findings from the Supplemental surveys with SMB customers include:

- Support for energy efficiency and renewable energy is also very high. However, in contrast to residential respondents, less than half of SMB respondents are aware of rebate programs, and a little less than a quarter have participated.
- As we found among residential respondents, energy efficiency is also the main driver in purchasing behavior for SMB respondents. More than two-thirds of respondents indicate that they typically purchase LED lamps and among those, the vast majority indicate they have purchased ENERGY STAR equipment.
- The primary drivers for the purchase of solar PV systems are saving money and a desire to use renewables.
- Electric vehicle (EV) saturation is likely to stay pretty flat, which is in contrast to the residential sector. Six percent (6%) of SMB respondents report that they currently have an EV and 11% indicate they will buy an EV in the future. Eleven percent (11%) report have a charging station with 15% planning to have one or more in the future.
- There is a clear interest in solar water heaters and smart thermostat technologies among the SMB respondents.

## Market Potential Study

The EM&V Contractor completed 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 Study<sup>26</sup> and the 2018 Potential Study Update that was conducted in CY18 as part of the Energy Efficiency Portfolio Standard (EEPS) Review Research.<sup>27</sup> The MPS was initiated in 2019.

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<sup>26</sup> 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.

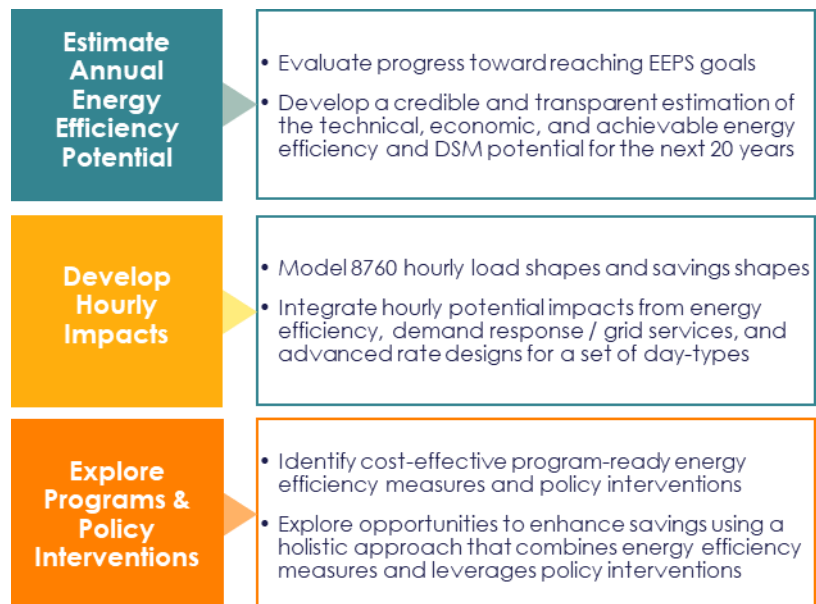
<sup>27</sup> EEPS Review Research Report, Prepared for the Hawaii Public Utilities Commission, Prepared by Applied Energy Group, February 2019.

## Purpose

The goals of the MPS are as follows:

- Evaluate the current status relative to the Energy Efficiency Portfolio Standard (EEPS) target and paths to continue to reach EEPS goals
- Quantify the landscape of energy efficiency and demand side management (DSM) over the next 20 years
- Provide a foundation to consider future programs and other interventions holistically

The figure to the right combines these primary goals with several secondary goals.



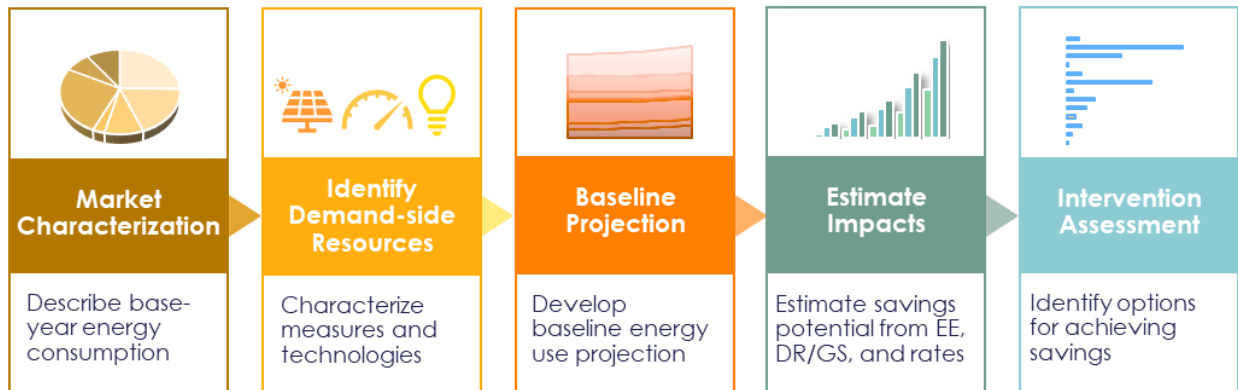
To gauge progress towards EEPS, the MPS needs to account for accomplishments since 2009 and forecasts of potential through 2030. The energy market looked very different in 2009 and much has changed since the 2014 Potential Study was completed:

- Hawaii has seen over a decade of federal and state codes and standards.
- New technologies have come on the market that impact how customers use and interact with energy (LEDs, connected devices, etc.).
- Solar photovoltaic (PV) penetration has grown substantially.
- Energy efficiency programs have helped customers make their buildings more efficient.

## Approach

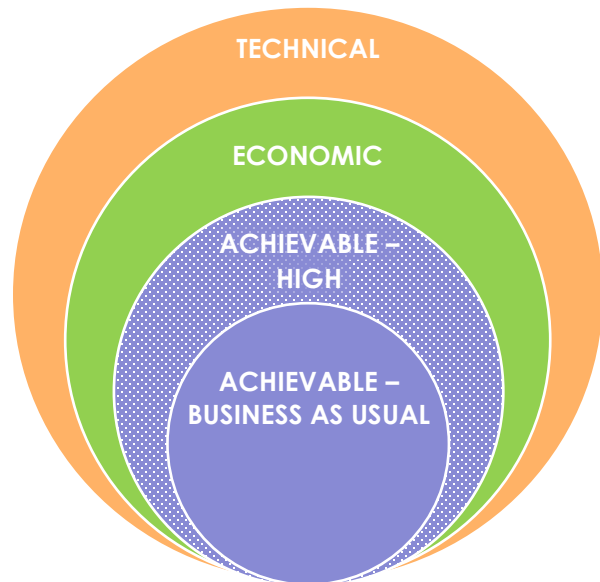
Using the resources from the HPUC's 2014 Potential Study and 2019 EEPS Review Research as a starting point, the EM&V Contractor updated the analysis to reflect current circumstances and conditions. To produce reliable and transparent estimates for the Hawaii MPS, the EM&V Contractor performed the five main steps shown in Figure 4-1.

Figure 4-1. Key Features of the Hawaii MPS



During this process, the EM&V Contractor estimated four levels of energy efficiency potential at the measure level through 2030 to gauge progress towards EEPs, as well as through 2040 to provide a foundation for future program considerations:

- **Technical potential:** The theoretical upper limit of efficiency potential. It assumes that customers adopt all feasible measures regardless of their cost or customer preference.
- **Economic potential:** Subset of technical potential that includes only cost-effective measures based on total resource cost test (TRC). Customers are assumed to purchase the most cost-effective option applicable at any decision juncture.
- **Achievable potential:** Subset of economic potential that accounts for likely customer adoption of energy efficiency measures. It refines economic potential by applying customer participation rates that account for market barriers, customer awareness and attitudes, program maturity, and recent program history. There are two levels of achievable potential.
  - **High:** Assumes higher levels of participation where additional opportunity is identified as well as expanded programs, future (new) state and federal codes and standards, future market effects, and other future interventions.
  - **Business as usual (BAU):** Assumes gradual maturation of future interventions which are similar to those in the market today.



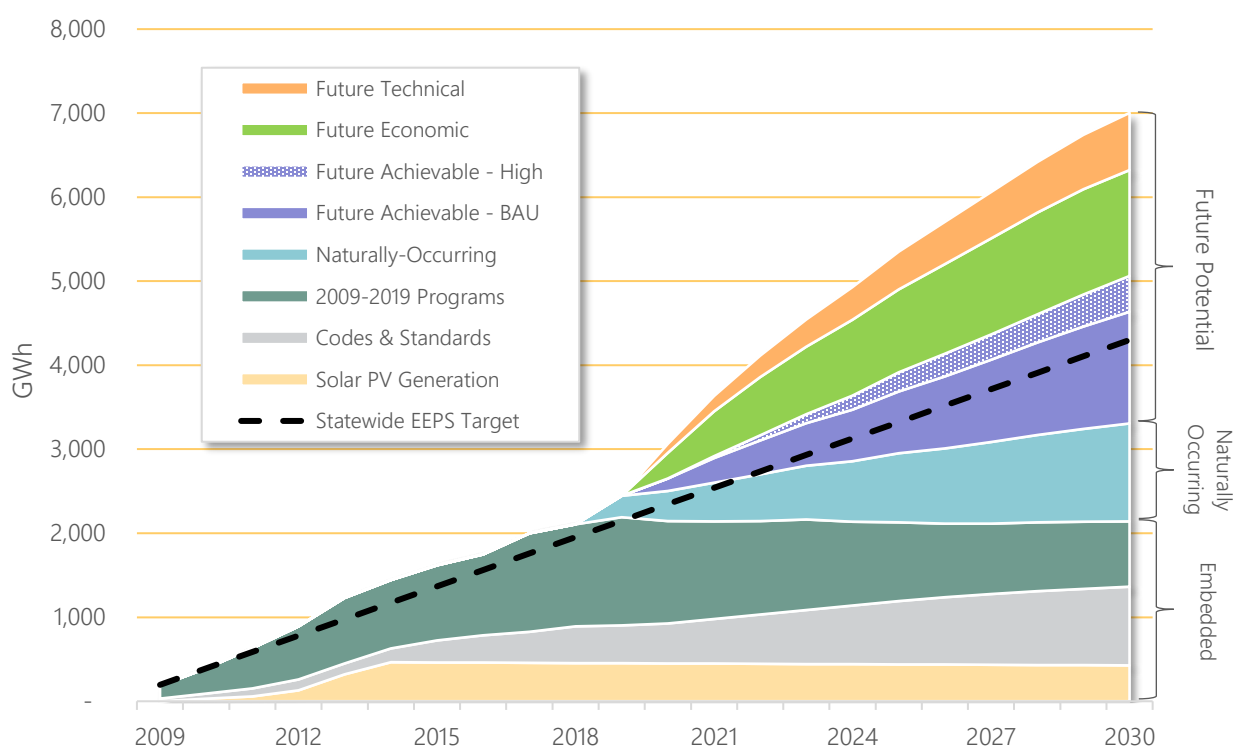
In addition to these four levels of potential, the EM&V Contractor also estimated technical achievable, a subset of technical potential that accounts for likely customer adoption of energy efficiency measures without consideration of costs. The achievable technical potential is useful for understanding how much

savings non-cost-effective measures might provide, as is the case in the analysis of demand response and grid services (DR/GS)<sup>28</sup>.

## Key Findings

Figure 4-2 presents the cumulative persistent savings over the entire EEPS horizon of 2009 through 2030. The graph shows that the interim EEPS target was met through 2018 and the 2030 target is projected to be achievable under a business as usual (BAU) scenario. While Hawai'i Energy's portfolio has historically provided the majority of the EEPS savings, other entities also contribute to achieving the EEPS goals: Commission Regulated Entities<sup>29</sup> and Non-Regulated Entities.<sup>30</sup> Therefore, attainment of this goal will require continued contributions by all of these entities at a similar level as in recent years, which may necessitate additional efforts in the short term to recover from the effects of the COVID-19 pandemic on "business as usual" for energy efficiency programs and the economy, in general.

Figure 4-2. Cumulative Persistent Energy Savings (GWh), 2009-2030, EEPS Perspective



These estimates reflect the change to the EISA standard that took place in late December 2019, which essentially removed the second tier of the standard<sup>31</sup>. The effect of this change was to shift savings that

<sup>28</sup> Also, programs typically consist of bundles of measures that may include both cost-effective and not cost-effective, as long as they are cost-effective when combined.

<sup>29</sup> Commission Regulated Entity savings include savings from utility administered and third party administered energy efficiency programs. The bulk of these savings are anticipated to be provided by Hawai'i Energy and Kauai Island Utility Cooperative (KIUC).

<sup>30</sup> Non-Regulated Entity savings include savings from legislative mandates, non-profits, other coordinated programs, building codes, and federal, state, and local appliance standards.

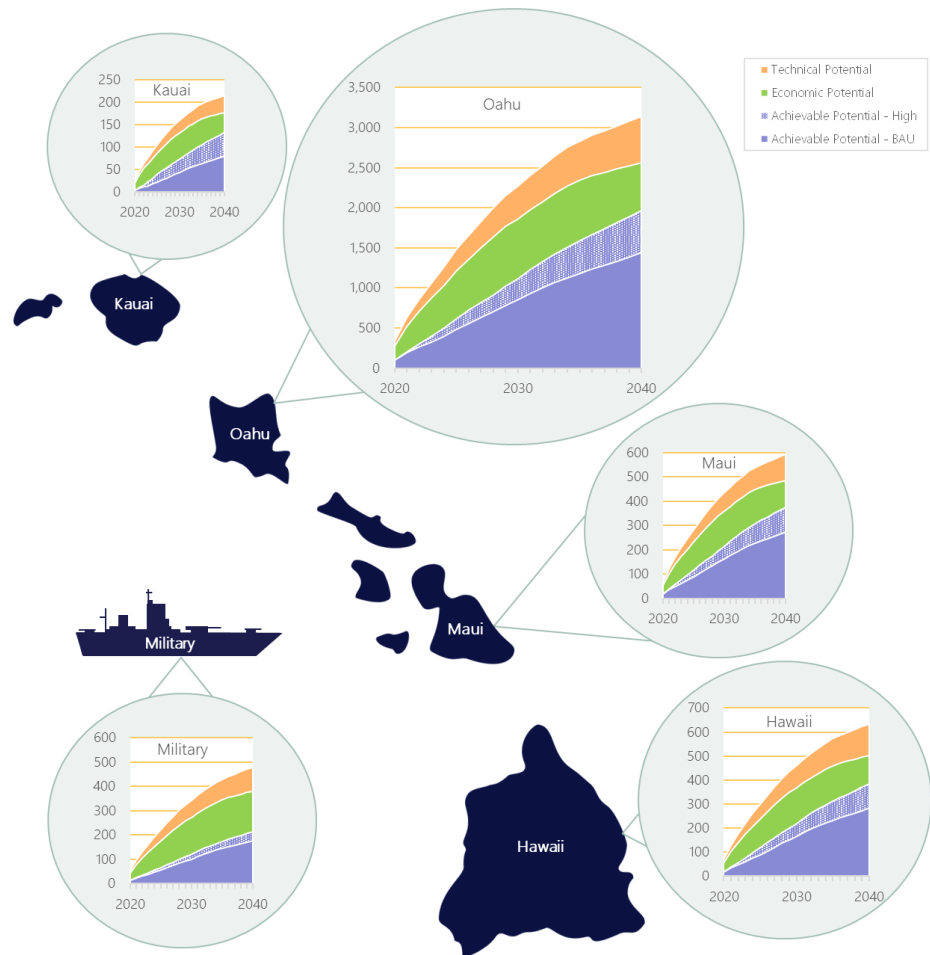
<sup>31</sup> On December 27, 2019, the U.S. Department of Energy issued a final ruling stating that the efficiency standards for GSILs do not need to be amended; therefore, the backstop did not go into effect as originally planned. (Tier 2 of EISA called for a 45 lm/W minimum efficacy backstop for general service incandescent lamps (GSILs), which was subject to an effective date of January 1, 2020.) This means that potential savings from lightbulbs fall outside of codes and standards and a portion of those savings are available for future programs, while a portion is allocated to future naturally occurring savings.

would have been attributed to appliance standards (Codes and Standards savings) to savings that could be achieved through programs and/or other interventions. Care should be taken when comparing these results with other potential studies completed in the same timeframe as the assumptions around EISA Tier 2 might be different than those used here.

Figure 4-3 presents the cumulative savings potential by an island in 2040. The end-use composition of the achievable potential savings is fairly consistent across the islands. Variation among end uses is small and is explained by the saturation of end-use technologies. That is a higher saturation of air conditioning results in a higher potential for savings from cooling-related measures.

The analysis found that a handful of residential and commercial measures account for the majority of savings in each sector. Figure 4-4 and Figure 4-5 show the projected savings for residential and commercial measures that contribute more than 50 GWh of cumulative persistent energy savings in 2030.

*Figure 4-3. Cumulative Savings Potential Summary, by Island and for the Military (GWh)*



- Residential sector. The residential measure with the greatest savings is solar water heaters, which pass the cost-effectiveness test throughout the study time horizon even though the federal tax credit is phased out. However, even with the tax credit, solar water heaters require a substantial investment, which limits adoption and achievable potential. The high growth in baseline cooling saturations through 2030 in regular-income homes<sup>32</sup> is driving the air conditioning potential. All but the most efficient ductless air conditioners pass the cost-effectiveness test. Also, connected home control systems include connected thermostat savings, which are cost-effective in most applications.

<sup>32</sup> Low- and medium-income (LMI) homes have a much lower saturation of air conditioning so have much lower potential savings from this end-use. Relatively speaking, the savings from lighting and water heating are higher in LMI compared to regular income.



- Commercial sector. Lighting end uses are represented in four of the top six commercial measures. A combination of high end-use intensity and popularity in programs is driving the lighting savings. The top measures include linear LED lamps (TLEDs) and LED fixtures plus controls.

Figure 4-4. Top Residential Measures, All Islands -Cumulative Savings in 2030 (GWh)

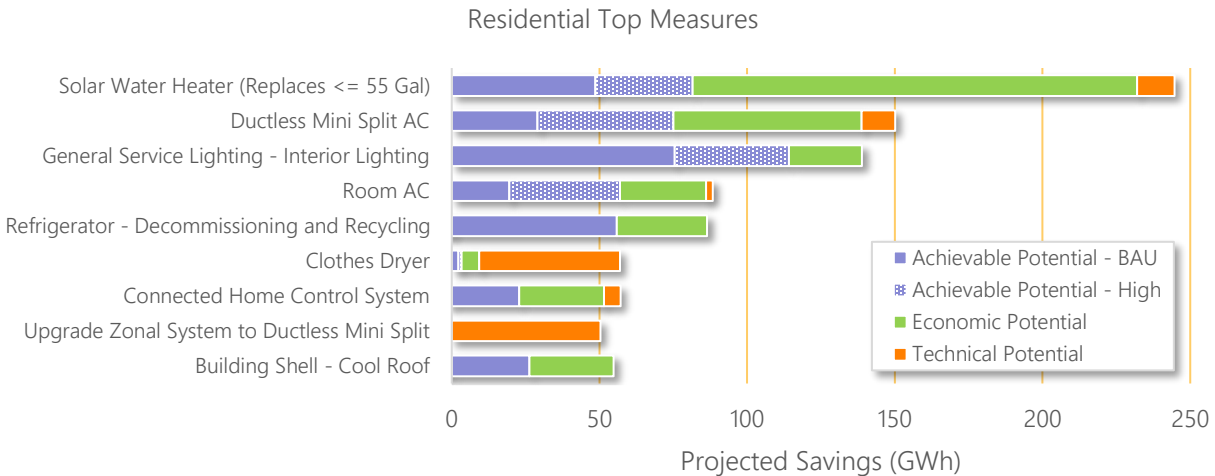
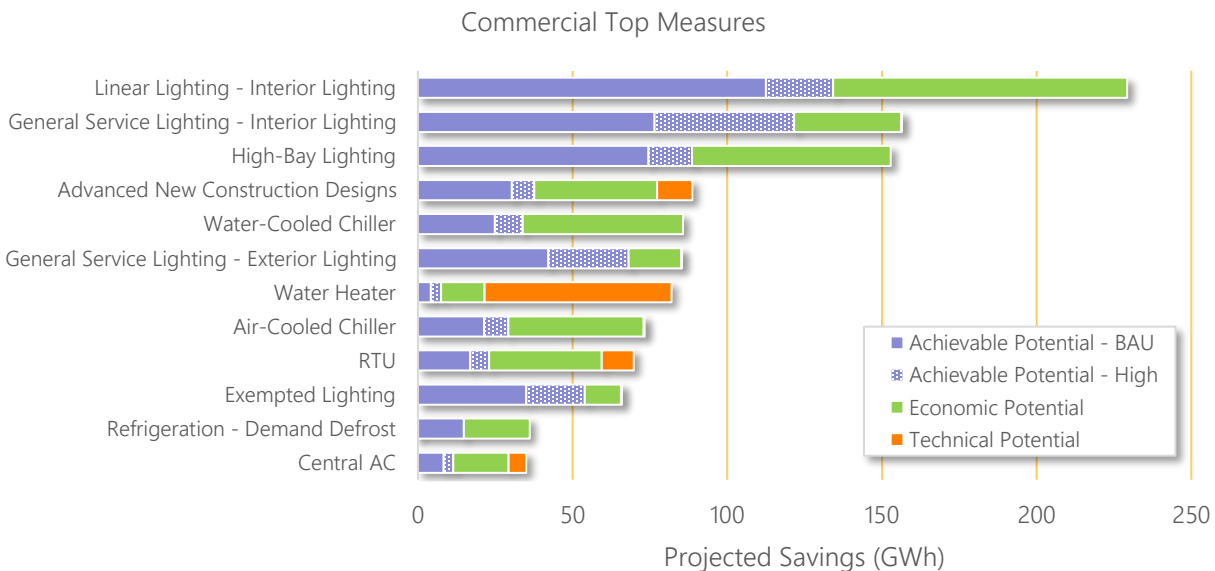


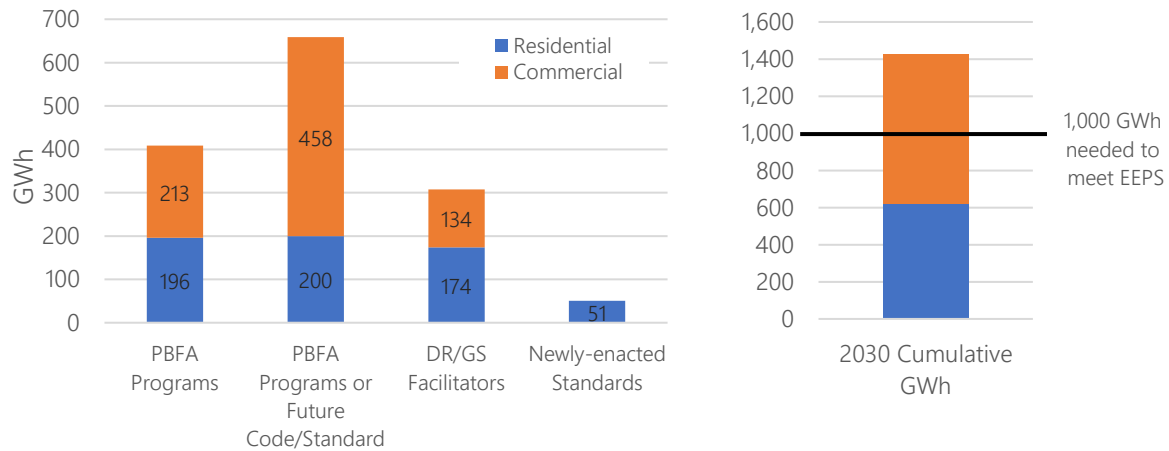
Figure 4-5. Top Commercial Measures, All Islands -Cumulative Savings in 2030 (GWh)



Results from the EM&V Contractor's 8760 hourly modeling of energy efficiency, demand-side rates, demand response / grid services show that integrating DSM resources can yield significantly greater energy savings than energy efficiency alone, helping Hawaii reach EEPS goals, while also addressing other grid needs, including peak load reductions. Also, assessment of the integration of hourly impacts from energy efficiency, DR/GS, and rates sheds light on the highest impact measures and possible strategies for maximizing the achievable energy savings potential, as well as pursuing temporal-based impacts to reduce peak demand and provide other grid services. (Details are provided in the final report.)

The analysis shows that strategically pursuing the most impactful measures with programs and other policy interventions should allow the State of Hawaii to obtain the amount of cumulative persisting energy savings still needed to meet the overall EEPS target of 4,300 GWh in 2030. As can be seen in Figure 4-6, about 1,000 GWh of cumulative persisting energy savings are still needed and the potential savings from just the most impactful measures are about 40% *higher* than needed to meet the target.

Figure 4-6. 2030 Cumulative Savings for Most Impactful Measures



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