California SEM Program M&V Guide

VERSION 4.0, JULY 31, 2025

SERGIODIAS CONSULTING LLC

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OVERVIEW

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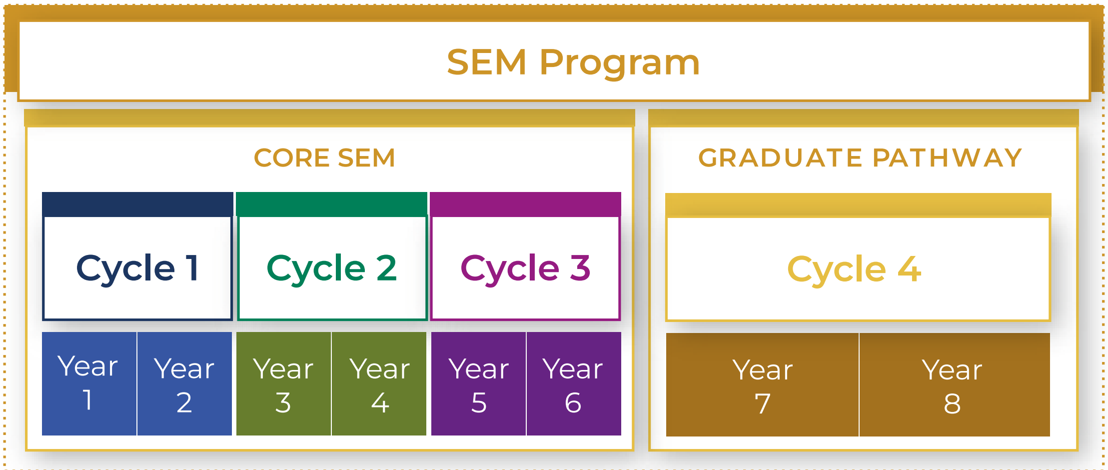
1 Overview

The purpose of this California SEM Measurement and Verification Guide (M&V Guide) is to define a set of principles, guidelines, and requirements that establish a systematic measurement and verification (M&V) process which can be used by any stakeholder as part of participation in a publicly funded Program Administrator (PA) sponsored strategic energy management (SEM) Program. The requirements of this M&V Guide shall be adhered to when a site is participating in a PA sponsored SEM Program paid for with ratepayer funds. Outside of a PA sponsored SEM Program, a site may wish to adapt elements of this M&V Guide to suit their own energy management business practice needs.

This M&V Guide is designed to work in coordination with the California SEM Program Design Guide (Design Guide) version 2.0 and later and is applicable to all customer segments (industrial, commercial, institutional, etc.). The SEM Program has two key sections:

- 1. Core SEM, which through three, two-year Cycles, help customers develop energy management business practices and save energy through their implementation.
- 2. The Graduate Pathway, which is a two-year Cycle but has a different approach and set of objectives.



A primary principle of the Core SEM is that over the three Cycles the customer will develop and learn to manage business practices that make up a well-structured and systematic energy management system (EnMS) based upon the ISO 50001:2018 standard.

A primary principle of the Graduate Pathway is that the customer has and maintains the business practices they developed in the Core SEM and is able to expand them.

This Guide applies to both Core SEM and the Graduate Pathway.

In the context of the California SEM Program, M&V is the process of:

1. Overview

The site participating in the SEM Program (customer), the SEM implementation contractor (implementer), and the PA are the three primary stakeholders who will be engaged in conducting the various elements of the M&V process.

The California Public Utilities Commission (CPUC) has specified in decision and other documentation that this M&V Guide provides the basis by which energy savings shall be determined as part of a PA sponsored SEM program. The sponsoring PA will direct the customer and implementer as to when energy savings shall be reported to the CPUC for regulatory reporting. This M&V Guide should serve as the basis of the validation of energy savings and contains the requirements that shall be followed when a customer is participating in a PA sponsored SEM Program. The annexes of this M&V Guide contain additional guidance.

If exceptions to this M&V Guide are sought, or clarification is needed, the PA shall be contacted.

1.1 Goals and Objectives of Conducting the M&V Process

The goals of conducting the M&V process are to:

1. Develop a deeper program and customer understanding of the relationship between energy uses, operations, and energy consumption at the site.
2. Determine energy and demand savings as information for customer and regulatory reporting purposes.
3. Enable the customer to manage all or the majority of the M&V process elements that support their energy management business practices.

The objectives of conducting the M&V process are to:

1. Characterize the energy consumption, energy uses, and relevant variables of the site.
2. Develop a plan to collect energy data.
3. If possible, develop and use energy consumption models for each type of energy consumed within the M&V boundaries.
4. Quantify energy savings for implemented energy performance improvement actions (EPIA) listed on the Opportunity Register.
5. Calculate energy savings realized during a defined Reporting Period.
6. Prepare documentation for reporting to the sponsoring PA and CPUC.
7. Teach elements of the M&V process to the customer as part of their energy management business practice development.

1.2 Terminology

The terminology used in this M&V Guide is consistent with the international standard ISO 50001:2018. In some cases, the terminology listed in Annex A - Terminology, of this M&V Guide provides commonly understood terms along with ISO 50001 references.

The concepts of energy performance and energy performance improvement are critical to the M&V process:

- Energy performance can be thought of as a snap shot in time of how much energy is being consumed or efficient the use of energy is.
- Energy performance improvement is related to a quantifiable change in the amount of energy consumed between two time periods during which EPIAs may be implemented.

An indefinite number of methods can be used to determine and report energy performance improvement. This M&V Guide uses estimated energy savings as an indicator of energy performance improvement. Customers may use the M&V process to develop other energy performance improvement indicators such as changes in energy intensity and energy efficiency in addition to estimations of energy savings.

1.3 Methods of Determining Energy Savings

This M&V Guide details two methods to determine energy savings. The methods are based upon:

1. One or more energy consumption adjustment models developed for each type of energy consumed within the M&V boundaries (commonly referred to as a top-down approach).
2. The aggregation of energy savings calculated for individual EPIAs implemented during the Reporting Period (commonly referred to as a bottom-up approach).

Both methods of determining energy savings are detailed in this M&V Guide.

Both methods provide value to the program and the customer but the meaning and context of resulting energy savings values will differ and needs to be contextualized appropriately. The two methods are foundationally different and reconciliation of energy savings values calculated from use of the two different methods will result in misleading conclusions and should not be conducted as part of a PA sponsored SEM program.

1.3.1 Energy Consumption Adjustment Models

The preferred method to calculate energy savings and track energy performance over time is to develop one or more energy consumption adjustment models for each type of energy consumed within the M&V boundaries. The development and use of energy consumption adjustment models serves two primary purposes:

Informative tool for customers to take action with

Energy consumption adjustment models developed to normalize energy consumption for relevant variables are tools that provide customers with information about the relationship of energy consumption, energy use, and operations. It is important that the customer work closely with the implementer to understand how energy consumption adjustment models are developed, can be used to track energy performance, and are used by the program to calculate energy savings.

Making energy savings values meaningful.

Energy savings are calculated by comparing the energy consumption of one time period to the energy consumption of another. Because variables that affect energy consumption are ever changing, the operational and external conditions of these time periods do not inherently reflect one another. By adjusting, via a regression model, the energy consumption of one of the two time periods such that the operational and external conditions are comparable, calculated energy savings values depict an accurate representation of the effect implemented EPIA and other actions have on energy consumption.

Both purposes for developing energy consumption adjustment models need to be equally considered throughout the M&V process.

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In some instances, energy consumption adjustment models for each type of energy cannot be created based upon the full M&V boundary (typically the site boundary). In these cases, multiple energy consumption adjustment models may be made so long as the boundaries of each model do not overlap with one another and fit within the larger M&V boundary. When multiple energy consumption adjustment models are developed, they typically focus on key processes, systems, and/or equipment. The creation of multiple models is not a requirement of this M&V Guide but is an option. The development of multiple models incurs additional effort and cost, though the customer may find greater value in using multiple models which, individually, more meaningfully relate to site operations than one overall site-wide model might.

Ideally M&V Boundary Energy Savings will be determined with one or more energy consumption adjustment models, though an M&V boundary smaller than the site boundary may be used. While the determination of energy savings with an energy consumption adjustment model does not rely on the calculation of energy savings of individual EPIAs, the energy savings of individual energy efficiency projects may be used in a limited capacity to provide confidence in top-down based Site-wide Projected Energy Savings but is not a requirement of this M&V Guide.

1.3.2 Aggregation of Energy Savings from Individual EPIA

If, for a given energy type, energy consumption adjustment models are not created or used to calculate energy savings, a bottom-up approach of determining energy savings by aggregating energy savings from select individual EPIAs may be conducted. Use of aggregated energy savings from individual implemented EPIAs will most likely not capture the total energy savings resulting from behavioral, retro-commissioning, and operations (BRO) activities and other EPIAs with smaller energy savings potential.

1.4 Avoided Energy Consumption and Annualized Energy Savings

M&V Boundary Energy Savings can be calculated from either energy consumption adjustment models (top-down approach) or aggregation of energy savings from individual EPIAs (bottom-up approach) on an Avoided Energy Consumption or annualized basis.

The CPUC developed NMEC Rulebook defines Avoided Energy Use (in this M&V Guide referred to as Avoided Energy Consumption) as:

> "...the amount of energy (or peak demand) that was not consumed or realized as a result of the energy efficiency project or program intervention. Avoided energy use is the difference between actual energy consumption in the "reporting period" and the consumption that is forecast for the same period using the "baseline energy consumption model," and where the baseline energy consumption model use is adjusted to reflect reporting period conditions. The Avoided Energy Use approach is used as the basis of customer incentive calculations and embedded M&V reporting of savings."

Energy savings represented as Avoided Energy Consumption represent the amount of energy savings realized during the Reporting Period. EPIAs and other energy saving actions may be implemented at any time during the Reporting Period. This means that energy savings activities implemented towards the end of the Reporting Period will not have a full 12 months of energy savings reflected in the reported Avoided Energy Consumption value. Many SEM programs report Avoided Energy Consumption energy savings.

Annualized energy savings are calculated to reflect a full 12 months of energy savings that will be realized after implementation of one or more EPIAs. Many custom capital and deemed energy efficiency programs report annualized energy savings.

Version 1.0 of this M&V Guide did not specify if energy savings should be reported on an Avoided Energy Consumption or annualized basis. In many cases top-down based energy savings were being reported on an Avoided Energy Consumption basis while bottom-up energy savings were being reported on an annualized basis.

In an effort to report SEM energy savings consistently within and between PA territories, with other PA energy efficiency programs, and at the request of the CPUC evaluator, version 2.0 of this M&V Guide included a process for annualizing top-down based energy savings and required reporting all energy savings on an annualized basis. The annualized process was adapted from one implemented by the Energy Trust of Oregon Industrial SEM program. Feedback after two years of use of this annualization process indicated the process of annualizing energy savings could be introducing unintended complications into reported values and was causing confusion when discussed with customers.

Based upon feedback from multiple stakeholders including PA staff, PA implementation contractors, CPUC staff, and CPUC evaluation contractors, and considering the recommendations made in the CPUC SEM evaluation report[1] and by a PA led M&V working group, this M&V Guide has been updated to no longer require annualization of top-down based energy savings. Annualization of top-down based energy savings may be performed with PA authorization only in the case when an energy consumption adjustment model is being retired or a customer will not be participating in the SEM program after the current Reporting Period.

The CPUC SEM evaluation report recommended that consistency in reporting energy savings be prioritized regardless of the method of determining energy savings. To ensure consistency in reporting energy savings all SEM energy savings shall by default be reported on an Avoided Energy Consumption basis regardless of being determined on a top-down and bottom-up basis.

For bottom-up energy savings this means that the annualized energy savings value for individual EPIAs shall be pro-rated for the Reporting Period based upon EPIA implementation date. To ensure a full annualization of EPIA energy savings is reported, the balance of the annualized energy savings for each EPIA shall be reported in the next Reporting Period regardless of whether a top-down or bottom-up approach is used for that type of energy in the next Reporting Period. If the customer does not end up participating in the SEM program in the subsequent year the balance of the annualized energy savings for the EPIA may still be claimed in the subsequent year with no associated cost of program implementation. Persistence of the EPIA in the subsequent Reporting Period shall be documented by confirming with the customer the EPIA is still installed and operational.

The only times at which energy savings for a given type of energy are allowed to be annualized shall be when an energy consumption adjustment model will be retired or if the customer is not intending to participate in the SEM program after the current Reporting Period. If either of these conditions is met and the PA agrees, then energy savings for that type of energy for that customer shall be reported on an annualized basis. If an energy consumption adjustment model is retired during the current Reporting Period and was used to claim Avoided Energy Consumption based energy savings in the prior Reporting Period, the unrealized energy savings between the claimed Avoided Energy Consumption energy savings of the previous Reporting Period and what would have been claimed in the previous Reporting period if Annualized Energy Savings were claimed may be claimed in the current reporting period in addition to new savings from a bottom-up approach if one is being used in the current Reporting Period.

See Section 3.13 for more information on calculating Avoided Energy Consumption and annualized energy savings with energy consumption adjustment models.

See Section 3.12.2 for more information on calculating Avoided Energy Consumption and annualized energy savings for EPIAs.

See Section 4 for more information on reporting energy savings to the CPUC.

[1] SBW Consulting Inc., Group D – D11.03 2018-19 Industrial Strategic Energy Management (SEM) Impact Evaluation, January 2022

1.5 Customer Learning and Leading the M&V Process

The ability of the customer to conduct elements of the M&V process independently after completing the PA sponsored SEM program is important to the viability of the customer's energy management system. Over the span of the SEM Program, it is expected, but not required, that the customer learn from the implementer how to independently manage the elements of the M&V processes that support their energy management business practices with limited assistance.

A distinction between the customer being able to manage the M&V process in general and being able to conduct activities to meet specific requirements of this M&V Guide should be made. Outside of a PA sponsored SEM program, the requirements of this M&V Guide become suggestions and the customer may deviate from them as desired to meet their individual needs. As an example, the benefits of developing and using energy consumption adjustment models may not outweigh the complexity and effort needed to establish energy performance improvement in this way. The customer may opt to use alternative and simpler energy performance indicators but would do so knowing the advantages and disadvantages of using these indicators.

The process of M&V documented in this M&V Guide will assist the customer beyond PA sponsored SEM program participation and the customer should focus on learning to manage M&V process activities that would be of value to them beyond the conclusion of the SEM Program Cycle. The portions of the M&V Guide that pertain to regulatory reporting and other PA and CPUC policies and requirements have limited value to the customer beyond the SEM Program and would likely need SEM Program support.

Beyond participation in a PA sponsored SEM program, the customer should review which requirements of this M&V Guide should be altered to best fit their own needs as part of their energy management business practices.

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1.6 Relationship to Other M&V Guides

This version of the M&V Guide, is an update to version 3.02 published July 06, 2022. This revision incorporates feedback from PA staff, SEM implementation contractors, CPUC staff, and CPUC evaluation contractors. Recommendations from the first CPUC evaluation report of the California SEM programs, 2018-19 Industrial Strategic Energy Management (SEM) Impact Evaluation, published January 31, 2022, and PA sponsored M&V working groups have been considered and appropriately incorporated.

Similar to previous versions of this M&V Guide, the key principles and specifications are based upon well-established SEM M&V practices and documents. Much of the technical content in this guide has been adapted from three SEM M&V documents:

- Energy Trust of Oregon Energy Production Efficiency, Energy Intensity Modeling Guideline, Version 2.2, January, 2019.
- Bonneville Power Administration, Commercial & Industrial Strategic Energy Management Measurement & Verification Reference Guide, Revision 1.0, March 31, 2022.
- U.S. Department of Energy Superior Energy Performance 50001, SEP 50001, Measurement & Verification Protocol: 2019, October 29, 2019.

This M&V Guide is also consistent with the principles and compatible with:

- **ISO 50015:2014** – Measurement and verification of energy performance of organizations – General principles and guidance.
- **ISO 50047:2016** – Determination of energy savings in organizations.

In addition, efforts were taken to ensure consistency in technical direction with:

- **ASHRAE Guideline 14:2014** – Measurement of Energy, Demand and Water Savings.
- **International Performance Measurement and Verification Protocol** – Option C, January 2012.

1.7 Relationship to the NMEC Rulebook

The CPUC developed Rulebook for Programs and Projects Based on Normalized Meter Energy Consumption (NMEC Rulebook) summarizes requirements for NMEC programs where energy savings are based on normalized metered energy consumption (NMEC). The purpose of the NMEC Rulebook is to provide a list of the directives and policies that have been established by the CPUC for the administration and implementation of such programs.

This M&V Guide and the NMEC Rulebook are based upon the common concept of determining energy savings on a site-wide, existing baseline, utility meter-based approach. While the concept is common, the CPUC has stated that the NMEC Rulebook and this M&V Guide are separate and not interchangeable. As stated in the January 7, 2020 version 2.0 of the NMEC Rulebook, “NMEC is not permissible for industrial operations and maintenance (O&M) or behavior, retro commissioning, and operations (BROs)-type projects except as a component of Commission defined Strategic Energy Management Programs.” The NMEC Rulebook continues that in Decision 18-01-004, “We clarify that this SEM program is the only program in which NMEC currently may be used to assess savings in industrial sites from operations and maintenance (O&M) or behavior, retro commissioning, and operations (BROs)-type activities.”

The separation of the NMEC Rulebook and this M&V Guide reflects the CPUC understanding that while the meter-based approach of the two documents contains many similarities, the NMEC Rulebook is oriented towards NMEC programs’ shorter duration than the six year-long SEM program.

When reasonable, consistency between the NMEC Rulebook and this M&V Guide has been considered.

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2 Planning

2.1 SEM Time Periods, Tools, and Reviews and Reports

2.1.1 SEM Time Periods

The M&V process described in this document is assumed to be conducted on an annual basis. Specific time periods listed below are established within and outside of the annual process. Use of these time periods helps define how energy performance is monitored and energy performance improvement is determined. These time periods may be changed as the M&V process is conducted.

The time periods are defined terms (**see Annex A - Terminology**). Requirements for use are provided here:

2.1.1.1 SEM Program Cycle

A consecutive 24-month time period during which the customer engages in the SEM program. As part of a well-established energy management system, energy consumption data and relevant variable data shall be collected continuously during the SEM Program Cycle regardless of energy savings determination approach that will be used.

2.1.1.2 Reporting Period

Time period for which energy saving are calculated. All portions of the SEM Program Cycle shall be encompassed by one or more Reporting Periods.

The PA sponsoring the SEM program shall be responsible for establishing the duration of the Reporting Period.

As part of a PA sponsored SEM Program Cycle, the default Reporting Period is one year starting at the beginning of the SEM Program Cycle. This assumption would allow for two consecutive Reporting Periods in each SEM Program Cycle. The PA sponsoring the SEM program may prescribe different Reporting Periods.

The first Reporting Period of a SEM Program Cycle is labeled as Reporting Period 1 whether or not energy consumption adjustment models are used across multiple SEM Program Cycles.

2.1.1.3 Baseline Period

A consecutive 12 or 24-month period that precedes the SEM Program Cycle and consists of a time period that is representative of normal operations within the site. During the Baseline Period energy consumption and relevant variable data are collected to create forecast energy consumption adjustment models and serves as the comparative basis by which improvements in energy performance are calculated against.

The Baseline Period shall be 12 or 24 consecutive months with the following considerations:

- **12 months:** Generally appropriate for sites with weather-dependent and seasonal operations. The 12-month period could be a calendar year, fiscal year, or other designated 12 consecutive months.
- **24 months:** Generally appropriate for highly seasonal models or models with monthly intervals, a 24-month Baseline Period may be optimal.

Alternative Baseline Period lengths may be used with PA approval. The rational for the alternative length shall be documented.

When choosing a Baseline Period length consider the reasonable ability to identify the implementation date and energy savings of EPIA implemented or non-routine events that may have occurred during the Baseline Period.

Ideally, the Baseline Period will end immediately prior to the start of the SEM Program Cycle. However, the Baseline Period shall not end more than three months prior to or after the beginning of the Reporting Period for which an energy consumption adjustment model is being developed. The three-month allowance provides for adjustments to the Baseline Period to account for abnormal operations, implementation of EPIAs, and non-routine events not expected to be observed again. The Baseline Period shall be updated as needed based upon the requirements of this M&V Guide.

2.1.1.4 Annualization Period

If energy savings are being determined with the use of energy consumption adjustment models and annualization of energy savings is approved by the PA, an Annualization Period shall be established for which the annualization of energy savings can be calculated following the requirements of this M&V Guide.

2.1.1.5 Reporting the Current SEM Program Cycle

In any report or review, when referring to the current SEM Program Cycle on reports or as part of reviews the following full statement designed to document the customer's current and past SEM program participation shall be used: SEM Program Cycle [#] Reporting Period [#], SEM program participation year [#].

Assuming one year-long Reporting Periods the full listing of potential statements designating the current SEM Program Cycles are:

- Core SEM Cycle 1, Reporting Period 1, SEM Program Year 1.
- Core SEM Cycle 1, Reporting Period 2, SEM Program Year 2.
- Core SEM Cycle 2, Reporting Period 1, SEM Program Year 3.
- Core SEM Cycle 2, Reporting Period 2, SEM Program Year 4.
- Core SEM Cycle 3, Reporting Period 1, SEM Program Year 5.
- Core SEM Cycle 3, Reporting Period 2, SEM Program Year 6.

Use of an abbreviated version of the full listing of potential statements designating the current SEM Program Cycles can be used with the format: "SEM Program Year X" where X is the current program year.

Graduate Pathway designations continue based upon the above format:

- Graduate Pathway Cycle 4, Reporting Period 1, SEM Program Year 7.
- Graduate Pathway Cycle 4, Reporting Period 2, SEM Program Year 8.

2.1.2 Tools

- 2.1.2.1 Energy Map
- 2.1.2.2 Energy Data Collection Plan
- 2.1.2.3 Energy Data and Performance Tracking Tool
- 2.1.2.4 Energy Consumption Adjustment Model Development Tool
- 2.1.2.5 Opportunity Register
- 2.1.2.6 Energy Management Assessment

2.1.2.1 Energy Map

Defined by the Consortium for Energy Efficiency, an Energy Map is, “a breakdown or map of energy end uses and costs across the company. This should include all significant end use systems, as well as other relevant variables of energy consumption such as production, weather, and product mix.”[2]

The Energy Map is intended to identify and show where and how much energy is used within a site, create awareness of site-wide energy use, and help prioritize the identification of energy-saving opportunities based on areas of high energy use in a site.

An Energy Map Tool, likely Excel-based, that helps the customer build a basic Energy Map, and optionally a detailed Energy Map, shall be provided to customers to help them organize and understand energy use at their site by area or system.

2.1.2.2 Energy Data Collection Plan

Energy Data and Performance Tracking Tools shall be designed and used to capture energy consumption and relevant variable data for each M&V boundary. Data captured by The Energy Data and Performance Tracking Tool shall also be used to track energy performance as determined by energy consumption adjustment models over time.

2.1.2.3 Energy Data and Performance Tracking Tool

The Energy Data and Performance Tracking Tool shall be designed and used to capture energy consumption and relevant variable data. Data captured by The Energy Data and Performance Tracking Tool shall also be used to track energy performance as determined by energy consumption adjustment models over time.

To ensure the customer can access their own data and continue to record and track data after an SEM Program Cycle, the implementer shall provide and ensure the customer can record and track data in a no-cost Energy Data and Performance Tracking Tool. An Excel based tool is likely to be provided as the underlying software is typically available to the customer. Other no-cost tools are acceptable so long as the customer can maintain access to the tools at no-cost beyond the SEM Program Cycle.

If the customer would rather use their own data collection tool, the implementer shall ensure it is configured to track all data identified in the Energy Data Collection Plan and data will be exportable to provide to the sponsoring PA if needed.

In addition to the no cost tool, and with approval from the sponsoring PA, implementers are permitted to make available to customers proprietary/for fee software tools to serve as the Energy Data and Performance Tracking Tool so long as data contained with these tools can be extracted and used to populate the no-cost Energy Data and Performance Tracking Tool at the conclusion of the SEM Program Cycle.

2.1.2.4 Energy Consumption Adjustment Model Development Tool

The implementer shall provide and show the customer a no-cost Energy Consumption Adjustment Model Development Tool. As part of a PA sponsored SEM program there are no specific software

[2] Consortium for Energy Efficiency (CEE), CEE Strategic Energy Management Minimum Elements, February 2014

requirements for building energy consumption adjustment models so long as the resulting model meets all validity requirements of this M&V Guide. Consider the software's flexibility and its ability to iterate quickly on relevant variable combinations. The customer does not have to be able to demonstrate an ability to use the tool but shall be shown the tool and its use described such that if the customer desires to use the no-cost beyond the PA sponsored SEM program they can do so.

In addition to the no-cost tool, and with approval from the sponsoring PA, implementers are permitted to make available to customers proprietary/for fee software tools to serve as the Energy Consumption Adjustment Model Development Tool so long as data contained with these tools can be extracted and used to populate the no-cost Energy Consumption Adjustment Model Development Tool at the conclusion of the SEM Program Cycle.

2.1.2.5 Opportunity Register

The Opportunity Register helps the customer prioritize and track opportunities to improve energy performance and their EnMS. The Opportunity Register is also an important piece of evidence of program influence as part of the CPUC's evaluation of the SEM program. The Opportunity Register is required to include data that will directly aid the customer as well as the CPUC evaluator.

The implementer shall provide and ensure the customer can record and track data in a no-cost Opportunity Register. An Excel based tool is likely to be provided as the underlying software is typically available to customers. Other no-cost tools are acceptable so long as the customer can maintain access to the tools at no-cost beyond the PA sponsored SEM Program Cycle.

In addition to the no-cost tool, and with approval from the sponsoring PA, implementers are permitted to make available to customers proprietary/for fee software tools to serve as the Opportunity Register so long as data contained with these tools can be extracted and used to populate the no-cost Opportunity Register at the conclusion of the SEM Program Cycle or at the request of the PA or customer.

2.1.2.6 Energy Management Assessment

The Energy Management Assessment (EMA) process described in the Design Guide will result in a quantitative output metric of EnMS development. This metric will be reported as part of the Mid-Year Review and SEM Reporting Period Performance Report. The requirements pertaining to the specific EMA and reporting of results detailed in the Design Guide shall be followed.

If the EMA question set required for use by the Design Guide is put into a proprietary/for fee tool, the underlaying question/statement set shall be made available to the customer at no cost and in a format of the customer's choosing.

2.1.3 Reviews and Reports

2.1.3.1
Mid-Year Review

2.1.3.2
SEM Reporting Period Performance Report

2.1.3.1 Mid-Year Review

The Mid-Year Review is an annual review of the M&V process conducted between the implementer and PA sponsoring the SEM program. The SEM program is a long duration engagement with integrated business practice development, EPIA implementation, and M&V activities, the PA has interest in ensuring the program is "on track" prior to annual submission of energy savings and future CPUC evaluation. An annual Mid-Year Review of the M&V process and key SEM program design components shall be conducted between the implementer and PA sponsoring the SEM program to ensure the program deliverables, including M&V deliverables, are being met prior to year-end reporting. The Mid-Year Review is not designed to be part of the CPUC evaluation process.

2.1.3.2 SEM Reporting Period Performance Report

The SEM Reporting Period Performance Report is a living documentation of the activities and outputs of the M&V process. The SEM Reporting Period Performance Report is intended to be for the PA sponsoring the SEM program but may be of use to the customer as a record of the M&V process that can be used in subsequent years.

2.2 Characterizing the Site

M&V is conducted within a defined set of boundaries for a given site for which the energy consumption is managed by a customer of the PA sponsoring the SEM program. The process of establishing M&V boundaries is based upon developing an understanding of the:

- Types of energy consumed,
- Energy uses and their operation,
- Energy meters, and
- Energy flows at the site

In many cases, establishing M&V boundaries may be relatively straightforward depending on the nature of the site and what information is already available. If the M&V process is being conducted as part of a PA sponsored SEM program, the M&V boundaries most likely will be the same as those used to define the site as part of the SEM program. M&V boundaries should align with the location of energy meters and energy uses such as production lines, process systems, buildings, and other equipment.

Depending on the site complexity, interest of the customer, and challenges creating energy consumption adjustment models for a site-wide M&V boundary, smaller M&V boundaries may be needed or more useful in understanding energy performance improvement.

Review of the M&V boundaries should be conducted regularly. The process of updating M&V boundaries is based upon detailed knowledge of energy consumption, energy use, and general operations within the site. This is information the customer should have intimate knowledge of.

This review could be a simple review to confirm what, if any, changes to the types of energy consumed, energy uses, energy meters, operations, and potentially relevant variables have occurred at the site and need to be reflected. If changes to the site, including the addition or removal of on-site generation and site expansions, have occurred an assessment should be made to understand how they may affect the M&V boundaries and other parts of the M&V process.

Subsequent parts of the M&V process may reveal a need to revisit M&V boundaries.

The process of first establishing and then reviewing M&V boundaries shall be conducted annually.

2.2.1 Site Boundaries

2.2.1.1 Defining the Customer

The customer is an organization enrolled in the PA sponsored SEM program and has control and responsibility for energy consumption as measured by one or more meters across one or more sites. Customers can choose to enroll sites simultaneously or at different times based on their organizational structure and management needs.

2.2.1.2 Defining the Site

A site is typically defined by the neighboring proximity of energy-consuming buildings, assets, or facilities, usually within a shared boundary such as a fence line and may have one or more associated street addresses. A site can encompass multiple buildings or assets and include multiple utility energy meters.

The process of defining a site should align with the customer's operational understanding. Any deviations from the general definition must be discussed between the customer and the SEM program implementer, with final approval from the Program Administrator (PA).

Examples:

- **School District Example**: A school district with one high school, two middle schools, and four elementary schools not located near each other would typically represent seven distinct sites. However, if one middle school is adjacent to an elementary school, the district may consider these two schools a single site if operationally beneficial. Such cases require discussion with the implementer and PA approval.
- **Healthcare Provider Example:** A healthcare provider operating a hospital complex at one address and an outpatient building located a block away, separated by other properties, must discuss with the implementer whether operational integration into one site makes sense for energy management purposes. Combining these into one site boundary requires PA approval

2.2.2 Energy Types

The scope of the M&V process shall include all energy types, which are delivered to, consumed within, and delivered away from the M&V boundaries. The originating source (e.g., utility, on-site generation, other organization) of the energy should be noted but does not prohibit any energy types from being included in the M&V process.

In some instances, to aid energy consumption adjustment model development it may be useful to remove energy conversion equipment from the M&V boundaries such that the energy the equipment produces is accounted for rather than the energy that enters it (e.g., account for the steam produced by a boiler rather than the biogas that feeds it, account for the electricity after the inverter that is generated by an on-site PV panel). See Annex B - Special Cases in Energy Accounting for examples of how to establish the delivered energy value for various M&V boundary situations.

Based upon the working understanding of the M&V boundaries a list of all energy types that the customer has authority of and that are delivered to, consumed within, and delivered away from the boundaries shall be created.

2.2.2.1 Quantifying Energy Consumption

For each energy type included in the M&V process, site-wide energy consumption shall be equal to or greater than zero.

If site-wide energy consumption for a given type of energy is calculated to be a negative value, it shall be accounted for as zero. In such cases, care shall be taken to ensure energy export and energy product are correctly accounted for.

2.2.2.1.1 On-site Energy Generation and Conversion

M&V boundaries are considered three-dimensional; thus, energy accounting shall include energy that enters the M&V boundaries from the sky (e.g., rooftop solar PV) and ground (e.g. on-site natural gas extraction) if consumed at the site in the form of an energy type for which energy savings are being determined.

The establishment of M&V boundaries shall consider on-site energy conversion equipment such as a Combined Heat and Power (CHP) system, natural gas fueled gas turbine engine, or biogas fueled boiler.

This consideration shall include analysis of how energy converted from one type to another (e.g., natural gas to steam and electricity) are ultimately consumed by energy uses within the M&V boundary and the consideration for how those energy types will be used in the future development of energy consumption adjustment models.

2.2.2.1.2 Types of Energy with Relatively Insignificant Consumption

A given type of energy may be omitted from the M&V process only if it accounts for 5.0% or less of the site's total prior year annual delivered energy.

In calculating the percent of total consumption represented by an omitted energy type, both the energy consumption of the omitted energy type and total site energy consumption shall be calculated on a delivered energy basis.

The determination to omit energy types shall be based on measured data or calculated analysis and documented in the SEM Reporting Period Performance Report.

> **EXAMPLE:** A site that produces and freezes large quantities of processed foods uses propane for two forklifts. The annual energy consumption of propane is calculated to be 2.5% of site total energy consumption. As a result, propane is omitted from the M&V process.

Justification for the omission of a given type of energy shall be documented.

2.2.3 Energy Uses

M&V boundaries shall be defined to encompass important energy uses such as production lines, process systems, and buildings as appropriate.

Uses of energy that consume a significant quantity of energy or are important to the operations at the site shall be identified.

If as part of the EnMS, significant energy use (SEU) selection criteria was developed, this criteria shall be used to identify SEUs.

2.2.4 Energy Meters

Data regarding the quantity of energy delivered into or away from the M&V boundaries (delivered to the site, delivered away as energy export, delivered away as energy product, or feedstock) may be available directly from energy meters (utility or submeters) or taken from a supplier invoice. Based upon the location of energy meters the M&V boundaries may need to be adjusted.

Use of existing utility energy meters may be sufficient to quantify the delivered energy.

If utility energy meters serve buildings, equipment, processes or other energy using systems outside the M&V boundaries (nominally outside the SEM program boundaries if the customer is participating in a PA sponsored SEM program) for which energy performance and energy savings are being determined, submeters shall be used to net out the energy consumption of these energy uses.

All utility and other relevant energy meters for all types of energy delivered to or away from the M&V boundaries as well as energy submeters shall be documented.

For each energy meter, the meter serial number, utility account number, or other unique identifiers shall be documented. The meter units and metering interval shall be documented. The major processes monitored by each energy meter shall be documented.

2.2.5 Energy Flows

The quantity of a particular type of energy that is consumed within the M&V boundaries is defined by the net energy flow of that energy type across the M&V boundaries.

Process flow diagrams, piping and instrumentation diagrams, and value stream maps can be helpful in creating diagram(s) that show energy flows. Indicate the flow of each type of energy on this diagram. The energy flows trace the “path” energy takes from the point it is delivered to the M&V boundaries and to the energy end uses. If applicable, the energy flows will include the “path” energy may take into and out of on-site storage, delivered away from the site as an energy product or energy export.

The energy content of the energy flows that do not terminate in energy end uses within the M&V boundaries will need to be netted out to correctly establish the amount of delivered energy.

The energy flow diagram does not need to include energy units, be to scale, and is an illustrative diagram of the various energy uses and sources within the M&V boundaries.

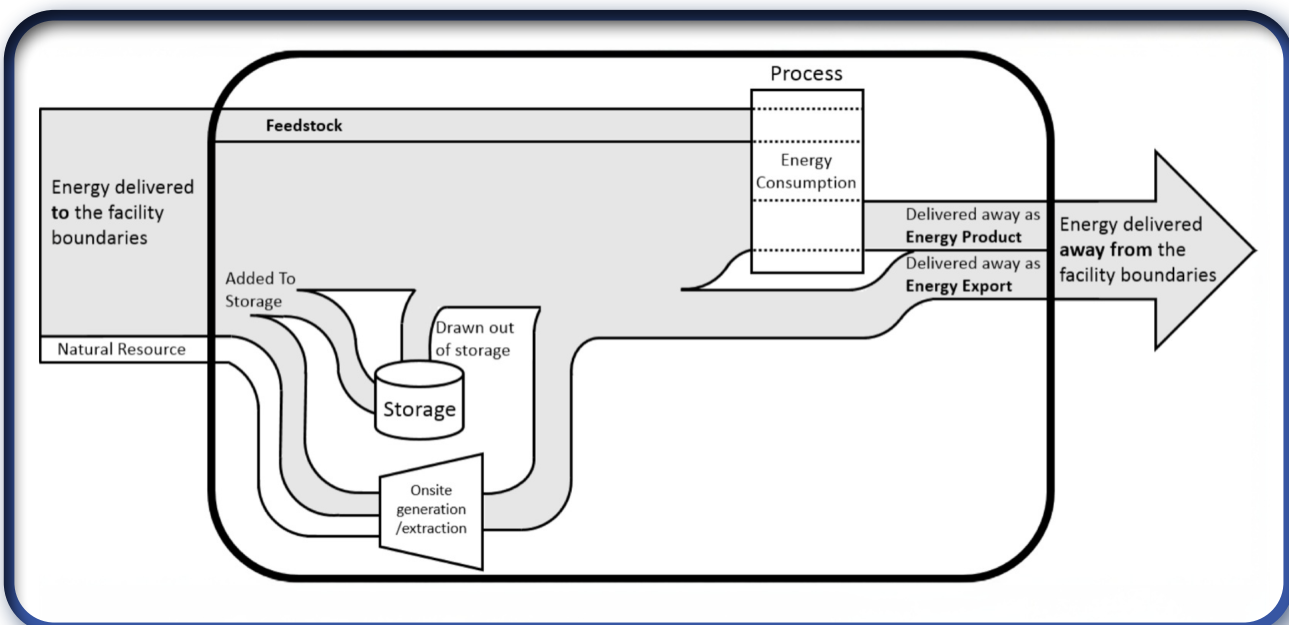

Figure 1: Generic Energy Consumption Accounting Flow Diagram.

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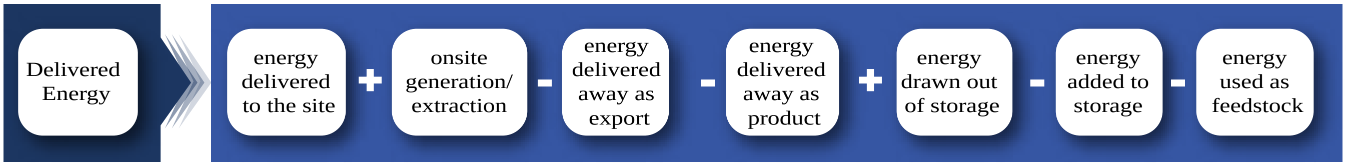
The below equation describes how to calculate energy consumption. Figure 1 graphically illustrates this relationship.



An energy flow diagram shall be created and reviewed annually with updates made reflecting changes at the site.

Additionally, if energy is used as a feedstock this shall be noted as part of the energy flow.

2.2.6 Energy Map

An energy map shall be developed through the process of establishing M&V boundaries and reviewed annually with updates made reflecting changes at the site.

The Energy Map shall contain at a minimum a listing of energy uses at the site with importance to the customer or that have a relatively large consumption of energy. For each energy use listed, the associated types of energy consumed, rough estimate of energy consumed, and relevant variables possible associated with the energy use shall be provided. Notation of which energy uses are selected as Significant Energy Uses (SEUs) and the criteria for selecting them shall be made on the Energy Map.

2.2.7 Documenting Site Boundaries

Documentation of site boundaries shall include a description and one or more clearly marked line drawings or aerial images of the site.

The line drawing(s) or aerial image(s) shall include demarcation of buildings and major equipment and processes, energy meters, and energy flows within the site boundaries.

Special note shall be made regarding the location and interrelationship of energy conversion equipment (e.g., CHP, on-site generation).

2.3 Relevant Variables

Relevant variables are quantifiable factors that routinely change and have a major impact on energy performance, including operational performance, and which directly affect the amount of energy consumed within the M&V boundaries. Relevant variables may or may not be in the control of the customer.

> **EXAMPLES:** Production quantities, equivalent products, number of batches, heating degree-days, humidity, occupancy, hours worked, number of shifts, customers served, and raw material characteristics.

Relevant variables are used to normalize energy consumption as part of an adjustment model. Relevant variables can also be used with other methods of tracking energy performance and determining energy performance improvement.

It is important to select a suite of relevant variables that will fully represent the use and consumption of energy within the M&V boundaries. Equally, it is important to not collect data on variables that have no bearing on the use and consumption of energy.

Sites with complex or diverse operations, for which there may be difficulty creating a single site-wide energy consumption adjustment model for each type of energy, should consider assessing additional potentially relevant variables that may be more directly related to a discrete process, building, or other operation that could be modeled in isolation.

Regular simple reviews of relevant variables should be conducted to ensure they are still relevant to the site's energy consumption.

A full review of selected relevant variables may be needed if additional or different energy consumption adjustment models are to be created or if significant operational changes have occurred at the site.

2.3.1 Identifying Potential Relevant Variables

In order to develop robust and meaningful adjustment models, care shall be taken to avoid:

- Omitting relevant variables that affect energy consumption.
- Including variables that do not directly affect energy consumption.

The process of identifying relevant variables shall be conducted regardless of the M&V method used and before attempting to develop energy consumption adjustment models.

A first step in this process is to assess where production data is available relative to energy-intensive processes. If a significant time offset exists between the energy-intensive process and the measurement point for a potential relevant variable, a note that a time-shift in interval data is needed to align the production data with energy consumption data shall be made.

Relevant variables shall be physical quantities, characteristics, or conditions. Financial metrics or metrics that include a financial component, such as product price or energy costs shall not be considered as relevant variables as they lack a physical relationship to energy consumption.

The following variables shall be considered for inclusion as relevant variables:

- Activity level (e.g., operating hours, operating mode (weekend/weekday), production level, product mix, and equivalent products, occupancy, etc.).
- Weather (e.g., heating degree-day, cooling degree-day, ambient temperature, and humidity, etc.).

Using engineering judgment, a list of potentially relevant variables that may or may not be included in the energy consumption adjustment models shall be developed.

For each potentially relevant variable included on this list, the energy type and energy use (of those identified in Section 2.2) that the relevant variable is suspected to affect shall be indicated.

2.3.1.1 Production Metrics

For industrial sites, a metric of production is often included as a relevant variable. It is important to understand how many product types are manufactured in a site and whether there is likely to be a difference in energy consumption based on operating parameters such as product type, process flow, or batch size. Site personnel who work closely with energy uses typically have insight into what variables should be considered. By thinking openly about which variables may affect energy consumption and how those variables relate to one another, the chances of developing a robust energy consumption adjustment model will be increased.

EXAMPLE: A site that produces two types of products, one of which is very energy intensive to produce and the other which is not, may consider including production levels from both products rather than an aggregated production value.

If multiple production variables are available, process flow diagrams and energy maps may be useful to identify potentially interactive effects and correlations. Using multiple measurement points in the same process line may not be necessary or beneficial. See Annex D – Multicollinearity and Autocorrelation, for more details.

Measurement Points	Pros	Cons
Raw material input	Provides a mechanism for capturing the effects of different types of raw materials.	Fails to provide a mechanism for understanding energy impact of yield/productivity improvements.
In-line metric	Allows for the selection of a production variable at energy-intensive processes, thereby minimizing a time-series shift.	Fails to provide a mechanism for incentivizing the energy impact of yield/productivity improvements downstream, from point of measurement.
End-of-line metric	Provides a mechanism for incentivizing the energy impact of yield/productivity improvements.	May induce a time-series shift for long lead-time processes.
Finished product shipped	Data can be captured via accounting systems.	May not sync with production depending on dwell time in the warehouse.

Table 1- Options for Production Relevant Variables

Raw material, in-line production, and finished product metrics each have pros and cons as relevant variables. An informed decision will take into account factors such as lead time, the desire to account for yield effects, as well as the prevalence of inventory fluctuations in-process or at the finished-product stage.

2.3.1.2 Weather Metric Requirements

One or more weather metrics such as outdoor air temperature, wet bulb temperature, heating degree day (HDD), cooling degree day (CDD) and rainfall will often be used in the formation of an energy consumption adjustment model.

Weather data shall be actual weather data from published government sources, such as primary National Oceanic and Atmospheric Administration (NOAA) weather stations, the National Climate Data Center (NCDC) database, or from a calibrated weather meter within close enough proximity to the site to reflect the weather conditions at the site.

If on-site weather station data is to be used it shall be calibrated per the manufacturer's specifications and confidence established that the station will be available through the SEM program cycle.

The customer must be able to access the same data during and after the SEM Program Cycle in order to be able to update the model themselves upon completion of the SEM Program Cycle.

In some cases, weather stations report in coordinated universal time (UTC) time, which means a daily average is not representative of a 12:00am-11:59pm day in local time. Proper time zone offsets shall be applied to data before averaging into a daily, weekly, or monthly interval.

If being used in the formulation of energy consumption adjustment models that will be used to report energy savings to the CPUC, HDD and CDD shall be calculated based upon at least daily data.

2.3.1.3 Indicator Variables and other Relevant Variables

Based on the energy map and energy uses, consider which other relevant variables may affect energy consumption such as raw material properties, operational modes (weekend/weekday) occupancy, shifts, and hours.

Indicator variables can represent tangible changes to operations, sites, and processes. Positively, the use of an indicator variable can help ensure energy consumption adjustment models are meaningfully constructed. Negatively, indicator variables can be developed semi-arbitrarily to ensure a model can be created regardless of the resulting model being meaningful. Whenever an indicator variable is used in a model, define whether it is a one-time change or a reoccurring event that will also apply in the Reporting Period.

An indicator variable could be used in conjunction with production data to create an artificial offset for regular non-production days. In this case as the indicator variables would establish a level of energy consumption for non-production days on which energy consumption would increase as production level rise.

Indicator variables may be used to represent seasonal changes, energy projects during the Baseline Period or other changes.

2.3.2 Identifying Data Sources

If possible, data sources for each potentially relevant variable shall be identified.

The list of potentially relevant variables shall be amended to include data sources.

For each data source, the serial number or other unique identifiers for meters that would be used to collect data shall be noted.

Data source descriptions shall be specific so that an individual familiar with the systems and operations of the site could understand where and how to collect relevant variable data.

Based upon energy consumption adjustment modeling efforts and with customer input, a list of relevant variables for which data will be collected shall be assembled.

Review of which variables are selected as relevant variables shall be conducted annually, reflecting lessons learned from the prior year and taking into account planned changes to the site.

Relevant variables shall be added and removed from the list of potential relevant variables as needed to reflect changes to energy uses and operations as well as taking into account feedback from efforts to establish energy consumption adjustment models.

Data for relevant variables shall be collected on an ongoing basis regardless of selected M&V approach.

2.3.3 Review of Relevant Variables

As needed, alternative relevant variables to facilitate model development may need to be identified.

An annual review, proportional to the changes that have occurred at the site since the last review and reflecting the need to develop any new energy consumption adjustment models, shall be conducted.

2.4 Planning for Energy Data Collection

Preparing for the collection of data involves the creation and update of an Energy Data Collection Plan, Energy Data and Performance Tracking Tool, and Opportunity Register.

As part of a PA sponsored SEM program, be aware of relevant PA or CPUC policies related to data collection and the source of energy, specifically for non-utility supplied energy and if a Public Purpose Program (PPP) charge is paid by the customer.

2.4.1 Energy Data Collection Plan

2.4.1.1 Developing the Energy Data Collection Plan

The Energy Data Collection Plan shall be developed for all customers regardless of M&V boundaries and method of determining energy savings to accommodate collection of energy consumption and relevant data identified as part of the M&V process, the process by which the data will be collected, and the persons responsible for collecting the data. The Energy Data Collection Plan will need to be modified to reflect selected M&V boundaries and method of determining energy savings.

The implementer shall work with the customer to develop an Energy Data Collection Plan being sure to identify who is responsible for collecting data, how often they are to collect data, and that they know how to record data in the Energy Data and Performance Tracking Tool.

The development and maintenance of the Energy Data Collection Plan shall be in part based upon information assembled when establishing M&V boundaries and identifying potential relevant variables. In addition to these considerations, the Energy Data Collection Plan shall include details identified in this section of the M&V Guide as well as by the PA and implementer if participating in a PA sponsored SEM program.

The Energy Data Collection Plan shall list the energy meters and relevant variables data sources for which data will be collected.

For each of these data sources the Energy Data Collection Plan shall indicate:

- How the data are to be collected.
- The frequency of data collection.
- Data storage method and location.
- The person(s) responsible for collecting and storing the data.
- The person(s) responsible for conducting quality control of the data.

A consistent and reliable process for acquiring and recording data shall be developed and recorded.

The steps (detailed appropriately to the skills, experience, and abilities of the person collecting the data) to be followed ensure timely acquisition and quality control of data shall be listed.

A complete collection process shall include:

- Data required.
- Data location.
- Method of analysis to ensure data quality.

In some sites, a data collection process may already be in place and can be utilized. If data that need to be collected are not already collected, then determine if the organization has the means to collect the data.

If not, the customer shall acquire additional metering equipment or identify different data that will fulfill the same need. The Energy Data Collection Plan shall reflect if such considerations are needed.

2.4.1.1.1 Meter Data

Energy meters (utility or submeters) may directly report energy consumption values or physical properties such as pressure, temperature, mass, volumetric flow, and heating value that can be used to calculate energy consumption by using equations and conversion factors

Equations and conversion factors used to convert meter output data to other metrics and values shall be documented.

Quantification of energy consumption or of a relevant variable via subtraction of readings from two or more calibrated meters is acceptable.

2.4.1.1.2 Frequency of Data Collection

Energy and relevant variable data shall be collected at least monthly if not more frequent (e.g., weekly, daily, and 15-minute interval).

In general, more frequent data collection can be beneficial in the development of robust energy consumption adjustment models.

The frequency of data collection may take into consideration the frequency at which energy consumption data and relevant variable data can be obtained and be meaningful.

While this M&V Guide makes this conditioned allowance for a slower collection of data, it is highly encouraged that data be collected at the most frequent rate possible for possible future use. More frequently collected data can be aggregated together to match the rate at which relevant variable data can be collected when forming energy consumption adjustment models (e.g., 15-minute interval electricity consumption data can be aggregated to a weekly basis if the relevant variables associated with electricity are only available on a weekly basis).

2.4.1.1.3 Energy Types with Multiple Sources and Meters

When a particular energy type is delivered to the M&V boundary from multiple sources (e.g., utility supplied electricity and on-site generated electricity from a PV system, chilled water delivered by another organization and water chilled by a chiller supplied with utility delivered electricity) or from multiple meters for utility supplied energy, the quantity of energy from each originating source shall be recorded separately.

These values may be aggregated in the formation of energy consumption adjustment models but the disaggregated values shall be recorded independently for regulatory reporting purposes.

2.4.1.1.4 Meter Calibration

All data used as part of the energy accounting, including those for energy consumption and relevant variables, shall be taken from measurement systems if possible. In some instances, such as that for on-site solar, a conservative approach to estimating energy by using PA approved tools and assumptions may be used. If such a tool is used, then reporting documentation needs to include all relevant assumptions and provide a link to the tool itself.

If energy consumption data are taken from a source other than the utility meter, calibration of that meter shall follow the manufacturer's recommendations.

Calibration records and records of repairs to calibrated meters shall be maintained by the customer and available for the implementer to review if requested.

Calibration records for utility meters are not the responsibility of the customer or implementer and do not need to be maintained.

If the customer is unable to have meters calibrated then the meter does not need to be calibrated. If the meter is being used for relative comparison (i.e. not for their absolute value but the relative difference between values over time, e.g. an uncalibrated production meter is used where absolute production values are not necessary, only their relative changes over time) then the meter does not need to be calibrated.

2.4.1.2 Updating the Data Collection Plan

The implementer shall check in with the customer on a regular basis to ensure the Energy Data Collection Plan is being updated as needed.

When major changes occur at the site the customer shall inform the implementer and together assess what changes are needed to the Energy Data Collection Plan.

The Energy Data Collection Plan shall be reviewed and updated on at least an annual basis following review of the M&V boundaries and selection of relevant variables.

The Energy Data Collection Plan may need to be additionally updated if it is found to be ineffective, identified meters are removed or added, additional relevant variables are identified, or other extenuating circumstances arise.

Changes to the Energy Data Collection Plan shall be documented.

The updated Energy Data Collection Plan shall be put into place and used to retroactively collect data for the SEM Program Cycle and any time prior as needed.

2.4.2 Energy Data and Performance Tracking Tool

One or more Energy Data and Performance Tracking Tool shall be developed for all sites for each M&V boundary regardless of the method of determining energy savings and based upon the Energy Data Collection Plan. Energy Data and Performance Tracking Tools shall be annually reviewed and updated appropriately. The data collected and retained in the Energy Data and Performance Tracking Tool should be customized for each M&V boundary and ensure that at least the minimum amount of data required for M&V is included.

2.4.3 The Opportunity Register

The Opportunity Register is a living document and shall be inclusive of energy performance and EnMS improvement opportunities identified and completed outside of and during the multiple year PA sponsored SEM program (i.e. the Opportunity Register should include identified and completed opportunities from prior year engagements in the PA sponsored SEM program). The implementer shall work with the PA and customer to identify opportunities that have been identified, planned, and implemented at least two years prior to the start of the first SEM Program Cycle the customer participated in.

The Opportunity Register is used by the CPUC to determine influence of PA sponsored SEM programs. As such, some required components of the Opportunity Register may provide less value to the customer than others. Outside of a PA sponsored SEM program the customer can alter the Opportunity Register to meet their own needs.

Each row of the Opportunity Register shall correspond to an individual Energy Performance Improvement Action (EPIA). Each row of the opportunity register shall be filled out with a level of completeness and detail reflecting the development and implementation of the associated EPIA. It is expected that the Opportunity Register, as a living document, will continue to be filled out as information about EPIAs are better understood and implementation of some EPIAs moves forward. Opportunity Register rows associated with EPIAs that are early in the planning or development stages will not need to be as complete as those for EPIAs that are implemented. Opportunity Register rows associated with an implemented EPIA for which energy savings will be claimed as part of the bottom-up method should be filled out completely.

2.4.3.1 Establishing the Opportunity Register

An Opportunity Register shall be created to accommodate data related to EPIAs and EnMS improvement opportunities.

The Opportunity Register shall include the following sections and fields for entry:

- **A description section:**
  - ID number
  - Name
  - Description (e.g. Replace outside air damper actuators in all AHUs, place employee energy savings opportunity box in break room)
  - Process/system category (e.g. HVAC, lighting, compressed air, pumping, opportunity identification)
  - Process/system description (e.g. equipment type, size, capacity, load, operating conditions)
  - Location (e.g. Building 7, process line 3)
  - Opportunity type (e.g. capital, process, maintenance, operational, behavioral, EnMS)
- **An identification section:**
  - Identified by (e.g. SEM treasure hunt, IOU assessment, employee suggestion, internal audit, management review)
  - Identification date
  - SEM influence (binary entry: "yes" or "no," depending if measure was identified or planned as part of a PA sponsored SEM program or not, see Section 3.12.2.2)
- **A prioritize section:**
  - Qualitative (e.g. low, medium, or high) or quantitative indicator of estimated energy saving for energy types primary affected
  - Qualitative (e.g. low, medium, or high) or quantitative indicator of cost/effort required
- **A planning section:**
  - Next steps (or the required actions to complete)
  - Owner (i.e. who is responsible to moving the opportunity forward as appropriate)
  - Target implementation date

- **An ensure persistence section:**
  - Backsliding risk (i.e. how likely it is that the energy savings from this project will decline without regular attention paid by key personnel),
  - Persistence strategy (brief description, this should likely be documented more fully elsewhere)
  - Start of Cycle 2 confirmation from customer EPIA is still installed and functional
  - Start of Cycle 2 persistence review date
  - Start of Cycle 3 confirmation from customer EPIA is still installed and functional
  - Start of Cycle 3 persistence review date
  - End of Cycle 3 confirmation from customer EPIA is still installed and functional
  - End of Cycle 3 persistence review date

  Note: The completion of persistence review and review date fields should be conducted, if applicable, based upon the implementation status and implementation date of the EPIA. The addition of more persistence review columns can be made based upon extended engagement in the SEM program (e.g. "Graduate Pathway")

- **An implementation section:**
  - Implementation status (e.g. implemented, implementing now, implement later, not to be implemented, not implement)
  - Implementation status date (i.e. the date the implementation status was updated)
  - Implementation date
  - EPIA cost - based upon guidance from PA along with invoice documentation supporting cost value

- **A results section:**
  - Annualized energy savings for each type of energy affected
  - Reporting Period pro-rated energy savings for each type of energy affected
  - Annualized demand savings for each type of energy affected
  - Reporting Period pro-rated demand savings for each type of energy affected

  Notes where documentation for data, calculations, and other details can be found.

The results section shall be completed if energy savings resulting from the EPIA will be included as part of reporting energy savings using a bottom-up approach. If this is the case the requirements of this M&V Guide shall be followed when calculating EPIA energy savings. Otherwise, the results section may optionally be completed or fields left blank.

The Opportunity Register may include additional sections and fields as suggested by the PA, implementer, and customer.

2.4.3.2 Planning to Collect Data for EPIAs

The Opportunity Register shall be filled out as part of a PA sponsored SEM program regardless if a top-down or bottom-up method will be used to determine energy savings. Guidance on calculating energy savings for individual EPIAs are listed in Annex C – Bottom Up EPIA Calculation Effort and should be consulted when planning for data collection to determine the results of implemented EPIAs if the energy savings for the EPIA will be included as part of reporting energy savings using the bottom-up method.

2.5 Selecting the M&V Boundaries and Method

Measurement and Verification (M&V) boundaries establish the geographic and operational limits within which energy performance improvements are measured, verified, and reported. These boundaries may align directly with the overall site boundaries or may consist of smaller, clearly defined systems or process areas within the larger site boundary.

Note, the definition of M&V boundary is: organizational, physical, site, equipment, systems, process or activity limits within which energy performance or energy performance improvement is measured and verified.

M&V boundaries, listed in order of preference, can be established site-wide, at a systems-level, or for individual EPIAs.

Site-wide and system-level M&V boundaries are used with the top-down energy consumption adjustment model method. EPIA M&V boundaries can be used with either a top-down or engineering calculation bottom-up method.

Selecting appropriate M&V boundaries involves a systematic evaluation to identify which approach (site-wide, system-level, or EPIA) is feasible and most beneficial for understanding and documenting energy performance improvements.

A structured logic flow shall follow to evaluate the appropriateness of using site-wide, system-level, or the EPIA M&V boundaries:

2.5.1 Assessing the Feasibility of Site-wide M&V Boundaries

A priority should be made on developing site-wide energy consumption adjustment models (a top-down approach) for each type of energy included in the M&V if feasible.

The following are non-exhaustive lists of potential indicators that site-wide energy consumption modeling efforts should not be made, that additional review and scrutiny should be placed on models as they may not be able to be used to calculate valid energy savings, or that energy models should be abandoned. Regardless of the following being true for a site, the implementer may wish to attempt to develop site-wide energy consumption adjustment models.

Before or at the beginning of engagement in the SEM Program:

- Estimated M&V Boundary Energy Savings potential is less than 1% of annual site energy consumption or less than 100,000 kWh of electricity per year or 20,000 therms per year.
- Major site, production, or schedule changes have occurred in the past year or are planned in the next year.
- Site energy consumption is increasing at a rate greater than a few percent per year.
- EPIAs with greater than 5% of a baseline energy consumption have been identified and planned for implementation by the customer prior to the engagement in the SEM program and will be implemented in the Baseline Period or during engagement in the SEM Program.
- Highly variable production, production cycles longer than a month, or seasonal production are observed.
- On-site energy generation isn't metered and cannot be reasonably assessed.
- More than 10 energy meters for a given type of energy are identified.

During engagement in the SEM Program:

- Energy and relevant variable data are not being collected and site staff are not indicating interest in correcting this issue.

- Energy and/or relevant variable data are recorded in a format that will require excessive time to process (e.g., PDF, manual logging sheets).
- Energy data quality is poor (e.g., missing intervals, multiple data points appear to be erroneous, interval data isn't consistent with billing data).

Relevant variable data quality is poor (e.g., significant missing intervals, multiple data points appear to be erroneous).

If a site-wide energy consumption adjustment model can potentially be developed for a given type of energy, then the following actions shall be taken:

- Finalize the data collection plan.
- Develop the site-wide energy consumption adjustment model.

2.5.2 Assessing the Feasibility of System-level M&V Boundaries

If for a given type of energy, a site-wide model cannot potentially be developed, an evaluation of the feasibility to create one or more system or process level energy consumption adjustment models (a top-down approach) should be made using criteria similar to those in section 2.5.1 and following considerations:

- Availability of clear, consistent sub-metered energy data.
- Significant energy consumption within defined systems or process areas.
- Relevant variables available at the system-level and can meet the requirement of section 2.3 applied to the system-level.
- Meaning and value to the customer.

A system-level boundary can include any physical scope of boundaries that fits within the site-wide boundary. Examples of system-level boundaries include one or more buildings, certain floors of a building, one or more process lines, a specific energy use (e.g. steam system).

If more than one system-level model is considered the M&V boundaries of each model shall not overlap.

If one or more system-wide energy consumption adjustment models are proposed for a given type of energy, then the following actions shall be taken:

- Document the rationale for the system-level M&V boundaries.
- Finalize the data collection plan including the system-level M&V boundaries.
- Develop the system-level energy consumption adjustment model(s).

If a system-level energy consumption adjustment model cannot potentially be developed for a given type of energy, then the reasons for this assessment shall be documented and a bottom-up method shall be considered.

2.5.3 Assessing the Feasibility of EPIA M&V Boundaries

An EPIA M&V boundaries approach limits the M&V boundaries to the physical scope of a single EPIA. An EPIA M&V boundary is described by the information entered for the EPIA in the Opportunity Register. As with system-level M&V boundaries more than one EPIA M&V boundaries can be established so long as the boundaries do not overlap and interactive effects are considered. A mixture of EPIA M&V boundaries and system-level M&V boundaries can be employed so long as the boundaries do not overlap and interactive effects are considered.

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Either an energy consumption adjustment model (top-down) method or engineering calculation (bottom-up) method can be used with EPIA M&V boundaries.

2.5.3.1 EPIA M&V Boundaries with a Top-down Method

If one or more EPIA M&V boundaries for which energy consumption adjustment models are proposed for a given type of energy, then the following actions shall be taken:

- Document the rationale for the EPIA M&V boundaries
- Finalize the data collection plan including the system-level M&V boundaries
- Develop the EPIA M&V boundary energy consumption adjustment model(s)

If a top-down method is used all requirements related to energy consumption adjustment models of this M&V Guide apply.

2.5.3.2 EPIA M&V Boundaries with a Bottom-up Method

A bottom-up method may be considered for an EPIA M&V boundary when:

- Distinct energy savings projects or actions (EPIAs) have been clearly identified
- Engineering calculations for these individual measures are feasible and practical
- Persistent difficulties exist in developing valid energy consumption adjustment models
- Efforts are being made to enable the creation of site-wide or system-level energy consumption adjustment models for subsequent Reporting Periods.

If a bottom-up method is sought for one or more EPIA M&V boundaries, the rationale to pursue the bottom-up method shall be documented in a "Notification of Bottom-up Method of Determining Energy Savings," (NOBU) summary and submitted to the PA for their review and approval. The NOBU shall contain:

- Detailed statement with supporting evidence of the efforts taken to-date to create site-wide and system-level energy consumption adjustment models.

- Justification with documentation for not further pursuing energy consumption adjustment models and switching to the bottom-up approach.

- Discussion of what efforts can and will be taken to enable the development of energy consumption adjustment models in subsequent Reporting Periods.

The NOBU shall be submitted to the PA for review and approval. The NOBU can be submitted at any time during the reporting period to the PA. The NOBU submission does not need to be connected to the mid-year report (see section 4.4 for details on mid-year reporting). The NOBU should be submitted as early as possible to enable robust review and comment but should only be done when documentation can clearly show efforts were made to understand if energy consumption adjustment models would be valid for site-wide or systems-level M&V boundaries. If a reasonable potential that energy consumption adjustment models for a site-wide or systems-level M&V boundary could be developed then efforts should be made to successfully develop those models rather than immediately pivot to a bottom-up approach.

An approved NOBU shall only be valid for the current Reporting Period. A new NOBU shall be required for each subsequent Reporting Period if the bottom-up method shall be requested for those Reporting Periods, otherwise the assumption will be made that an energy consumption adjustment model will be developed for the same or different M&V boundaries.

NOTE: Only one NOBU summary is required for a site, regardless of the number of EPIA M&V boundaries established.

2.5.4 Updating the Site Characterization with M&V Boundaries

For each type of energy, all decisions regarding the selection of site-wide, system-level, or EPIA M&V boundaries must be clearly documented as part of the site characterization process (following site boundaries, see section 2.2.7). Documentation shall include:

- Chosen M&V boundaries
- Updated site images and flow diagrams reflecting any system-level M&V boundaries
- Chosen M&V approach for any EPIA M&V boundaries justification (top-down or bottom-up)
- NOBU summary, if appropriate
- Detailed rationale and supporting documentation for any deviations from initial feasibility assessments

2.5.5 Updating the Data Collection Plan with M&V Boundaries

The Data Collection Plan should be updated to reflect chosen M&V boundaries. The data collection plan must be tailored to the chosen M&V boundaries and selected top-down or bottom-up method meeting the requirements of the Data Collection Plan (section 2.4.1).

2.5.6 Updating M&V Boundaries

Throughout the Reporting Period controlled or uncontrolled events, available data, or other factors may necessitate updating the M&V boundaries. If M&V boundaries are to be updated the process and hierarchy outlined in section 2.5 should be followed. The PA should be notified if M&V boundaries are to be changed.

Some examples of reasons to update M&V boundaries include:

- Cases where valid energy consumption adjustment models do not reflect operational or other realities observed during the Reporting Period.
- Cases where results (positive or negative) from energy consumption adjustment models do not align with other information such as expected energy savings from implemented EPIAs.
- Changes in customer engagement.
- Changes in data availability and quality.
- Additional data are made available that enable the development of site-wide or system-level energy consumption models.
- Uncertainty in data quality or continued unavailability of data.

The observation that an energy consumption adjustment model is resulting in negative savings alone in not justification for updating M&V boundaries (see section 4.1.6).

2.6 Collecting Data and Assessing Data Quality

Site level energy data collection shall be conducted regardless of the selected M&V boundaries and if an energy consumption adjustment model can or will be developed. Collected data may be used later if operations or other factors change as that data provides information about site operations in relationship to the energy management system and captures results of implemented EPIA.

Data specific to the M&V boundaries should also be collected.

The Energy Data Collection Plan shall be continuously used to guide the collection of energy consumption and relevant variable data in the Energy Data and Performance Tracking Tool. The customer shall ensure that data needed to calculate energy savings for implemented EPIAs listed on the Opportunity Register are collected as needed. Data pertaining to specific EPIAs do not necessarily need to be tracked in the Energy Data and Performance Tracking Tool. The collection, recording, and maintenance of data shall be led by the customer.

2.6.1 Collecting Data

The implementer shall ensure that data are being collected in accordance with the Energy Data Collection Plan on at least a monthly basis to ensure that data are being accurately collected and recorded.

Energy data shall be recorded in the Energy Data and Performance Tracking Tool. Raw source data shall be preserved along with modifications made to data. Data continuity is critical to maintaining energy consumption adjustment model accuracy through the SEM program engagement.

As data are collected, issues that arise with implementing the Energy Data Collection Plan shall be documented and used to assess if modifications to the Energy Data Collection Plan are needed.

2.6.2 Reviewing for Data Outliers and Missing Data Points

Data outliers and missing data points can negatively impact the accuracy of energy consumption adjustment models.

Data outliers and missing data points shall be identified and addressed.

Energy consumption and relevant variable data shall be screened for anomalous values that are not representative of typical operating conditions. If high variability is characteristic of the operation, outliers do not necessarily need to be removed. Data outliers can be an indicator of poor operational control and can be used to help identify possible energy performance improvement actions. The effect of outliers on the reliability of energy consumption adjustment models and the reason for removing them shall be maintained as a record.

If an anomalous value is found, reasons for the anomaly shall be identified if possible. If the anomaly is determined to be a data error, the error shall be corrected if possible. If the anomaly is determined to be a data error that cannot be corrected, the anomalous value shall be deleted from the data set. The effects of data errors on the reliability of the energy consumption adjustment model and the reason for making any changes to the data set shall be maintained as a record. If the anomalous value is determined not to be a data error it shall be left in the data set.

An initial review for outliers and missing data can be conducted by creating time series plots of data for energy consumption and relevant variable independently in a time series format. Outliers and missing or erroneous entries shall be flagged for review, investigation, and correction (if possible) by applying a general rule for identifying data that lie outside the range of plus or minus three standard deviations from the mean.

A resolution strategy shall be developed for identified outliers. Regardless of rationale or explanation, data outliers beyond the plus or minus three standard deviations from the mean may be omitted. If outliers related to specific operating conditions are excluded from the Baseline Period, the intervals in the Reporting Period corresponding to the same conditions must also be excluded from the Reporting Period. The strategy used to remove outliers shall be documented.

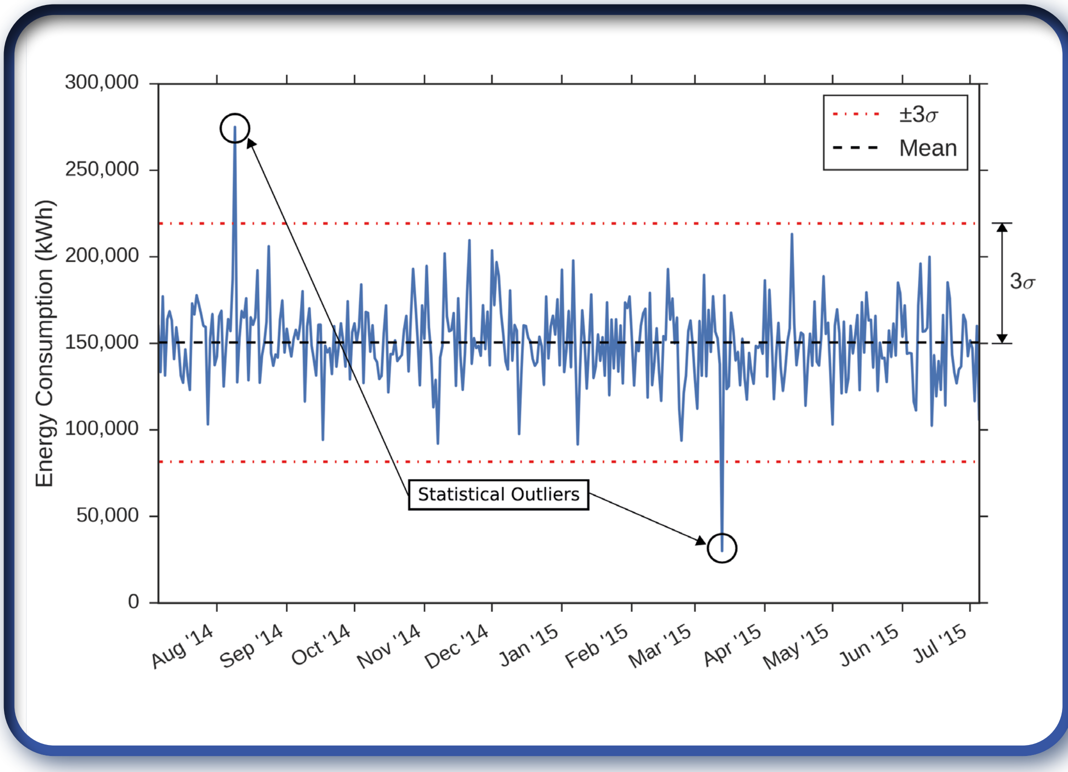

Figure 2. Example of Graphical Methods to Identify Outliers.

Omitted data shall not be replaced with a calculated interpolation. Filling in missing data can skew energy consumption adjustment model validity.

> **NOTE:** A particular type of outlier results from shut-down periods where production is zero. In some facilities, this may only occur for a handful of days per year. If a single energy consumption adjustment model can be created that reflects both the production and non-production days, the shut-down outliers do not need to be excluded. Alternatively, a relevant variable can be created to account for the effect of reoccurring shutdown days. If an otherwise valid adjustment model cannot be created to accommodate the shut-down periods, these periods may be excluded from the model or treated as a separate mode of operation and modeled independently. When determining a strategy, consider whether energy savings are expected to be achieved during shutdown periods.

> **NOTE:** Outliers should not be excluded from data sets unless there is a reason to do so. For example, a site may have outliers on major holidays. Consider adding an indicator variable to represent those holidays, or simply exclude these holidays from the model. Note that any reoccurring periods that are excluded from the baseline model must also be excluded from the Reporting Period.

> **NOTE:** Be careful to distinguish between a zero-data point and a missing data point. Missing data should be excluded and not treated as a zero.

> **NOTE:** The removal of outliers, especially in the cases when data is collected on a monthly basis, can significantly affect an energy consumption model's predictive power. Careful consideration should be made regarding the removal of outliers when data is collected on a less frequent basis.

Outliers shall be reviewed by the customer and implementer so that both parties understand the cause of the anomaly. The customer shall take corrective action to reduce the potential for data outliers if possible as outliers can be an indicator of poor operational control or data collection systems. The omission of data points shall be documented.

2.6.3 Adjusting Data for Time-Series Offsets

Energy consumption and relevant variable data will frequently not be available for exact calendar months or aligned with other time intervals. For example, monthly production data may be reported on the first of the month, while utility data may be provided mid-month. Alignment of time intervals is preferred and may facilitate development of more representative adjustment models, but it is not required.

A time-series offset may exist between energy consumption and relevant variable data. Energy consumption and relevant variable data shall be reviewed to identify time-series offsets. This most commonly occurs when data are collected at high frequency levels (typically weekly or higher). Time-series offsets that negatively affect adjustment model development shall not be used.

Time-series plots shall be used to identify consistent offsets between energy consumption data and each relevant variable. For example, if an energy-intensive process has a two-day lead time from the point at which production levels are measured, a two-day time series adjustment may need to be applied to the production variable.

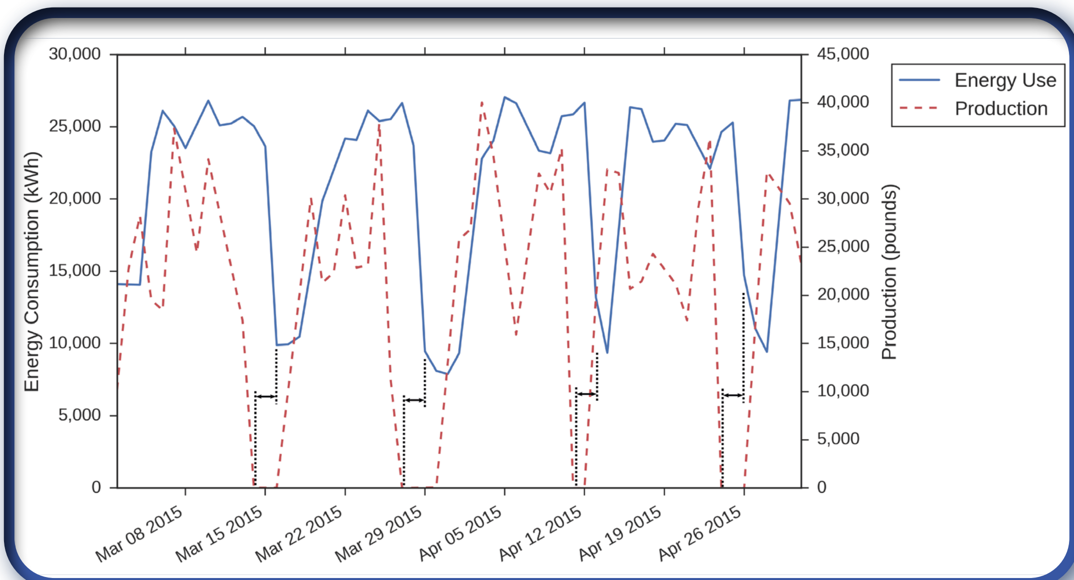

Figure 3. Example of a Time-series Plot (Energy Consumption and Production vs. Time). Arrows Indicate the Time-series Offset.

If such an offset is identified, the customer and implementer shall discuss if the application of a time-series adjustment, or if aggregating data such that the data frequency interval is lower (e.g. aggregate so that all data are represented on a weekly rather than daily time interval), would improve the adjustment model. The decision to use a time-series adjustment shall be documented.

As part of an PA sponsored SEM program engagement, data collected on a monthly basis or irregular time intervals (such as billing cycles roughly issued on a monthly basis) shall be weighted based upon the number of days in the month the data were collected. Weighting should be based upon the number of days within the month or irregular time interval. These weighted values should be recorded alongside the original values and weighting value.

ENERGY MODELING

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3 Energy Consumption Adjustment Modeling

3.1 Introduction

The primary method for determining energy savings shall be to develop and use one or more energy consumption adjustment models for each type of energy identified in Section 2.2.1

To aid in the customer's understanding of their site and ability to develop energy consumption adjustment models, the implementer shall strive to develop simple and easily understood models rather than complex models that may statistically be more precise. Multiple energy consumption adjustment models for a specific type of energy may be needed to achieve this simplicity principle.

While a number of energy consumption adjustment modeling methods exist, the forecast method shall be used if energy consumption adjustment models are to be developed as part of a PA sponsored SEM Program Cycle as it meets all of the goals and objectives identified in this M&V Guide.

The forecast energy consumption adjustment model method allows the model user to estimate what Reporting Period energy consumption would have been if the site had not implemented any EPIAs during the Reporting Period and operated as it did during the Baseline Period.

The forecast method provides a predictive energy consumption adjustment model that once developed can be used to track energy performance and routinely determine energy savings.

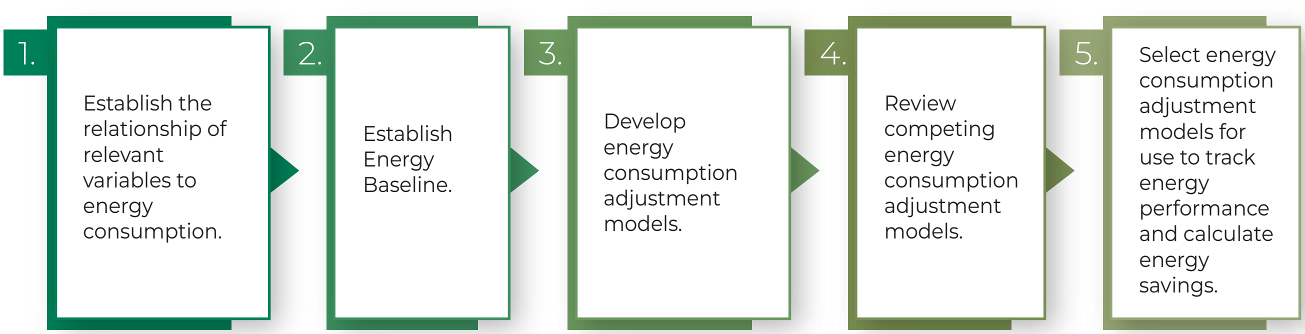
The forecast model can also be used to project energy demand if future relevant variable quantities, such as production volume, are known.

Alternative modeling methods do not necessarily meet all of the objectives for energy consumption adjustment models identified in this M&V Guide and do not necessarily offer an opportunity for immediate customer education and ability to respond to unexpected model results.

This M&V Guide acknowledges that the forecast model method does have limitations, particularly if site energy use and operating conditions change significantly during the Reporting Period. If forecast models cannot be developed for a given type of energy, then the implementer may use the backcast model method for the purposes of regulatory reporting of energy savings. Only the backcast model method is provided as an alternative in this M&V Guide. This limitation is intentional as to deter excess expenditure or resources to develop any working energy consumption adjustment model and help ensure the focus of the M&V process remains on customer education and building systems that the customer can use on their own in the future.

3.2 Process

Development of one or more energy consumption adjustment models for each energy type shall be considered with the following process:



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3.3 Considerations when Developing Energy Consumption Adjustment Models with Data from Multiple Meters

When developing energy consumption adjustment models and energy data for a given type of energy is available from multiple meters, one of the following options shall be followed:

- Aggregate energy data. Sum the data from two or more meters to create an aggregate of site energy data. If meter data is collected at different intervals, aggregate to the largest sampling interval. This method is appropriate when:
  - Meters have the same interval, or the meter capturing the greatest energy consumption has the largest sampling interval.
  - The same relevant variables apply to all meters.
  - The resulting energy consumption adjustment model created by using the aggregate data is simple and meaningful.
- Build separate energy consumption adjustment models. Build an individual energy consumption adjustment model for each meter. Energy savings calculated for each model will be aggregated. Multiple models for a given type of energy may be created so long as the boundaries of each model do not overlap with one another and fit within the larger M&V boundary. Each model must meet the requirements of Sections 3.7.2 and 3.7.3. This method is appropriate when:
  - An aggregate energy consumption adjustment model will have a large number of relevant variables.
  - Meters serve different areas or processes with different relevant variables.
  - Meters have different measurement intervals, especially if a meter with the largest energy consumption has much finer granularity than the other meter(s).
  - The customer prefers separate models for greater context of energy performance tracking and energy savings.
- Ignore meters. If the loads connected to a meter are outside the M&V boundaries or are used to meter negligible portion of a given type of energy (approximately less than 2% of site energy baseline energy consumption for a given type of energy), exclude these meters.

3.4 Establishing Relationships Between Energy Consumption and Relevant Variables

Energy consumption adjustment models shall be created based upon an informed understanding of the characteristics of the equipment, operations, and processes present within the M&V boundaries. To establish the relationship between energy consumption and relevant variables the following guidance shall be followed appropriately:

3.4.1 Confirming a Relationship

Use scatter diagrams to visually confirm whether a linear relationship exists between energy consumption data for each type of energy for which energy savings are being determined and each relevant variable.

Though not statistically tested at this point, a lack of relationship between energy consumption and a relevant variable for which a relationship was expected shall prompt a discussion between the customer and implementer. This result may be due to poor operational control or a mischaracterization of the site.

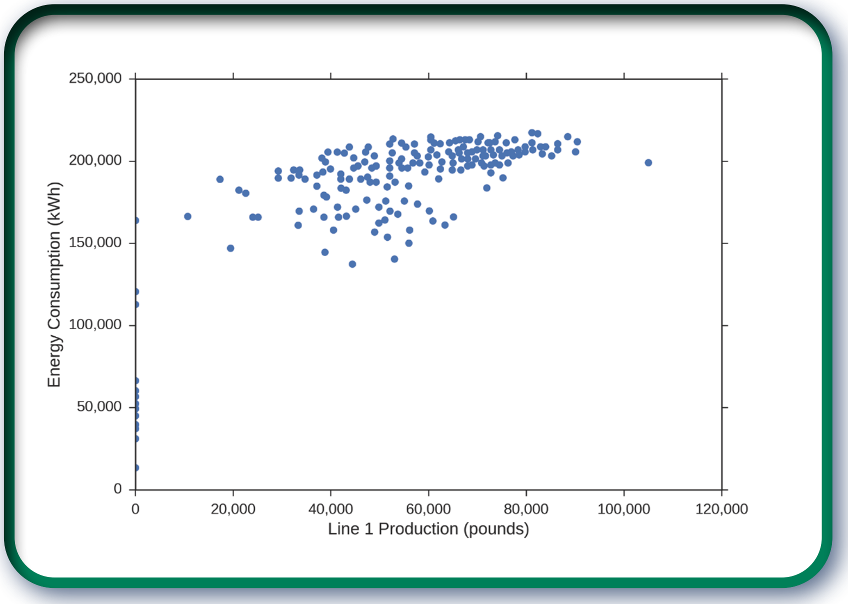

Figure 4. Example of a Scatter Plot (Energy Consumption vs. Production).

3.4.2 Change-point Variables

Sites may have operational conditions related to energy consumption that change at some value of that variable. A common example is of sites that have an ambient-dependent energy profile which will often exhibit a “change-point” characteristic. The presence of a “change-point” can be determined by plotting a relevant variable versus energy consumption. Modeling a site that exhibits a change-point with a single linear model introduces unnecessary error. Alternative relevant variables or a Multi-Mode Model shall be considered if a change-point is observed.

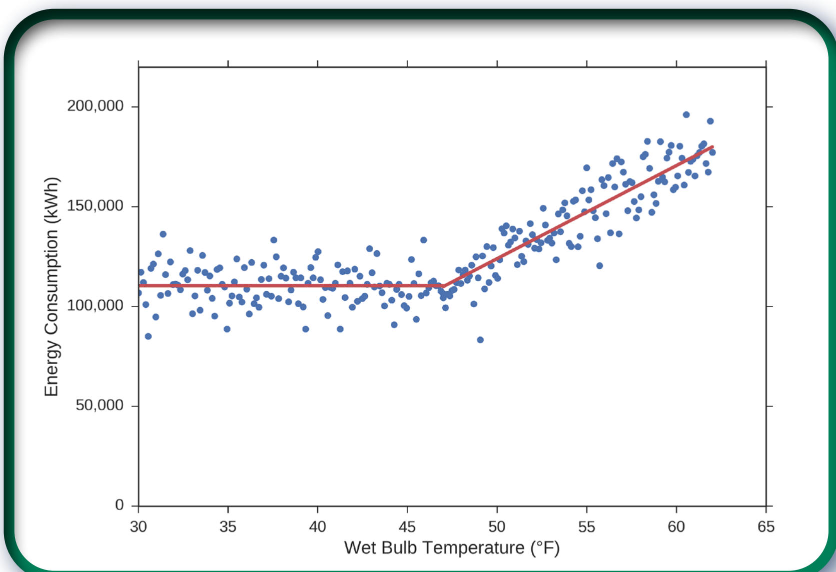

Figure 5. Example of a Change-point.

3.4.3 Multicollinearity

When two or more relevant variables exhibit correlation for the same energy type, multicollinearity is present. Adding and removing variables from the adjustment model will affect the significance of other variables. The presence of collinear variables can understate the statistical significance of individual relevant variables. Although in many cases multicollinearity is unavoidable, it reduces the ability of statistical tests to establish model validity. While multicollinearity does not affect the model's predictive capacity, it has the potential to add unnecessary complexity. Multicollinearity shall be minimized if possible. See Annex D – Multicollinearity and Autocorrelation, for a discussion on the effect of multicollinearity on an adjustment model.

3.4.4 Weather Variables

Weather can be represented in terms of a number of variables including average temperature, solar radiation, rainfall humidity, wet-bulb temperature, CDD and HDD, etc.. When developing energy consumption adjustment models both approaches should be examined. For weekly and monthly models, a CDD/HDD model is preferred because it better represents heating and cooling demands over an aggregate period. For daily models, a CDD/HDD model is functionally equivalent to an average temperature model with a change point.

Weather correlation often masks other seasonal changes. Judgment and knowledge about the site and its equipment should be used to determine whether energy consumption is truly affected by ambient weather. If no justification exists for a weather correlation, identify a more appropriate relevant variable to characterize the seasonal changes.

3.5 Establishing Energy Baseline

Pursuant to CPUC Decision 16-08-019, SEM uses and "existing baseline condition" basis for determining energy savings. As such, the energy baseline naturally accounts for a site's compliance with code and local regulation and any program influenced improvements in energy efficiency shall be claimed and attributed to the SEM program. Past and current operational practices (whether good or bad), currently installed technology (industry standard or not), as well as, past, current, and future code, regulatory, and permit compliance (or lack thereof), and operations are included "as is" in the energy baseline and themselves should not be taken into account to adjust the energy baseline.

While the energy baseline is an existing conditions baseline, certain EPIAs and non-routine events that may have taken place during the Baseline Period need to be removed from the energy baseline to establish a clear understanding of the relationship of energy consumption to relevant variables prior to the time periods for which an energy consumption adjustment model will be used.

In order to create energy consumption adjustment models that reflect regular site operations, customer and PA records shall be reviewed to determine if any incentivized or non-incentivized EPIAs with sizable energy savings were implemented during the Baseline Period. In addition to reviewing customer records, interviews with customer staff shall be conducted to determine if other non-incentivized EPIAs or changes that increased energy consumption occurred. If the customer had previously participated in a PA sponsored SEM Program Cycle the Opportunity Register should be a continuation from that prior engagement and shall be reviewed for implemented EPIAs.

If such EPIAs were implemented during the Baseline Period, project records shall be obtained to accurately capture implementation dates and the magnitude of verified savings as needed. Ensure these EPIAs are documented on the Opportunity Register.

If EPIAs implemented during the Baseline Period are identified, consider modifying the Baseline Period to a time period when the EPIA was not implemented. If the EPIA was implemented after the Baseline Period and prior to the start of the SEM Engagement Period adjust the baseline to account for the EPIA.

If the Baseline Period includes implemented EPIAs, confirm whether the PA does or does not have approved annualized energy savings values for the EPIA. Approved energy savings values shall be used for any adjustment made because of the EPIA. If the PA approved energy savings values are not available, calculate energy savings for the EPIA following the requirements of this M&V Guide (see Section 3.12.2.1).

Use prorated energy savings values to adjust the energy consumption of the Energy Baseline using PA approved energy savings values if they are available. Prorating of energy savings should be based upon the EPIA implementation date. Confirm the implementation date recorded by the PA, if available, against the records and memory of site staff. Use the implementation date that best connects to when energy savings resulting from the EPIA would have been realized.

EPIAs that are known to have a seasonal nature can be removed from the energy baseline accounting for known seasonality.

3.6 Developing Energy Consumption Adjustment Models

Using information gathered as part of the M&V process, for each energy type for which data are collected, develop one or more energy consumption adjustment models with the form:

$$\text{Energy Consumption} \Rightarrow b_0 + b_i x_i + b_{i+1} x_{i+1} + \ldots + b_n x_n$$

with ***i*** from ***1*** to ***n*** representing the number of relevant variables used in the energy consumption adjustment model and where ***xi*** is the relevant variable quantity, ***b0*** is the base load delivered energy consumption not related to relevant variables, and ***bi*** (when ***i > 0***) is the incremental energy consumption per unit of that relevant variable (coefficient).

Attempts shall be made to develop one or more energy consumption adjustment models for each energy type in order to capture the full M&V boundary as best possible. If development of models to encompass the full M&V boundary is not possible then developing multiple energy consumption models that "fit" within the M&V boundary shall be attempted.

Depending on the list of selected relevant variables identified in the Energy Data Collection Plan for which data were collected, attempts shall be made to develop competing models that can be assessed with the quantitative and qualitative validity tests described in the energy consumption adjustment model validity section (3.7) of this M&V Guide.

3.6.1 Simplicity principal

The desire to create the most descriptive or "perfect" model can lead to a disproportionate use of resources. The objectives of creating energy consumption models extend beyond creating tools to estimate M&V Boundary Energy Savings.

Simple energy consumption adjustment models have multiple benefits:

Easier data collection:	Better understanding of the model:	Reduced likelihood of outliers and errors:
In some cases, collecting production data may be a burden to the customer. Minimizing the data requirements for a customer may increase buy-in to data collection and use of the energy consumption adjustment models used to track energy performance, and are used by the program to calculate energy savings.	A model that can be easily explained will be better understood by the customer, which will increase their trust in the energy savings predicted by the final model.	A model with fewer variables is less likely to suffer from data-entry errors and/or outliers during the Reporting Period. A simple model is more "durable" and therefore more useful to a customer long-term.

Customers need to be able to understand the modeling process and outputs so they can track energy performance and determine energy performance improvement using the model. Creating simple models that are easily understood in their relationship of energy consumption and relevant variables will assist in this understanding.

As guidance, if the number of relevant variables are being used in a single energy consumption adjustment model is greater than the number of energy baseline period intervals divided by six the modeler should consider options to simplify the model. However, also consider that an energy consumption adjustment model which is too simple and does not include sufficient relevant variables can provide poor predictive capability. Weigh the pros and cons of each combination of variables to determine a minimal level of model complexity while providing adequate energy savings estimations.

3.6.2 Frequency of Data used to Create Models

When possible, use daily intervals to develop energy consumption adjustment models. Models based on daily data allows the customer to track energy performance frequently during the SEM Program Cycle and can improve overall model accuracy by increasing the number of Baseline and Reporting Period data points. Meter data can often be acquired in 15-minute intervals and summed into daily energy data. The frequency of energy data will need to match that of relevant variable data.

If a multi-day time-shift exists between energy consumption and the primary production relevant variable, consider using weekly model rather than a daily model.

If daily production or other relevant variable data is not available, weekly or monthly model intervals can be used. Weekly model intervals are preferred over monthly. Ensure that energy consumption data is accurately summed to match relevant variable intervals.

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3.7 Reviewing Competing Energy Consumption Adjustment Models

3.7.1 Assessing Statistical Significance of Relevant Variables

To establish quantitative validity, each relevant variable used in an energy consumption adjustment model shall meet all of the following statistical tests:

Statistical Tests	Statistical Test Threshold Values
T-stat	Absolute value > 2.00
p-value	< 0.05

Table 2: Relevant Variable Statistical Tests

Adding and removing relevant variables will affect the significance of other relevant variables. In many cases, multicollinearity is unavoidable; however, multicollinearity should be taken into consideration when validating the statistical significance of each relevant variable. While multicollinearity does not affect the model's predictive capacity, it has the potential to add unnecessary complexity. See Annex D – Multicollinearity and Autocorrelation, for information.

3.7.2 Validating Models with Statistical Tests

The following statistical tests shall be applied to all energy consumption adjustment models:

Statistical Tests	Statistical Test Threshold Values
Number of Relevant Variables	< 5
Model R^2	> 0.75
Net Determination Bias	< 0.005%
Coefficient of Variation	< 20% for daily models < 10% for weekly models < 5% for monthly models
Durbin-Watson	~ 2
Fractional Savings Uncertainty (predictive)	< 50% Apply roughly estimated energy savings and Reporting Period interval frequency.

Table 3: Energy Consumption Statistical Tests

3.7.3 Validating Models with Qualitative Considerations

As energy consumption adjustment models shall be only used to calculate energy savings if the model meaningfully represents the site's relationship of energy consumption to relevant variables.

Equal to the statistical validity tests, the selection of energy consumption models shall be based upon assessment of qualitative considerations, including that:

- The model when applied to Baseline Period appears to produce a stable and near zero savings result.
- The selection of relevant variables in the adjustment model and the subsequently determined relevant variable coefficients are consistent with a logical understanding of the energy use and energy consumption of the site.
- Meters used were functioning, calibrated, and maintained as appropriate.

Additionally, considerations including the simplicity of the energy consumption adjustment model, meaning of the model to the customer, and the ability to continue collecting data required for use of the model shall be considered.

3.7.4 Table of Competing Models

In order to demonstrate the effort and process followed to develop and select meaningful energy consumption adjustment models a description of the modeling down selection process and a table of competing models shall be created for each energy consumption adjustment model developed. The model down selection process and table of competing models shall be provided during the Mid-Year Review if available at that time and documented in the SEM Reporting Period Performance Report.

The description of the modeling down selection process shall include:

- The number of models developed and assessed.
- The number of models that met more than 50% of the statistical tests identified in Section 3.7.2.
- The number of model that were considered for use and the qualitative assessment applied.
- A statement of the quantitative and qualitative reasons why the model selected for use was chosen over others.

The table of competing models shall include at most three of the most meaningful energy consumption adjustment models that were considered with both quantitative and qualitative assessment but not selected for use. The table shall include a row for each competing model and a column for each of the following:

- Model reference number.
- Data interval (frequency).
- Baseline Period start and end dates.
- Upcoming Reporting Period start and end dates.
- R^2.
- Net determination bias.
- Coefficient of variation.
- Durbin Watson.
- Projected fractional savings uncertainty.
- Comments about the model.

Four columns of each row should be subdivided to provide information about the relevant variables that are used to form the model. The four columns should include:

- Name of the relevant variable.
- Relevant variable coefficient value.
- T-stat.
- P-value.

An example showing the graphical layout of the table of competing models is provided in Annex E – Graphical Representation of the Table of Competing Models.

The table of competing models shall be filled out as the energy consumption adjustment modeling development effort proceeds.

3.8 Selecting Energy Consumption Adjustment Models to Track Energy Performance and Calculate Energy Savings

The selection of energy consumption adjustment models that will be used to track energy performance and determine energy performance improvement shall be made based upon quantitative and qualitative model validity testing described in this M&V Guide.

The table of competing models should be used along with qualitative assessments to select energy consumption adjustment models that will be used to track energy performance and calculate energy savings.

The selection of energy consumption adjustment models should not be narrowly driven by evaluating which model "best" meets statistical tests as meaningful models may not meet all listed statistical tests. For example, a low R^2 value may be the result for a site with low variation in energy consumption. In cases where all of the tests cannot be met but a model passes a majority of the statistical tests and meets the qualitative requirements of Section 3.7.3, the customer and implementer together shall select which models to use moving forward. The energy consumption adjustment model selection rationale shall be documented.

3.9 Ongoing Confirmation of Model Validity

It is recommended, but not required, that on at least quarterly basis confirmation of model validity be reviewed with the customer.

If conducted, ongoing confirmation of model validity should include answering the following questions:

- Have operating characteristics dramatically changed?
- Has production or other relevant variable values changed to they are outside the range as recorded during the Baseline Period?
- Have any major energy uses been installed or removed?
- Does the level of energy savings achieved so far not reasonably align with energy savings from implemented EPIAs listed on the Opportunity Register?
- Have the site or M&V boundaries changed?

If any of the above questions are answered, "yes," then the quantitative and qualitative validity of the model should be confirmed. If the model cannot be confirmed as valid, options listed in Section 3.10 shall be considered.

Data collected for use with the selected energy consumption adjustment model shall be analyzed as well. Individual data intervals in the Reporting Period should be flagged as an outlier if a relevant variable data point is 10% beyond the bounds of the energy baseline data set.

These points may be handled in one of three ways:

Include the point without alteration.

This is appropriate if a representative population of residuals (defined by the implementer) for the point is not an outlier (plus or minus three standard deviations from the mean of the representative population) compared to the overall population of residuals.

Exclude the point.

This is appropriate if a representative population of residuals (defined by the implementer) of the outlier point (plus or minus three standard deviations from the mean of the representative population) is an outlier compared to the overall population of residuals. In this case the energy savings from this outlier point would have an outsized effect on the energy

Develop a new energy consumption adjustment model.

This is appropriate if the outlier interval data points (plus or minus three standard deviations from the mean of the representative population) are caused by an issue that will fundamentally result in an energy consumption adjustment model that does not have a meaningful relationship to the energy consumption, uses, and operations of the site.

3.10 Options when a Valid Energy Consumption Adjustment Model Cannot be Created or Models in use Fail Validity Tests

Energy consumption adjustment models that do not meet the model selection requirements of Section 3.8 cannot be used in the calculation of energy savings as part of a PA sponsored SEM program and may potentially mislead customers. This applies to models being newly developed and models that have been used in the past.

If such a case occurs, the party responsible for developing energy consumption adjustment models shall first attempt to modify the forecast adjustment model. This process might include modifications to the assumed relevant variables and frequency of data collection. Any changes that result in a successful energy consumption adjustment model shall be noted in the Energy Data Collection Plan.

Changes to the Baseline Period are allowed as detailed in Section 2.1.1.3 but are not recommended. The objective of the M&V process is not to hunt for a valid model but to collect data and assess if a model can be made to meaningfully represent the relationship of energy consumption to relevant variables.

The below sections provide guidance when the development of an energy consumption adjustment model is not successful.

3.10.1.1 Non-Routine Adjustments to the Baseline Energy Consumption

Non-routine adjustments (NRA) are made to the observed (actual) energy consumption in the baseline and/or Reporting Periods if one or both of the following non-routine events (NRE) have occurred:

1. If static factors have changed during the Reporting Period.
2. If relevant variables have been subject to unusual changes.

Examples of events that might require a non-routine adjustment include the following:

- A supplier goes out of business, and an equivalent raw material is not available. A process modification is needed to use a different type of raw material. No data exist for Baseline Period operating conditions with the new type of raw material.
- Processes are outsourced, enhancing profitability and decreasing energy consumption.

- Business acquisition occurs which results in data not being available or in limits on the data available for the period prior to the acquisition.
- A piece of equipment becomes inoperable and is replaced with a temporary piece of equipment that consumes a different type of energy (e.g. air compressor or chiller replaced by a diesel-powered rental).
- A process is temporarily outsource to another site or supplier.

NREs can be detected through human feedback or statistical approaches. Site staff may be aware of changes to equipment, system, and processes that would cause a NRE. Manual identification of NREs relies on site staff knowledge of normal and abnormal operations which may cause some NREs to go undetected. Site staff knowledge of NREs shall be supported by statistical and other appropriate analysis.

NRE identification shall be supported by statistical or other quantified analysis. Any numeric inputs to non-routine adjustment calculations shall be based on observed, measured, or metered data.

Examples of statistical and other quantified analysis approaches to NRE identification can be found in EVO' IPMVP Application Guide on Non-routine Events & Adjustments[3] publication and the 2020 ECEEE conference paper Non-routing adjustments – towards standardizing M&V approach for quantifying the effects of static factors.[4]

The effort expended to calculate the amount of energy the non-routine adjustment will result in should be proportional to the level of expected energy adjustment and be in line with the guidance of Annex C – Bottom Up EPIA Calculation Effort and Documentation.

The method for identifying and making the NRAs and the rationale for that method shall be maintained, including a start and end date, why they are "non-routine," the general reasonableness of the methodology and calculations, the adequacy of the metering and monitoring methodologies, and conformance of the calculations applied. All calculations and data processing shall be transparent and retained within the model files and in other documentation as required in the M&V Guide and by the PA.

If an open-ended non-routine event is specified, the documentation shall state clear conditions for how and when to re-evaluate ending the adjustment. For example, if an air compressor fails and a backup unit is in place, the condition would be the repair of the air compressor, and shutdown of the backup unit would end the non-routine event.

NRAs shall only be used after review and approval from the PA. The method for making the non-routine adjustment and the rationale for that method shall be documented.

3.10.1.2 Factoring for Seasonality and Operational Modes

Many sites experience seasonal swings in operation. Swings can occur because of seasonal changes in product type, product quantity, or correlations between ambient temperature and process loads. When operational swings cause a fundamental change in the energy consumption of a site, consider building multiple models if a single model is unable to adequately capture the seasonal variations.

If seasonal changes are moderate and gradual, a single model may be sufficient to characterize the entire energy baseline.

If a site has a short period of abnormally high or low production with a different energy signature, or a negligible number of shutdown days throughout the year, consider removing these periods in the Baseline and Reporting Period as outliers.

[3]Efficiency Valuation Organization (EVO), IPMVP Application Guide on Non-routine Events & Adjustments, 2020
[4]Earni, S. and Therkelsen, P., Non-routing adjustments – towards standardizing M&V approach for quantifying the effects of static factors. 2020. Presented at the ECEEE Industrial Summer Study, virtual event, DOI 10.20357/B71W20

If short periods of abnormally high or low production with a different energy signature necessitates removal of these time periods from the energy consumption model, ensure that similar operational modes are not included in avoided or annualized energy savings determined from use of the energy consumption adjustment model.

If seasonal changes are abrupt and extreme, consider creating a model that includes a production based relevant variable and another model that does not.

3.10.1.3 Change M&V Boundaries

If the M&V boundary is supplied by multiple meters, disaggregating the meters may result in better model resolution.

Sites experiencing swings due to weekend shutdowns are best modeled as one model with Saturday/Sunday/weekend indicator variables for simplicity.

Table 4 is non exhaustive but outlines the pros and cons for building one model versus two models in certain circumstances.

Strategy	Pros	Cons
Single model with assumed year-round savings	Captures savings at all intervals. Easier to maintain one model than two. Most straightforward method, if energy consumption stays consistent.	Periods with abnormally high or low production can skew the model. Seasonal production relevant variables can lead to complex models with many relevant variables.
Single model with abnormally high or low production periods removed	Improves model accuracy during normal production periods. Works well if energy efficiency opportunities are minimal during excluded periods.	Reduces number of baseline data points. Unknown number of future data points due to production changes.
Dual production/non-production model	Each model has fewer variables and is easier to understand. Can improve model fitness compared to single model.	Maintenance of two models. Reduces number of baseline data points for each model.

Table 4: Options for Modeling for sites with Production Swings

Models that exclude a significant site operation are not acceptable in general. If a model excludes shut down times or other period of low consumption and operation this is acceptable. If a model was to exclude certain product lines or other energy consuming operations arbitrarily this is not acceptable.

The requirements of Sections 3.3 and 3.8 shall be followed when creating multiple models.

If attempts to modify an invalid model are unsuccessful, and the model remains out of compliance with the majority of validity requirements in Section 3.7, and Section 3.9 the efforts to remedy the model should be documented in a Notification of Bottom-up Method of Determining Energy Savings, and the implementer should use the bottom-up methodology for estimating and reporting savings from implemented EPIAs.

3.10.1.4 Backcast Energy Consumption Adjustment Model Development Method

If forecast energy consumption adjustment models still cannot be created, use of the backcast method to develop energy consumption adjustment models can be considered. The development of a backcast energy consumption model is optional. A bottom-up approach to determining energy savings may be preferred. Rationale for the use of the backcast model over reporting energy savings aggregated from implemented EPIAs must be supported, documented, and accepted by the PA. Such rationale could include assumptions that significant energy savings will be achieved from operational actions that would not be accounted for by the aggregation of energy savings for EPIA listed on the Opportunity Register.

Backcast normalization results in a model of the Reporting Period energy consumption that is applied to the Baseline Period and Reporting Period-relevant variable values to calculate adjusted Reporting Period energy consumption for comparison with observed (actual) Baseline Period energy consumption. The adjusted Reporting Period energy consumption is an estimate of the energy consumption that would have been expected at Baseline Period relevant variable values, if the Reporting Period operating systems and practices were in place during the Baseline Period.

The backcast normalization method is applicable in instances where:

- One or more relevant variables has significantly increased or decreased from the Baseline Period through the Reporting Period.
- The resolution of the energy signature for the Baseline Period was relatively poor and the resolution of the energy signature during the Reporting Period has significantly improved.
- No major operational or structural changes have occurred during the SEM Program Cycle.

The backcast modeling method may be used so long as the validity requirements of Section 3.7 are taken into account. The justification and use of a backcast modeling method shall be documented.

3.11 Continued Use of Energy Baselines and Energy Consumption Adjustment Model(s)

Over the course of one or more SEM Program Cycles, changes to the operations, production, or equipment can invalidate energy consumption models. If during periodic checks or during the Mid-Year Review an energy consumption adjustment model is found to not be valid per the quantitative and qualitative tests in this M&V Guide, first examine if the model can be updated or if the energy baseline and energy consumption adjustment model are no longer viable.

If the energy baseline is no longer viable or the existing energy consumption adjustment model becomes invalid, use of the energy consumption model shall be suspended and Section 3.10 followed.

An energy consumption adjustment model and its associated energy baseline that was approved for use during a previous Reporting Period may be accepted for continued use so long as ***all of the following are true:***

- The customer has continuously participated in a PA sponsored SEM Program Cycle since the original development of the energy consumption adjustment model (with an allowance for gaps between SEM Program Cycles resulting from cohort launch or other timing issues).
- Energy saving values that were submitted and accepted by the PA for all Reporting Periods that preceded the current Reporting Period are available.
- The energy consumption adjustment model and energy baseline data meet the quantitative and qualitative requirements of this M&V Guide.
- An Opportunity Register originally developed as part of a prior SEM Program Cycle is available.
- Relevant variables selected as part of the process detailed in Section 2.3 are not different than those used in the existing energy consumption adjustment model.

- More granular energy consumption and relevant variable data are not available compared to those available when the existing energy consumption adjustment model was created.
- The M&V boundaries have not changed.
- The customer has not requested a new model.

The above listed criteria shall be reviewed before continued use of existing energy consumption adjustment modes in a new Reporting Period. If following this review the energy consumption adjustment model is not found to be valid, the energy consumption adjustment model shall not be used and a new energy baseline and energy consumption adjustment model(s) shall be developed.

The PA sponsoring the SEM program may at its discretion require a new Baseline Period, energy baseline, and energy consumption adjustment model development. This may be required at the beginning of new SEM Program Cycles to create a distinct basis for energy savings determination and to remove all residual effects of existing energy consumption adjustment models.

3.12 Monitoring Energy Performance

Energy performance should be monitored on a regular basis using the selected energy consumption adjustment models and the Opportunity Register.

This review is not intended to be a detailed evaluation to see if energy performance is as expected but allows for the identification of trends and decide if corrective actions need to be taken.

Backsliding refers to worsening energy performance compared to a previous achieved benchmark. Energy consumption adjustment models can be used to provide a feedback loop to identify and correct backsliding.

By reviewing if EPIAs are being implemented and generating expected energy saving and other results, the customer can ensure they are on track to meet energy performance targets and assess the effectiveness of their EnMS.

The review provides the implementer and customer a chance to ensure energy savings from implemented EPIAs are calculated with appropriate relative effort compared to an expected energy savings potential.

3.12.1 Tracking Energy Performance with Energy Consumption Adjustment Models

Data to be collected and captured by the Energy Performance Tracking Tool shall be updated with new data on at least a monthly basis.

The customer and implementer shall review the Energy Performance Tracking Tool on a regular basis to ensure data are being collected, energy performance is being calculated correctly, detect anomalous values, and account for situations not present in the Baseline Period that may need to be corrected for.

A time-series plot of actual and predicted energy consumption for each energy consumption model in use shall be created while tracking energy performance.

As new energy performance values are reviewed, an assessment to see if backsliding is occurring shall be performed. When backsliding is identified, corrective action shall be taken.

3.12.2 Tracking Energy Performance with the Opportunity Register

On a regular basis, the customer and implementer shall together review the Opportunity Register to ensure that EPIAs are being implemented. If EPIAs are not being implemented as anticipated an assessment of why they are not being implemented shall be conducted.

The implementer shall verify, at least quarterly, that the Opportunity Register is updated and maintained.

3.12.2.1 Calculating Annualized and Avoided Energy Consumption Energy Savings for EPIAs

Annualized and pro-rated energy savings for the Reporting Period (energy savings that would be realized in the Reporting Period based upon the EPIA implementation date) shall be determined after the action is implemented for each EPIA that will be included as part of the bottom-up based energy savings reporting.

In many cases, it will be difficult to assess the energy savings potential of BRO measures with accuracy.

M&V plans for EPIAs shall not be required.

If the customer will be applying for a custom capital or deemed incentive for a given EPIA listed on the Opportunity Register, the M&V practices governing those programs shall be followed. The energy savings value claimed as part of an incentivized project shall be recorded in the Opportunity Register.

If the EPIA listed on the Opportunity Register will not be used to apply for a custom capital or deemed incentive, the effort expended to calculate energy savings for the EPIA shall be less than that of incentivized custom capital project and proportional to the level of expected energy savings. Annex C – Bottom Up EPIA Calculation Effort has more information on this topic.

A required data point for each EPIA on the Opportunity Register is the EPIA implementation date. This data shall be determined by the implementer in conversation with the customer using reasonable considerations of the EPIA.

The listed EPIA implementation date shall be used to delineate the temporal fraction of annualized energy savings that will be prorated and attributed to the current Reporting Period.

Prorated energy savings for each EPIA that annualized energy savings were calculated for shall be determined based upon the listed implementation date and reasonable considerations such as seasonality and a principle of simplicity.

Energy savings calculations for EPIA shall be documented and defendable. Documentation of the process used to determine EPIA energy savings does not have to be included in detail in the Opportunity Register but shall be referenced and linked so the calculations can be easily found using the EPIA identifiers listed on the Opportunity Register.

3.12.2.2 Determining if Energy Performance Improvement Actions were Identified and Planned Outside of a SEM Program Cycle.

Pursuant to CPUC Decision 16-08-019, existing baseline conditions should be the basis for measurement of SEM savings for behavioral, retro-commissioning, and operational projects as well as capital projects. As such, EPIAs that were identified and planned for implementation outside of any SEM Program Cycle would be considered part of the existing baseline condition and resulting energy savings if the EPIA was implemented during any SEM Program Cycle shall not be reported as part of the SEM program.

The implementer shall work with the customer to identify and list, as part of the Opportunity Register, EPIAs that were identified and planned outside of any SEM Program Cycle but not yet implemented. The timely collection of information and documentation regarding these EPIAs is critical, as time moves forward confidence in the information that new customer staff and memories about these EPIAs will become less reliable. Documentation collected as part of the ongoing SEM engagement is more trustworthy than that collected after the program engagement.

For each listed EPIA that was identified outside any SEM Program Cycle, a determination shall be made if it was not only identified but also planned for implementation outside any SEM Program Cycle. Energy savings resulting from EPIAs that are both identified and planned outside of any SEM Program Cycle shall be included as part of the Non-SEM Program Energy Savings. Energy savings that ultimately result from EPIAs that were identified outside of any SEM Program Cycle but not planned for implementation shall be included as part of future SEM Program Energy Savings when the EPIA is implemented during a Reporting Period.

The determination whether an EPIA was not only identified but also planned for implementation outside of any SEM Program Cycle shall be based on evidence of planning taking place within the 12 months prior to the SEM Program Cycle. Evidence older than 12 months indicates that while planning may have been started, EPIA implementation was stalled and the SEM program influenced its implementation. A, "wish-list," or brainstorming list of EPIA ideas does not qualify as a planned EPIAs. Evidence of an EPIA being planned for implementation could include the following:

- Budget allocated for the EPIA.
- Contracts signed related to EPIA implementation.
- Purchase orders issued or other indications of spending on the EPIA.
- Internal project manager assigned.
- Detailed EPIA implementation scope and schedule developed.

EPIAs shall not be considered as identified and planned outside of an SEM Program Cycle

If an EPIA was identified and planned outside of an SEM Program Cycle but the implementation was abandoned or postponed, the EPIA may be considered as "planned" during an SEM Program Cycle if it can be demonstrated that the EPIA implementation was accelerated (e.g., from scheduled for implementation in three years to scheduled for implementation in one year).

The Opportunity Register shall be updated to indicate if each listed EPIA is determined to have been both identified and planned outside of any SEM Program Cycle or not. The rationale for the determination shall be recorded as part of the Opportunity Register.

Identification of EPIAs for which energy savings were removed from each type of energy savings shall be documented.

3.13 Calculating Energy Savings with Energy Consumption Adjustment Models

3.13.1 Process

Energy savings of all types of energy shall be calculated and confidence established for the Reporting Period. In order to calculate M&V Boundary Energy Savings during a Reporting Period the following process shall be followed:

1. Confirm the Reporting Period.
2. Calculate Avoided Energy Consumption energy savings.
3. Calculated incremental savings when energy consumption adjustment models are used for multiple Reporting Periods.
4. Annualize energy savings (if approved by PA).
5. Establish confidence in energy savings values.

Preparation of energy savings for regulatory reporting will be addressed in Section 4.

3.13.2 Confirm the Reporting Period

If not already done, a Reporting Period shall be established with a clear start and end date in accordance with Section 2.1.1.2.

3.13.3 Calculating Avoided Energy Consumption Energy Savings

3.13.3.1 Calculating Interval Avoided Energy Consumption Energy Savings

For each energy consumption adjustment model selected for use, Avoided Energy Consumption energy savings shall be calculated by applying the following equation using observed (actual) and estimated (predicted) energy consumption values for each interval of the Reporting Period.

$$\text{Energy Savings}_{\text{Reporting Period Interval}} = \text{Energy Consumption}^{\text{Modeled}}_{\text{Reporting Period Interval}} - \text{Energy Consumption}^{\text{Observed}}_{\text{Reporting Period Interval}}$$

3.13.3.2 Aggregating Interval Avoided Energy Consumption Energy Savings

Avoided Energy Consumption energy savings for the entire Reporting Period are calculated by aggregating the Avoided Energy Consumption energy savings for each interval of the Reporting Period.

$$\text{Energy Savings}_{\text{Reporting Period}} = \sum_{i=1}^{n} \text{Energy Savings}_{\text{Reporting Period Interval } i}$$

WHERE:

» n= number of intervals in the Reporting Period

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Energy savings calculated using the above equation are for the current Reporting Period as compared to the energy baseline and will be cumulative of all energy savings activities between the end of the Baseline Period and the current Reporting Period. See Section 3.13.4 to determine incremental energy savings for the current Reporting Period.

Regardless of requests to annualize energy savings Avoided Energy Consumption Energy Savings shall be documented for all Reporting Periods.

3.13.3.3 Visualizing Energy Savings

The cumulative sum of differences (CUSUM) calculation is an effective means of quantifying and visualizing energy savings for each type of energy during the Reporting Period.

A CUSUM graph provides an illustration of the total savings achieved as compared to the energy baseline. A CUSUM graph for each type of energy for which energy consumption adjustment models are being used to calculate energy savings shall be developed and accompanied by a time-series plot of actual and predicted energy consumption.

> **NOTE:** A consensus whether to display CUSUM energy savings as a positive or negative value does not exist. Some PA sponsored SEM programs mandate increasing energy savings be displayed as a positive value while other programs mandate the opposite. Implementers and customers can display CUSUM energy savings as positive or negative so long as graphical representations of CUSUM energy savings clearly indicate the direction of increased energy savings. At its discretion the sponsoring PA may require one approach or the other.

The implementation date of selected EPIAs listed on the Opportunity Register for which energy savings have been calculated shall be indicated on the CUSUM graph.

Significant changes in CUSUM slope, positive and negative, should be investigated with analysis results noted as footnotes to the CUSUM graph.

3.13.4 Establishing Confidence in Energy Savings

Fractional savings uncertainty (FSU) analysis is a method for both assessing the validity of an energy consumption adjustment model at the development stage as well as judging the validity of energy savings realized from an energy consumption adjustment model.

An FSU calculation shall be conducted for each M&V Boundary Energy Savings value calculated and used as the basis of an energy savings value to be reported.

The fractional uncertainty can be estimated with the general FSU equation as follows:

$$\frac{\Delta E_{save,m}}{E_{save,m}} \quad t \cdot \frac{1.26 \cdot CV\left(\left(\frac{n}{n'}\right)\left(1+\frac{2}{n'}\right)\cdot\frac{1}{m}\right)^{\frac{1}{2}}}{F}$$

WHERE:

- t= t-statistic for desired confidence level
- CV= coefficient of variation

- » n= number of observations in the Baseline Period
- » m= number of observations in the Reporting Period
- » F= observed savings fraction during Reporting Period
- » n'= number of independent Baseline Period observations
- » p= auto-correlation coefficient

$$n' = n\frac{(1-\rho)}{(1+\rho)}$$

According to ASHRAE Guideline 14:2014, for monthly data an assumption that autocorrelation is **0** so **n**' is equal to **n**.

When Reporting Period intervals are monthly or daily the improved FSU equation from Sun and Baltazar should be used which replaces the 1.26 coefficient in the above equation with a polynomial:

$$\frac{\Delta E_{save,m}}{E_{save,m}} = t \cdot \frac{(aM^2+bM+c)\cdot CV\left(\left(\frac{n}{n'}\right)\left(1+\frac{2}{n'}\right)\cdot\frac{1}{m}\right)^{\frac{1}{2}}}{F}$$

Where:

- » M = number of months of Reporting Period data
- » a, b, and c are defined as follows:

Data Interval	Monthly	Daily
a	-0.00022	-0.00024
b	0.03306	0.03535
c	0.94054	1.00286

Table 5: FSU Equation Coefficients

FSU is typically used to assess energy consumption adjustment models in one of two ways.

- **At Model Development** – During the development of an energy consumption adjustment model, the projected FSU can be calculated based on a standard energy savings amount (typically 5%), and used to indicate how the energy consumption adjustment model is expected to perform at the standard savings rate and may help when selecting the final model out of the potential candidates.

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- **When assessing model-based energy savings** – Upon the completion of the Reporting Period, the FSU can be assessed based on the actual realized energy savings. At this stage the savings fraction used to calculate the FSU should be the total savings realized in the energy consumption adjustment model before incremental savings are calculated or adjustments are made for EPIAs realized outside of SEM.

ASHRAE Guideline 14-2002, Section 5.3.2.2 specifies that the level of uncertainty must be less than 50% of the annual reported savings, at a confidence level of 68%. The FSU threshold is not an absolute requirement, but can be used as guidance when assessing energy consumption adjustment model or savings validity. The overall validity of the model using various modeling statistics and FSU should be considered together when evaluating the acceptability of energy consumption adjustment model-based energy savings values.

The FSU threshold provides guidance for a general acceptable level of savings uncertainty, however, when the FSU threshold is not met, energy savings may still be considered valid when other indicators of valid energy savings are present. For an FSU value calculated with an energy consumption adjustment model spanning nine or more months general FSU ranges and recommended treatment for assessing energy savings are included below:

- When FSU is less than 0.5, the reported energy savings value should be considered valid.
- If the FSU falls between 0.5 and 1.0 of the reported energy savings, assess the pattern of the CUSUM for a clear and observable savings trend and review the Implemented EPIAs on the Opportunity Register to support validating energy savings.
- If the FSU falls between 1.0 and 1.5 of the reported energy savings, this is indicator that the energy savings may not be valid. In this case validating model-based energy savings may require additional support. In addition to assessing the pattern of the CUSUM for a clear and observable savings trend and reviewing the Implemented EPIAs on the Opportunity Register, providing supporting bottom-up engineering calculations related to implemented EPIAs to demonstrate the reasonableness of the savings determined by the model may be appropriate. Note that in this situation, the bottom-up calculations may be very high level and will not be used to specifically claim savings, but instead demonstrate that the savings determined from the model are reasonable. The energy model will then be used to determine final savings.
- When the FSU is greater than 1.5, this is an indicator that the energy savings are not valid.

Note that FSU can be artificially inflated due to the limited number of data points in each model. This can occur when the number of data points included in the energy consumption adjustment models is low (e.g. monthly interval model). Care should be taken when assessing the FSU when it is expected to be artificially high; the above FSU ranges may not be applicable or additional support to validate energy savings may be recommended. The table in Annex F – Fractional Savings Uncertainty Scenarios, provides an additional example of how FSU may vary depending on the model interval and level of energy savings

3.13.5 Calculating Incremental Energy Savings for Consecutive Reporting Periods using the Same Energy Consumption Adjustment Model

Energy consumption adjustment models with a consistent Baseline Period can be used to calculate energy savings for multiple Reporting Periods. Energy savings values for consecutive Reporting Periods are by nature cumulative of energy savings resulting from actions taken in the current as well as prior Reporting Periods.

Incremental energy savings for the current Reporting Period shall be calculated if energy consumption adjustment models are used for more than one Reporting Period as a way of "artificially re-baselining" the energy consumption model.

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Incremental Site-wide Avoided Energy Consumption energy savings for the current Reporting Period shall be calculated by subtracting the PA approved incremental energy savings from prior Reporting Periods from the energy savings of the current Reporting Period energy savings. The prior Reporting Period energy savings must be cumulative with all other prior Reporting Periods for which the same energy consumption adjustment model and associated energy baseline have been used. Annex H – Cumulative and Incremental Savings Example provides an example of how incremental Site-wide Avoided Energy Consumption savings are determined when an energy consumption adjustment model is used for multiple years.

If an energy consumption adjustment model is re-baselined (a new energy baseline established and new energy consumption adjustment model(s) developed) any savings achieved prior to the new Baseline Period do not need to be removed from energy savings calculations made for the current Reporting Period as they will have been incorporated into the new model. Energy savings achieved during the Baseline Period must be accounted for following the guidance in Section 3.5.

3.13.6 Annualization of Energy Savings

Annualization of M&V Boundary Energy Savings shall only be performed when annualization will demonstrably improve the meaning and accuracy of energy savings and with PA approval. See Section 1.4 for additional discussion on annualization.

If, in this case, a top-down approach will be attempted in the subsequent Reporting Period, a new Baseline Period that encompasses the current Reporting Period shall be established along with new energy consumption adjustment model(s). Appropriate adjustments to the new Baseline Period shall be made to account for any known EPIAs implemented during that time.

If annualization of energy savings is authorized by the PA, the following process should be followed:

3.13.6.1 Considerations for Seasonality

When the distribution of relevant variables used for a particular energy consumption adjustment model is expected to be markedly different throughout the Reporting Period, this distribution must be considered when annualizing energy savings. If the ratio of higher to lower expected production level is not anticipated to stay seasonally consistent, the Reporting Period can be divided into two or more distinct periods for a given energy consumption adjustment model. This method is generally only feasible for daily models. There must be a minimum number of intervals (normally 30 for daily models) in each period to justify the split. Use of this method shall be documented.

3.13.6.2 Annualization Period

Annualization of energy savings is dependent upon extrapolating energy savings calculated during a short time period (Annualization Period) established towards the end of the Reporting Period. This time period, the Annualization Period, shall be at least 90 and no more than 120 consecutive days within the final 9 months of the Reporting Period.

If an energy consumption model has been developed for a time period shorter than 90 days annualization shall not be performed and Avoided Energy Consumption values should be used.

Annualization Periods longer than 120 days can be utilized depending on the variability of the site but shall be wholly within the final 9 months of the Reporting Period. If the customer's operation is highly seasonal, and only has one model, a longer Annualization Period that addresses seasonal impact on varying energy savings rates should be selected. The rationale for selecting an Annualization Period duration longer than 120 days shall be documented. The annualization period shall be reflective of the impact of relevant EPIAs. Variation from the 90 and 120 day requirements to accommodate EPIAs shall be approved by the PA and documented.

Ideally, the end of the Annualization Period should be established as close to the end of the Reporting Period as possible to reflect the full impact of the activities taken during the Reporting Period. The rationale for ending the Annualization Period prior to the end of the Reporting Period shall be documented.

3.13.6.3 Confirming Data Quality within the Annualization Period

Data collected during the Annualization Period should be reviewed in detail to detect anomalous values and account for situations that did not happen in the Baseline Period.

Individual data intervals in the Annualization Period should be flagged if a relevant variable data point is 10% beyond the bounds of the energy baseline data set.

These points may be handled in one of three ways:

- Include the point without alteration.
  - This is appropriate if the residual for the point is not an outlier compared to the representative population of residuals (as determined by the implementer).
- Exclude the point.
  - This is appropriate if the residual of the outlier point is an outlier compared to the overall population of residuals. In this case the energy savings from this outlier point would have an outsized effect on the energy savings measurement.
- Shift the Annualization Period.
  - This is appropriate if the interval in question is towards the end of the current Annualization Period and shifting the period will omit the interval in question while otherwise maintaining the integrity of the Annualization Period.
- Remodel
  - This is appropriate if no Annualization Period can be established during which a valid energy savings value can be calculated.

If an outlier is detected, qualitative justification based on visual representation of the data and quantitative justification should be provided, rationalizing the selected approach used to address the outlier. The selected approach should be documented.

3.13.6.4 Calculating annualized energy savings

Annualized energy savings shall be calculated using the following equation:

$$\text{Annualized Energy Savings} = \left(\sum_{i=1}^{n} (\text{Energy Savings})_i \right) \times \left(\frac{n_{year}}{n} \right)$$

WHERE:

- n = number of intervals in the Annualization Period
- n_{year} = 365 days represented in the intervals being used

With energy savings being calculated using the equation in Section 3.13.3.1.

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4 Reviewing and Reporting of Energy Savings

Reporting requirements of the M&V Guide apply to each site enrolled in the SEM program. If a site has more than one M&V boundary, a single report is to be completed but must contain information on all associated M&V boundaries. As customers may have multiple sites enrolled in the SEM program, a summary report for all of the customer's multiple sites may optionally be developed in addition to the individual site reporting requirements of the M&V Guide.

4.1 Preparing Energy Savings for Regulatory Reporting

4.1.1 General

For the current Reporting Period, Avoided Energy Consumption energy savings values shall be calculated for each type of energy included in the M&V process using one of two methods:

1. Energy consumption adjustment models, if the development of valid energy consumption models is successful.
2. Aggregation of energy savings from individual EPIAs listed on the Opportunity Register.

Annualized energy savings shall only be reported with PA permission per the requirements of this M&V Guide.

For each type of energy, if valid energy consumption adjustment models were not developed and used to calculate energy savings then the bottom-up method of aggregating energy savings resulting from the implementation of EPIAs listed on the Opportunity Register shall be reported for that type of energy.

If for a given type of energy one or more energy consumption adjustment models were developed for part of the Reporting Period (e.g. during seasonal operations for a resort or food producer) but one or more energy consumption adjustment models could not be developed for the other part of the Reporting Period, then energy savings may be reported for that other part of the Reporting Period with either a top-down or bottom-up method.

Energy savings for different types of energy may be reported using different methods for the same customer (e.g. natural gas energy savings reported using a bottom-up approach and electricity energy savings reported using a top-down approach).

As described in more detail in Section 1.4: For each type of energy included in the M&V process, annualization of top-down based energy savings may be performed only in the case when an energy consumption adjustment model is being retired or a customer will not be participating in the SEM program after the current Reporting Period. Bottom-up estimates will be prorated based on the installation date.

When communicating with the customer, PA, and CPUC case shall be taken to label energy savings as either "avoided energy consumption energy savings" or "annualized energy savings." The label "energy savings" may be used with the implicit assumption it refers to energy savings determined on an Avoided Energy Consumption basis.

The SEM Reporting Period Performance Report, Opportunity Register, and Energy Data and Performance Tracking Tool shall be provided to the CPUC as requested when reporting energy savings. The CPUC may have additional requests for data though the SEM Reporting Period Performance Report should be adequate to evaluate if the energy savings reported conform to the requirements of this M&V Guide.

Program cost-effectiveness shall be based upon SEM Program Energy Savings.

This M&V Guide does not consider regulatory reporting aimed to evaluate the development of customer EnMS. As the M&V process is a component of a functional EnMS, requests pertaining to the customer's understanding, activities, and leadership of parts of the M&V process may be made by the CPUC.

4.1.2 Energy Savings Terminology

The below listing defines types of energy savings that will be referenced in the process of appropriately removing different types of energy savings from M&V Boundary Energy Savings for each type of energy.

M&V Boundary Energy Savings: 1	Non-SEM Program Energy Savings: 2	SEM Program Energy Savings: 3	SEM Non-incented Project Energy Savings: 4	SEM Incented Energy Savings: 5
Incremental, energy savings for a given type of energy resulting from the aggregation of energy savings from each energy consumption adjustment model developed for the same energy type. These "modeled" savings encompass all energy saving types listed below.	Energy savings calculated for EPIAs identified and planned outside of any SEM Program Cycle and implemented during the current Reporting Period, whether receiving other incentives or not.	M&V Boundary Energy Savings minus Non-SEM Program Energy Savings. This value is the combination of BRO, capital, and deemed projects that were influenced by SEM.	Energy savings for an EPIA (project) identified during any SEM Program Cycle and implemented during the current Reporting Period that is to receive an incentive from a PA program other than the SEM program. PA custom capital M&V requirements (ex-ante, ex-post, etc.) may apply.	SEM Program Energy Savings minus SEM Non-incented Project Energy Savings. At the discretion of the PA, this energy savings value can be used to pay SEM performance incentives.

Mathematically:

SEM Program Energy Savings = M&V Boundary Energy Savings - Non-SEM Program Energy Savings

SEM Incented Energy Savings = SEM Program Energy Savings - SEM Non-incented Project Energy Savings

The figure below illustrates the relationship of the different types of energy savings.

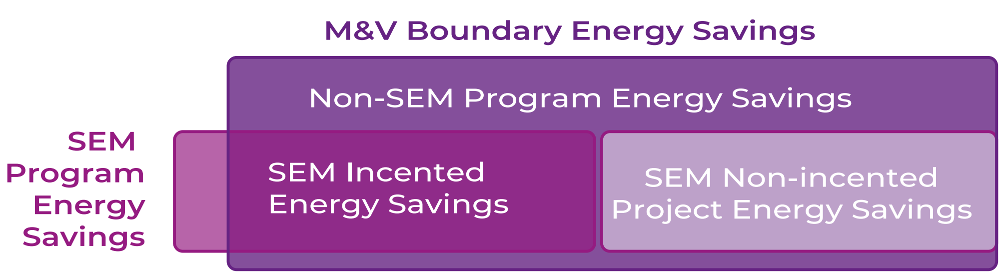

Figure 6: Relationship Between Different Type of Energy Savings

4.1.3 Requirements for Claiming Savings via Top-Down Method

If one or more valid energy consumption adjustment models were created and used to calculate energy savings for a given type of energy, then incremental Avoided Energy Consumption energy savings for the current Reporting Period shall be used as the basis of M&V Boundary Energy Savings.

If the PA has provided explicit permission to report annualized energy savings values, then all other energy savings types shall also be used and reported on an annualized basis (including those related to individual EPIAs).

Incremental energy savings shall be reported rather than energy savings cumulative of multiple Reporting Periods.

If incremental energy savings for a given type of energy are calculated for the purposes of regulatory reporting, energy savings resulting from EPIAs implemented during the Reporting Period that are incentivized by another PA program or were identified and planned outside of participation in any SEM Program Cycle shall be removed from the energy savings value reported.

The process used to remove energy savings resulting from EPIAs implemented during the Reporting Period that are incentivized by another PA program or were identified and planned outside of participation in any SEM Program Cycle shall be documented. See Section 3.12.2.2 how to determine if an EPIA would be included or excluded.

M&V Boundary Energy Savings, Non-SEM Program Energy Savings, SEM Program Energy Savings, SEM Non-incented Project Energy Savings, and SEM Incented Energy Savings shall be calculated for each type of energy.

4.1.4 Requirements for Claiming Energy Savings via Bottom-Up Method

If approved by the PA, then a bottom-up approach of calculating energy savings for a given type of energy may be used for the Reporting Period. This bottom-up approach is only allowed if one or more energy consumption adjustment models per the requirements of this M&V Guide cannot be developed, used to calculate energy savings, and used to report energy savings to the PA for a given type of energy.

4.1.4.1 Determining if Avoided Energy Consumption or Annualized Energy Savings Should be Reported

Only energy savings for EPIAs listed on the Opportunity Register, and assessed to not have been identified and planned outside of a PA sponsored SEM program shall be included in the bottom-up calculation. Not all EPIAs for which energy savings have been calculated must be included in the bottom-up calculation. Reasons to not include energy savings from specific EPIA may include lack of confidence in the estimated energy savings value and uncertainty that the implemented EPIA will remain in place during the SEM Program Cycle.

If the PA has not given explicit permission to report annualized savings, then energy savings shall be reported on an Avoided Energy Consumption basis. Only the prorated portion of the annualized EPIA energy savings for the current Reporting Period shall be reported to the PA. The balance of the annualized energy savings for the EPIA shall be claimed in the subsequent Reporting Period without modification to the originally calculated energy savings. If the customer does participate in the SEM program in the subsequent year, the balance of the annualized energy savings for the EPIA may still be claimed in the subsequent year with no associated cost of program implementation.

If the PA has given explicit permission to report annualized energy savings, then energy savings shall be reported on an annualized basis.

4.1.4.2 Aggregating EPIA Energy Savings

Reporting Period energy savings can be calculated from the aggregation of energy savings resulting from the implementation of individual EPIAs, a "bottom-up approach."

If a bottom-up calculation is made in addition to development and use of a valid energy consumption adjustment model for the same type of energy, the resulting aggregated energy savings can be used as a "gut check" in comparison to energy savings calculated with energy consumption adjustment models.

As part of a PA sponsored SEM program, energy savings calculated from the two energy savings determination methods (top-down and bottom-up) shall not be reconciled as the foundational assumptions of the two methods are incongruent.

If the bottom-up aggregation of energy savings approach to calculating energy savings is used to report energy savings, it should be done with the understanding that evaluation of energy savings for individual EPIA listed on the Opportunity Register may occur. Energy savings for each EPIA included in the submitted energy savings report to the CPUC shall be developed using the guidance of Annex C – Bottom Up EPIA Calculation Effort. Evaluation of bottom-up savings shall not be conducted to the level of rigor and specificity as is conducted for projects that are part of custom capital incentive programs. The evaluation shall be a check of the reasonable nature of the EPIA energy savings calculation approach, recognizing the requirements of this M&V Guide direct that a detailed M&V plan for each EPIA is not to be developed.

4.1.5 Considerations for Non-utility Energy (aka Non-IOU Fuels)

The implementer shall be responsible for ensuring the customer pays a public purpose program surcharge for each type of energy for which energy savings will be reported and that the reported energy savings value is attributed to energy for which the public purpose program surcharge was paid.

Energy savings shall only be reported when they are coincident with time intervals when the customer is purchasing power from the grid.

The implementer shall be responsible for adjusting energy savings values to account for PA and CPUC requirements pertaining to claiming energy savings for sites that have on-site energy generation and non-utility (non-IOU) supplied energy/fuel (both referred to as non-utility energy in this M&V Guide). In general, energy savings claims should only support impacts to PA supplied energy. If a site generates energy and exports excess energy to the grid, those time periods shall be excluded from savings claims for that type of energy.

In general, the CPUC November 6, 2015 published, "Energy Efficiency Savings Eligibility at Sites with non-IOU Supplied Energy Sources – Guidance Document" version 1.1 should be consulted when considering if non-utility energy will affect reportable energy savings.

Non-IOU fuels must be able to be accounted for as they contribute to the M&V boundary itself. If a non-IOU fuel is split between multiple M&V boundaries it may be difficult or even impossible to determine how much non-IOU fuels contribute to the M&V boundary without additional submetering.

4.1.5.1 Top-Down Method

For each interval of the energy consumption adjustment model (e.g. if the model is developed on a monthly basis the evaluation of non-utility energy shall be conducted on a monthly basis) determine:

1. "Predicted Energy Consumption"	2. "Actual Energy Consumption"	3. "Predicted Energy Consumption Less On-site Generation"	4. "M&V Boundary Energy Savings"
Energy consumption adjustment model predicted energy consumption (grid purchased and on-site generated energy consumption without any Reporting Period EPIAs or other energy savings actions implemented).	Actual energy consumption (grid purchased and on-site generated energy consumption with any Reporting Period EPIAs or other energy savings actions implemented).	On-site generated energy consumed within the M&V boundaries removed from "Predicted Energy Consumption" ("Predicted Energy Consumption Less On-site Generation" does not included energy generated on-site and exported from the site).	"Predicted Energy Consumption" - "Actual Energy Consumption."

For each interval of the energy consumption adjustment model, use the below logic to determine if reportable energy savings need to be adjusted to account for non-utility energy. Each logic sets (i.e. a, b, and c) below is provided in a full statement using the terminology from above as well as in mathematical form using the numbered items (i.e. 1, 2, 3, and 4) from above.

a) If "M&V Boundary Energy Savings" are less than the "Predicted Energy Consumption Less On-site Generation" and "M&V Boundary Energy Savings" are greater than 0, then M&V Boundary Energy Savings for that interval do not need to be adjusted for non-utility energy and "M&V Boundary Energy Savings" are the originally calculated "M&V Boundary Energy Savings."

If $4 < 3$ and $4 > 0$ **then 3 is the interval energy savings not adjusted for non-utility energy**

b) If "M&V Boundary Energy Savings" are greater than the "Predicted Energy Consumption Less On-site Generation" and "M&V Boundary Energy Savings" are greater than 0, then M&V Boundary Energy Savings for that interval need to be adjusted for non-utility energy and "M&V Boundary Energy Savings" shall be the "Predicted Energy Consumption Less On-site Generation" value.

If $4 > 3$ and $4 > 0$ **then 4 is the interval energy savings adjusted for non-utility energy**

c) If neither of the above are true then "M&V Boundary Energy Savings" shall not be adjusted for non-utility energy and "M&V Boundary Energy Savings" are the originally calculated "M&V Boundary Energy Savings.

If a) and b) are not true then 4 is the interval energy savings not adjusted for non-utility energy

Note that energy exports shall be ignored such that grid purchased energy is not reduced by exported energy.

- Generally, natural gas is not exported to the grid.
- This applies when converting electricity export from a generator that uses natural gas or biofuel to generate electricity.

Graphical representation of when energy savings would be reduced due to non-utility energy is illustrated below in Figure 7.

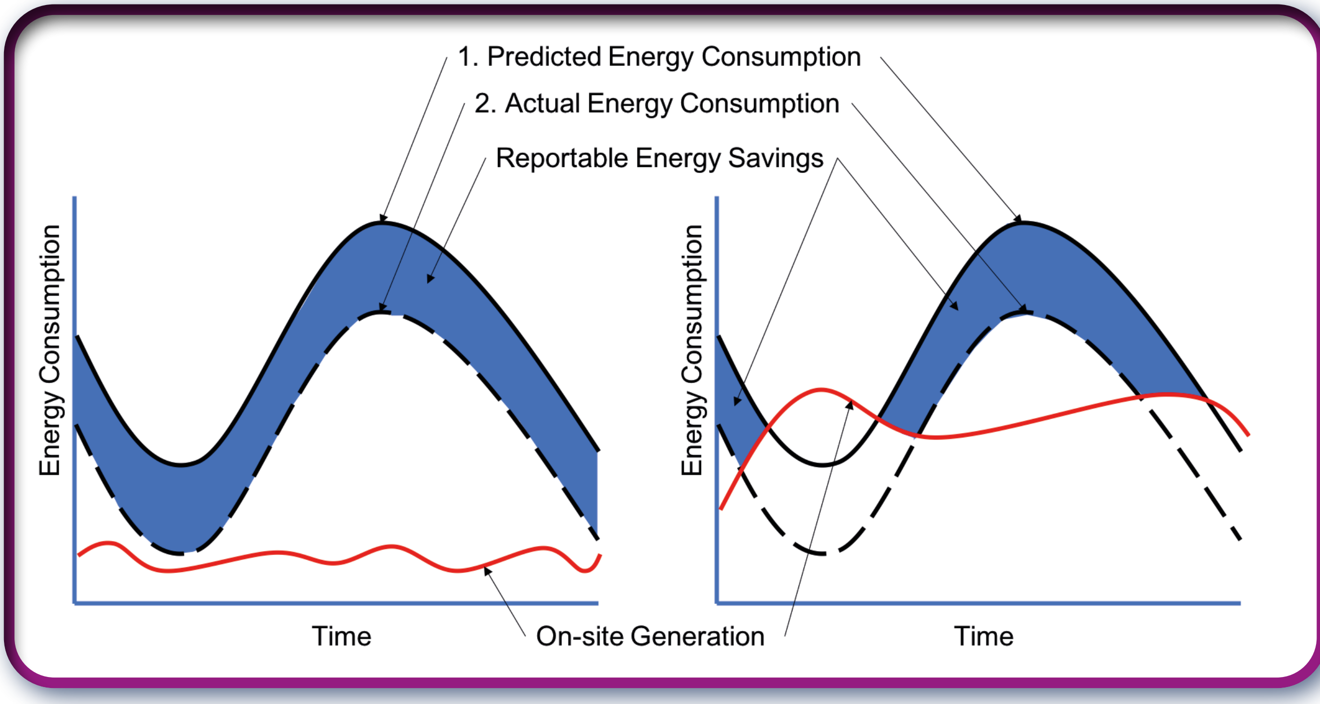

Figure 7: Illustration of when energy savings are reduced by non-utility energy

4.1.5.2 Bottom-Up Method

When energy savings are being determined with a bottom-up approach, the guidance of the CPUC November 6, 2015 published, "Energy Efficiency Savings Eligibility at Sites with non-IOU Supplied Energy Sources – Guidance Document" version 1.1 shall be followed to determine the effect and accounting of non-utility energy. The PA shall confirm appropriate application of the CPUC guidance.

When conducting a non-IOU energy analysis for energy savings determined from a bottom-up method, the non-IOU energy analysis should be conducted and applied to the energy savings before the energy savings are pro-rated between the current and subsequent Reporting Periods. The non-IOU energy analysis should not be replicated in the subsequent Reporting Period.

4.1.6 Unexpected Energy Savings

Unexpected energy savings refer to either positive or negative savings calculated using energy consumption adjustment models that are counter to anticipated results and not reasonably attributable to the SEM program.

Unexpected savings may be the result of:

- External factors outside of SEM program influence (e.g., market dynamics, workforce changes, societal disruptions).
- Site activities or operational changes unrelated to SEM program.

In cases where unexpected savings—positive or negative—are calculated the implementer shall investigate and document the likely causes and include them in the SEM Reporting Period Performance Report.

If negative savings are calculated and no EPIAs were implemented during the Reporting Period for that energy type, the energy savings shall be reported as zero.

If negative savings are calculated and EPIAs were implemented during the Reporting Period and an adequate investigation and documentation of possible reasons for the negative savings was conducted showing the SEM program was not responsible for the results, the energy savings shall be reported as zero and a bottom-up approach may be used.

If positive unexpected savings are calculated using an energy consumption adjustment model that cannot be credibly attributed to SEM-related efforts then these savings shall not be claimed. Alternative M&V boundaries or a bottom-up approach may be considered following the requirements of this M&V Guide. A reconciliation of unexpected energy savings from the original energy consumption model with energy savings calculated based on individual implemented EPIAs shall not be conducted given the incompatible approaches in determining energy savings.

If EPIAs are implemented that knowingly increase energy consumption for a particular energy type related to that EPIA (e.g., installing an electric heater in place of a gas unit), then the negative energy savings associated with these actions shall be reported. These are considered intentional trade-offs within the SEM program scope and must be included in energy savings reporting. Note that this analysis is not meant to be related to NREs or interactive effects within a site but for EPIAs focused on switching energy types.

In all cases, the guiding principle is that unexpected savings shall only be reported (positive or negative) if there is clear, credible evidence that they were caused by SEM program-related actions. Otherwise, they shall be excluded or set to zero in the reported results. The decision to report zero savings must be approved by the PA and clearly justified in the program documentation.

4.2 Calculating Demand Savings

Electricity demand savings can be difficult to determine and can be done in multiple ways.

In 2021, the CPUC evaluator created an Excel based SEM Demand Savings Calculator that uses an input of claimed electricity savings and existing load shapes to determine demand savings. This CPUC-developed demand savings tool shall be the default approach to determining reportable electricity demand savings. The CPUC-developed tool may be updated by the CPUC at its discretion.

Alternative methods to determining electricity demand savings shall only be used if approved by the PA.

Alternative methods of determining electricity demand savings using energy savings determined from energy consumption adjustment models shall only be conducted when the model is based on hourly or more frequent interval data to calculate demand savings. This hourly or more frequent interval data requirement may not align with the interval frequency with which energy consumption adjustment models were developed.

The shift towards Total System Benefits will affect how demand savings are valued and potentially determined. Annex H – Total System Benefits offers a brief introduction to the concept.

4.3 Greenhouse Gas Savings

Greenhouse Gas (GHG) emissions are regulated by the California Air Resources Board (CARB). Many companies have voluntarily joined decarbonization programs with GHG emission reduction targets and reporting requirements. A wide variety of methods exist for establishing a GHG inventory and for reporting GHG emissions reductions. Reporting GHG emissions reductions is currently not a regulatory requirement of this M&V Guide though changes to CPUC policies are being made to better align with GHG related objectives established by the California legislature and governor. The shift towards Total System Benefits will affect how GHG emission savings are valued and potentially determined. Annex H – Total System Benefits offers a brief introduction to the TSB concept.

The calculation of GHG emissions itself is not a requirement of this M&V Guide but guidance is provided here as the likelihood of interest in GHG emissions by the PA and customer is growing. If GHG emissions are calculated as part of the PA sponsored SEM program the requirements (shall statements) of this section shall be followed.

4.3.1 Sources of GHG Emissions

In the US, nearly 80% of all GHG emissions are energy related.[5] For organizations, these energy-related GHG emissions can come from:

- Direct GHG emissions from the combustion of energy (e.g. natural gas used in process heating) at the site.
- Indirect GHG emissions that come from consumption of delivered energy (e.g. electricity consumed) at the site.
- Indirect GHG emissions that come from energy consumed by activities (e.g. outsourced production processes) throughout an organization's value chain.

Additionally, other gaseous species such as those from refrigeration system and process emissions contribute to climate change. These non-energy related GHG emissions can be managed with an energy management system but are not the focus of this M&V Guide. This M&V Guide can be used to inform the determination of energy-related GHG emission reductions.

The process of energy accounting (collection of energy consumption data by energy type) and energy savings determined via top down or bottom-up methods can aid in the determination of energy-related GHG emissions reductions.

The purpose for determining energy-related GHG emissions reduction should be established. This purpose will inform the scope and method by which energy-related GHG emissions should be determined.

[5]Intergovernmental Panel on Climate Change (IPCC), Climate Change 2022 Impacts, Adaptation, and Vulnerability Summary for Policymakers, Accessed May 2022, https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_FinalDraft_FullReport.pdf

4.3.2 GHG Emission Scopes

The GHG Protocol's, "Corporate Accounting and Reporting Standard," defines three categories, or "scopes" of direct and indirect emissions that are widely used and should be considered:[6]

Scope 1 Emissions:

Direct GHG emissions.

Direct GHG emissions occur from sources that are owned or controlled by the organization, for example, emissions from combustion in owned or controlled boilers, furnaces, vehicles, etc.; emissions from chemical production in owned or controlled process equipment.

Scope 2 Emissions:

Electricity indirect GHG emissions.

Scope 2 accounts for GHG emissions from the generation of purchased electricity, steam, heat, or cooling consumed by the organization. Purchased electricity is defined as electricity that is purchased or otherwise brought into the organizational boundary of the company. For purchased energy, scope 2 emissions physically occur at the site where electricity, steam, heat, or cooling is generated.

Scope 3 Emissions:

Other indirect GHG emissions.

Scope 3 is an optional reporting category that allows for the treatment of all other indirect emissions. Scope 3 emissions are a consequence of the activities of the organization, but occur from sources not owned or controlled by the organization. Some examples of scope 3 activities are extraction and production of purchased materials; transportation of purchased fuels; and use of sold products and services.

For most organizations, inclusion of scope 1 and scope 2 emissions is the minimum that should be considered when determining the EnMS scope and boundaries. Data collected by following the processes of this M&V Guide may be of use in determining scope 3 emissions, but this M&V Guide focuses on guidance related to scope 1 and 2 emissions.

4.3.3 Care When Selecting Methods to Determine Energy-related GHG Emissions Reductions

This M&V Guide was not designed to determine a greenhouse gas (GHG) emission inventory or GHG emission reductions. This M&V Guide reports normalized energy savings which can be used with GHG emission factors for specific energy types to establish a normalized energy-related GHG emissions reduction value, an indicator of GHG performance improvement.

Use of normalized energy savings to determine GHG emissions reduction values is not conformant with most GHG reporting methods and does not convey actual GHG emissions reductions. Major GHG inventory and reporting protocols, such as the World Resources Institute's and World Business Council for Sustainable Development's GHG Reporting Protocol[7], provide guidance on how to establish a GHG emissions inventory for a given period of time. This inventory is not normalized for variables such as occupancy, production, or weather. The difference between GHG emission inventories for two different time periods can be used to establish if GHG emissions have been reduced on an absolute basis. It is worth noting these absolute basis methods of reporting GHG inventories and reductions are dominant in decarbonization programs and policies.

A recent study of 86 industrial facilities was conducted by the Lawrence Berkeley National Laboratory to understand variation in calculated GHG emissions reduction using an SEM M&V type approach (the SEP M&V Protocol) compared to one of the most widely used GHG inventory reporting protocols from WRI, the GHG Reporting Protocol. The analysis showed significant deviations in estimates for GHG reductions, primarily because the SEP M&V method uses regression analysis to normalize relevant variables, while the WRI methods rely on absolute energy consumption. The variation of results between the two

[6] World Business Council for Sustainable Development and World Resources Institute, The Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard, March 2004

[7] WRI, Greenhouse Gas Protocol, https://www.wri.org/initiatives/greenhouse-gas-protocol

approaches ranged from negligible to more than 500%. This variance was largely driven by conditions when relevant variables used in the development of energy consumption adjustment models was high between the Baseline Period and Reporting Period. Lower variance in the relevant variables reduced the difference in reported GHG emissions. Suggestion to use energy consumption model based GHG savings as a proxy for absolute emissions reduction when relevant variable variance is low is faulty. This approach inherently and needlessly introduces error when a viable alternative method exists and can make use of already collected energy data. Other major GHG emissions reduction protocols such as the Science Based Targets initiative do not allow for normalized GHG emissions reporting at this time.

As GHG emissions reduction protocols such as the GHG Reporting Protocol and the regulatory reporting required by CARB does not allow for normalized GHG emissions reporting care should be taken to contextualize and properly label GHG emissions reductions determined using normalized energy savings values. Only GHG emissions reductions conforming to a major GHG emissions reduction protocol should be presented as “GHG emissions reductions” or with other similar labels.

4.3.4 Methods, Guides, and Protocols Commonly used to Establish GHG Inventories and Emissions Reductions

Users of the M&V Guide wishing to establish GHG inventories and emissions reductions should be familiar with methods, guides, and protocols used to establish GHG inventories and emissions reductions.

As the legislatively authorized regulator of GHG emissions, CARB mandates reporting of GHG emissions and participation in California’s cap and trade program depending on a site’s GHG emissions. As reporting requirements and regulations may change, implementers should stay aware of current CARB policies. Currently CARB requires reporting of Scope 1 emissions only on an absolute basis. [8] [9]

Implementers and customers alike should be aware of other relevant GHG inventory and emissions reduction program and policies. These include the WRI GHG Reporting Protocol, Science Based Targets initiative, [10] and the U.S. Environmental Protection Agency’s Center for Corporate Climate Leadership. [11]

4.3.5 SEM Program GHG Reduction Calculation Requirements

The implementer shall assess if the customer wishes to discuss GHG inventories, reporting, reduction calculations, or other related topics. This conversation may be part of the larger SEM program engagement.

If the customer would like to discuss GHG related M&V the implementer shall document if the customer has an existing GHG emissions reduction target and if they are required or planning to use a specific GHG emissions reduction reporting mechanism.

The implementer shall work with the customer to understand their current and future GHG related program engagements, both voluntary and required.

The implementer shall discuss different methods of creating GHG inventories, reporting, and reduction calculations with the customer.

If GHG emissions reductions are calculated as part of a PA sponsored SEM program the implementer shall calculate and clearly and consistently label energy-related GHG emissions reductions as being “normalized emissions reductions,” or “absolute emissions reductions,” and include description of the method and scopes included in the reported value.

[8] California Air Resources Board, Mandatory GHG Reporting – Guidance Documents, Accessed May 2022, https://ww2.arb.ca.gov/mrr-guidance

[9] California Air Resources Board, Cal e-GGRT, Accessed May 2022, https://ssl.arb.ca.gov/Cal-eGGRT/login.do

[10] Science Based Targets initiative (SBTi), Set a Target, Accessed May 2022, https://sciencebasedtargets.org/set-a-target

[11] United States Environmental Protection Agency, EPA Center for Corporate Climate Leadership, Accessed May 2022, https://www.epa.gov/climateleadership

In addition to customer interest in calculating GHG reduction, the implementer shall be aware of GHG reduction calculation methods and requirements that would be used as part of future TSB determination. As GHG reporting relative to TSB is not specified at the time of this M&V Guide publication the implementer shall work with the PA to understand what changes and requirements develop over time.

4.4 Mid-Year Review of the M&V Process

4.4.1 General

The Mid-year Review is required in order to ensure the PA has insights to the progress and status of individual sites in the SEM program and demonstrate program engagement to evaluators. Materials used as part of the Mid-Year Review should be developed so they become components of the SEM Reporting Period Performance Report.

The Mid-Year Review shall occur approximately four to six months after the start of an SEM Program Cycle and then again approximately 12 months after. The implementer may request to delay the first Mid-Year Review with PA permission. Reasons to delay the first Mid-Year Review may include timing of SEM program delivery and challenges and data availability to develop energy consumption adjustment models.

All required items listed below shall be presented if available. If a required item is not available, documented justification of why it is not available shall be provided. Such justification may relate to customer participation, continued efforts to develop valid energy consumption adjustment models, etc. If valid energy consumption adjustment models have not yet been developed but are still being attempted the current status of model development shall be reported in addition to the reasons for development challenges.

The PA shall review the Mid-Year Review materials and provide feedback to the implementer. The PA may require additional documentation beyond the items and tools listed below. The Mid-Year Review can be conducted in person, remotely via web meeting, or through desk audit by PA staff. The PA shall specify how the Mid-Year Review will be conducted.

4.4.2 Mid-year Review Items

The implementer shall provide responses to the below items as part of the Mid-year Review. Provide a brief description of:

- **Business Description** – Provide a brief description of the customer, their business, and their operations. If already documented in prior Reporting Periods, provide a brief description of any changes of the above.
- **Business or Market Changes** – Identify any observed or anticipated business or market changes that will impact SEM participation and M&V.
- **Site Staff Engagement** – Identify the current and anticipated engagement level of site staff in the SEM program since the start of the Reporting Period.
- **Energy Team Changes** – Identify if there have been or are anticipated to be any changes to the energy team at the site. Identify the level of commitment and resources management provides to the SEM engagement.
- **Process Changes**– Identify if there have been or are anticipated to be any process changes that will impact the customer's ability to participate in the SEM program or ability to conduct M&V.

- **New Product/Services or New Operations** – Identify any observed or anticipated new products/services or operations that will impact SEM participation and M&V.
- **Anticipated M&V Boundaries** – Include for each type of energy that will be included in the M&V process the anticipated M&V boundaries. Specify any changes to the M&V boundaries that have changed from prior Reporting Periods.
- **Anticipated M&V Method** – Include for each type of energy that will be included in the M&V process the M&V method (top-down or bottom-up) that is expected to be used. If a top-down method is being pursued, indicate for each type of energy the status of energy consumption adjustment model development for the M&V boundaries. Specify any change to the anticipated M&V method if different from prior Reporting Periods.
- **Energy Data Collection Plan** – Identify if a data collection plan has been developed that reflects the expected M&V method and boundaries for this Reporting Period and if site staff understand their role and are committed to it. Have there been changes to a previously developed Energy Data Collection Plan? What prompted these changes if any?
- **Utility Meters** – For each type of energy to be included in the M&V process, list all utility meters that are anticipated to be used. Identify any changes to the list of utility meters from previous Reporting Periods.
- **Data Collection Efforts** – Identify any challenges regarding data collection. Identify if the installation of submetering at the site would facilitate energy consumption adjustment model development.
- **Energy Data Collection Tracker Tool** – Has the Energy Data and Performance Tracker Tool been updated to reflect change in the Energy Data Collection Plan? Is the customer using the Energy Data and Performance Tracker Tool?
- **New or Retired non-IOU Fuels** – Identify any existing non-IOU fuels that affect the M&V process. Identify any anticipated changes to non-IOU provided energy sources during the Reporting Period.
- **New or Retired on-site generation** – Identify any existing on-site generation within the anticipated M&V boundaries. Identify any anticipated changes to on-site generation during the Reporting Period.
- **IDSM Opportunities** – Identify any IDSM opportunities that the customer has interest in or plans to implement.
- **Treasure Hunt** – Identify the month and year (exact date is also acceptable) of the most recent and upcoming Treasure Hunt.
- **Energy Management Assessment** – Identify the month and year (exact date is also acceptable) of the most recent and upcoming EMA. Results of the most recent and previous EMA.

4.4.3 Mid-year Review Tools

The following items shall be provided as part of the Mid-Year Review:

For all participants	For first year participants
Energy Data and Performance Tracking Tool if actively being used at time of the mid-year review. Opportunity Register completed only as fully as benefitting the customer and to show active use of the Opportunity Register at the time of the mid-year review.	Documentation that meets the requirements of Section 4.5..1.4, through Section 4.5.1.7, as fully as can be met at this time, shall be provided.

4.5 SEM Reporting Period Performance Report Preparation Checklist

A SEM Reporting Period Performance Report shall be developed for each Reporting Period.

The information in the SEM Reporting Period Performance Report should be unique to the site and reflect the participation of the site in the SEM program.

4.5.1 SEM Reporting Period Performance Report Requirements

The SEM Reporting Period Performance Report shall contain the following information. The SEM Reporting Period Performance Report may be amended with additional information at the request of the PA or discretion of the implementer. The implementer can format the report as needed. The implementer shall add graphics and other supporting information when justifying changes to data or results.

4.5.1.1 Table of Current and Historic Energy Savings

A table of current and historic reported energy savings along with incentives paid and to be paid shall be placed at the beginning of the report. For this table, values for the current Reporting Period are being newly reported by the implementer and previous Reporting Period values should be updated to reflect values accepted by the PA and actually reported to the CPUC.

	SEM Program Year					
	1	2	3	4	5	6
Electricity (kWh)						
Reporting Period Electricity Savings (Avoided or Annualized)						
Reporting Period Electricity Savings Method (Top-down or Bottom-up) (if Top-down is the model new or continued from the Previous Reporting Period)						
Electricity Savings to be Claimed from the Prior Reporting Period						
Electricity Savings to be Claimed from the Current Reporting Period						
Electricity Savings to be Claimed in the next Reporting Period						
Electricity Incentive Awarded in the Current Reporting Period ($)						
Electricity Demand Savings (kW)						
Electricity Demand Savings to be Claimed from the Prior Reporting Period						
Electricity Demand Savings to be Claimed from the Current Reporting Period						
Electricity Demand Savings to be Claimed in the next Reporting Period						
Electricity Demand Incentive to be Awarded in the Current Reporting Period ($)						
Natural Gas (Therms)						
Reporting Period Natural Gas Savings (Avoided or Annualized)						
Reporting Period Natural Gas Savings Method (Top-down or Bottom-up) (if Top-down is the model new or continued from the Previous Reporting Period)						
Natural Gas Savings to be Claimed from the Prior Reporting Period						
Natural Gas Savings to be Claimed from the Current Reporting Period						
Natural Gas Savings to be Claimed in the next Reporting Period						
Natural Gas Incentive to be Awarded in the Current Reporting Period ($)						
Finalization						
Milestone Incentives Awarded in the Current Reporting Period ($)						
Total Incentives to be Awarded in the Current Reporting Period ($)						

4.5.1.2 SEM Time Periods (2.1)

1. Documentation of current SEM Program Cycle participation. (2.1.1.5)
2. SEM Program Cycle start and end dates. (2.1.1.1)
3. Time periods for the current SEM Program Cycle. Starting and ending dates for all Reporting Periods and Baseline Periods of the current SEM Program Cycle for each energy consumption adjustment model developed. (2.1.1.2 and 2.1.1.3) included in the energy consumption adjustment model table of Section 4.5.1.10.

4.5.1.3 Site Characterization (2.2)

1. Customer and site definition
   a. A brief description of the customer, their business and their operations. (2.2.1.1)
   b. A brief description of the site (2.2.1.2)
2. M&V Boundaries (2.5)
   a. A description of M&V boundaries.
   b. Aerial images or line drawings of the site with M&V boundaries provided.

3. Energy types
    a. A table of all energy types that are delivered to and away from the M&V boundaries with associated energy using equipment, processes, and systems. If the type of energy is included in the M&V process. If the type of energy is delivered away from the facility boundaries, stored on-site, is a feedstock, and is generated/extracted on-site. (2.2.2)
    b. A statement affirming that the customer is supplied with non-utility (non-IOU) fuels or not. (2.2.2)
        I. If applicable, a description of the non-utility energy present at the site.
    c. A statement affirming if the customer does or does not have on-site generation. (2.2.1.1)
        I. If applicable, a description of the on-site generation equipment and use.
        II. If applicable, a description of how the M&V boundaries were modified to account for on-site generation.
    d. A statement and analysis supporting decision to omit any energy types from the M&V process. (2.2.1.2)
4. Energy meters
    a. A table of all utility and other energy meters and submeters for all types of energy with unique identifiers, associated units and metering interval, and all major processes monitored. (2.2.4)
    b. A list of equations and conversion factors used to measure energy consumption. (2.2.4)
5. Energy flows
    a. An energy flow drawing. (2.2.5)
6. Energy Map
    a. As a separate document referred to in the SEM Reporting Period Performance Report or as part of the SEM Reporting Period Performance Report: The Energy Map. (2.2.6)
7. Statement of current energy performance improvement targets or energy savings goals.

4.5.1.4 Relevant Variables (2.3)

1. A table of potential relevant variables including associated data sources, energy types expected to be affected by the variables, and rationale for inclusion in the Energy Data Collection Plan. (2.3.1 – 2.3.2)
2. Notation on the list of potential relevant variables or a separate list of relevant variables selected for data will be collected.

4.5.1.5 Energy Data Collection (2.4)

1. As a separate document referred to in the SEM Reporting Period Performance Report or as part of the SEM Reporting Period Performance Report: The Energy Data Collection Plan. (2.4.1)
    » Energy meters
    » Relevant variable sources
    » For each data source: how to be collected, frequency of data collection, data storage method and location, person(s) responsible for collecting and storing data, person(s)
    » A statement confirming that non-utility energy meters are calibrated is appropriate.

2. A statement describing the review and any updates to the Energy Data Collection Plan (2.4.1.2)
3. Energy Data and Performance Tracking Tool (2.4.2)
   » If savings are being claimed, as a separate document referred to in the SEM Reporting Period Performance Report or as part of the SEM Reporting Period Performance Report: The Energy Data and Performance Tracking Tool.

4. Opportunity Register (2.4.3)
   » As a separate document referred to in the SEM Reporting Period Performance Report or as part of the SEM Reporting Period Performance Report: The Opportunity Register.

4.5.1.6 Collecting Data and Assessing Data Quality (2.6)

1. A statement if there were or were not issues related to implementing the Energy Data Collection Plan. (2.6.1)
2. A statement if there were or were not changes made to the data set. (2.6.2)
   a. If applicable, a statement of the reason and description of any changes to the data set.
3. A statement if there were or were not data removed as outliers or anomalous data. (2.6.2)
   a. If applicable, a description of the strategy used to remove outliers or anomalous data.
4. A statement if time-series adjustments were or were not made to the data. (2.6.3)
   a. If applicable, a description of the analysis for the decision to use a time-series adjustment.

4.5.1.7 Energy Consumption Adjustment Modeling (3)

For each type of energy included in the M&V process

1. A statement of energy savings method (top-down or bottom-up to be used. (3.1)
   a. If applicable, as a separate document referred to in the SEM Reporting Period Performance Report or as part of the SEM Reporting Period Performance Report a Notification of Bottom-up Method of Determining Energy Savings. (3.1)

For each developed energy consumption adjustment model used to determine M&V Boundary Energy Savings:

1. A statement if the energy consumption adjustment model used was developed and used as part of a previous Reporting Period. (3.1)
   a. If applicable, list all prior Reporting Periods that the energy consumption adjustment model was used for.
2. Image of scatter diagrams of energy consumption and each relevant variable used in the model or clear instructions where to find such diagrams in the Energy Data and Performance Tracking Tool or Energy Consumption Adjustment Model Development Tool. (3.4)
3. A statement if the energy baseline was or was not modified in any way. (3.5)
   a. If applicable, a description of the rationale and how the energy baseline was modified.

4. As a separate document referred to in the SEM Reporting Period Performance Report or as part of the SEM Reporting Period Performance Report: The Table of Competing Models. (3.7.4)
5. Identification of which model was selected for use in calculating M&V Boundary Energy Savings. (3.8)
6. A statement of the rationale for selecting energy consumption adjustment models that will be used to determine M&V Boundary Energy Savings. (3.8)
7. A statement confirming if or if not ongoing confirmation of model validity was conducted and at what frequency (3.9)
    a. The statement should confirm that the listed questions in section 3.9 were included and addressed in the ongoing confirmation of model validity.
8. A statement if or if not individual intervals in the Reporting Period were flagged as having relevant variables data points outside allowed bounds of the energy baseline data set. (3.9)
    a. If applicable, a statement of how these intervals were addressed along with clear instructions where to find relevant data entries in the Energy Data and Performance Tracking Tool or Energy Consumption Adjustment Model Development Tool.
9. A statement of the methods used to identify the presence of non-routine events. (3.10.1.1)
10. A statement if non-routine events were or were not identified. (3.10.1.1)
    a. If applicable, a description of the non-routine events and methods and rationale for use of the method used for making non-routine adjustments.
11. If applicable, a statement of the rationale for why backcast normalization was used rather than a bottom-up approach of aggregating energy savings from individual EPIAs.

4.5.1.8 Monitoring Energy Performance (3.12)

1. For each type of energy included in the M&V process, a plot of actual and predicted energy consumption that spans the Baseline Period and all Reporting Periods (current and historic) for which the energy consumption adjustment model has been used. This plot may either be in the SEM Reporting Period Performance Report or part of the Energy Data and Performance Tacking Tool with clear instructions where to find the plot. (3.12.1)
2. A statement confirming if the customer and implementer together did or did not review the Opportunity Register to ensure that EPIAs were being implemented and energy savings were calculated and were within reason of what was expected. (3.12)
3. As a separate document referred to in the SEM Reporting Period Performance Report or as part of the SEM Reporting Period Performance Report, for each EPIA being included as part of a bottom-up calculation for energy savings for regulatory reporting:
    a. The method and analysis used to determine annualized and Avoided Energy Consumption Energy Savings for EPIAs
    b. The method and analysis used to determine if the EPIA was identified and planned outside of a SEM Program Cycle.
4. For each type of energy included in the M&V process for which energy consumption adjustment models were used to report energy savings, identify the EPIAs for which energy savings were removed from the model-based energy savings.

4.5.1.9 Calculating M&V Boundary Energy Savings with Energy Consumption Adjustment Models (3.13)

For each type of energy included in the M&V process:

1. A CUSUM plot with annotation and footnotes that spans the Baseline Period and all Reporting Periods (current and historic) for which the energy consumption adjustment model has been used. This plot may also be either be in the SEM Reporting Period Performance Report or part of the Energy Data and Performance Tacking Tool but must be replicated in this report. (3.12.1)
2. A statement indicating if energy savings will be reported on an Avoided Energy Consumption or annualized basis for the current Reporting Period.
3. If annualized energy savings are being reported:

    a. A statement of the rationale for annualization and that the PA has approved annualization.

    b. If applicable, a statement that the Reporting Period will be divided to accommodate seasonality and,

    c. A statement of the start and end date of the Annualization Period.

    d. If applicable, a statement with the rationale for an Annualization Period longer than 120 days.

    e. If applicable, a statement with the rationale for an Annualization Period that ends prior to the end of the Reporting Period.

    f. If applicable, a statement and analysis of how outliers were addressed in the Annualization Period.

4.5.1.10 Reported Energy Savings (4)

For each type of energy included in the M&V process:

1. For each type of energy, a table listing current Reporting Period Avoided Energy Consumption M&V Boundary Energy Savings, Non-SEM Program Energy Savings, SEM Program Energy Savings, SEM Incented Energy Savings, and SEM Non-incented Project Energy Savings. (4.1.2)
2. As part of the SEM Reporting Period Performance Report or in another document, non-utility supplied energy (non-IOU fuels) analysis,
3. If applicable, annualized energy savings value being reported.
4. For each energy type for which a bottom-up approach is being used, a table identifying the EPIAs for which energy savings are being claimed which can be used to connect to the Opportunity Register.

    a. For each EPIA, the pro-rated energy savings value to claim in the current Reporting Period from the previous Reporting Period (if applicable)

    b. For each EPIA, the pro-rated energy savings value to claim in the current Reporting Period from the current Reporting Period

    c. For each EPIA, the pro-rated energy saving value to claim in the next Reporting Period (this will be 0 if the PA has given permission to report savings using an annualized basis).

4.5.1.11 Calculating Demand Savings (4.2)

1. A statement confirming if electricity demand savings are being reported or not.

2. If applicable, a statement describing the method used to determine electricity demand savings.

3. If applicable, documentation or provision of the tool used to determine electricity demand savings.

4. If applicable, the calculated electricity demand savings.

4.5.1.12 Greenhouse Gas Savings (4.3)

1. A statement if the customer did or did not want to discuss GHG inventories, reporting, reduction calculations, or other related topics.

2. If applicable, a statement confirming if the customer does or does not have a GHG emissions reduction target and description of the GHG emission reduction target if they have one.

3. If applicable, a statement regarding any voluntary or required GHG related programs the customer is currently or may participate in.

4. If applicable, listing of calculated energy-related GHG emissions reductions with proper labeling.

4.5.1.13 EMA Results

For each Reporting Period a table of EMA score results should be filled out and built up during subsequent Reporting Periods.

	SEM Program Year					
	1	2	3	4	5	6
EMA Section 1: Context of the Organization						
EMA Section 2: Leadership						
EMA Section 3: Planning						
EMA Section 4: Support						
EMA Section 5: Operation						
EMA Section 6: Performance Evaluation						
EMA Section 7: Improvement						
EMA Overall Score						

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5.1 References

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5.2 Acknowledgements

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5.3 Annex A - Terminology

For the purposes of this M&V Guide, the following terms and definitions apply.

This terminology guide is focused on providing clarity to assist the establishment of the M&V process. Statistical tests are not defined as detailed understanding of the meaning of these test is not required of the customer and competent implementers should already be familiar with these terms. Additionally, these terms are well established in authoritative and easily obtained statistics reference manuals.

“ **Annualization Period:** defined period of time selected for the annualization of energy savings

→ Additional specification provided in Section 2.1.1.4

“ **Avoided Energy Use** / **Avoided Energy Consumption:** Avoided Energy Use is the amount of energy (or peak demand) that was not consumed or realized as a result of the energy efficiency project or program intervention. Avoided energy use is the difference between actual energy consumption in the “reporting period” and the consumption that is forecast for the same period using the “baseline energy consumption model,” and where the baseline energy consumption model use is adjusted to reflect reporting period conditions. The Avoided Energy Use approach is used as the basis of customer incentive calculations and embedded M&V reporting of savings.

〉 **Source:** CPUC NMEC Rulebook version 2.0

→ Additional specifications provided in Section 1.4

“ **Baseline Period:** Specific period of time before the implementation of an energy performance improvement action selected for comparison with the Reporting Period and the calculation of the energy performance and of energy performance improvement

〉 **Source**: ISO 50015:2014, 3.1

→ Additional specifications provided in Section 2.1.1.3

“ **Behavioral:** Behavioral activities provide energy savings from interventions that result in changes in actions by customers with respect to energy usage in a building. Behavioral activities consist of actions such as manually turning off lights and equipment, adjusting blinds, reducing water use and so on.

〉 **Source**: CPUC NMEC Rulebook version 2.0

“ **Boundary:** physical or organizational limits
Example: A process; a group of processes; a site; multiple sites under the control of an organization, or an entire organization

〉 **Source**: ISO 50001:2018, 3.1.3 - modified (removed Note 1)

“ **BRO:** The combination of behavioral, retrocommissioning, and operational activities

“ **Energy:** electricity, fuels, steam, heat, compressed air, and other like media
Note 1: for the purposes of this Guide, energy refers to the various types of energy, which can be purchased, stored, treated, used in equipment or in a process, or recovered.

〉 **Source**: ISO 50001:2018, 3.5.1 - modified (replaced “International Standard” with “this Guide”, and removed “including renewable” in Note 1)

“ **Energy baseline:** quantitative reference(s) providing a basis for comparison of energy performance
Note 1: An energy baseline is based on data from a specified period of time and/or conditions, as defined by the organization
Note 2: Energy baselines are used for determination of energy performance improvement, as a reference before and after, or with and without implementation of energy performance improvement actions.

〉 **Source**: ISO 50001:2018, 3.4.7

" **Energy consumption:** quantity of energy applied

〉 Source: ISO 50001:2018, 3.5.2

" **Energy efficiency:** ratio or other quantitative relationship between an output of performance, service, goods, commodities, or energy, and an input of energy

〉 Source: ISO 50001:2018, 3.5.3 – modified (removed examples and Note 1)

" **Energy export:** The quantity of energy delivered away from the M&V boundary such that the site is not be counted as a net negative consumer of energy

〉 Source: Modified from SEP 50001 M&V Protocol, 2019

" **Energy management system:** management system to establish an energy policy, objectives, energy targets, action plans and process(es) to achieve the objectives and energy targets

〉 Source: ISO 50001:2018, 3.2.2

" **Energy performance:** measurable result(s) related to energy efficiency, energy use, and energy consumption
Note 1: Energy performance can be measured against the organization's objectives, energy targets and other energy performance requirements.
Note2: Energy performance is one component of the performance of the energy management system

〉 Source: ISO 50001:2018, 3.4.3

" **Energy performance improvement:** improvement in measurable results of energy efficiency, or energy consumption related to energy use, compared to the energy baseline
Note 1: This M&V Guide uses energy savings as the indicator of energy performance improvement.

〉 Source 50001:2018, 3.4.6 – modified (added note)

" **Energy performance improvement action:** action or measure or group of action or measures implemented or planned within an organization intended to achieve energy performance improvement through technological, managerial or operational, behavioral, economical, or other changes
Note 1: Energy performance improvement actions includes both BRO and capital projects.

〉 Source: ISO 50015:2014, 3.3 – modified (added note)

" **Energy product:** Any excess energy delivered away from the M&V boundaries after a net zero level of energy consumption is reached

〉 Source: Modified from SEP 50001 M&V Protocol, 2019

Energy target: quantifiable objective of energy performance improvement

〉 **Source**: ISO 50001:2018, 3.4.15

Energy use: application of energy
Examples: ventilation; lighting; heating; cooling; transportation; data storage; production process
Note 1: Energy use is sometimes referred to as "energy end-use"

〉 **Source**: ISO 50001:2011, 3.5.4

Feedstock: raw or unprocessed material used as an input to a manufacturing process to be converted to a product
Example: crude oil used to produce petroleum products

Measurement and verification (M&V): process of planning, measuring, collecting data, analyzing, verifying, and reporting energy performance or energy performance improvement for defined M&V boundaries

〉 **Source**: ISO 50015:2014, 3.11

M&V boundary: organizational, physical, site, equipment, systems, process or activity limits within which energy performance or energy performance improvement is measured and verified

〉 **Source**: ISO 50015:2014, 3.12

→ See Section 2.5

Natural resources: Energy delivered to the M&V boundaries that is not supplied by an organization
Examples: sunlight, natural gas from an on-site well, geothermal

〉 **Source**: Modified from SEP 50001 M&V Protocol, 2019

Non-routine adjustment: adjustment made to the energy baseline or Reporting Period energy consumption to account for unusual changes in relevant variables or static factors, outside the changes accounted for by normalization
Note 1: non-routine adjustments may apply where the energy baseline or Reporting Period no longer reflects energy use or energy consumption patterns, or there have been major changes to the process, operational patterns, or energy using systems

〉 **Source**: ISO 50015:2014, 3.16 – modified (added, "or Reporting Period energy consumption")

Non-SEM Program Energy Savings: Energy savings calculated for EPIAs identified and planned outside of any SEM Program Cycle and implemented during the current Reporting Period, whether receiving other incentives or not.

→ Definition also provided in Section 4.1.2

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Normalization: modification of data to account for changes to enable comparison of energy performance under equivalent conditions

〉 Source: ISO 50001:2018, 3.4.10

Operational Activities: Control-based; they improve or adjust existing controls to optimize equipment performance. Operational activities include maintaining room temperature set points, revising equipment operating schedules consistent with current building occupancy schedule, and changing equipment set points in response to current weather conditions.

〉 **Source**: CPUC NMEC Rulebook version 2.0

Relevant variable: quantifiable factor that affects energy performance and routinely changes
Note 1: Significance criteria are determined by the organization
Note 2: Other commonly terms for relevant variables include independent variable and energy driver
Examples: Weather conditions, operating conditions (indoor temperature, light level), working hours, production output

〉 **Source**: ISO 50001:2018, 3.4.9 – modified (added Note 2)

Reporting Period: defined period of time selected for calculation and reporting of energy performance

〉 **Source**: ISO 50001:3.17, 3.17

→ Additional specifications provided in Section 2.1.1.2

Retrocommissioning: A systematic process of identifying and implementing operational and maintenance improvements to achieve the design intentions consistent with the current usage of a building. The process is designed to improve the performance of building subsystems as well as optimize the performance of the overall system. Retrocommissioning focuses on operations and maintenance improvements and diagnostic testing, although major repairs and equipment upgrades may be identified and recommended through the process. Minor repairs required to conduct diagnostic testing may also be implemented.

Behavioral, Operational, Maintenance and Repair measures may be identified and carried out during a retrocommissioning project. Behavioral, operational and maintenance activities may also be implemented separately as “operations and maintenance” projects in existing buildings.

〉 **Source**: CPUC NMEC Rulebook version 2.0

SEM Incented Energy Savings: SEM Program Energy Savings minus SEM Non-incented Project Energy Savings.

→ Additional specification provided in Section 4.1.2

SEM Non-incented Project Energy Savings: Energy savings for an EPIA (project) identified during any SEM Program Cycle and implemented during the current Reporting Period that is to receive an incentive from another PA program.

→ Additional specification provided in Section 4.1.2

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“ **SEM Program Cycle:** 24 month period that distinguishes each “cycle” detailed in the SEM Program Design Guide. There are three “cycles” in the SEM Program Design Guide.

→ Additional specifications provided in Section 2.1.1.1

“ **SEM Program Energy Savings:** Site-wide Projected Energy Savings minus Non-SEM Program Energy Savings

→ Additional specification provided in Section 4.1.2

“ **M&V Boundary Energy Savings:** Incremental energy savings for a given type of energy resulting from the aggregation of energy savings from each energy consumption adjustment model developed for the same energy type.

→ Additional specification provided in Section 4.1.2

“ **Static factor:** Identified factor that impacts energy performance and does not routinely change
Example 1 Examples of static factors may include site size, design of installed equipment, the number of weekly production shifts, the number or type of occupants, range of products
Example 2 An example of a change in a static factor could be a change in a manufacturing process raw material from aluminum to plastic may lead to a non-routine adjustment.

〉 **Source**: ISO 50015, 3.20

“ **Strategic Energy Management (SEM):** A holistic approach to managing energy consumption in order to continuously improve energy performance, by achieving persistent energy and cost savings over the long term. SEM focuses on business practice change from senior management through shop floor staff, affecting organizational culture to reduce energy waste and improve energy intensity. SEM emphasizes equipping and enabling plant management and staff to impact energy consumption through behavioral and operational change. While SEM does not emphasize a technical or project centric approach, SEM principles and objectives may support capital project implementation.

〉 **Source**: CEE SEM Minimum Element – modified (replaced energy use with consumption)

5.4 Annex B - Special Cases in Energy Accounting

The below scenarios are provided as examples and are not requirements of this M&V Guide. Current PA and CPUC policies should be reviewed and used throughout the M&V process.

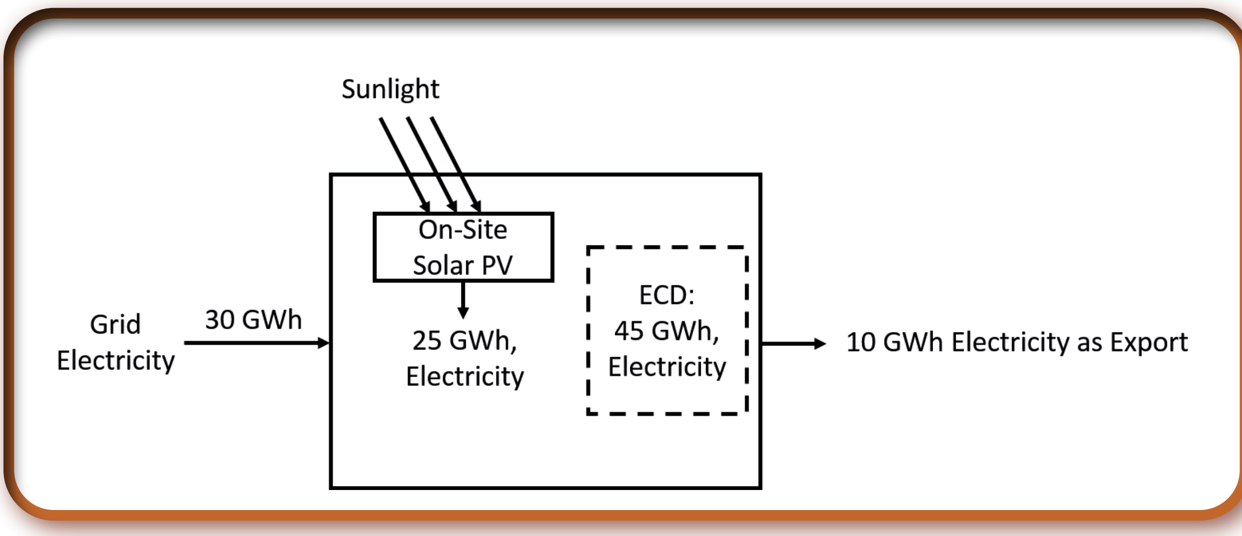
5.4.1 Energy Accounting of Energy Export and Energy Product

Energy delivered away from the M&V boundaries shall be accounted for as either an energy export or energy product.

Energy Export

The maximum allowable amount of energy export is equal to the quantity of energy delivered into the site boundary of the same energy type such that a net zero level is reached on a delivered energy basis. A site may not be counted as a net negative consumer of any energy type.

> **EXAMPLE:** A site purchases 30 GWh of grid electricity and produces 25 GWh of electricity with on-site photovoltaic (PV) panels. The site consumes 45 GWh and delivers 10 GWh away from the M&V boundaries. The 10 GWh delivered away from the M&V boundaries is treated as energy export. See figure below.

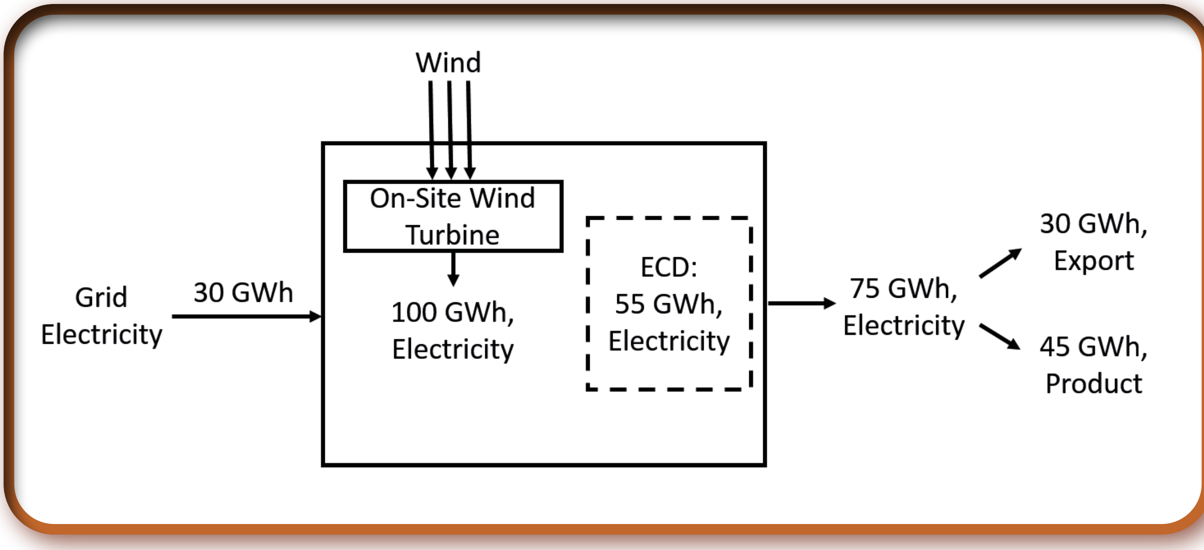


Delivered Energy → 30 GWh + 25 GWh - 10 GWh = 45 GWh

Energy Product

For each energy type, if a net zero level is reached on a delivered energy basis, any excess energy delivered away from the M&V boundaries is accounted for as an energy product. This may result from a site producing large quantities of on-site energy. Energy product shall be considered as a relevant variable for adjustment models.

> **EXAMPLE:** A site purchases 30 GWh of grid electricity and generates 100 GWh of electricity with on-site wind turbines. The site consumes 55 GWh and delivers 75 GWh away from the M&V boundaries. A maximum quantity of 30 GWh is treated as energy export. The remaining 45 GWh is treated as energy product. See figure below.



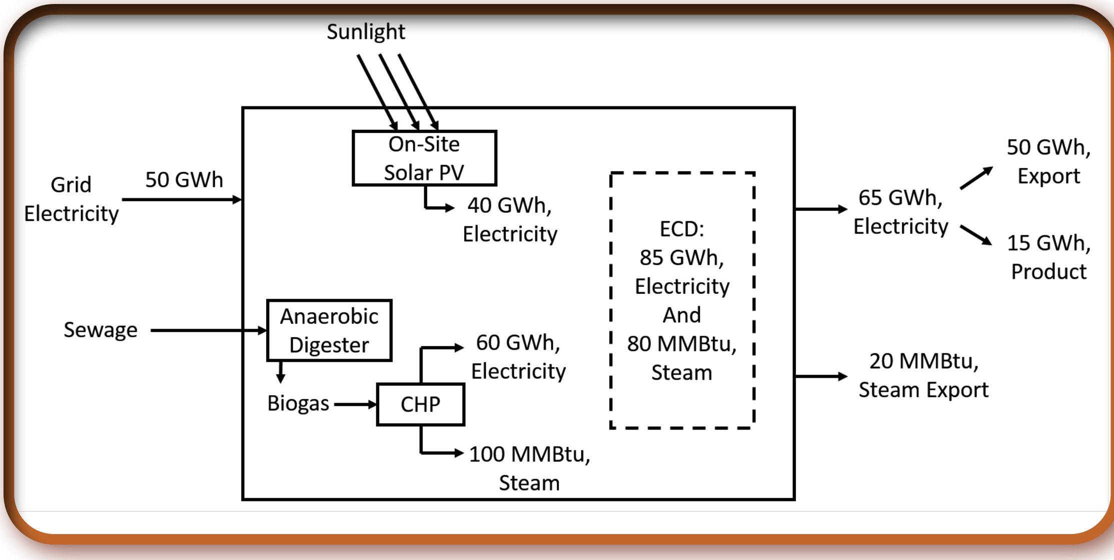
Delivered Energy ➤ 30 GWh + 100 GWh - 30 GWh - 45 GWh = 55 GWh

5.4.2 On-site Extraction or Generation of Energy from Natural Resources

Energy from natural resources that are delivered into and consumed within or delivered away from the M&V boundaries shall be included in the energy accounting. The point at which on-site extracted or generated energy is metered and accounted for may be selected by the organization so long as it is at a reasonable point along the extraction or generation process flow (e.g., a site may choose to meter biogas flow and energy content or the resulting electricity and hot water generated from the utilization of the same biogas). This measurement point shall be consistent between the baseline and Reporting Periods. This allowance is made recognizing that the quantity of energy of some natural resources (e.g., photons or wind) or the energy derived thereof (e.g., biogas) may be difficult to meter. In such cases, the quantity of energy generated within the M&V boundaries from the natural resource (e.g., AC electricity from the inverter of a PV panel system) may be metered and included in the energy accounting.

NOTE: While metering energy at a point along the extraction or generation process flow downstream of the M&V boundaries may be simpler and more cost effective (e.g. metering hot water produced from a biogas fired boiler, rather than the biogas produced from a sewage fed digester), the effect of energy performance improvement actions implemented upstream of the point of metering may not be reflected in the calculated site-wide energy performance improvement.

EXAMPLE: A wastewater treatment site uses sewage to generate biogas, which is used to generate electricity and steam in a CHP system. The site also purchases grid electricity, and generates on-site electricity with an array of PV panels. As the site cannot cost-effectively install meters to measure biogas flow and energy content, the site decides to meter the electricity and steam coming out of the CHP system for energy accounting purposes. In one month, the biogas CHP system produces 60 GWh of electricity and 100 MMBTU of steam. The site purchases 50 GWh of grid electricity and generates 40 GWh of on-site electricity with the PV panels. The site consumes 85 GWh of electricity and delivers 65 GWh of electricity away from the M&V boundaries. The site consumes 80 MMBTU of steam and delivers 20 MMBTU away from the M&V boundaries. See figure below.



Electricity : Delivered Energy → 50 GWh + 60 GWh + 40 GWh - 50 GWh - 15 GWh = 85 GWh

Steam : Delivered Energy → 100 MMBtu - 20 *MMBtu* = 80 MMBtu

5.4.3 Feedstock and Resulting Energy Types

In some instances, energy delivered to the M&V boundaries may be used as a feedstock rather than consumed as energy. The portion of an energy type used as a feedstock shall be subtracted from the delivered energy. The commodity that is being produced from the feedstock shall be considered as a relevant variable in the energy consumption adjustment model.

Any energy types resulting from the processing of feedstock (e.g., process gas produced during the refining process, heat generated by an exothermic reaction, biogas generated from sewage) that are consumed within or delivered away from the M&V boundaries shall be included in the energy accounting.

> **EXAMPLE:** A site purchases 1000 Therms of natural gas and uses 750 Therms to produce hydrogen, which is sold as a commodity, while consuming the other 250 Therms within the site boundary in a boiler. The energy accounting shall include 250 Therms. The production quantity of hydrogen shall be considered as a relevant variable in the energy consumption adjustment model.

5.5 Annex C – Bottom Up EPIA Calculation Effort and Documentation

Every bottom-up calculation being used to report claimable energy savings should include a description of the project that at the very least describes:

- The implemented measure
- The baseline equipment/operation (equipment #, size, operating hours etc.

The post-installation equipment/operation and specifically how it has changed between the baseline and post implementation phases.

In 2022 a joint PA working group submitted a table detailing the level of effort that should be used when calculating energy savings resulting from individual EPIAs. This table was reviewed by a larger stakeholder group of PA staff and contractors and CPUC staff and contracted evaluators. The documentation column was added as part of M&V Guide version 4.0. The table is provided as reference below.

Note: the table below is only relevant for EPIAs and their associated energy savings that will be reported for the purpose of claiming energy savings using the bottom-up approach. This table may provide useful guidance to characterize and document the energy savings from EPIAs for which energy savings are not being claimed via a bottom-up approach.

	EPIA Savings	Baseline/Implementation Verification Techniques	Examples (not exhaustive or exclusive)	Example Supporting Documentation
Notes: Implementers will follow these guidelines to the best of their ability. In cases where supporting information is not available or is not reasonably obtainable, the implementer will provide an explanation and substitute whatever information is available. All savings calculations will be provided in an unlocked excel spreadsheet or PA approved tool.				
A	**Electric:** Less than **50,000** kWh **Gas:** Less than **25,000** Therms	**Process:** Collect information for calculations by phone or email from operators, contractors, and/or suppliers. Pre or post inspection not required. **Calculation Approach:** Simple calculation methods using engineering judgement.	· HVAC adjustments; · Compressed air leak repair; · Automation controls; · Reduce lighting levels; · Steam trap repair and replacement	■ Confirmation of project implementation (email or other confirmation) ■ Project narrative including: » Details of the implemented measure » A clear description of the location of upgrade » The baseline equipment/operation (equipment #, size, operating hours etc. » The post-installation equipment/operation ■ Confirmation of annual hours of runtime through conversations with site personnel ■ Justification of assumptions used. ■ Must provide at least 1 additional supporting documentation item. Examples of supporting documentation listed below. Other applicable documentation types are acceptable. » Photos of equipment, » Nameplates/specifications » Setpoints, gauge readings, » Screenshots from control systems (such as SCADA or EMIS). » Spot measurements, » Other data from end user or vendors,
B	**Electric:** **50,000** kWh to **150,000** kWh **Gas:** **25,000** Therms to **50,000** Therms	**Process:** Collect information for calculations by phone or email from operators, contractors, and/or suppliers. If helpful, consider a site visit but it is not required. **Calculation Approach:** Calculations will use collected site information and engineering judgement.	· Adjust air compressor setpoints; · Dryer controls; · Lighting controls; · Lighting upgrade to LED; · Compressed air leak repair; · VFDs; HVAC chedules and setbacks; · Shut off equipment when not in use	■ Confirmation of project implementation (email or other confirmation) ■ Project narrative including: » Details of the implemented measure » A clear description of the location of upgrade » The baseline equipment/operation (equipment #, size, operating hours etc. » The post-installation equipment/operation and specifically how it has changed between the baseline and post implementation phases. ■ Confirm annual hours of runtime through conversations with site personnel, control systems, logs, or trends, and list the source if applicable. ■ Justification of assumptions used. ■ Confirm quantities, schedule, setpoints, loading, performance improvement, performance issues as applicable. ■ Must provide at least 2 additional supporting documentation items. Examples of supporting documentation listed below. Other applicable documentation types are acceptable. » Photos of equipment, » Nameplates/specifications » Setpoints, gauge readings, » Screenshots from control systems (such as SCADA or EMIS). » Spot measurements, » Short or long term data trends » Other data from end user or vendors » including quotes or other project details.

5. Annex

	EPIA Savings	Baseline/Implementation Verification Techniques	Examples (not exhaustive or exclusive)	Example Supporting Documentation
C	**Electric:** 150,000 kWh to 500,000 kWh **Gas:** 50,000 Therms to 200,000 Therms	**Process:** If information for calculations may be adequately collected by phone and email from operators, contractors, and/or suppliers, Datalogging is encouraged though not required Optional, visit site to collect the information. A pre-inspection visit is not required. **Supporting Information:** as appropriate, to supplement information from operators, contractors, and suppliers... **Calculation Approach:** Calculations will use collected site information, data logging or site provided data (if available), and engineering judgement. Calculations may involve bin analyses or seasonal adjustments and may use PA-approved tools if applicable. Normalization to production or weather is recommended, if applicable.	· VFDs; · Lighting upgrades; · Replace pneumatic pump with electric; HVAC schedules and setbacks; · Compressed air valve replacement; · Compressor controls; · Economizer optimization; · Lighting upgrade to LED; · Chiller temperature adjustments	■ Project narrative including: » Details of the implemented measure » A clear description of the location of upgrade » The baseline equipment/operation (equipment #, size, operating hours etc. » The post-installation equipment/operation and specifically how it has changed between the baseline and post implementation phases. » Confirm annual hours of runtime through conversations with site personnel, control systems, logs, or trends, and list the source if applicable. ■ Justification of assumptions used. ■ Confirm quantities, schedule, setpoints, loading, performance improvement, performance issues as applicable. ■ Must provide at least 3 additional supporting documentation items. Examples of supporting documentation listed below. Other applicable documentation types are acceptable. » Photos of equipment, » Nameplates/specifications » Setpoints, gauge readings, » Screenshots from control systems (such as SCADA or EMIS). » Spot measurements, » Short or long term data trends » Other data from end user or vendors including quotes or other project details.
D	**Electric:** Greater than 500,000 kWh **Gas:** Greater than 200,000 Therms	**Process:** While the SEM M&V Guide does not require a specific M&V Plan for bottom-up EPIAs, it is best practice to describe an M&V strategy for EPIAs with this level of savings. Required supporting information and data will be collected prior to installation of the EPIA to validate assumptions in the savings analysis. Often, site personnel can provide post-installation data and information, therefore, a post-installation site visit may not be necessary if the information can be collected remotely. If a pre-installation visit cannot be completed or is not relevant, the implementer will justify the reason a site visit was not completed. Datalogging/interval monitoring/historical trend data is typical. Duration is a professional judgment and depends on the patterns of variability in the measured quantities. Sufficient	**Large projects:** Capital claimed through SEM program or BRO	■ Confirmation of project implementation (email or other confirmation) ■ Project narrative including: » A thorough description of the project implemented and how the savings were achieved. Details of the implemented measure » A clear description of the location of upgrade » The baseline equipment/operation (equipment #, size, operating hours etc. » The expected post-installation equipment/operation and specifically how it has changed between the baseline and post implementation phases. » Confirm annual hours of runtime through conversations with site personnel, control systems, logs, or trends, and provide supporting documentation. ■ Justification of assumptions used. ■ Confirm quantities, schedule, setpoints, loading, performance improvement, performance issues as applicable. ■ Must provide at least 4 additional supporting documentation items. » Nameplates/specifications » Setpoints, gauge readings, » Screenshots from control systems (such as SCADA or EMIS). » Spot measurements, » Short -or long- term data trends » Other data from end user or vendors including quotes or other project details.

		duration is needed to capture the operating modes needed to extrapolate monitored results to an annual basis. **Calculation Approach:** Calculations will use collected site information, data logging or site provided data, and engineering judgement. Calculations will account for production variation, any seasonal weather variation, and Non-Routine Events, if applicable. Calculations may involve bin analyses, modeling tools, or may use PA-approved tools if applicable. Cascading effects between EPIAs will be taken into account, if applicable.		

5.6 Annex D – Multicollinearity and Autocorrelation

5.6.1 Multicollinearity

Multicollinearity is present when two or more relevant variables in a regression model are correlated between themselves. When two relevant variables are correlated, including both variables, instead of just one, may not add appreciably to the model's explanatory power.

Keep the following points in mind when validating an adjustment model:

- The presence of correlated variables should serve as a warning that the statistical significance of a variable in a particular regression model does not, by itself, indicate how closely that variable is correlated with energy consumption. The modeler should use caution in excluding any variables that may actually be relevant variables, but are masked by correlated variables.
- Multicollinearity has limited influence on the predictive capability of the final model if operating conditions stay relatively consistent. However, if the relationship between the correlated relevant variables changes during the Reporting Period, the model will lose predictive power.
- Multicollinearity can be identified by using XY scatterplots to view the relationship between two relevant variables. Additionally, the coefficients in a model will swing drastically if a variable with multicollinearity is added or removed.
- Perform a general assessment of multicollinearity by regressing each variable against the other hypothesis variables and examine the R2 of each relationship. As a rule of thumb, any bivariate correlation with R2 > 0.7 is an indication that multicollinearity needs to be carefully considered in the variable selection process.
- Multicollinearity can also be identified by calculating the variance inflation factor (VIF), which describes the increase in standard error compared to the standard error if the variable were uncorrelated with the other predictor variables.
- The simplest solution to addressing multicollinearity is to drop one of the variables from the regression analysis. However, this approach may negatively affect the model's predictive capability. The modeler should use his/her best engineering judgment along with an understanding of how the customer's site uses energy to include or exclude variables, while considering factors such as data availability and model complexity.

  EXAMPLE: At a soft drink bottling site, energy consumption and production increase in the summer, due to higher seasonal sales. Both energy and production show a strong correlation with ambient, dry bulb temperature. The modeler includes the production variable in the adjustment model, but is unsure whether to include the ambient temperature variable. In this example, plot the production variable against the temperature variable to determine the correlation. If the R2 is greater than 0.7, consider removing the temperature variable from the model. Justify the decision using engineering knowledge about the temperature dependency of equipment and loads at the site.

5.6.2 Autocorrelation

Autocorrelation is present when the error term in a time period is related to the error term in a prior time period. In other words, autocorrelation is characterized by a correlation in the residuals.

Calculate the autocorrelation coefficient and plot model residuals over the Baseline Period. If autocorrelation is detected, the number of independent baseline points is effectively reduced. The typical remedy involves increasing the sample size, or selecting a different data interval. For annual models with daily baseline intervals, moderate autocorrelation may not be a concern.

According to ASHRAE Guideline 14:2014, for monthly data an assumption that autocorrelation is 0 so n' is equal to n.

Typically, regression-based energy models exhibit positive autocorrelation. Positive auto-correlation occurs when the sign change of the residuals is infrequent. Conversely, too frequent sign changes in the residual pattern results in negative autocorrelation.

There is no defined threshold for the autocorrelation coefficient in the model development phase. Autocorrelation becomes a factor in the fractional savings uncertainty analysis when it has the mathematical effect of reducing performance period energy data samples.

The Durbin-Watson test can also be used to determine if autocorrelation is statistically significant. For uncorrelated errors, the Durbin-Watson number, d, should be approximately 2. The upper and lower bounds for the Durbin-Watson statistic are a function of sample size, the number of predictor variables and desired confidence level.

5.7 Annex E – Graphical Representation of the Table of Competing Models

A graphical representation of the table of competing models is provided below. Refer to Section 3.7.4 for details.

Model reference number	Data interval	Baseline Period start and end dates	Upcoming Reporting Period start and end dates	R^2	Net deter-mination bias	Coefficient of variation	Durbin Watson	Projected FSU	Comments	Name of Relevant Variable	Relevant variable Coefficient Value	T-stat	P-value
Model 1													
Model 2													
Model 3													

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Daily Model
68% confidence, 365 baseline intervals, 90 reporting intervals

F(%savings)					
CV	2.5%	5.0%	10.0%	15.0%	20.0%
0.03	23%	12%	6%	4%	3%
0.05	46%	23%	12%	8%	6%
0.10	92%	46%	23%	15%	12%
0.15	139%	69%	35%	23%	17%
0.20	185%	92%	46%	31%	23%
0.30	277%	139%	69%	46%	35%

68%	confidence
1.00	T-stat
365	baseline intervals
90	reporting intervals
0.5	autocorrelation coefficient
121.67	n-prime

Weekly Model
68% confidence, 52 baseline intervals, 13 reporting intervals

F(%savings)					
CV	2.5%	5.0%	10.0%	15.0%	20.0%
0.03	47%	23%	12%	8%	6%
0.05	93%	47%	23%	16%	12%
0.10	187%	93%	47%	31%	23%
0.15	280%	140%	70%	47%	35%
0.20	374%	187%	93%	62%	47%
0.30	561%	280%	140%	93%	70%

68%	confidence
1.00	T-stat
52	baseline intervals
13	reporting intervals
0.25	autocorrelation coefficient
31.20	n-prime

Monthly Model
68% confidence, 12 baseline intervals, 3 reporting intervals

F(%savings)					
CV	2.5%	5.0%	10.0%	15.0%	20.0%
0.03	82%	41%	20%	14%	10%
0.05	164%	82%	41%	27%	20%
0.10	327%	164%	82%	55%	41%
0.15	491%	246%	123%	82%	61%
0.20	655%	327%	164%	109%	82%
0.30	982%	491%	246%	164%	123%

68%	confidence
1.04	T-stat
12	baseline intervals
3	reporting intervals
0	autocorrelation coefficient
12.00	n-prime

Notes:

ASHRAE guidelines specify 50% uncertainty at 68% confidence.

100% uncertainty means that the savings are not negative.

Uncertainty higher than 100% means there is a chance that savings are negative.

Monthly models will generally not show autocorrelation.

Daily and weekly models will generally show autocorrelation. Usually the addition of production data lowers the autocorrelation.

5.9 Annex G – Cumulative and Incremental Savings Example

This annex provides a six-year example of how incremental energy savings would be calculated assuming an energy consumption adjustment model was valid for that full time period. Two scenarios of the same example are provided based upon an assumption of how backsliding would be reported.

5.9.1 Scenario 1: Backsliding reported as 0 energy savings:

SEM Program Year	Cumulative M&V Boundary Energy Savings	Incremental M&V Boundary Energy Savings
1	200,000	200,000
2	300,000	100,000
3	250,000	0
4	500,000	200,000
5	600,000	100,000
6	550,000	0

Table 6: Example of Cumulative and Incremental Energy Savings and not Reporting Negative Savings

Note that SEM Program Years 3 and 6 showed backsliding and a reduction of cumulative M&V Boundary Energy Savings. It is assumed the implementer could not show any reason why such backsliding should occur due to the SEM program (for example multiple EPIAs were installed in the Reporting Periods) and so a reported energy savings value of 0 was claimed. See Section 4.1.6 for more details.

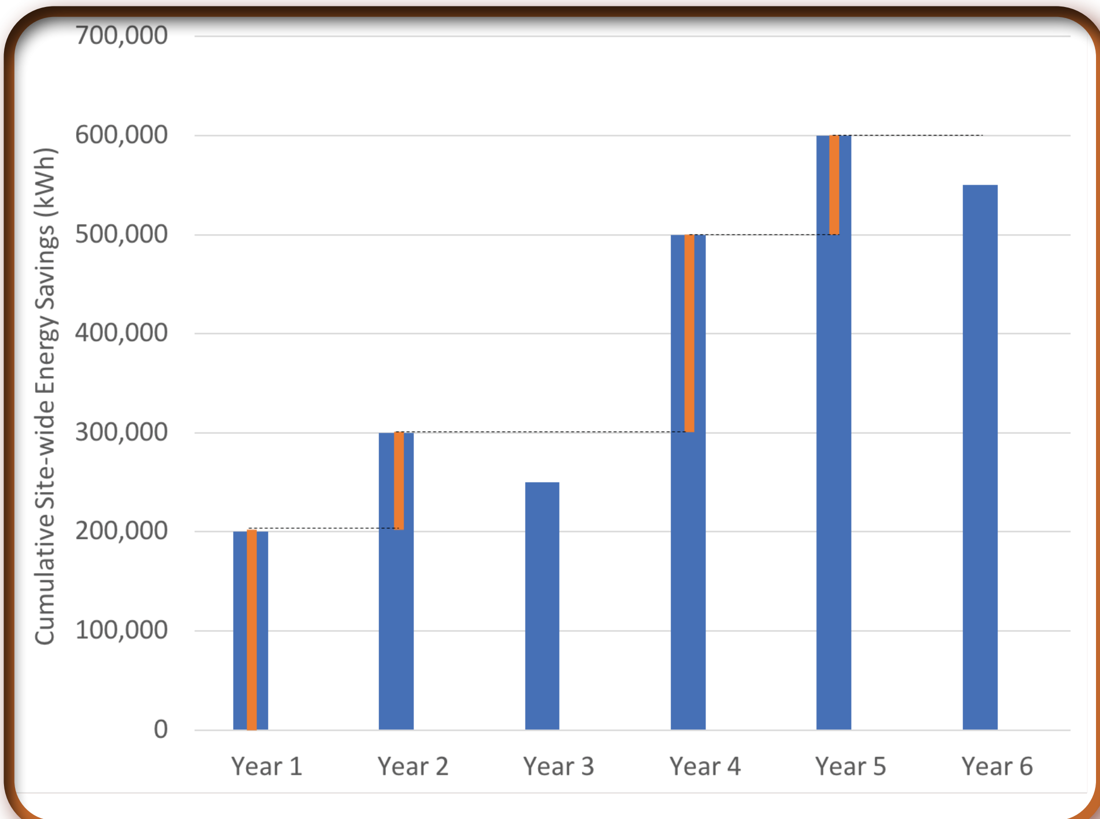

Figure 8: Example of Cumulative and Incremental Energy Savings and not Reporting Negative Savings.

In this chart blue bars are cumulative energy savings, orange bars are reportable incremental savings.

5.9.2 Scenario 2: Backsliding claimed as negative energy savings values.

If the implementer showed reason for the backsliding, or could not show evidence the SEM program was taking positive actions to reduce energy consumption such as the implementation of EPIAs, then the energy savings values of -50,000 kWh should be claimed in SEM Program Years 3 and 6. An updated table of savings and figure assuming this approach is taken is shown below

SEM Program Year	Cumulative M&V Boundary Energy Savings	Incremental M&V Boundary Energy Savings
1	200,000	200,000
2	300,000	100,000
3	250,000	-50,000
4	500,000	250,000
5	600,000	100,000
6	550,000	-50,000

Table 7: Example of Cumulative and Incremental Energy Savings and Reporting Negative Savings

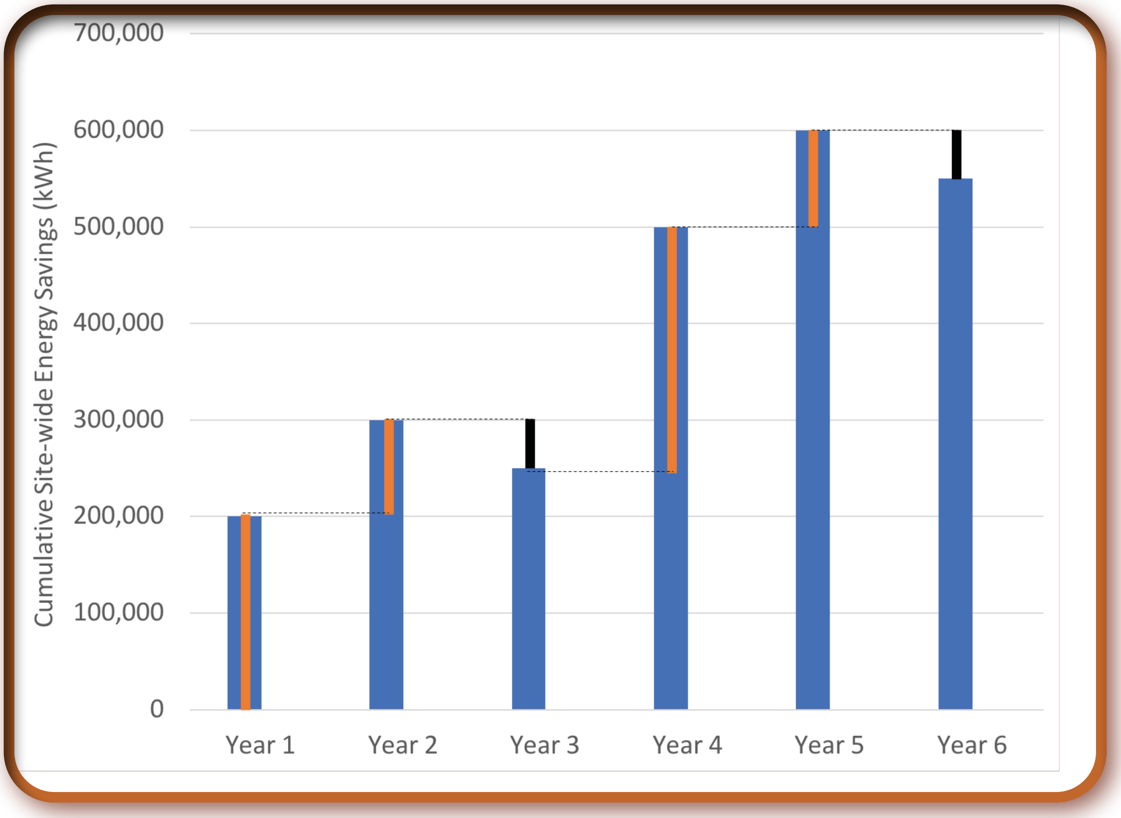

Figure 9: Example of Cumulative and Incremental Energy Savings and Reporting Negative Savings.

In this chart blue bars are cumulative energy savings, orange bars are reportable incremental savings, and black bars are reported negative savings.

5.10 Annex H – Total System Benefits

This Annex provides information pertaining to the concept of Total System Benefits (TSB).

TSB has the potential to help calculate benefit attributions to integrated energy savings (IDSM) projects that include various energy efficiency and non-energy efficiency technologies at a customer's site. Because SEM is a whole site energy savings program strategy, having a way to calculate the benefits of an IDSM approach is helpful as identified in the Assigned Commissioners Ruling issued in October of 2008.[12] For this reason a draft SEM Demand Savings Calculator, utilizing the TSB concepts summarized above, was developed to serve as an illustrative tool to begin to understand how various demand side technologies interact for program planning purposes. While utilizing this tool is not a requirement of the SEM program, further refinement of it (ex; updating load profiles used as an input), will continue to help further inform consideration of IDSM as a part of the overall SEM program design (see Section 4.2).

This Annex provides quotes taken from the CPUC document, "Total System Benefit Technical Guidance," Version 1.2, released October 25, 2021. CPUC authors state that this document is, "CPUC staff-level guidance introduces and describes the calculation steps for the Total System Benefit (TSB) metric implemented by D.21-05-031." All statements in quotation marks in this section are direct quotes from the CPUC technical guidance document.

The provided statements are intended to be informative about changes the CPUC is making on how it will be valuing ratepayer funded energy efficiency programs. The statements focus on information that may help in making changes in program and M&V approaches in the future.

PA staff should be consulted for full and up to date details about TSB.

The TSB metric creates, "a single goal expressed in dollars, which represents the value of the energy efficiency resources to the grid." In short, the TSB metric will encourage PAs to, "optimize portfolios to save energy during high value hours."

"The TSB metric was adopted in D.21-05-031 as the official metric for energy efficiency portfolio planning staring in 2024, but PAs should informally file and report on the metric in program years 2022 and 2023." "Starting in 2024, the TSB metric will replace kWh, kW, and Term as the primary goal for the energy efficiency portfolios administered by the California investor-owned utilities and other program administrators."

TSB will, "encourage program administrators to pursue energy savings that deliver high value in some or all of the avoided cost categories:

- Energy,
- Generation capacity,
- Ancillary services,
- Transmission and distribution capacity,
- High global warming potential (GWP) gases, and
- GHGs."

[12] This ruling identified the following priorities for implementation of IDSM activities: 1) comprehensive and coordinated marketing, packaging and delivery including outreach and education of customers and presentation of program options in a unified fashion to customers, 2) operational improvements including offering integrated audits and recommendations, combining EE, DR, DG, and other applicable incentives in the same project, and 3) optimization including equipment that enables multiple DSM options (EE, DR, etc.) and provide synergy across DSM program types (p.7).

"The GHG costs include both carbon (expressed through the GHG adder) and high global-warming potential gasses, such as methane and refrigerants."

As TSB looks to quantify the value of energy efficiency to the grid, the time at which energy savings are realized is important. Because the SEM M&V process tracks actual energy consumption with as much fidelity as possible, data from the SEM program could be of value in developing actual TSB time of energy savings value as compared to industry average load shapes that may not reflect a customer's actual operations.

5.11 Annex I – Revision History

The below table documents changes made to this M&V Guide.

Version and Date	Section	Change
0,	Document	Version 4.0 Released

Table 8: Revision History.

Sergio Dias Consulting is a professional consulting firm that provides strategic expertise to sustainability, decarbonization, and industrial energy efficiency programs, government organizations, energy utilities, policy makers, and companies. With over 30 years of sustainability, business, industry and energy efficiency experience and an extensive network, our company:

- Develops and designs sustainability, decarbonization, and energy efficiency programs, policies and strategic plans.
- Assesses the effectiveness of existing programs, policies and plans.
- Designs "Market Transformation" programs.
- Evaluates the impact of sustainability, decarbonization, and energy efficiency programs.
- Provides support for the launch of new programs.

Sergio Dias Consulting is at the forefront of the sustainability, decarbonization and energy efficiency fields and has led projects with international manufacturers, energy utilities, regional industry associations, state and federal government agencies, and non-profit organizations . Our leading-edge work on Decarbonization, Market Transformation and Strategic Energy Management strategies is recognized internationally.