HAWAIʻI ENERGY

Custom Project Guidance:

EM&V-Related Considerations

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- Ramsey Brown, Leidos / Hawai‘i Energy
- Vinh-Phong N. Ngo, Leidos / Hawai‘i Energy
- Keith Block, Leidos / Hawai‘i Energy
- Caroline Carl, Leidos / Hawai‘i Energy
- Brian Kealoha, Leidos / Hawai‘i Energy
- Sehun Nakama, Leidos / Hawai‘i Energy
- Kelly Parmenter, Applied Energy Group / EM&V Contractor
- Kelly Marrin, Applied Energy Group / EM&V Contractor
- Ingrid Rohmund, Applied Energy Group / EM&V Contractor
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- Sue Hanson, Tetra Tech / EM&V Contractor
- Mary Sutter, Grounded Research and Consulting / EEM Team
- Steven R. Schiller, Schiller Consulting / EEM Team
- Ted Pope, 2050 Partners, Inc. / EEM Team
- Ashley Norman, Hawai‘i Public Utilities Commission
- Nikki Matsumura, Hawai‘i Public Utilities Commission

List of Acronyms

AC: Air Conditioning
ARC: Accelerated Replacement Cost
CBEEM: Custom Business Energy Efficiency Measures
CFR: Code of Federal Regulations
CREEM: Custom Residential Energy Efficiency Measures
CF: Coincidence Factor
DOE: Department of Energy
EEM: Energy Efficiency Management Team
EFLH: Equivalent Full Load Hours
EISA: Energy Independence and Securities Act
EM&V: Evaluation, Measurement, and Verification
EPCA: Energy Policy and Conservation Act
EUL: Effective Useful Life
FMC: Full Measure Cost
GSL: General Service Lamp
HECO: Hawaiian Electric Company
HPUC: Hawai'i Public Utilities Commission
HVAC: Heating, Ventilating, and Air Conditioning
IMC: Incremental Measure Cost
IPMVP: International Performance Measurement and Verification Protocol
kW: Kilowatt
kWh: Kilowatt-Hour
M&V: Measurement and Verification
NTG: Net-to-Gross
PY: Program Year
QA/QC: Quality Assurance/Quality Control
RUL: Remaining Useful Life
SAE: Statistically Adjusted Engineering
TAG: Technical Advisory Group
TMY: Typical Meteorological Year
TRB: Total Resource Benefit
TRM: Technical Reference Manual
UMP: Uniform Methods Project
VFD: Variable Frequency Drive
VRF: Variable Refrigerant Flow

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Summary

The Custom Project Guidance Document supplements the Hawai'i Energy Technical Reference Manual (TRM) and TRM Framework. It provides information on custom projects applicable to Hawai'i Energy's custom programs. The scope covers documentation, data collection, and analysis guidance related to the evaluation, measurement, and verification (EM&V) of custom programs. Both minimum requirements and optional best practices are included, along with specific examples for common custom projects.

In essence, the overall minimum requirement is that the documentation and savings calculations performed during both custom project implementation and custom program verification must be sufficiently transparent to allow another analyst to assess program eligibility, understand the savings analysis, and be able to replicate calculations if needed. Later in the document are examples and details to enable meeting this minimum requirement.

1. Introduction

Purpose

The purpose of the Custom Project Guidance Document is to define the types of projects applicable for a custom savings estimation path, to describe eligibility requirements and program rules for custom projects, and to provide guidance on custom project documentation and energy savings estimation approaches. The focus is on EM&V-related considerations. This type of guidance is useful to ensure that custom projects are consistently and thoroughly described and analyzed during program implementation, which in turn facilitates an effective assessment of energy and demand savings during the annual EM&V process.

The intended audience is Hawai'i Energy and the EM&V Contractor:

- For Hawai'i Energy, the guidance is intended to reduce uncertainty in claimed savings estimates and to mitigate risks associated with low realization rates (verified savings/claimed savings) during verification by the EM&V Contractor. An additional intention is for the document to serve as a resource for Hawai'i Energy Advisors to refer to when reviewing and assisting with custom projects and when conducting site inspections and other quality assurance and quality control (QA/QC) processes.
- For the EM&V Contractor, the guidance is intended to ensure that sufficient information is gathered and documented during project implementation to enable verification or independent evaluation of the savings estimates during the annual verification effort. It is also intended to provide high-level guidance on impact evaluation best practices.

Relationship to the TRM

The Custom Project Guidance Document is complementary to the Hawai'i Energy TRM. While the TRM focuses on fully deemed and semi-prescriptive measures and provides limited guidance for certain custom measures, the Custom Project Guidance Document covers general guidance applicable to custom measures with a focus on EM&V-related documentation, data collection, and analysis considerations. The TRM also contains key metrics applicable to all types of measures—deemed, semi-prescriptive, and custom—including avoided costs, net-to-gross (NTG) ratios, system loss factors (SLF), avoided emissions, and avoided barrels of oil.

Update Process

This document was initially developed based on a recommendation from the EM&V Contractor to specify minimum documentation and analysis requirements needed to support EM&V of custom projects and to provide guidance on additional best practices for improving the rigor and transparency of savings estimation approaches.

The first effective date of the document is July 1, 2022, which is the beginning of PY22. This document will remain in effect until superseded by a later version.

Table 1 shows the timing and roles for future revisions to the Custom Project Guidance Document. Future revisions to this document will be made as-needed to address program modifications, findings during the verification process, updates to the TRM or TRM Framework, or other future input from the EM&V Contractor, EEM, TAG, HPUC or Hawai'i Energy. Table 1 also summarizes the processes for updates to the TRM, TRM Framework, and documents that support custom projects (e.g., custom project worksheets and the incentive application). The TRM and program-related documents will be updated annually for each new program year, while the TRM Framework will only be updated as-needed to reflect changes in the process of updating, maintaining, and applying the TRM.

Table 1. Document Update Timing and Roles

Document	Timing	Roles
Custom Project Guidance	**As-needed** based on program modifications, findings during the annual verification process, updates to the TRM or TRM Framework, or other future stakeholder input	**The EM&V Contractor's TRM Administrator** will lead the update process and will be responsible for draft and final deliverables **Hawai'i Energy** will provide input and review drafts **The EEM** will oversee the process, provide input, and review drafts **The HPUC** will review and approve final deliverables **Input from the TAG** will be solicited during future revisions
TRM	**Annual updates** prior to the start of each program year **Mid-year updates** as needed to add or modify content for a given program year	**The EM&V Contractor's TRM Administrator** will lead the update process and will be responsible for draft and final deliverables, including the prioritization memo, analysis files, summary of updates made, and the updated TRM **Hawai'i Energy** will provide input and review drafts **The EEM** will oversee the process, provide input, and review drafts **The HPUC** will review and approve the list of planned updates and final deliverables **The TAG** will provide input on content to be updated
TRM Framework	**As-needed** based on changes to the process of developing, maintaining, and applying the TRM	**The EM&V Contractor's TRM Administrator** will lead the update process and will be responsible for draft and final deliverables **Hawai'i Energy** will provide input and review drafts **The EEM** will oversee the process, provide input, and review drafts **The HPUC** will review and approve final deliverables **The TAG** will be notified about revisions to the framework
Custom Project Worksheets and Incentive Application	**Annual updates** prior to the start of each program year to reflect changes in program rules, revised milestone dates, updated TRM information, etc.	**Hawai'i Energy** is responsible for developing and maintaining program materials to meet program needs and to ensure they are consistent with current TRM and EM&V requirements

2. Custom Path Applicability

Definition of a Custom Project

A custom project consists of a single measure or a combination of measures that is larger in scope, more complex, and less well-characterized than a deemed or semi-prescriptive measure. Custom projects require collection and analysis of site-specific data to estimate energy and demand savings reliably and to determine the customer's incentive. The Hawai'i Energy TRM Framework defines custom projects and their savings calculations as follows:[1]

> *Custom savings calculations are most commonly used for measures or packages of measures that are more complex than deemed or semi-prescriptive savings projects or are larger in scope than intended by deemed savings projects. For this reason, the TRM does not prescribe calculation approaches for fully custom measures, but instead provides guidance on the types of measures and projects that should be handled with a custom approach.*
>
> *For the Hawai'i Energy programs, custom projects may be complex projects with multiple components, first-of-their-kind projects, or special projects that are unique to a particular customer and are handled on a case-by-case basis. These projects require a level of transparency and documentation that is not required by most deemed and semi-prescriptive measures. Custom projects should be sufficiently detailed to allow for quality control review.*
>
> *Custom calculations should be derived by industry best practices, such as those found in the Uniform Methods Project (UMP) protocols[2] and the International Performance Measurement and Verification Protocol (IPMVP).[3] The data collected, data editing, and data analysis should be documented so that savings can be reproduced, assuming there is access to any software used by the practitioner.*

Examples of Custom Projects

The list below summarizes examples of measures currently designated as custom in the TRM.[4] These measures should be evaluated using the custom path.

- Building recommissioning or retro-commissioning
- New construction or major renovation
- Certain types of HVAC equipment:
  - Water-cooled chillers ≥ 600 tons
  - Air-cooled chillers ≥ 300 tons
  - Any chiller that is part of a larger, multi-system plant
  - Split/single package air conditioning (AC) and air-source heat pump systems with capacities ≥ 240,000 Btu/h in total
  - Vertical AC and heat pump systems with capacities ≥ 240,000 Btu/h in total
  - Variable refrigerant flow (VRF) systems with capacities ≥ 240,000 Btu/h in total
  - Water-source heat pump systems with capacities ≥ 135,000 Btu/h in total
  - Water-source VRFs replacing air-cooled AC or air-source heat pump systems
  - Air-cooled VRFs replacing water-source heat pump systems
  - Chillers, AC, or heat pump projects that are not like-for-like replacements

[1] Hawai'i Energy Technical Reference Manual Framework, Version 1.1, June 1, 2020, Table 6, page 18.
[2] Uniform Methods Project: Determining Energy Efficiency Savings for Specific Measures, Office of Energy Efficiency & Renewable Energy. Protocols for various measures are available here: https://www.energy.gov/eere/about-us/ump-protocols.
[3] IPMVP resource documents are available here with a subscription: https://evo-world.org/en/products-services-mainmenu-en/protocols/ipmvp.
[4] Hawai'i Energy Efficiency Program, July 1, 2021 through June 30, 2022, Technical Reference Manual, PY 2021 V1.0, Measure Savings Calculations, March 31, 2021. See "Custom" sheet and individual measures sheets.

    - Early retirement projects
    - Installations in industrial or cold storage applications
- Certain types of commercial water heaters
    - Some types of heat pump water heater upgrades, including systems with tank sizes > 120 gallons and systems installed in building types not covered in the TRM's prescriptive approach
    - Solar water heaters and heat pump water heaters where the baseline electric storage water heater has an input rating > 12 kW (40,950 Btu/hr)
- Variable frequency drive (VFD) applied to > 200 horsepower motor
- Specialized processing equipment (e.g., a new packaging machine for a water bottling facility)
- Non-prescriptive commercial lighting
    - Lighting replacements that are not "like-for-like"[5]
    - Lighting installed through the Energy Advantage program
- Distribution transformers

In addition, projects that are part of a larger project with a variety of efficiency measures being installed simultaneously, or other unique projects, would be candidates for custom evaluation, at the discretion of Hawai'i Energy.

Some measures currently designated as custom may be converted to deemed or semi-prescriptive measures in the future. For example, the commercial kitchen dishwasher measure was added to the TRM as a new custom measure in PY18 and was then converted to a semi-prescriptive measure in the PY22 TRM.

Use of TRM for Custom Projects

In addition to listing specific custom measures, the TRM provides key metrics (including avoided costs, NTG ratios, SLFs, avoided emissions, and avoided barrels of oil) that are used for custom project analysis as well as for analysis of deemed and semi-prescriptive measures. Other deemed parameters in the TRM may be useful to supplement custom savings calculations, such as interactive effects factors, persistence factors, equivalent full load hours (EFLH), coincidence factors (CF), and effective useful lifetimes (EULs). For some custom measures, the TRM provides algorithms that can be used with custom entries. For example, the Energy Advantage entry in the TRM specifies how to use a series of algorithms along with site-specific operating hours and equipment data to estimate savings impacts.

Projects with Prescriptive and Custom Measures

If a project includes both prescriptive and custom measures, Hawai'i Energy and the EM&V Contractor will calculate energy and demand impacts for prescriptive measures using the TRM algorithms. Then, the net impacts for the custom measures will be calculated assuming the prescriptive measures were installed first. This "loading order" of the prescriptive and custom measures helps account for interactive effects between the measures, while still allowing the prescriptive measures to be treated as such. For example, the individual savings from installation of window film (a semi-prescriptive measures) and replacement of a 350-ton air-cooled chiller (a custom measure) are not additive because the window film measure reduces the cooling load met by the chiller. Therefore, to account for interactive effects, the custom savings calculations for the chiller should include the presence of window film in the baseline.

It is best to track prescriptive and custom measures separately under their respective program types, but there may be instances where it is beneficial to combine them to simplify the customer's incentive payment. When

[5] An example of lighting project that is not considered to be a "like-for-like" replacement is a redesign that converts linear fluorescent lamp fixtures to LED recessed lighting.

prescriptive measures are combined with custom measures and tracked under CBEEM or CREEM, the prescriptive measures and their associated savings and incentives must be clearly flagged in the tracking database.

3. Custom Program Rules

The subsections below describe the general program rules provided by Hawai'i Energy to customers interested in implementing a custom project. Specific documentation and analysis requirements for custom projects are determined by Hawai'i Energy on a case-by-case basis.

General Program Rules[6]

1. To ensure the best chances of qualifying for an incentive, Hawai'i Energy requires that customers contact the program for preliminary approval prior to the start of any work. Otherwise, the project is at significant risk of being disqualified. Projects are handled on a case-by-case basis and may require documentation before and after implementation (e.g., pre- and post-data, pre-inspection, etc.).
2. Incentives may not exceed 50% of incremental project costs.
3. The Simple Payback period of the project must be greater than one year for custom non-lighting projects and greater than six months for custom lighting projects.
4. The Utility Benefit Test must be equal to or greater than one.
5. Incentives are based on projected energy and on-peak demand savings for both new construction and retrofit projects:
    a. On-Peak Demand savings: The amount of kW saved during 5pm to 9pm on weekdays.
    b. First-Year Energy savings: The amount of kWh saved in the first year based on average annual operating hours.
6. All equipment must meet program minimum efficiency requirements. Applicant must complete and submit relevant program-provided custom worksheets.
7. All other Program Rules are listed in the most current version of the Commercial Incentive Application. Corresponding requirements or worksheets available through https://hawaiienergy.com/for-businesses (see Text Box 1).

Text Box 1. Hawai'i Energy's custom project worksheets help customers calculate energy and demand savings, project costs, the estimated incentive, and program requirements such as the Simple Payback period and Utility Benefit Test.

New Construction

New construction energy models must simulate whole building performance and provide energy and demand savings calculations along with the source of input parameters. Elements include building design/floorplan and modelled electricity consumption for both the baseline and efficient case. Reports that meet these requirements are accepted from software such as DOE2 eQUEST, EnergyPlus, OpenStudio, BEM Project Portfolio, Carrier HAP, Trane TRACE, and/or other Hawai'i Energy approved modeling software. For the energy model approach, equipment minimum efficiency requirements may vary as savings are calculated based on modeled energy reduction and individual equipment requirements may be unfeasible.

Projects Spanning Multiple Program Years

Rebate payment and savings claim are made upon project completion, or reasonable phased completion of large, long-term projects. The former aligns with standard prescriptive rebate processes. The latter allows customers and contractors to receive milestone rebate payments to support cash flow and acknowledges milestone completion of projects. Savings are claimed in the Program Year that milestone rebate payments are provided.

[6] Program rules may change over time. Only significant changes will require an update to this Custom Project Guidance Document, at the HPUC's discretion.

Exceptions

All custom projects are unique and may not easily conform to standardized processes. Exceptions to certain program rules may be made when the community benefit derived from the completion of the project outweighs the need to satisfy said requirement. An example of a program exception is when a project does not pass the Utility Benefit Test but provides significant benefits to the customer. For such projects, Hawai'i Energy may reasonably alter program rules and requirements, documenting reasons for departure from the typical project processes. When exceptions are made, Hawai'i Energy recognizes they assume a degree of risk that the claimed savings may be adjusted or rejected during the annual verification process (see Text Box 2).

Text Box 2. Currently, there is no requirement in Hawaii for review of custom projects by the EM&V Contractor or other third party during the implementation phase. A best practice (when budget is available) is to involve a reviewer in the project approval process to reduce uncertainty related to verified eligibility and verified impacts for the program administrator. Mid-program year involvement of the EM&V Contractor is commonly referred to as "integrated evaluation."

4. Guidance on Project Documentation

The subsections below give guidance on the types of project-level documentation to be provided by Hawai'i Energy to the EM&V Contractor and by the EM&V Contractor to Hawai'i Energy. All documentation would also be shared with the EEM and HPUC.

Provided by Hawai'i Energy

Table 2 lists the project-level documentation to be maintained by Hawai'i Energy and provided to the EM&V Contractor upon request to support the annual verification effort. The table includes the likely source of the original information. Much of this information would be part of the project submittal package provided to Hawai'i Energy by the customer (see Text Box 3). The remainder would be generated by Hawai'i Energy.

Text Box 3. Hawai'i Energy requires customers to submit the following types of information in the project submittal package: incentive application, custom project worksheet, energy savings calculations, proof of purchase (project invoice or equivalent documentation, equipment specification sheets), IRS Form W-9, and other project-specific documentation as requested.

Table 2. Required Documentation to be Provided by Hawai'i Energy to EM&V Contractor when Requested

Type of Documentation	Source of Original Information
General customer information	Customer
Description of project and measures, including baseline conditions	Customer with guidance from Hawai'i Energy
Key implementation dates	Customer
Site-specific data collected	Customer or Hawai'i Energy
Energy and demand savings calculations, including lifetime estimates	Customer with guidance from Hawai'i Energy
Project costs and invoices	Customer
Equipment specifications and relevant drawings	Customer
Documentation to justify early retirement projects	Customer with guidance from Hawai'i Energy
QA/QC and site inspection documentation	Hawai'i Energy

Below are details about the required documentation.

General Customer Information: Required elements are customer name, contact information, account number, rate schedule, facility type,[7] and street address and county where the project was implemented.

Description of Project and Measures, including Baseline Conditions: [8] Required elements are designation of the project type (new construction, major renovation, replace-on-burnout, new equipment installation, early retirement/replacement, or add-on equipment), associated measure types (lighting, HVAC, controls, etc.), location of the project within the building or site, project square-footage (if applicable), and baseline conditions (code or standard, standard industry practice, existing/pre-conditions, single versus dual baseline, etc.). Optional documentation includes a short narrative of how the project will save energy and reduce peak demand, including a description of interactive effects.

Key Implementation Dates: Required elements are documentation of application approval date (i.e., date and signature on fully executed incentive application), project start date, project completion date, and incentive payment date. If the project spans multiple program years and has milestone payments, this must be clearly indicated in the documentation, with the completed and planned incentive payment dates and amounts.

Site-Specific Data Collected: By definition, custom project analysis involves use of site-specific data. The level of data collection will vary based on the project, but examples include building-specific operating hours, spot measurements of equipment and operating conditions, short-term metering with temporary data loggers, long-term metering with designated submeters and from building automation systems, utility billing data, etc.

Energy and Demand Savings Calculations, including Lifetime Estimates: Required elements are peak demand reduction (5-9 PM on non-holiday weekdays), first year energy savings, lifetime energy savings, and total resource benefit (TRB). The underlying calculations and assumptions are also required, including the name and version of software used for simulation models. For models that are not publicly available, detailed descriptions of inputs, outputs and other modeling parameters and assumptions must be provided so that the calculations methods can be verified for reasonableness and the estimates could be replicated with independent analysis, if needed. To verify lifetime savings estimates and the TRB, the EUL of the measure, remaining useful life (RUL) of measure (for early retirement projects), and length of first baseline period (for measures affected by upcoming changes to code or standard) are required.

Project Costs and Invoices: Required elements are actual implementation costs (including permits, equipment, materials, taxes and fees, removal costs less salvage value, labor, etc.) and estimated operating costs (energy and demand costs, maintenance costs, etc.) for the project, and estimated implementation and operating costs for the baseline case. Itemized invoices are the best practice for all measures associated with a given project and incentive application; but, if an itemized invoice is not available, additional proof of purchase such as an installation verification form signed by the customer is sufficient in limited exceptions.[9] To the extent possible, extraneous costs not associated with measures should be removed or clearly indicated on the invoice. The new equipment documentation must clearly show the manufacturer, model number and quantity of equipment purchased. A best practice is to document assumptions used to estimate the baseline case costs. Another best practice is to document the approach used to estimate costs for early retirement projects.

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[7] Designation of the facility type (e.g., cold storage, education, grocery, health, hotel/motel, industrial, office, restaurant, retail, warehouse, other) is needed to verify any use of segment-specific factors from the TRM (e.g., CF, EFLH) or any use of segment-specific prototypes or load shapes in the savings calculations.

[8] For more information on baseline conditions, refer to the Hawai'i Energy Technical Reference Manual Framework, Version 1.1, June 1, 2020. Table 3. Baseline Conditions and Attributes.

[9] The expectation is that invoices would be available for most projects (e.g., for about 9 out of 10 custom projects in a typical year). Any exceptions to the invoice requirement should be accompanied by a written explanation for the lack of invoice. For each exception, the installation verification form or equivalent documentation must include a count of measures installed and affirm that the customer paid for as well as implemented the measures as intended.

Equipment Specifications and Relevant Drawings: Equipment specifications or technical drawings showing architectural or engineering designs related to the project are required if they have been included in the submittal package and can be used to verify installations. For clarity, equipment specification sheets should have the appropriate energy efficiency rating data circled or otherwise indicated for the equipment installed.

Documentation to Justify Early Retirement Projects: For all projects using an early retirement baseline, a best practice is to provide appropriate documentation to validate that the pre-existing baseline equipment was in place and operating. Typically, documentation includes evidence of the pre-existing measure's specifications (such as photographs of equipment nameplates or specification sheets) to verify the age and expected performance of the pre-existing equipment. Additional documentation could include a signed statement from the customer verifying that it was operational at the time of retirement, dated measurement results demonstrating the pre-existing measure was functional (e.g., from performance logs), or a video showing the pre-existing measure in operation.

QA/QC and Site Inspection Documentation: Notes, correspondence, or other information Hawai'i Energy maintains when conducting QA/QC review of the customer's initial application and project submittal package should be documented. In addition, documentation of any site inspections performed by Hawai'i Energy is required and Hawai'i Energy should ensure that site inspections are sufficiently rigorous to catch mistakes made in the customer's submittal package. Documentation should include descriptions of any adjustments or corrections made to the original information provided by the customer. Examples of optional, but recommended, documentation best practices include checklists that are designed to simplify and standardize project QA/QC review and pre- or post-installation inspections. (See Appendix A for examples of elements to include in checklists.)

Additionally, there are two types of documentation that are optional:

- **M&V Plan:** Only required if an M&V Plan has been developed. Otherwise, an M&V Plan would be an optional, but recommended, best practice, especially for more complex projects. Refer to IPMVP for guidance on developing an IPMVP-adherent M&V Plan.[10]
- **Evidence of Program Influence:** The TRM prescribes a NTG value of 0.75 for Custom Business Energy Efficiency Measures (CBEEM) and a NTG value of 0.65 for Custom Residential Energy Efficiency Measures (CREEM). Evidence of program influence is not required by the EM&V Contractor. However, an optional best practice is to document that the program influenced the customer's decision to implement the project. For examples of documentation used to show evidence of program influence, please refer to the CPUC's Statewide Custom Project Guidance Document.[11]

Provided by the EM&V Contractor

In addition to the verification plan and verification report, which cover verification methods and results for the portfolio of Hawai'i Energy programs including the custom programs, there are several main types of information related specifically to the custom programs to be provided by the EM&V Contractor to Hawai'i Energy, if requested. Table 3 lists the required documentation. The paragraphs below the table describe the types of required documentation in more detail and optional documentation.

[10] Efficiency Valuation Organization, International Performance Measurement and Verification Protocol, Core Concepts, April 2016, EVO 10000-1:2016, Chapter 7. IPMVP Adherent M&V Plan and Report. Available here with subscription: https://evo-world.org/en/products-services-mainmenu-en/protocols/ipmvp.

[11] California Public Utilities Commission, Statewide Custom Project Guidance Document, Version 1.3, September 30, 2020, https://www.cpuc.ca.gov/General.aspx?id=4133. Section 2.4 Proving Program Influence.

Table 3. Required Documentation to be Provided by the EM&V Contractor to Hawai'i Energy when requested

Type of Documentation
Sampling plan
Sample selection
On-site verification plan
On-site verification report
Desk review report
Documentation on sample expansion to the population

Below are details about the required documentation.

Sampling Plan: The sampling plan will cover desk reviews and on-site work associated with verification of CBEEM and CREEM. It must include information on stratification, population size, sample size, and details of the sampling approach.

Sample Selection: A list of projects selected for desk reviews and on-site verification (as applicable) is required. It will provide information pulled from the program database for each selected sample point, including customer location and contact information, project and measure descriptions, and claimed energy and demand impacts.

On-Site Verification Plan: If on-site verification is planned, each site's plan will contain a description of the project and measures to be verified, information on the savings estimation approaches used for claimed savings, and a detailed plan for verifying the installation and operation of the measures and for validating the savings estimation approaches, including relevant on-site safety protocols. (See Text Box 4)

> **Text Box 4.** If Hawaii's EM&V practices move from verification to independent evaluation in the future, a best practice is to develop an M&V plan for on-site work, which would detail both measurement and verification activities that support independent evaluation of impacts.

On-Site Verification Report: The on-site verification report will include a description of the project and measures, the site visit date and staff involved, a summary of claimed and verified impacts (peak demand reduction, first year energy savings, EUL and lifetime savings approach, and incentive), an assessment of project eligibility, an explanation of adjustments made to claimed impacts, additional data collected and analyzed by the EM&V Contractor (e.g., additional post-installation energy use data from submeters, control systems, or utility billing data), detailed calculations (either within the report or in a supplementary analysis file), any additional findings from the verification, and relevant photos. A best practice is to develop a standardized reporting template that is used for each site visit.

Desk Review Report: The desk review report will include a description of the project and measures, the reviewer's name, a summary of claimed and verified impacts (peak demand reduction, first year energy savings, EUL and lifetime savings approach, TRB, and incentive), an assessment of project eligibility, an explanation of adjustments made to claimed impacts, detailed calculations (either within the report or in a supplementary analysis file), and any additional findings from the verification. A best practice is to develop a standardized reporting template that is used for each desk review.

Documentation on Sample Expansion to the Population: A description of the approach used to expand results from the desk review and on-site verification samples to the population of custom projects is required. A best practice is to make the calculations available to Hawai'i Energy upon request.

Additionally, there are two types of documentation that are optional:

- **On-Site Verification Schedule:** A best practice is for the EM&V Contractor to work with Hawai'i Energy to contact customers and to provide Hawai'i Energy with a schedule of planned on-site verification visits.
- **QA/QC Checklists:** A best practice is for the EM&V Contractor to develop checklists to simplify and standardize internal QA/QC reviews for deliverables related to EM&V of custom projects. These checklists could be made available to Hawai'i Energy.

5. Guidance on Savings Estimation Approaches

IPMVP Options

Savings estimation approaches for custom projects are, by definition, unprescribed; however, there are still basic requirements for rigor that must be applied to yield reasonably accurate estimates of energy and peak demand impacts. One basic requirement is that customer-specific data is collected and used in the savings calculations. IPMVP lays out guidelines for estimating savings of individual custom projects. The protocol covers four types of options for determining savings.[12] Options A-D form the basis of standard practice for calculating impacts for custom projects and are described next. Table 4 (next page) provides examples of application of each of these options.

A. Retrofit-Isolation: Key Parameter Measurement: Savings for an isolated project are determined using engineering calculations[13] of baseline period (pre-implementation) energy use and reporting period (post-implementation) energy use.[14] Baseline and reporting period energy estimates rely on short-term or continuous measurements of at least one key parameter during both the pre- and post-implementation periods. Key parameters are those that define the energy use characteristics of systems affected by the project. Other parameters needed to calculate savings are stipulated (estimated) using historical data, manufacturer specifications, or engineering judgment, which could include deemed parameters from the TRM. Routine and non-routine adjustments are made as required.[15] This approach does not capture interactive effects outside the measurement boundary.

B. Retrofit-Isolation: All Parameter Measurement: Savings are determined for an isolated project using analysis of short-term or continuous measurement of all parameters that define baseline and reporting period energy use. Alternatively, savings are determined with engineering calculations that use measurements of parameters that are proxies of energy use. Routine and non-routine adjustments are made as required. This approach does not capture interactive effects outside the measurement boundary.

C. Whole Facility: Savings are determined by using statistical models to analyze facility-level meter data (e.g., utility billing data or interval data) collected during the baseline and reporting periods. Routine and non-routine adjustments are made as required. This approach captures interactive effects across various measures implemented in the facility, but requires more sophisticated models to isolate savings from individual measures.

D. Calibrated Simulation: Savings are determined with energy simulation models that are calibrated with pre- and/or post-implementation utility billing data or interval data. Models may also be refined with end-use metering (e.g., for simulating specialized processing equipment). Simulation is performed at the facility or

[12] Efficiency Valuation Organization, International Performance Measurement and Verification Protocol, Core Concepts, April 2016, EVO 10000-1:2016, Chapter 6. IPMVP Options. Available here with subscription: https://evo-world.org/en/products-services-mainmenu-en/protocols/ipmvp.

[13] In some cases, it may be appropriate to combine the engineering calculations for Options A and B with statistical analysis of measured data. See the Statistically Adjusted Engineering Model discussion in the Statistical Analysis subsection.

[14] By "energy use" we mean both energy consumption (kWh) and demand (kW).

[15] Routine adjustments account for expected changes in energy use due to explanatory variables like weather, production, and normal occupancy patterns. Non-routine adjustments account for unexpected changes in static factors such as building closures (e.g., due to the Covid-19 pandemic), changes in square footage of the space served by the system, changes in production mix or the number of shifts; could also include changes in codes or standards.

sub-facility level. It is often used when reliable meter data is not available for either the baseline or reporting period. This approach captures interactive effects across various measures implemented in the facility or system boundary, and can provide savings for individual measures.

Applying Approaches to Common Projects

Though many types of custom projects could be implemented through Hawai'i Energy's programs, some typical project types were listed in Section 2. Table 4 provides examples of general approaches for estimating savings for each of these types of typical custom projects and lists considerations related to determining the appropriate baseline. For the first seven types of projects, the table names IPMVP options. Specifically, Option A is listed for lighting redesigns; Option B for HVAC, water heating, VFD, and specialized process equipment retrofits; Option C for building re/retro-commissioning or as an alternative to Option B for HVAC and commercial water heater projects; and Option D for new construction, major renovation, and when new processing equipment is added (without "like-for-like" replacement of pre-existing equipment). Distribution transformers and lighting installed through the Energy Advantage program are considered partially custom, meaning they use customer-specific inputs to semi-prescriptive savings approaches, as described in the TRM. Any projects qualifying for early retirement require dual baseline treatment. The first baseline is the pre-existing equipment. The second baseline is subject to federal and state regulations in effect at time of project implementation. The length of the first baseline period is the RUL of the pre-existing equipment; the length of the second baseline period is the EUL – RUL. If the RUL is unknown, a best practice is to assume RUL = EUL/3.

Table 4. Examples of Savings Estimation Approaches for Typical Custom Projects

Type of Project	Savings Estimation Approach (Examples)	Baseline Considerations
Lighting redesign (replacements that are not "like-for-like")	IPMVP Option A for complex projects; engineering calculations using custom operating hours for simpler projects	Baseline is subject to 10 CFR 430.32 (n) and 10 CFR 430.32 (x);[16] general service lamps (GSLs) are an exception[17]
HVAC equipment qualifying as a custom project	IPMVP Option B (best practice) or Option A or Option C (alternatives)	Baseline is subject to Standard 90.1 and 10 CFR 431.97[18]
Commercial water heaters	IPMVP Option B (best practice) or Option C (alternative) for complex projects; engineering calculations using customer-specific parameters for simpler projects	Baseline technology depends on capacity and is subject to 10 CFR 430.32 (d) or 10 CFR 431.110
VFD, > 200 horsepower motor	IPMVP Option B	Baseline is motor under constant loading
Specialized processing equipment	IPMVP Option B for retrofit of existing equipment;	For retrofits, the baseline is pre-existing equipment (or standard industry practice); for new

[16] Refer to the Electronic Code of Federal Regulations, Title 10, Chapter 11, Subchapter D Energy Conservation for relevant standards (especially, Part 430: Energy Conservation Program for Consumer Products and Part 431: Energy Efficiency Program for Certain Commercial and Industrial Equipment).

[17] For consistency with the TRM, custom lighting projects affected by the Energy Independence and Securities Act (EISA) 2007 GSL requirements are subject to a dual baseline for PY21. The first baseline must comply with EISA legislation that had 2012-2014 effective dates (EISA Tier 1 halogen lamps). The second baseline must comply with the original EISA Tier 2 Backstop requirement of 45 lumens per Watt and the expanded definition of GSLs. For PY22 and later, GSL projects should use a single baseline (EISA Tier 2).

[18] ANSI/ASHRAE/IES Standard 90.1 Energy Standard sets minimum energy efficiency requirements for design and construction of new buildings, major renovations, and new systems and equipment within existing buildings. Standard 90.1 applies to most buildings except low-rise residential buildings. The Department of Energy (DOE) through the Energy Policy and Conservation Act (EPCA) establishes federal standards for certain types of HVAC equipment (10 CFR 431.97); the federal standards match (or in some cases exceed) the 90.1 standards. Manufacturers must comply with the federal standards, so both Standard 90.1 and 10 CFR 431.97 dictate the minimum efficiency of products available on the market.

Type of Project	Savings Estimation Approach (Examples)	Baseline Considerations
	IPMVP Option D for new equipment installation	installations, the baseline is standard industry practice[19]
Building recommissioning or retro-commissioning	IPMVP Option C	Baseline is energy use of building prior to re/retro-commissioning
New construction or major renovation	IPMVP Option D	Baseline is subject to the IECC building code[20] and Standard 90.1 in effect at time of project
Energy Advantage lighting	No measurement required; use custom operating hours along with semi-prescriptive approach described in TRM	A dual baseline may be required: the first baseline is the pre-existing lighting; the second baseline is subject to 10 CFR 430.32 (n) and 10 CFR 430.32 (x); GSLs are an exception[21]
Distribution transformers	Collect data on age of pre-existing transformers to determine baseline approach; measure load on transformers or assume no-load losses for calculations with semi-prescriptive approach	A dual baseline may be required: the first baseline is the pre-existing transformer; the second baseline is subject to 10 CFR 431.196
Any other custom early retirement project	Varies	A dual baseline is required: the first baseline is the pre-existing equipment; the second baseline is subject to federal and state regulations in effect at time of project implementation

Site Inspections

The purpose of pre-implementation inspection is to verify pre-existing measure conditions and confirm eligibility of the proposed project. The pre-inspection will also determine if the project has already been initiated. Post-implementation inspection is used to ensure the equipment associated with the measure is installed properly and is consistent with project information and savings estimates submitted by the customer. Post-inspections may be used to verify that replaced equipment has been removed and is no longer in use elsewhere in the facility. At a minimum, visual inspection is required for projects meeting the criteria for site inspections. An additional best practice is to verify performance with measurements (see following section).

Hawai'i Energy determines the criteria for when pre- and post-implementation site inspections are performed by Hawai'i Energy staff. Pre-implementation inspections are carried out at Hawai'i Energy's discretion to support the project pre-approval process.[22] If insufficient baseline information is available during the pre-approval process, the project will be denied. Hawai'i Energy requires post-implementation inspections on all single commercial

[19] If standard industry practice is unknown for retrofit or new installations, the minimum efficiency solution currently available on the market should be used.

[20] International Energy Conservation Code. Available here: https://codes.iccsafe.org/. The State of Hawaii adopted IECC 2018 on December 15, 2020. The deadline for County adoption is December 15, 2022.

[21] For consistency with the TRM, custom lighting projects affected by the Energy Independence and Securities Act (EISA) 2007 GSL requirements are subject to a dual baseline for PY21. The first baseline must comply with EISA legislation that had 2012-2014 effective dates (EISA Tier 1 halogen lamps). The second baseline must comply with the original EISA Tier 2 Backstop requirement of 45 lumens per Watt and the expanded definition of GSLs. For PY22 and later, GSL projects should use a single baseline (EISA Tier 2).

[22] Hawai'i Energy requires pre-approval for custom projects. However, they are notified at various stages throughout the design and construction process, and a pre-inspection is not always feasible. In these cases, Hawai'i Energy may make exceptions to pre-approval as they seek to ascertain accurate base case information without disrupting project progress.

projects receiving a rebate greater than or equal to $25,000, with limited exceptions.[23] Historically, projects meeting this rebate threshold have generally represented 15-20% of the CBEEM portfolio.

Measurements and Data Collection

Measurements may be performed by the customer or Hawai'i Energy during the implementation phase to assess performance of equipment and systems pre- and post-implementation and to support energy and demand savings estimation and incentive calculations. Types of measurements include spot measurements, short-term data logging, trend data, and continuous data collection. Spot measurements are useful for determining characteristics of equipment and systems at a point in time. Temporary, short-term data loggers measure parameters over a defined time period. Trend data from building automation systems may be captured and logged pre- and post-implementation for specific equipment. Continuous data collection relies on dedicated utility meters, sub-meters, or other devices. Examples of parameters to measure include power draw (or voltage, current, power factor as proxies), light level, temperature, pressure, air flow, etc. Spot measurements and measurements with short-term data loggers must be made by qualified professionals; there are considerable safety considerations and significant room for error in collecting insufficient, incomplete, or inaccurate data. When specifying measurement instrumentation, it is important to consider and document the rated precision of the instruments.

Measurement and other types of data collection requirements vary by project type. Table 5 provides guidance on minimum requirements for three common types of custom projects: like-for-like lighting retrofit (e.g., via Energy Advantage Program), AC or heat pump retrofit, and new construction. For additional guidance on these and other measures, refer to the Uniform Methods Project[24] and ASHRAE Guideline 14.[25]

Table 5. Measurement and Other Data Collection Requirements for Example Types of Projects

Type of Project	Measurement Requirements	Other Data Collection Requirements
Like-for-like lighting retrofit	No measurement required	• Operating hours for the building to determine hours of use • Manufacturer specifications to determine baseline and efficiency case wattages • Documentation that new lighting meets program qualifications
AC or heat pump retrofit that qualifies for the custom path	IPMVP Option B (best practice) or A: • Conduct short-term RMS power measurements (kW) encompassing all components (compressor, condenser, evaporator, supply fans), or short-term current (Amps) measurements and spot measurements of voltage (V)[26] • ≤15-min intervals, time-stamped (mm/dd/yy hh:mm)	• Hourly weather station data: actual weather during pre- and post-implementation measurement periods and typical meteorological year (TMY) data for normalization • Manufacturer specifications for capacity and rated efficiency of baseline and efficient case equipment • Documentation to support early retirement, if applicable

[23] Exceptions to physical inspections are made when significant security, health, or other risks are present. Examples of exceptions include military projects and projects implemented during the Covid-19 pandemic. For these exceptions, an Installation Verification Form is used in place of the post-implementation inspection. The form is completed and signed by the customer to affirm that the project was implemented as planned.

[24] Uniform Methods Project: Determining Energy Efficiency Savings for Specific Measures, Office of Energy Efficiency & Renewable Energy. Protocols for various measures are available here: https://www.energy.gov/eere/about-us/ump-protocols.

[25] ASHRAE Guideline 14-2014, Measurement of Energy, Demand, and Water Savings, available for purchase here: https://webstore.ansi.org/standards/ashrae/ashraeguideline142014.

[26] Measure true RMS, or account for power factor and harmonic distortion if you measure Amp and Volt. RMS = root mean square.

Type of Project	Measurement Requirements	Other Data Collection Requirements
	• ≥2 weeks of pre- and post-implementation data collection during normal operation[27] • Or, use equivalent data collected from dedicated sub-meters or building automation systems IPVMP Option C (if HVAC system accounts for a substantial portion of the total utility bill):[28] • ≥12 mo of pre-implementation monthly billing data • ≥3 mo of post-implementation monthly billing data with the intention of collecting sufficient post-implementation data to capture the full range of data expected for explanatory variables (e.g., weather and operation) during a typical year[29,30]	
New construction with multiple measures	IPMVP Option D • ≥3 mo of post-construction utility billing data during a time period that represents normal building operation[31] • If available, building-level hourly interval data and sub-meter data for key systems affected by the measure could be used to help calibrate the model	• Data on building type, size, shape, envelope, equipment, set-points, operating schedules, occupancy, etc. to build model • Actual and TMY hourly weather station data for post-construction measurement period • Documentation for any measures receiving incentives under prescriptive path[32]

Statistical Analysis

Individual measures or packages of measures that yield appreciable facility-level savings (ideally, greater than 10% of facility energy use) benefit from statistical analysis of energy impacts using utility billing data. Building-level interval data may be required to measure smaller savings, such as for re- or retro-commissioning. Statistical analysis of short-term measurements or continuous sub-metered data coupled with engineering approaches is also effective for analyzing impacts for end-use level measures like HVAC, water heating, and process equipment. Various types of software can be used for statistical analysis, including Excel, SAS, and R. This type of analysis should be performed by an experienced analyst. The following subsections summarize some of the key requirements for billing analysis and statistically adjusted engineering (SAE) models.

[27] Data must be collected during periods that reflect normal operation, or adjustments must be made in statistical models to normalize baseline and reporting period energy use results.

[28] A rule-of-thumb for building-level monthly billing analysis is for the expected energy savings from the measure to be ≥10% of total facility baseline energy use. See Efficiency Valuation Organization, International Performance Measurement and Verification Protocol, Concepts and Options for Determining Energy and Water Savings, Volume 1, Jan 2012, EVO 10000-1:2012, Section 4.8 Option C: Whole Facility, page 25.

[29] Hawai'i Energy's current requirement is a minimum of 3 months of post-implementation billing data. The EM&V team recommends at least 6 months (and preferably 12 months) of post-implementation billing data when applying Option C or Option D. Hawai'i Energy understands that the EM&V team may adjust savings estimates using a greater amount of post-implementation billing data during the verification process and that Hawai'i Energy will assume any risk associated with differences in claimed and verified savings. The minimum requirement for post-implementation billing data is subject to change in a future edition of this document.

[30] When the post-implementation data collection period spans multiple program years, Hawai'i Energy may work with the customer to arrange milestone savings estimates and incentive payments to ease the financial burden on both the customer and the program. The savings would be estimated during the first program year with a partial incentive payment; then, there would be a "true-up" of savings and final incentive payment when data collection and analysis has been completed. See earlier Section on handling Projects Spanning Multiple Program Years.

[31] See footnote 299.

[32] See previous section on Projects with Prescriptive and Custom Measures.

Billing Analysis: Statistical billing analysis models use monthly billing data and are generally used to calculate facility-level savings estimates. They can also be used to calculate savings for individual measures by adding indicators to the model that account for the presence of a particular measure. As noted previously, they require energy data collected during the baseline period (pre-implementation) and reporting period (post-implementation). The current minimum requirements are 12 months of baseline billing data and 3 months[33] of reporting period billing data. When the reporting period spans multiple program years, Hawai'i Energy may work with the customer to arrange milestone savings estimates and incentive payments to ease the financial burden on both the customer and the program.

Statistically Adjusted Engineering Models: SAE models can be applied to a facility with multiple measures or to individual systems within a building. The model uses statistical regression analysis that combines engineering approaches with short-term or continuous interval data at the facility or end-use level to assess changes in energy use associated with installing various measures. Minimum data requirements are strongly dependent on the measure(s) being analyzed. Best practice is at least 2 weeks of 15-min interval data for key parameters during baseline and reporting periods. Data is often aggregated to the hourly or daily level depending on the model.

Variables: Statistical models use regression analysis and are built with a series of variables. The regression analysis process looks at the relationship between the dependent variable (energy or demand) and the explanatory variables and returns estimates of the coefficients for the explanatory variables and uncertainty or error (indicating statistical significance) of those variables. The result is a mathematical model that predicts how the dependent variable is related to the explanatory variables. The variables selected for a given model will depend on the type of measure(s) and data being analyzed. Models may include calendar effects (e.g., indicator variables for each hour, day or month included in the analysis). Weather variables (e.g., cooling degree days or enthalpy metrics) are required for building-level analysis and for analysis of any weather-sensitive measures. For some projects, the use of other explanatory variables, such as occupancy rates, days of the week, school days, or production, may be necessary to properly regress the data. All variable coefficients must be tested for statistical significance before finalizing the model specification.[34] The final analysis comparing baseline and reporting period energy and demand should apply normalized datasets to help ensure an "apples-to-apples" comparison of pre- and post-implementation conditions. Specifically, TMY weather should be used to represent any weather variables and normal operation factors should be used for operational variables like operating hours or production.

On-Site Generation

A special case affecting custom project eligibility and the savings estimation approach is when the customer has on-site generation or purchases electricity from another non-HECO resource. In these cases, reasonable attempts should be made to estimate the amount of energy savings and demand reduction that are coincident with the energy supplied by HECO, and to count only that subset of savings in the program's claimed savings. However, the HPUC has the ability to set in place specific exceptions to handling on-site generation (such as considering renewable generation exempt from this treatment) and may choose to do so in the future.

[33] See footnote 299.

[34] For example, the t-statistics for the coefficients can be assessed to determine statistical significance using a "t-table" that contains critical (minimum acceptable) values of t as a function of t-distribution probability (or, confidence level) and degrees of freedom. Degrees of freedom (DF) for a regression model = n – p – 1, where n = # of data points in the sample and p = # of regression model variables. (See https://t-tables.net/.) In addition, P-values of less than 0.05 for the coefficients indicate statistical significance.

Reporting Uncertainty

A best practice is to report the uncertainty of the savings estimates by combining measurement and modeling error (along with any sampling error).[35] When reporting uncertainty, include the precision and confidence level (e.g., ±X% at Y% confidence).

6. Guidance on Impact Evaluation

In Hawaii, the current focus related to impact evaluation is *verification* of claimed savings and not *independent evaluation*.[36] This applies to both prescriptive and custom measures. Therefore, the EM&V Contractor's data collection, measurement, and analysis requirements with respect to custom projects tend to be limited to efforts that support verification. The following subsections provide general guidance for essential elements of the annual verification process for Hawai'i Energy's custom programs. Refer to Section 4 for additional guidance related to the EM&V Contractor's documentation requirements.

Statistical Sampling

For custom programs, typically it is not possible to verify the savings calculations for a census of projects using parameters tracked in the database due to the custom nature of the savings estimation approaches. Therefore, statistical sampling is used. Valid and efficient sampling enables the EM&V Contractor to gather data needed to make unbiased estimates that can achieve target precision levels in the most cost-effective way. The first requirement for statistical sampling is development of a sampling plan. The sampling plan should define the following aspects of the sample design:

- Population being studied—individual custom projects or customers who have implemented one or more custom projects during the program year.
- Sampling frame—the frame will be different than the population if any projects or customers must be excluded (e.g., due to missing data, security reasons, or other considerations).[37]
- Stratification and segmentation based on the priority of different types of savings (energy savings versus peak demand reduction) and segments (customer type, measure type). Using a stratified design improves the precision of the estimates for a given sample size. A best practice is use Neyman allocation to allocate the sample to the strata.[38]
- Sample size—a standard practice is to define the sample size to target a 10% relative precision with 90% confidence (often referred to as 90/10)

Once the sample is designed, the selection must be done carefully and without bias. A standard practice is to randomly select customers or projects for inclusion in the sample.[39] When selecting a sample for on-site visits, it may be necessary to assign back-up sample points that can be used if the primary customers refuse to participate or are if sites are difficult to access for some reason.

[35] For more information, refer to Efficiency Valuation Organization, International Performance Measurement and Verification Protocol, Uncertainty Assessment, Apr. 2018. EVO 10100 – 1:2018.

[36] This guidance document should be updated if the role of the EM&V Contractor shifts from verification to independent evaluation in the future to include more information on approaches evaluators should use to independently measure and calculate savings.

[37] It is important to note that if the sample frame and population differ, the uncertainty resulting from the exclusion of some custom projects from the frame is impossible to quantify.

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

[39] Often, evaluators create a "certainty" stratum that purposefully includes a few of the highest savings projects and then use random sampling for the other strata.

Verification Approaches

For custom program verification, the EM&V Contractor should conduct a detailed review of the savings approaches and calculations for a sample of projects to confirm or adjust savings. The choice of verification methods will depend on the number and types of custom projects, relative impact on the portfolio, data availability, budget and accuracy priorities, and other considerations. At a minimum, engineering desk reviews are required for a sample of custom projects, while the use of on-site data collection is at the discretion of the HPUC, EEM, and EM&V Contractor and may be warranted only for larger, more complex custom projects. Any on-site work requires an on-site verification plan.

Engineering Desk Review: The desk review process involves reviewing data from the tracking system, collecting and reviewing detailed project documentation for the sample of projects selected, and in some cases carrying out additional research to inform the savings analysis. At a minimum, the desk review must include a) an assessment of project eligibility, including invoice verification (or review of sufficient documentation in lieu of an invoice), b) verification of first year and lifetime energy savings and peak demand reduction, including details on any adjustments made to the claimed savings estimates, and c) an assessment of the incentive payment.

On-Site Verification: The most effective way to verify that measures were implemented as reported is to visually inspect them. Due to cost, inconvenience to customers, and other factors, on-site verification should be limited to a sample of projects that will provide the greatest benefits to the verification. The minimum on-site verification requirement is to visually inspect that measures are installed and operating according to project documentation and program rules. In projects involving multiple measures or large counts of equipment spread across an extensive facility or campus, it may be necessary to limit visual inspections to a subset of the installations. In these cases, the EM&V Contractor must document the method used to sample the equipment for inspection.

On-Site Measurement: When warranted by the complexity of a measure, budget availability, and requirements for savings accuracy, it may be appropriate to take spot measurements to help verify the savings. Any planned measurements should be included in the on-site verification plan. Beyond spot measurements, the EM&V Contractor may collect additional trend data from the customer as available from existing sub-meters, control systems, or utility bills. However, independent installation of metering equipment to conduct short-term monitoring of equipment for a sample of projects would only be performed upon approval from the EEM and HPUC. Documentation is required for all on-site measurements.

Expansion of Sample Results to Population

After calculating verified impacts for each sample point, the results must be expanded to estimate the verified impacts for the population of custom projects. A best practice is to use a combined ratio estimate. The combined ratio estimate results in a more precise estimate of savings because it leverages the correlation between the claimed savings, known for all customers in the population, and the verified savings, known only for the sample. The EM&V Contractor is required to include the achieved precision and confidence level when reporting savings.

Appendix A. Examples of Elements that could be Included in Checklists

The following lists are examples of elements that could be included in checklists associated with QA/QC review of customer submitted information and site inspections.

QA/QC Checklist for Review of Project Application for Pre-Approval

- Name or ID of customer; rebate ID
- Short description of project and measures
- Name of Hawai'i Energy reviewer
- Date of review
- Checklist items (examples):
    - Initial (pre-implementation) information is complete
    - Proposed project is applicable for custom path and meets program requirements
- Application status
    - Project is pre-approved and may proceed
    - Pre-implementation inspection is required before approval
    - Other information is required before approval
        - List requirements (e.g., pre-implementation data collection)
- Customer has been notified of next steps

Pre-Implementation Site Inspection Checklist

- Name or ID of customer; rebate ID
- Address of site; location of project at site
- Short description of project and measures
- Name of Hawai'i Energy inspector
- Date of inspection and time
- Other attendees
- Checklist items (examples):
    - Project has not yet been implemented
    - Pre-existing measure conditions are consistent with application; note any discrepancies
    - Building type is consistent with application
    - Project is applicable for custom path
- Other information collected by Hawaii Energy (examples):
    - Operating hours
    - Measurements of baseline equipment (spot measurements, short-term logging)
    - Trend data from BAS logs
    - Verification of operation for early retirement projects
    - Presence of on-site generation
- Project status
    - Passes inspection
    - Additional data is requested of customer
    - Project fails
    - Notes
- Customer has been notified of next steps

QA/QC Checklist for Review of Project Submittal Package

- Name or ID of customer; rebate ID
- Short description of project and measures
- Name of Hawai'i Energy reviewer
- Date of review
- Checklist items (examples):
    - Final (post-implementation) incentive application form is complete
    - IRS Form W-9 has been provided
    - Custom project worksheet is complete
    - Energy and demand calculation details have been provided
    - Baseline is correct
    - Analysis is reasonable
    - Proof of purchase is sufficient and consistent with project
    - Equipment specification sheets have been provided
    - Other requested project documentation has been provided (e.g., site specific data collected, documentation to justify early retirement, relevant drawings or photographs)
    - Project as implemented meets eligibility requirements
    - Customer followed program rules
- Status
    - Approved and ready for incentive payment
    - Requires post-inspection
    - Requires additional information
- Customer has been notified of next steps

Post-Implementation Site Inspection Checklist

- Name or ID of customer; rebate ID
- Address of site; location of project at site
- Short description of project and measures
- Name of Hawai'i Energy inspector
- Date of inspection and time
- Other attendees
- Checklist items (examples):
    - Project was implemented as expected (location, equipment specifications, quantities, set-points, etc.) and is consistent with project submittal package (including calculations); note any discrepancies
    - Replaced equipment has been removed and is not in use elsewhere in facility
    - Building type is consistent with application
    - Project meets program rules
- Other information collected by Hawaii Energy (examples):
    - Operating hours
    - Measurements of new equipment (spot measurements, short-term logging)
    - Trend data from BAS logs
    - Presence of on-site generation
- Project status

    - Passes inspection
    - Additional data is requested of customer
    - Project fails
    - Notes
- Customer has been notified of next steps

Signatures

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Approvals:

Hawai‘i Energy

Brian Kealoha	*Executive Director, Hawai‘i Energy*	*4/11/2022*
Name	Title, Organization	Date

EM&V Contractor

Kelly E. Parmenter	*TRM Administrator, Applied Energy Group*	*4/5/2022*
Name	Title, Organization	Date

Energy Efficiency Manager

Mary Sutter	*Partner, Grounded Research and Consulting, LLC*	*4/12/2022*
Name	Title, Organization	Date

Hawai‘i Public Utilities Commission

Ashley Norman	*Utility Analyst, Hawaii Public Utilities*	*5/03/2022*
Name	Title, Organization	Date