Seattle City Light

ENERGY EFFICIENCY AS A SERVICE M&V PLAN

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1. Abbreviations and Acronyms

EV	Electric Vehicle
EE Developer	Energy Efficiency Developer
EEaS	Energy Efficiency as a Service
ECMs	Energy Conservation Measures
M&V	Measurement and Verification
NREs	Non-Routine Events
NRAs	Non-Routine Adjustments
SEC	Seattle Energy Code
SDCI	Seattle Department of Construction and Inspections
EUI	Energy Use Intensity (energy use/floor area/year)
PA	Participant Agreement
PPA	Power Purchase Agreement

2. Introduction

This M&V Plan describes the procedures and methods to be used by the independent, third-party Measurement and Verification (M&V) Consultant, hired by Seattle City Light (City Light), to determine energy savings in the Energy Efficiency as a Service (EEaS) Pilot Program. These energy savings are the basis for Efficiency Energy Service fees and Power Purchase Agreement (PPA) payments as described in the EEaS Program Manual.

This document provides the detailed M&V procedures that will be followed in the EEaS Program. It describes the how the measurement and verification (M&V) activities for individual projects will be executed for the EEaS Program. Although other program documents including the Program Manual provide some M&V information, this document takes precedence in the case of any differences with the other documents.

Energy savings resulting from improvements in building performance (also known as energy conservation measures or ECMs) will be quantified at a whole-building level, using data from utility meters. For existing buildings participating in this program, the M&V Consultant will rely on the building's meter data and independent variables (such as weather, indicators of occupancy load, building operation modes, and so on) to develop regression-based energy models and estimate performance period savings.

For new construction[1] buildings participating in this program, the M&V Consultant will rely on requirements and data used in the Seattle Energy Code's (SEC) Target Performance Path (SEC Section C401) to define the baseline and use metered energy and other site-level data to estimate energy savings in the performance period.

Energy savings will be calculated as Avoided Energy Use when calculating the performance-based savings and determining Efficiency Energy transactions in the EEaS Program.

- For existing buildings, Avoided Energy Use[2] is the reduction in energy use that occurred in the performance period, relative to what would have occurred if the facility had been equipped and operated as it was in the baseline period, but under performance period operating conditions.

[1] See glossary for definition.
[2] Avoided Energy Use is defined in the Glossary as well as in the International Performance Measurement and Verification Protocol (IPMVP), Core Concepts, available at www.evo-world.org.

- For new construction, the difference between the Seattle Energy Code target energy use (C401) and the Participant's actual energy use shall be considered the Avoided Energy Use.

For each project, energy savings will be determined for each monthly billing period with financial transactions (collection of Efficiency Energy Service fees from the Participant and payments to the Energy Efficiency Project Developer [EE Developer]) made after a threshold savings level has been achieved. Any significant changes to energy use that are unrelated to the performance of the energy conservation measures (ECMs) will be accounted for through an annual true-up procedure.

The savings calculation methodologies described in this M&V Plan follow the two well-known industry guidelines: The International Performance Measurement and Verification Protocol (IPVMP),[3] Option C *Whole Building*, and ASHRAE Guideline 14-2014[4] *Whole Building Performance Path*. The IPMVP provides common terminology and describes best practices for the savings verification methods while the ASHRAE Guideline 14 describes the method's more detailed technical requirements. This M&V Plan's use of terminology is consistent with these guidelines with some minor differences noted in the Glossary.

The M&V procedures for existing building and new construction projects are similar but are flexible to address each project's unique circumstances. This M&V Plan has been organized so that Participants and EE Developers need only familiarize themselves with the M&V procedures for their project type. Section 3 provides a step-by-step overview of the existing buildings and new construction M&V procedures. Sections 4 and 5 provide in-depth descriptions of the M&V requirements for existing buildings and new construction projects, respectively. Section 6 provides descriptions of requirements common to both project types. A glossary of terms is provided in an appendix to reduce ambiguity, and industry standard guidelines and protocols and other referenced works are listed in the References section.

[3] International Performance Measurement and Verification Protocol (IPMVP), Efficiency Valuation Organization, www.evo-world.org.
[4] American Society of Heating Refrigeration and Air-conditioning Engineers (ASHRAE) Guideline 14-2014 Measurement of Energy and Demand Savings. Available from www.ashrae.org

3. Procedures

This section summarizes for easy reference the M&V procedures for existing buildings and new construction projects. More detailed descriptions of the step-by-step procedures are provided in Sections 4 and 5. The procedures for existing buildings and new construction projects are similar although specific activities may be different to achieve similar milestones.

M&V activities for each project type begin after the project applications are accepted.

- In the Contract Period, existing building baseline data is collected, and baseline models are established. For new construction projects, output from the final construction permit energy simulation models are collected and baseline energy use values are established.

- In the Construction Period, ECMs are installed in the existing building projects and the efficient building is built for new construction projects. After existing building installation/new construction is complete, the ECMs may be verified by City Light. Data collection begins and monthly energy savings is determined.

- After the minimum thresholds for existing buildings and new construction projects have been met, the Performance Period begins. Monthly Efficiency Energy fees and payments are determined, and financial transactions begin. Annually, energy savings are trued-up in cases of significant non-routine events and non-electric fuel data is analyzed to assure no fuel switching has occurred.

To provide context for when the M&V procedures are carried out, they are shown within the four periods of participation in the EEaS Program[5] Application Period, Contract Period, Construction Period, and Performance Period. Although they follow the same M&V concepts and have similar analysis activities, there are differences between the existing building and new construction procedures which are described below.

[5] See EEaS Program Manual, Section 9 Participation Process for details

3.1. Existing Buildings Overview of M&V Procedures

Figure 1 illustrates the EEaS Program's M&V procedures for existing buildings projects. The procedures are described in a step-by-step process here and in more detail in Section 4.

Step 1. Review Application. In this step, City Light reviews the information available in the Participant's EEaS Program Application to determine whether the project meets the program requirements defined in the *EEaS Program Manual v2.0, Section 12 Project Selection Criteria*. A brief analysis of the building's energy use may be conducted to assure an accurate baseline model may be developed.

Step 2. Confirm Baseline Conditions. In this step, City Light establishes the baseline conditions of the building. This includes verifying the existing building's equipment and operations, the proposed ECMs and their estimated savings, plans for verifying ECM installation, and identification of static factors that may change over time. Site visits may be scheduled with the Participant to complete this step.

Step 3. Develop Baseline Models. Baseline energy and independent variable data are collected and prepared for analysis. Models for savings determination will be based on daily time intervals. The models shall be regression-based using publicly available, well-documented modeling algorithms.

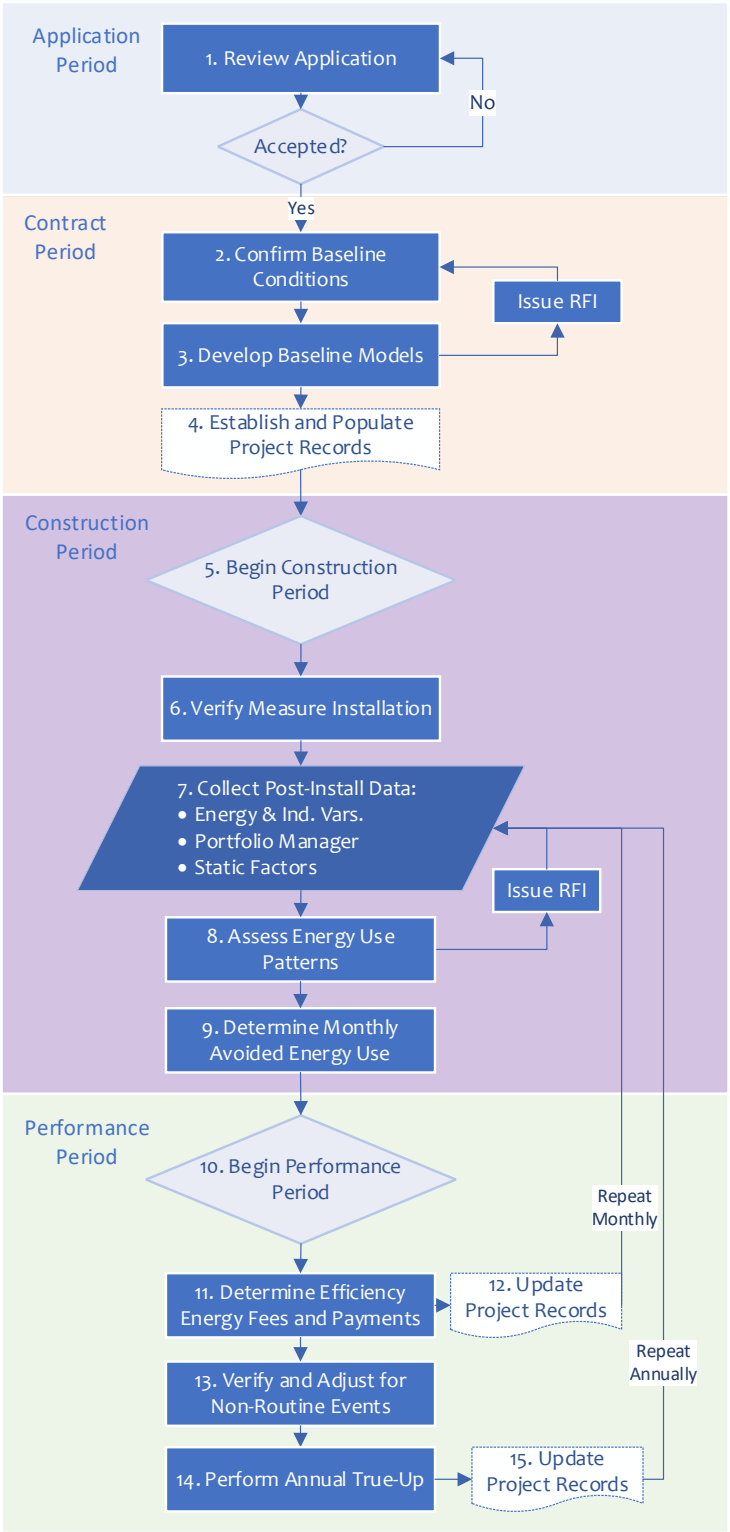

Figure 1. Existing Buildings M&V Procedures.

Acceptable baseline models are those models that meet each of the acceptance criteria documented in Section 4. Should a baseline model be found not to meet the criteria, City Light will work with the Participant and EE Developer to determine if a baseline model can be created that meets program criteria, by requesting additional information through a request for information (RFI).

Step 4. Populate Project Records. The M&V Consultant will maintain a secure on-line backed-up electronic folder structure available to City Light and record the key site data collected and analyzed throughout the project. Each project's baseline model documentation, data, and live calculation files shall be stored in its own folder.

Step 5 (Milestone). Begin Construction Period. The construction period begins after City Light, the Participant, and the EE Developer agree on the baseline model and savings procedures, and the Participant Agreement (PA) and Power Purchase Agreement (PPA) are executed with each party. Once the ECMs are installed, the EE Developer notifies City Light and tracking of monthly energy savings begins.

Step 6. Verify Measure Installation. At the discretion of City Light, individual ECMs will be verified. ECM verification may be performed by collecting and reviewing commissioning documentation, site inspections, collection and analysis of building control system trend data, and collection and review of contractor documentation. Documentation of verified measures will be added to the project's records.

Step 7. Collect Post-Installation Data. Each month energy data will be collected from City Light, weather data from the NOAA Boeing Field weather station, and other independent variable data as required from the Participant, such as from its ENERGY STAR Portfolio Manager® account, or directly from its building control or energy monitoring systems. Energy data in daily or 15-minute time intervals, as available, are collected for M&V analysis. Participant's monthly bills are collected for quality control checks and to determine the Efficiency Energy for the current billing period. Data sources related to quantifying changes in static factors are also identified and collected from the Participant and EE Developer.

Step 8. Assess Energy Use Patterns. The collected energy use data will be analyzed to identify any unusual energy use patterns. The M&V Consultant will maintain an NRE log

for the project that documents observed energy anomalies and records key findings from assessment efforts. Changes in energy use that are determined to be significant will be flagged for additional analysis and investigation as part of the verification and true-up process described in Step 13 and 14. City Light can issue an RFI to the Participant or the EE Developer and/or perform a site visit to collect more information if deemed warranted.

Step 9. Determine Monthly Avoided Energy Use. For each monthly billing period, data and information will be collected according to the Participant's established M&V procedures and used to determine the billing period's Adjusted Baseline Use. The billing period's Avoided Energy Use will be determined from the difference between the billing period Adjusted Baseline Use and the billing period Actual Energy Use.

Step 10 (Milestone). Begin Performance Period. The performance period and financial transactions begin when the monthly billing period Avoided Energy Use exceeds 10% of the monthly billing period Adjusted Baseline Energy Use for the first time during the contract.

Step 11. Determine Efficiency Energy Fees and Payments. For each monthly billing period during the Performance Period, the monthly billing period Avoided Energy Use (Efficiency Energy) is multiplied by the Project's Efficiency Energy Charge to determine the EE Service Fee charge (to Participant) and by the PPA Price to determine the PPA payment (to EE Developer) for the billing period. EE Service Fees and PPA payments are assessed in the billing period immediately following the billing period from which the Avoided Energy Use was determined. A monthly memo report describing Avoided Energy Use and EE Service Fees and PPA payments is provided to City Light for each participating project. City Light will provide each Participant and EE Developer with their monthly memo.

Step 12. Update Project Records. The M&V Consultant will update project data files, live calculations, and documentation in each project's folders on a monthly cadence or when other action related to a project is executed.

Step 13. Verify and Adjust for Non-Routine Events. Once per year, the data collected for each project and information regarding unusual energy use behavior, flagged in Step

8 or communicated by the Participant or EE Developer, is investigated to determine whether an annual true-up is recommended. Where City Light determines a non-routine adjustment is warranted, it may verify its cause and collect data by issuing an RFI and/or performing a site visit and direct the M&V Consultant to quantify and document the adjustment.

Step 14. Perform Annual True-Up. For authorized non-routine adjustments, the M&V Consultant shall determine the amount of the adjustment to be applied to the annual total Avoided Energy Use and determine the adjustments to be applied in the following month's billing period.

Step 15. Update Project Records. The EEaS project's electronic records will be updated to include the Annual Report and any adjusted baseline energy consumption, along with other relevant materials. An Annual Report describing the previous year's Avoided Energy Use and EE Service Fees and PPA payments, completed ECMs, flagged NREs, performed NRAs, and resulting true-ups (if any) is provided to City Light for each participating project. City Light will provide each Participant and EE Developer with their Annual Reports.

The Annual Reports and Monthly Avoided Energy Use Calculations will continue for the duration of the EEaS Performance Period for the project, or until the M&V Consultant is notified by City Light. Repeat Steps 7 through 15, as required.

3.2. New Construction Overview of M&V Procedures

A brief overview of each step is provided below while the procedures and more detailed requirements are described in Section 5. Figure 2 provides an outline of the steps as the project moves from the Application Period to the EEaS Construction Period, and then into the program's Performance Period.

Step 1. Review Application. In this step, City Light and the M&V Consultant review the information available in the Participant's EEaS Program Application to determine whether the project meets the key program eligibility requirements defined in the *EEaS Program Manual v2.0, Section 12 Project Selection Criteria*.

Step 2. Review Project Documentation. Once the program application is accepted by City Light, this step assembles the needed project documentation. This includes items required in the SEC code compliance process managed by Seattle Department of Construction and Inspections (SDCI), and other items needed from the Participant and/or EE Developer.

Step 3. Establish Baseline Energy Values. The annual baseline energy and monthly baseline values for the EEaS Program are established in this step using information collected in Steps 1

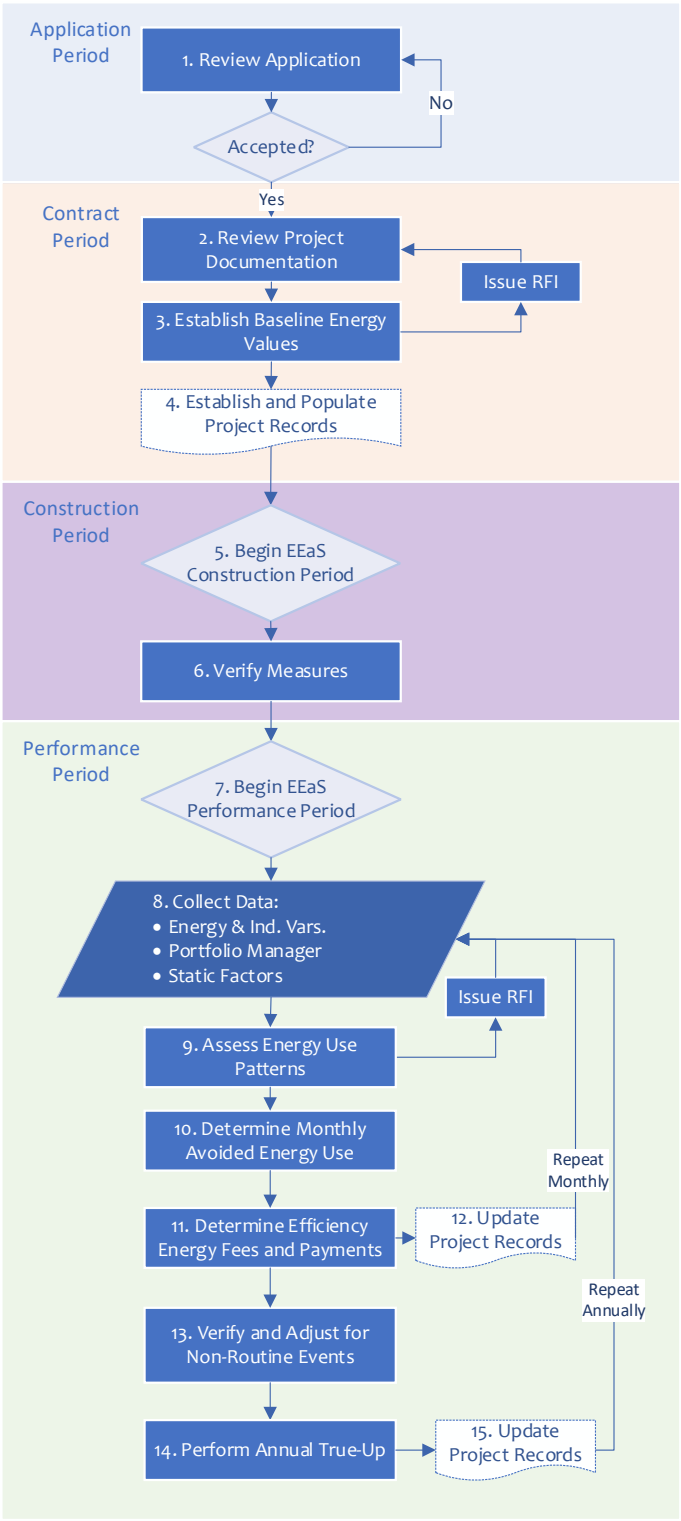

Figure 2: New Construction M&V Procedures

and 2. The baseline energy use will be the monthly allocation of the total allowable annual electricity consumption estimated in compliance with the Seattle Energy Code's (SEC) Target Performance Path (TPP). The baseline energy values are determined as set out in the version of the SEC that the building is permitted under.

Step 4. Establish and Populate Project Records. Once the baseline values have been determined and project data collected for each Participant, this step will create the project file that will be utilized to store project-specific EEaS materials. The M&V Consultant will maintain a secure on-line backed-up electronic folder structure available to City Light and record the key site data collected and analyzed throughout the project. Each project's baseline model documentation, data, and live calculation files shall be stored in its own folder.

Step 5 (Milestone). Begin EEaS Construction Period. The EEaS Construction Period[6] begins after City Light, the Participant, and the EE Developer agree on the baseline values and savings procedures, and the Participant Agreement and Power Purchase Agreement are executed. The length of the construction period will vary for each EEaS new construction project but is not expected to last more than three years. Once the certificate of occupancy is issued by SDCI, the EEaS Program may begin tracking monthly savings.

Step 6. Verify Measures. At the discretion of City Light, operating conditions at individual sites including specific ECMs may be verified.

Step 7 (Milestone). Begin EEaS Performance Period. The performance period and financial transactions begin when the Participant demonstrates to City Light that the building has reached 75% occupancy based on the building areas included in the measurement boundary.

Step 8. Collect Data. Each month energy data will be collected from City Light, weather data from the NOAA Boeing Field weather station, and other independent variable data as required from the Participant, such as from its ENERGY STAR Portfolio Manager account, or directly from its building control or energy monitoring systems. Energy data in daily or 15-minute time intervals, as available, are collected for M&V analysis. Participant's monthly bills are collected for quality control checks and to determine Efficiency Energy for the billing period. Data sources related to quantifying changes in static factors are also identified and collected for the Participant and EE Developer.

Step 9. Assess Energy Use Patterns. The collected energy use data will be analyzed to identify potential non-routine events and will maintain an NRE log for the project that documents

[6] Projects are permitted to start construction on the facility prior to the start of the EEaS Construction period.

observed energy anomalies and records key findings from assessment efforts. An RFI may be issued to the Participant or the EE Developer for assistance in identifying any unusual energy usage. Changes in energy use that are determined to be significant will be flagged for additional analysis and investigation and included as part of the assessment and true-up process described in Step 13 and 14. City Light can issue an RFI and/or perform a site visit to collect more information if deemed warranted.

Step 10. Determine Monthly Avoided Energy Use. During each month of the performance period, the M&V Consultant will use the Baseline Energy Values and the Actual Energy Use for the billing period to determine the monthly billing period Avoided Energy Use.

Step 11. Determine Efficiency Energy Fees and Payments. For each monthly billing period during the Performance Period, the monthly billing period Avoided Energy Use (Efficiency Energy) is multiplied by the Project's Efficiency Energy Charge to determine the EE Service Fee charge (to Participant) and by the PPA Price to determine the PPA payment (to EE Developer) for the billing period. EE Service Fees and PPA payments are included in the billing period immediately following the billing period from which the Avoided Energy Use was determined. A monthly memo report describing Avoided Energy Use and EE Service Fees and PPA payments is provided to City Light for each participating project. City Light will provide each Participant and EE Developer with their monthly memo.

Step 12. Update Project Records. The M&V Consultant will update project data files, live calculations, and documentation in each project's folders on a monthly cadence or when other action related to a project is executed.

Step 13. Verify and Adjust for Non-Routine Events. At the end of each performance year (i.e., 12-month period from start of the performance period) an assessment will be made to determine if any non-routine adjustments to the baseline energy values are needed. The M&V Consultant will review the project's NRE log, the EE Developer's quarterly reports, responses to pertinent RFIs, energy consumption data, monthly billing data, and weather data, and will recommend specific non-routine adjustments to City Light as appropriate. Where City Light determines a non-routine adjustment is warranted, it may verify its cause and collect data by issuing an RFI and/or performing a site visit and direct the M&V Consultant to quantify and document the adjustment.

Step 14. Perform Annual True-Up. After any non-routine adjustments identified under Step 13 have been made, the non-routine adjustments to the baseline values as described in the SEC to account for specific conditions for the current performance year will be made. The Avoided

Energy Use for the past 12 months will be recalculated, as necessary. The M&V Consultant shall determine the amount of the adjustment to be applied to the annual total Avoided Energy Use and determine the adjustments to be applied in the following month's billing period.

The M&V Consultant will allocate the adjusted annual baseline energy to monthly adjusted baseline values for the upcoming year based on the actual load profile from the last year.

Step 15. Update Project Records. The EEaS project's electronic records will be updated to include the Annual Report and the adjusted baseline energy consumption for the new performance period, along with other relevant materials. An Annual Report describing the previous year's Avoided Energy Use and EE Service Fees and PPA payments, completed ECMs, flagged NREs, performed NRAs, and resulting true-ups (if any) is provided to City Light for each participating project. City Light will provide each Participant and EE Developer with their Annual Reports.

The Annual Reports and Monthly Avoided Energy Use Calculations will continue for the duration of the EEaS Performance Period for the project, or until the M&V Consultant is notified by City Light.

Repeat Steps 7 through 15, as required.

4. Detailed M&V Requirements: Existing Buildings

For Existing Buildings, the procedures for determining the baseline model and calculating Avoided Energy Use (Efficiency Energy) described here largely follow ASHRAE Guideline 14-2014, Sections 4 and 5.1, "Whole Building Performance Path." Avoided Energy Use will be determined for each customer's monthly billing period.

Step 1. Review Application

City Light will review each application from potential participants to ensure that the project meets the program's eligibility criteria. After the eligibility review, a more in-depth review and inquiry will be conducted. This will include:

1. Verification that the meters identified in the application measure at least 90% of the energy use of the equipment serving the space in the building that is considered to be within the project boundary.

2. Verification that meters serving the equipment and floor areas both inside and outside the measurement boundary are documented.

3. A preliminary 'modelability' analysis will be performed to assure a baseline energy model can be developed and meet the goodness of fit and accuracy criteria as described in Step 3. At least one-year of energy data will be collected and inspected for gaps, repeated values and outliers. The corresponding ambient temperature data will be collected from the Boeing Field NOAA weather station. Multiple modeling algorithms (described in Appendix B) will be used until an acceptable energy model can be developed. Different consecutive 12-month periods of data may be used to make this assessment if necessary.

4. As part of the 'modelability' analysis, the data will be inspected to determine whether there are significant periods of anomalous behavior that are not well explained by the model (that is, a potential non-routine event). Such energy use behavior may include added or removed loads, temporary or permanent shifts in energy use, or extended impacts due to the low-occupancy period resulting from the COVID-19 stay-at-home orders.

An information request may be provided to the applicant to determine the causes of anomalous energy use behavior. Information concerning the availability of any additional data sources that will help address and assure the building is 'modelable' may be requested. Participants that

meet the eligibility criteria and fulfill the meter and modelability requirements will be accepted into the program.

Step 2. Confirm Baseline Conditions

After a project has been accepted into the EEaS Program, the building's baseline conditions will be verified by City Light. Additional information will be collected to document ECMs, their savings potential, and additional resources that may be tapped throughout the life of each project. City Light may schedule a meeting or site inspection to review the information provided in the application and document these additional resources. Information that may be collected is described in the following list.

- Confirm submitted application information. In this task the information provided on the application will be verified and may include an on-site inspection of the building and equipment served by the energy meters, confirm whether other energy commodities are used (district steam, natural gas, etc.) or presence of self-generation (photovoltaics, wind turbines, other renewable energy sources, cogeneration equipment, etc.).

- Identify additional sources of data from the building that are useful for energy modeling, such as building HVAC or lighting controls system trends, monthly reports on leased tenant space or occupancy levels from the building leasing office, data from energy submeters or other information systems, and so on.

- A compilation of the building's baseline period equipment and systems, their operations, and schedules of use will be collected. This information is often available in an energy audit and a copy will be requested should one exist.

- Review the proposed ECMs and equipment they will replace or augment. Collect ECM descriptions, calculations used to quantify their savings, including data used, assumptions made, and savings estimation method description. Collect and review ECM operational verification or commissioning plans. Obtain an implementation schedule, if available.

- Identify static factors that may potentially change throughout the duration of the engagement with the EEaS Program. This step may be informed based on the anomalous behavior identified in the initial modelability assessment. Such changes in static factors affect energy use in the building but are not due to the installed ECMs. Significant changes in static factors represent non-routine events (NREs) and may require

adjustments to the baseline energy use to assure savings are estimated accurately. Examples of static factors that may change over time include:

- Change in space use type, such as from retail to restaurant or vice versa.
- Expansion or destruction of conditioned building floor area.
- Addition or removal of large equipment, such as data servers, kilns, and refrigerators.
- Change in operating hours or equipment operations.
- Fuel switching on water or space heat.
- Electric vehicle charging infrastructure (shall be sub-metered and added to the baseline).
- On-site generation (shall be sub-metered and removed from the avoided energy use of the site).
- Occupancy changes that are not captured in the baseline model, measured by leased square footage.
- Temporary, one-time, or rare events that fall outside of regular operation conditions, such as power loss or emergency operations.

Documentation of the building's baseline conditions shall be collected and saved in the project file for future reference.

Step 3. Develop Baseline Models

For buildings with multiple accounts or meters, at least 90% of the building's electricity use must be included and accounted for by the meters included in the project. To define the measurement boundary, building equipment and areas served by each meter should be described in the application. Building systems that are affected by the installed ECMs and are provided electricity through multiple meters must identify the meters so that their data may be used in the savings analysis.

The Participant site's energy use and data from selected independent variables shall be used to develop an accurate regression-based baseline model according to the requirements described below. The M&V Consultant may make several iterations of model development with additional

independent variable data before arriving at the accepted model. Once determined, the accepted model shall be fully documented in the project files to maintain for future reference.

Collect Baseline Period Data

Building data to collect for baseline modeling include:

- Historical utility meter data and other fuel use data for each project for 12 to 36 months prior the ECM implementation period shall be collected from City Light and the Participant's ENERGY STAR Portfolio Manager account. Energy data collected from City Light will be in 15-minute, daily, and monthly billing period form, as available from each Participant's meters.

- Ambient temperature is expected to be a key independent variable. Other weather variables such as humidity may be tested whether they improve the baseline models. Weather data for the same time period as the energy use data will be collected from the NOAA Integrated Service Database (ISD) for the Boeing Field weather station.

- Other data that influences energy use in the Participant's building may be collected and evaluated for use in developing the baseline model and quantifying performance period savings. Such data may describe occupancy, operation modes, holidays, equipment operation schedules, or other effects in a Participant's building. Sources for these additional variables could include trend files from the building controls system, monthly records from the property manager's office, data recorded in the Participant's ENERGY STAR Portfolio Manager account, or other data archive from the building.

- As warranted, index variable data generated from analysis of a group of peer buildings to each participating building may be used as a proxy variable in baseline models and savings analysis. Such an index variable would be used to explain a Participant building's response to exogenous effects such as the low-occupancy COVID-19 period and other large regional influences, in cases where building-specific data is not available. It would only be used in such cases that it has been shown to be a statistically significant driver of the Participant building's energy use. The analysis and derivation of any index variables used will be fully documented and available for review.

- Sub-metered energy data for on-site generation, including photovoltaic systems, or other renewable energy sources. Data from other sub-metered energy-using equipment or spaces in the building may be collected. Sub-meter accuracy specifications should be

collected and documented. Recent calibration documentation will be collected for meters that require periodic calibration.

- Data and information related to changes in static factors or other causes of baseline period non-routine events shall be collected. Data may be continuously monitored and recorded such as energy submeters on electric car charging stations, or data may be logs of event occurrences, such as shifts in operation hours, construction of additional floor space, changes in space uses, or additions or removal of loads. Information may also be obtained from Participant's quarterly reports.

Data Preparation

Preparation of energy and independent variable data is required before analyses. Procedures detailed in Section 6 will be followed.

Results of all data quality checks, including documentation of missing and repeated values and treatment of outliers will be recorded in the project files.

Baseline Modeling

A regression-based baseline energy model will be developed for the combined data from energy meters that serve building equipment inside the project measurement boundary. Baseline models will be developed from daily time interval data.

The baseline period duration for existing building projects must be at least 12 months. Longer durations are acceptable for the purposes of increasing modeling accuracy or replacing missing or removed data in cases of poor data quality or occurrence of non-routine events.

Baseline model development is an iterative process. Several factors must be considered to develop the most accurate and reliable baseline energy model useful for the duration of the Participant's site in the EEaS Program. Such factors include:

- Selection of specific baseline period from up to 36 months prior to start of the contract start date,

- Influence on energy use of parameters other than ambient temperature, and the availability of additional independent variable data,

- Presence of baseline period non-routine events and methods to remove their impacts from the savings analysis,

- Choice of modeling algorithm, modeling algorithms are described in Section 7.
- Baseline model compliance with the goodness of fit and accuracy metrics, and
- Adherence of baseline model to assumptions of regression modeling. Four main assumptions of linear regression are:
    - Linearity of data: The relationship between the predictor and the predicted is assumed to be linear.
    - Normality of residuals: The residuals are assumed to be normally distributed. Residuals are the difference between the predictor and predicted values.
    - Homoscedasticity: (homogeneity of residual variance): The residuals are assumed to have a constant variance.
    - Independence of residuals: The residuals are assumed to be independent of each other.

Significant deviations of these assumptions lead to models with poor prediction capability. Baseline models will be selected such that deviations from these assumptions are minimal.

NREs are significant changes to the building or its operations that are unrelated to the ECMs and may occur throughout the baseline, construction, or performance periods. They may be caused by changes to a building's static factors (listed above in Step 2). Should they occur in the period used to develop the baseline model, information will be requested to identify their cause, duration, and impact on energy use. Should the NRE prove to have a significant impact on baseline energy use, an appropriate approach to account for the NRE in the baseline model will be used. Useful methods, such as those described in the *IPMVP Application Guide on Non-Routine Events & Adjustments,*[7] may be used in the development of baseline models.

Each accepted baseline model must pass the model acceptance criteria described below. The M&V Consultant shall document the modeling algorithm chosen, the modeling strategy employed, and describe how the model will be adjusted under performance period conditions.

Model Acceptance Criteria

[7] IPMVP Application Guide on Non-Routine Events & Adjustments, dated October 2020 is available from www.evo-world.org.

The baseline model shall be fit using a least-squares regression method. The model must meet the following acceptance criteria:

- The baseline regression model reasonably adheres to the assumptions of linear regressions.
- The net determination bias must be less than 0.005%.
- The coefficient of variation of the root mean square error CV(RSME) shall be less than or equal to 20%.
- Estimated savings uncertainty for the minimum 25% savings required must be less than 30% at the 90% confidence level.[8]
- t-statistics for each independent variable coefficient shall be >1.73 for a 90% confidence level.
- The model's Significance F metric must be lower than 0.1 at the 90% confidence level to assure it is statistically better than a mean model.

In addition, the baseline model's predictive accuracy will be assessed by comparing its predictions to 3–6 months of pre-installation energy data that was not used to develop the baseline model.

The coefficient of determination, R^2 (or 'adjusted R^2' for models with more than one independent variable), is an indication of how well the independent variables in a regression model 'explain' the independent variable. It will be used to guide the selection of a model from a number of different model options, but not as a pass or fail criterion.

Any significant trend in the baseline period energy use should be examined to determine whether energy use is increasing or decreasing in a manner unexplained by the independent variables. This may be shown visually by plotting the timeseries of the residuals (differences between the modeled and actual energy use) and the predictions of a linear regression of the residuals versus time. If the t-statistic for the slope of the trendline is greater than 1.62 (90% confidence level), the trend in energy use is significant. If necessary, the M&V Consultant will

[8] Uncertainty in savings will be calculated using procedures in ASHRAE Guideline 14-2014.

recommend how to adjust baseline model predictions based on this trend. Useful techniques are found in City Light's Deep Retrofit Pay for Performance Program user manual.[9]

Require Additional Information

Should additional information be required from the Participant or EE Developer to improve the baseline model, a request for information will be developed and issued. Examples of additional information are described in Table 1 of the Participation Agreement, which includes:

1. Engineering description of building systems and operations, occupancy hours, weekend operations
2. Updated list of ECMs, if any
3. More descriptive information on ECMs
4. Existing control system capabilities
5. Plans for additional metering or submetering
6. List of meters and equipment or areas served by meters
7. Questions based on review of baseline period energy use data (operation modes, operations during the pandemic, manual changes to operations or control system settings, etc.)
8. Additional data available sources (sub-metering, control system trends, key access card data, etc.)
9. Static factors
10. Periodic maintenance events that may affect energy use (if any): e.g., pumping load after fire sprinkler test, backup generator tests, battery tests
11. NRE clarification data

[9] Version 1.0, September 2018, available at: https://energysolutions.seattle.gov/wp-content/uploads/P4P-Deep-Retrofit-Program-Manual.pdf

Step 4. Establish & Populate Project Records

Once the baseline model has been developed and site data collected for each Participant, the M&V Consultant will assure it has been fully documented in each project's folders. Each folder shall include:

- Documentation of Building Baseline Conditions identified in Step 2 above.
- Description of energy meters and measurement boundary.
- All raw data collected: electricity and other fuel source, data from Participant including control system trend files and data downloaded from Participant's ENERGY STAR Portfolio Manager account or property management office.
- Files of processed data used in baseline model development.
- Live analysis code used to develop baseline model.
- Documentation of baseline model including modeling algorithm used, modeling strategy, list of independent variables, use of operation modes, identification and treatment of NREs, goodness of fit and accuracy metrics.
- Description of how Avoided Energy Use will be determined each month in the Performance Period. This may include descriptions of how meter data is combined, how the baseline model is used to determine the Performance Period Adjusted Baseline Energy Use, how actual Performance Period Energy Use is determined, and how Performance Period Avoided Energy Use is calculated.
- Documentation of correspondence and project information exchanged between City Light, M&V Consultant, Participant and EE Developer.
- The folders shall be intuitive to enable quick access and referencing of project baseline documentation and project savings procedures. All raw and processed data and results shall be available in formats ready to review.

Step 5 (Milestone). Begin Construction Period

The construction period begins after City Light, the Participant, and the EE Developer agree on the baseline model and savings procedures, and the Participant Agreement and Power Purchase

Agreement are executed. Once ECMs are installed, the EE Developer notifies City Light and monthly energy savings are tracked.

Step 6. Verify Measure Installation

At the discretion of City Light, individual ECMs will be verified. ECM verification may be performed by collecting and reviewing commissioning documentation, site inspections, collection and analysis of building control system trend data, and collection and review of contractor documentation. Documentation of verified measures will be added to the project's records.

Step 7. Collect Post-Installation Data

Each month, energy and independent variable data will be collected and analyzed to determine the progress of savings resulting from the installed ECMs. The data to be collected are specified in each project's baseline and savings analysis procedures documentation. The data to collect generally include:

- Utility meter data and other fuel use data for each project from City Light and the Participant's ENERGY STAR Portfolio Manager account. Energy data collected from City Light can be in 15-minute, hourly, or daily form, as available from each Participant's meters. Monthly billing period data are also collected. Participant's ENERGY STAR Portfolio Manager account provides data for other fuel uses.

- Ambient temperature or other weather variables as found to be statistically significant in the baseline model. Weather data for the same monthly billing period will be collected each month from the NOAA ISD for the Boeing Field weather station.

- Other data that influences energy use in the Participant's building as identified in the baseline model documentation. Such data may describe occupancy, operation modes, holidays, equipment operation schedules, or other effects in buildings, and is collected from the Participant.

- Index variable data as developed for each Participant building by City Light.

- Sub-metered energy data for on-site generation, including photovoltaic systems, other renewable energy sources. Sub-metered data for other building subsystems as specified in the project's baseline model documentation.

- Data and information related to changes in static factors or other causes of baseline period non-routine events shall be collected. Data may be continuously monitored and recorded such as energy submeters on electric car charging stations, it may be logs of event occurrences, such as shifts in operation hours, construction of additional floor space, changes in space uses, or additions or removal of loads. Information may also be obtained from Participant's quarterly reports.

Step 8. Assess Energy Use Patterns

The data will be compiled into a continuous dataset to establish a record of energy use throughout the life of the project. This dataset is used to quantify the Avoided Energy Use as well as to detect and adjust for significant NREs.

The M&V Consultant may use the following approaches to identify potential NREs:

- Information from the EE Developer/Participant, direct knowledge of the building, or direction from City Light. Participants and EE Developers are required to inform City Light of changes in static factors or other events that have a significant impact on the building's energy use through their required quarterly reports.

- Anomalies observed in monthly billing reports (e.g., differences in billed energy and total metered energy).

- Use of various change detection techniques. Change detection techniques include charting of the data for visual inspection, developing models based on post-installation data and examining residuals, and reviewing unexpected changes to cumulative summations of energy savings. Additional techniques are based on analysis of the energy use data and are described in the *IPMVP Application Guide on Non-Routine Events & Adjustments*.

When potential NREs are flagged, the M&V Consultant will issue a request for information (RFI) for City Light to review and forward to the Participant and EE Developer so the cause of the flagged potential NRE can be identified in a timely manner.

Once identified, the M&V Consultant will characterize each non-routine event based on:

- The time period in which it occurred.

- Whether it is a temporary or permanent change.

- Whether the NRE represents a constant or variable load.
- Whether the NRE represents added or removed load.

This characterization will help estimate the NRE's impact and duration, whether using engineering calculations or data analysis.

The M&V Consultant will compile relevant information including detailed description of the non-routine event, duration, and the operational condition going forward. The M&V Consultant shall work with City Light to request further information about the event from the EE Developer/Participant. Information on detected anomalies, confirmed NREs, affected equipment, and other pertinent information will be logged for each project throughout the year, an example of such a log is provided in the table below.

Table 1 – Example non-routine event log

No.	Anomaly detected date	Anomaly End date (if ended)	Detection Method (change detection method, Participant quarterly report)	Affected Equipment	Cause Description	Cause Documentation	Energy Impact Significant?	Adjustment Method	NRA Amount
1									
2									
3									

Adjustments for NREs with significant impacts on Avoided Energy Use will be made on an annual basis. Each month detected NREs will be logged and stored in the project files for future reference and potential adjustments during the annual true-up (Step 13).

Step 9. Determine Monthly Avoided Energy Use

Each month, the energy and independent variable data is collected and prepared as described in Step 3. Avoided Energy Use is determined according to the documented description and procedures for each EEaS project. Avoided Energy Use will be determined for each project's monthly billing period, based on the project's baseline adjustment model and data for the duration of the contract.

To determine the monthly Avoided Energy Use, the energy use and independent variable data will be collected and prepared for energy savings analysis. Start and end dates from the monthly billing period will be used to define each monthly Performance Period for which monthly Avoided Energy Use will be determined.

The Adjusted Baseline Use will be determined by inputting the independent variable data into the baseline adjustment model. The monthly Adjusted Baseline Use and monthly Actual Energy Use are determined by summation of their respective daily values over the billing period. The total monthly Actual Energy Use will be compared with the monthly billing period energy use (from the monthly bill) to assure they are in alignment.

The monthly Avoided Energy Use is calculated as the difference between the monthly Adjusted Baseline Use less the monthly Actual Energy Use. Each Performance Period's monthly Avoided Energy Use defines the Efficiency Energy, which is used to determine the fees and payments to Participants and EE Developers.

In cases where differences in calculating the Avoided Energy Use are required due to changes in available data, analysis procedures, or other project circumstances, the deviations from the original Avoided Energy Use calculation procedures shall be documented in the project's files.

Step 10 (Milestone). Begin Performance Period

The Performance Period will start when enough of the ECMs specified in the ECM plan are completed for the monthly Avoided Energy Use to exceed 10% savings of monthly Adjusted Baseline Energy Use. The calendar month when the Performance Period begins will be documented in the project's files.

Participants and EE Developers may continue to identify and implement ECMs, notifying City Light in its required quarterly reporting.

Step 11. Determine Efficiency Energy Fees and Payments

During the Performance Period, City Light will charge each Participant an EE Service Fee every month, which is the EEaS Charge times the Efficiency Energy determined in Step 9. The EEaS Charge is determined as described in the EEaS Program Manual in Section 5.2. EE Service Fees will be added to the Participant's monthly bill in the month following the month the Efficiency Energy was determined, as specified in the EEaS Program Manual and Participation Agreement.

Similarly, the EE Developer will receive a payment every month from City Light for the Efficiency Energy generated in the previous month. The PPA Payment is the PPA Price times the Efficiency Energy determined in Step 9. The PPA Price is determined as described in the EEaS Program Manual in Section 5.2. PPA Payments will be made in the month following the month the Efficiency Energy was determined, as specified in the EEaS Program Manual and Power Purchase Agreement.

Per the EEaS Program documents, the monthly Efficiency Energy is expected to be maintained over 12.5% of monthly Adjusted Baseline Use. Payments halt for months that this amount is not maintained. Please reference the PA and PPA for more details.

The M&V Consultant will provide a monthly report to City Light for each EEaS Project that includes:

- The Efficiency Energy determined for the current monthly billing period.
- The EE Service Fee to be charged to the Participant on their next monthly bill.
- The PPA Payment to be paid to the EE Developer.
- Supporting data, calculations, and charts (e.g., time series cumulative savings summation charts)

City Light will provide each Participant and EE Developer with their monthly memo.

Step 12. Update Project Records

The M&V Consultant will update project data files, live calculations, and documentation in each project's folders on a monthly cadence or when other action related to a project is executed.

For each EEaS Project, a log of NREs will be maintained. This NRE log will include approximate dates the NREs were detected, how they were detected, and descriptions of their significance. This log will serve as a reference for the annual true-up process each year.

These electronic project records will be accessible to City Light.

Step 13. Verify and Adjust for Non-Routine Events

At the end of each Performance Period year, an assessment of the NREs will be made. The purpose of this assessment is to determine whether the impacts on the project's energy use of individual NREs are significantly high enough to warrant an adjustment to the annual savings in the annual true-up process. Examples of NREs are described in Step 2. NREs may be reported as changes in Static Factors by Participants in their quarterly reports or may be detected by analysis of the energy use data compiled for each project.

The energy use data collected throughout the project, as well as the log of NREs compiled throughout the year will be used identify and evaluate performance period NREs. The M&V Consultant may use the following approaches to investigate NREs:

- Assessment of interval meter data and independent variables.
- Information from the EE Developer or Participant, direct knowledge of the building, or direction from City Light.
- Tracking of model residuals over time.
- Visual observations of outliers on a model scatter chart.
- Calculations of the z-scores or t-scores for data points.

In addition, 'change detection' models may be used to identify NREs and quantify their impacts. Descriptions of different NRE detection and adjustment methods are found in the IPMVP Application Guide on Non-Routine Events & Adjustments.

Non-electric fuel data will be collected and analyzed to determine whether there have been significant changes. When significant changes have occurred, the M&V Consultant will issue an RFI For City Light to review and forward to the Participant and EE Developer to determine the cause. The purpose is to prevent fuel-switching, which is not allowed. Not all changes to non-electric fuels are disallowed, however should non-electric fuel changes be determined to be caused by the ECMs installed as part of the EEaS Program, the M&V Consultant shall provide analysis and City Light shall determine the consequences for the project.

If the NREs warrant a non-routine adjustment, the M&V Consultant will propose a recommended non- routine adjustment to City Light for approval. Ideally these adjustments will be based on verified sub- metered data. Otherwise, the M&V Consultant may estimate non-routine adjustments with statistical or engineering methods. Whether statistical or engineering methods are used, the calculations will be documented clearly and reside in the project files so that the adjustments can easily be reviewed.

If the building increases in building size or changes use type during the contract or performance period, City Light may choose to pivot the baseline to a new construction methodology described in Section 5, as the baseline model is no longer representative of how much energy the building would have used had no ECMs occurred. The new baseline shall be based on the

Target Performance Path Energy Use Intensities (EUIs) in the Seattle Energy Code adopted at the time of construction or renovation.

Procedures around non-routine adjustments may be updated during the EEaS Program to reflect best industry practice.

Step 14. Perform Annual True-Up

For each project, once the energy impact of all significant NREs have been determined, adjustments to the annual Avoided Energy Use will be made. The M&V Consultant will determine whether the adjustment resulted in overestimation or underestimation of the annual Avoided Energy Use and determine the amount of overpayment or underpayment of EE Service Fees by the Participant and PPA Payments to the EE Developer. Corrections to the EE Service Fees and PPA Payments will be made in the following billing period.

Step 15. Update Project Records

The M&V Consultant will provide an annual report per building to City Light, every 12 months after the start of its contract term, including:

1. Monthly and annual Avoided Energy Use per site
    a. kWh savings total and percent (compared to baseline)
    b. Non-electric fuel use, including analysis of interactive effects, if any and assessment of fuel switching, if applicable
2. Identification of ECMs completed per site in the data
3. Summary of flagged and verified NREs per site
4. Inventory of permanent and temporary NRAs recommended and made at each site, and adjustments to Avoided Energy Use.

City Light will provide each Participant and EE Developer with their Annual Reports.

5. Detailed M&V Requirements: New Construction

This section describes the procedures for M&V of new construction projects that were outlined in Section 3. Projects may fall under either the 2015 or 2018 versions of the SEC based on the permit issued by Seattle Department of Construction and Inspections (SDCI).

The procedures for the EEaS Program detailed below accommodate both versions of the SEC, which have differences in determining the project's Baseline Energy Values. The procedures described below are differentiated by code version, where needed.

For new construction buildings participating in the EEaS Program, the M&V Consultant will rely on data required by the Target Performance Path defined in Section C401.3 of the Seattle Energy Code (SEC). Unless otherwise specified, data will be provided by the Participant (not SDCI).

Step 1. Review Application

In this step, City Light and the M&V Consultant review the information available in the Participant's EEaS Program Application to determine whether the project meets the program eligibility requirements defined in the EEaS Program Manual v2.0, Section 12 Project Selection Criteria. If sufficient information to make this assessment is not provided, additional information can be requested by City Light.

The information needed to evaluate the key program technical eligibility criteria are described below.

1. State under which version of SEC (2015 or 2018) the project is permitted.

2. Provide the evidence that the project is permitted under and shows compliance with the Seattle Energy Code's (SEC) Target Performance Path (TPP) defined in Section C401.3 of either the 2015 or 2018 versions.

3. Describe the general methodology used to determine saving estimates. Include a list of the improvements and ECMs in the new facility and their estimated energy savings in kWh per year and as a percent of the maximum allowed energy.

4. To initially assess EEaS Program eligibility, provide the predicted annual energy use of the proposed facility by the SDCI approved simulation model and how it compares to SEC requirements. These values should be used in Equation 1 to calculate the percent annual

energy savings. EEaS Program eligibility requires annual savings of 25% or greater and values will be confirmed in Step 3.

Equation 1: Percent Energy Savings for New Construction EEaS Program Eligibility

Percent Savings = (Maximum Allowable Energy Use – Estimated Total Energy Use)/Maximum Allowable Energy Use

Where 'Estimated Total Energy Use' is the total annual kWh use predicted by the SDCI approved energy simulation, and

'Maximum Allowable Energy Use' is established by SEC 2015 or SEC 2018 requirements, as described in Step 3.

1. Describe planned or installed utility metering at the facility. When available, provide the electric utility account(s) with City Light, including a list of utility meters and building areas served by each.

    a. Note the EEaS Program requires electric meters to be under a commercial rate code and to provide data in intervals of one-hour or less. Multi-family residential and some mixed-use new construction projects must have been granted a master meter exception by City Light as described in the EEaS Program Manual.

City Light and the M&V Consultant will assess the quality and completeness of the application.

Step 2. Review Project Documentation

Once the program application is accepted by City Light, the needed project documentation is assembled and reviewed by the M&V Consultant.

The EEaS Program leverages items required in the SEC 2015 and 2018 code compliance process managed by SDCI, however, items will be supplied by the Participant to City Light. The following items are needed to validate key data in the program application and to establish the Baseline Energy Values:

1. Supporting information for data included in the program Application from Step 1 is provided in the modeling summary report(s) required in SEC Section C401.3.4, which should be submitted to City Light. Nominally, these should include:

a. Documentation of the modeling assumptions, modelling software version number, a description of energy measures and improvements (ECMs) included over minimum SEC requirements, the total conditioned building area in square feet (ft^2), area by space-type included (such as Retail and Office), and annual operating hours for Retail.

b. The expected annual energy use from the energy simulation model based on typical year conditions, and summaries of energy consumption by end-use by space type.

1. If not included in the modeling summary report, the following details must be provided separately to City Light:

   a. The maximum allowable annual energy use determined for the facility as approved by SDCI.

   b. Total energy use per year and per month (in kWh). Use of other fuels is not allowable.

   c. The estimated capacity (kW) and annual energy production (kWh) expected from self-generated sources (e.g., kWh from roof-mounted solar).

   d. The estimated capacity and annual energy use of end-uses included in the energy simulation models that necessitate reporting, adjustments, or energy sub-metering by SDCI during the energy demonstration period described in SEC Section 401.3.6 – *Demonstration of operating use*, such as on-site generation and data center IT energy.

   e. Details of any spaces in the facility that are not included in the energy simulation model, which will not be included in the EEaS Program's analyses. Describe how the energy use in these spaces will be metered, including details on metering where appropriate.

   f. The input and output files from the energy simulation model(s) approved by SDCI.

   g. Any retail spaces included in the proposed simulation model should be listed, including the corresponding annual energy use from the proposed model and the operating hours used in the analyses.

2. Projects under SEC 2018 should include additional details from the proposed simulation model. The values needed are referenced in SEC C407.3 and defined in ASHRAE 90.1 Appendix G Section 1.2 for Performance Rating Method and include:

a. 'Target' Building Performance Factor, represents the minimum percent reduction in energy consumption required compared to ASHARE 90.1-2004 based on the Maximum Allowable BPF.

b. Baseline Building Unregulated Energy Consumption (BBUEC), which includes IT energy, plug loads, process loads in kWh/yr.

c. Baseline Building Regulated Energy Consumption (BBREC), which includes HVAC, Lighting, Fans, DHW, etc.) in kWh/yr.

d. Electronic copies of the baseline and proposed model input and output file need to be in a format suitable for rerunning the models and shall not consist solely of formatted reports of the inputs. Files should be available throughout the project duration.

Step 3. Establish Baseline Energy Values

The M&V Consultant will establish annual and monthly Baseline Energy Values for the EEaS Program using data collected in Steps 1 and 2. Generally:

- All areas included in the energy simulation model will be included in the measurement boundary. Areas not represented in the energy simulation model require separate energy meters.

This step also confirms the maximum allowable annual energy use for the facility. The procedures vary under SEC 2015 and 2018 and are described below.

SEC 2015:

The maximum allowable energy use is based on the 'energy use target' in (kBTU/ft^2/yr.) established under SEC 2015 Section C401.3.2. These values vary by type of building use, and a weighted average is used to determine the maximum allowable energy use for the facility, with parking garages and conditioned building spaces calculated separately. Table 2 shows an example calculation for an office facility with an open parking garage.

Table 2 - Example Calculation of Weighted Average Maximum Allowable Energy Using SEC 2015 Energy Use Targets

Area	Building Area Type	Energy Use Target (kBTU/Sq ft./Yr)	Area (Sq. Ft.)	kBTU/Yr
Conditioned Building	Office	40	173,500	6,940,000
	Retail	60	26,500	1,590,000

Areas	Sub-totals:	42.7	200,000	8,530,000
Parking Garage	Open Garage	6	20,000	120,000
Whole Facility	**Totals:**		**220,000**	**8,650,000**
	Weighted Energy Use Target	**39.3**		
	Maximum Allowable Energy Use			**8,650,000**

-End SEC 2015-

SEC 2018:

In SEC 2018, the maximum allowable annual energy use is determined from the results of the energy simulations following the Performance Rating Method in ASHRAE 90.1 Appendix G Section 1.2 and the maximum allowable building performance factors (BPFs) defined in SEC 2018 Section C401.3. and described below.

First, the maximum allowable or 'target' BPF is calculated based on a weighted average of the space type BPF and the percent of total building area represented by the space types included in the proposed simulation model. The calculated weighted-average BPF is increased by 12% per SEC 2018 Section C401.3.1.1 to determine the maximum allowable BPF, as shown in the example in Table 3.

(Note SEC's compliance requires the actual building performance factor be less than the maximum allowable BPF. A change in the BPF affects the total allowable energy use (kWh) for the project and the Baseline Energy Values.

Table 3 - Example Calculation of Maximum Allowable Building Performance Factor Using SEC 2018

Area	Building Area Type	Building Performance Factor	Area (Sq. Ft.)	% Space
Conditioned Building	Office	0.51	173,500	79%
	Retail	0.43	26,500	12%
Parking Garage	Other	0.49	20,000	9%
Total Facility	Totals:		220,000	100%
	Weighted Building Performance Factor:	0.50		
Increased Building Performance Factor	**Maximum allowable BPF Code:**	**0.56**		

Next, the BPF from the baseline simulation model will be validated using ASHRAE Appendix G[10] to ensure it is no more than the Maximum Allowable BPF code, described above and shown in Table 3. If substantially different, the simulation model will need to be updated and re-submitted. The M&V Consultant will make this determination based on the change in BPF, the modeling details provided in Step 2, the cause of the change, and the results of the model's sensitivity analyses described in SEC C401.3.4.

Next, the maximum allowable energy in kWh/year for the project is determined from the approved baseline simulation model representing the maximum allowable BPF.

The EEaS Program eligibility is confirmed if the estimated energy use in the proposed simulation model is 25% less than the equivalent energy in the calculated carbon budget using Equation 2 as shown in the example in Table 4.

Table 4: Example EEaS Program Eligibility Assessment for SEC 2018

EEaS Eligibility Criteria	kWh / Year
SEC Maximum Allowable Energy Use	2,226,850
Estimated Total Energy Use in Proposed Simulation Model	1,640,465
Estimated Savings	586,385
Percent of Baseline Saved	26%
Minimum EEaS Savings Required	**25%**
Eligible for EEaS	**YES**

-End SEC 2018-

For both SEC 2015 and SEC 2018, once the annual savings are confirmed, the monthly Baseline Energy Values for the first 12-month performance period will be determined. These values are from the proposed energy simulation model results and will be updated for subsequent years based on the actual monthly load profiles, as described in Step 14. For the first year of the performance period, the annual baseline energy (kWh) will be allocated by month based on the percent of the annual electricity use estimated for each month in the proposed simulation model.

City Light will make the final determination on the Baseline Energy Values used.

[10] See *ASHRAE Standard 90.1-2016 Performance Rating Reference Guide* from PNNL

Step 4. Establish and Populate Project Records

Once the baseline energy use and the initial monthly baseline model have been established and site data collected for each Participant, this step will create the project's electronic file that will be utilized to store project specific EEaS materials. The M&V Consultant will set up a project file and record the key site data collected in Steps 2 and 3. Data not yet available will be recorded when it becomes available. Each project's file shall include:

1. All data collected in Steps 1 and 2.

   (Note - a summary of items is not included to prevent confusion.)

2. Key data collected and determinations made in Step 3 related to the baseline model including the annual baseline energy in kWh established, details of calculations made, and sources of data used. This includes:

   a. A description of all energy meters included and measurement boundary, and detailed rational for any City Light meters excluded.

   b. The annual baseline energy in kWh and the Year-1 monthly Baseline Energy Values in kWh and percent of annual kWh estimated.

   c. The modeled operating hours for each retail space, the weighted average operating hours based on percent of retail area, and the total energy use of the retail spaces estimated in the proposed model.

3. Description of how Performance Period Energy Use and Avoided Energy Use will be determined in the Performance Period. Any specific energy allowances related to IT energy (SEC C401.3.7) or other end-use will be documented as well as details of any sub-metered data excluded or included. These calculations typically follow Equations 2, 3, and 4 below but will be customized for each project.

   Equation 2: General Equation for Performance Period Energy Use

   Performance Period Energy Use (kWh) = [Energy Use from City Light Meters(kWh)] –/+ [Sub-metered Energy (kWh)]

Equation 3: General Equation for Adjusted Baseline Energy Use

*Adjusted Baseline Energy Use (kWh) = Baseline Energy + (IT Allowance - IT Energy Actual*1.45) - (Generation Allowance - Onsite Generation) +/- [Non-Routine Adjustments]*

Equation 4: General Equation for Avoided Energy Use

Avoided Energy Use (kWh) = [Adjusted Baseline Energy Use – Performance Period Energy Use]

4. Correspondence and project information exchanged between City Light, M&V Consultant, Participant and EE Developer.

5. The EEaS Charge and PPA Price and methods established in the Participant Agreement (PA) and Power Purchase Agreement (for calculating the fees and payments that to be made in Step 11. The values and details which define how the EE Service Fees and PPA Payments are determined and the schedule of any planned updates.

Step 5 (Milestone). Begin EEaS Construction Period

The EEaS Construction Period[11] begins after City Light, the Participant, and the EE Developer agree on the baseline energy values and savings procedures, and the Participant Agreement (PA) and Power Purchase Agreement (PPA) are executed. The length of the EEaS Construction Period will vary for each EEaS new construction project but is not expected to last more than three years.

Once the certificate of occupancy is issued by SDCI, this step establishes details of the ongoing data required, which at a minimum will include:

1. Content of quarterly reports to be provided by EE Developer throughout the EEaS performance period will be defined. Updates on current site-level operations are needed periodically so that calculations of Avoided Energy Use are correct. Details which may affect the Baseline Energy Values are needed such as:

    a. Total building occupancy (e.g., percent leased/month).

    b. Square footages by space-type and percent of the total building area for each.

[11] Projects are permitted to start construction on the facility prior to the start of the EEaS Construction period.

c. Retail operating hours for each retail space included in the measurement boundary.

d. Sub-metered energy data.

e. Unusual site-level activities or other changes.

2. Data from meters included in the project's measurement boundary and related variables which will be collected by the M&V Consultant monthly, includes:

   a. Energy use data from City Light's meters and all sub-metered energy data.

   b. For sites with ITE loads of 50 kW, the requirements for submetering IT energy in SEC C401.3.2.1 will apply to the EEaS Program and are to remain in place for the duration of the program. These requirements also apply to new IT loads added during the performance period.

   c. Energy use and other data from the Participant's ENERGY STAR Portfolio Manager and other sources. The Participant must grant the M&V Consultant access to account as well as to Seattle City Light billing information and interval meter data for the participating building. The Participant is required to enroll in auto-updates of the building's energy data and accurately collect and maintain other relevant data in Portfolio Manager.

3. City Light will establish the EEaS billing periods for the site, which coordinate with billing dates used in Step 9 when monthly efficiency energy is calculated.

4. The EEaS Program will use similar strategies as those prescribed for the code required energy demonstration period defined in SEC Section C401.3.6 ("Demonstration of Operating Energy Use"), which may be concurrent. The Participant should provide:

   a. Copies of key correspondence with SDCI related to the fulfillment of SEC C401.3.6. This will include relevant details such as the maximum allowable energy determined by SEC during the demonstration period and adjustments made such as those for data center allowances or changes in occupancy.

   b. Descriptions and data from all submeters which will be included in the SDCI energy demonstration period (e.g., electric vehicles, solar, data center loads). Any energy sub-meters such as those for data center loads should identify the City Light meter serving the load as well as a description of areas and loads measured.

c. Electrical use data and billing details for all City Light's electric meters serving the building, once available:

   i. Meters serving all areas represented in the energy simulation model must be included in the measurement boundary. Detailed rational for any meters not intended to be included is required and must be approved by City Light.

   ii. Where multiple meters are present, a description of areas, end-uses and systems served by each energy meter and each submeter is needed. Electrical one-line diagrams may be requested.

   iii. Copies of recent City Light monthly bills for all meters at the facility.

5. Energy use and other data in ENERGY STAR Portfolio Manager will be verified. ENERGY STAR Portfolio Manager must be kept up to date, including all internal loads (e.g., number of occupants) and fuel and water use data, which should be automatically updated by the utility.

The source, responsible party, analysis procedures, reporting formats, and required communications will be determined and documented in this step. Once data collection procedures are established, they will be recorded in the project's records and the EE Developer and M&V Consultant can begin collecting data on an ongoing basis. Data analysis and reporting will begin in Step 7.

Step 6: Verify Measures

The EE Developer will provide the commissioning related reports specified in SEC Section C408 System Commissioning to document the installed equipment and operating conditions of the ECMs.

At the discretion of City Light, conditions at individual sites and installation of ECMs may be verified (activities conducted by City Light). Verification activities may be performed by reviewing commissioning documentation, analysis of building control or energy information systems data, review of contractor documentation, conducting site inspections, collecting sub-metered data, or other activities. Any documentation of verified measures collected will be added to the project's records.

Step 7 (Milestone). Begin EEaS Performance Period

For New Construction EEaS projects, the performance period will begin when the building has reached 75% occupancy based on the leased or occupied building areas included in the measurement boundary. This milestone should be reported by the EE Developer to City Light and may correspond to the beginning of the energy demonstration period conducted by the SDCI. The EE Developer should provide supporting documentation to City Light of this project milestone, who will provide written notification to the M&V Consultant and EE Developer of the start date established for the EEaS project's performance period.

The contracted financial transactions with City Light on the EEaS project can now begin. The M&V activities for the project's performance period commence and follow a 12-month cycle.

Step 8. Collect Data

The data collected in this step follows the procedures defined in Step 5, which establishes details of the ongoing data required, and will be ongoing for the duration of participation in the EEaS Program. All data collected will be added to the project's records (established in Step 4).

Activities include:

1. M&V Consultant will download required energy data, including from any self-generation source or other sub-meters, as well as other required data identified in Step 2 and 3.

2. The EE Developer will submit quarterly reports as defined in Step 5.

3. The M&V Consultant will review the quarterly reports for completeness and for potential NREs. Potential NREs will be added to the project's NRE Log and verified, as necessary. Quarterly submittals or requests for information over 90 days late may be considered a default of program terms for the project.

4. M&V Consultant will conduct data quality control procedures on energy, weather, and other variable data used in analyses. This includes checking the data for reasonableness, missing or repeated values, and outliers.

5. Preparation of energy and independent variable data is required before analyses. Procedures detailed in Section 6, below will be followed. Results of all data quality checks, including documentation of missing and repeated values and treatment of outliers will be recorded in the project files.

6. Energy data from meters serving equipment within the same measurement boundary shall be combined at the daily time interval.

Results of all data quality checks, including documentation of missing or repeated values and treatment of outliers will be recorded in the project files. City Light will be notified of unusual or persistent issues.

Step 9. Assess Energy Use Patterns

This step assesses the data collected in Step 8 for potential non-routine events (NREs). Non-routine events are changes to a buildings energy-consuming systems and equipment that are not related to the ECMs. More information and examples of NREs are available.[12] The data will be compiled into a continuous dataset to establish a record of energy use throughout the life of the project. This dataset is used to quantify the Avoided Energy Use as well as to detect and adjust for significant NREs.

The M&V Consultant may use the following approaches to identify potential NREs:

- Information from the EE Developer/Participant, direct knowledge of the building, or direction from City Light. Participants and EE Developers are required to inform City Light of changes in static factors or other events that have a significant impact on the building's energy use through their required quarterly reports.

- Anomalies observed in monthly billing reports (e.g., differences in billed energy and total metered energy).

- Use of various change detection techniques. Change detection techniques include charting of the data for visual inspection, developing models based on post-installation data and examining residuals, and reviewing unexpected changes to cumulative summations of energy savings. Additional techniques are based on analysis of the energy use data and are described in the *IPMVP Application Guide on Non-Routine Events & Adjustments*. When a significant NRE is detected in the data, the M&V Consultant will issue a request for information (RFI) for City Light to review and forward to the Participant and EE Developer.

When potential NREs are flagged, an RFI will typically be issued to the EE Developer so the cause of the flagged potential NRE can be identified in a timely manner.

[12] See IPMVP's Application Guide on Non-Routine Events and Adjustments

Once identified, the M&V Consultant should characterize each non-routine event based on:

- The time period in which it occurred.
- Whether it is a temporary or permanent change.
- Whether the NRE represents a constant or variable load.
- Whether the NRE represents added or removed load.

This characterization will help estimate the NRE's impact and duration, whether using engineering calculations or data analysis.

The M&V Consultant will compile relevant information including detailed description of the non-routine event, duration, and the operational condition going forward. The M&V Consultant shall work with City Light to request further information about the event from the EE Developer/Participant. Information on detected anomalies, confirmed NREs, affected equipment, and other pertinent information will be logged for each project throughout the year, an example of such a log is provided in the table below.

Table 5 – Example of non-routine event log

No.	Anomaly detected date	Anomaly End date (if ended)	Detection Method (change detection method, Participant quarterly report)	Affected Equipment	Cause Description	Cause Documentation	Energy Impact Significant?	Adjustment Method	NRA Amount
1									
2									
3									

Adjustments for NREs with significant impacts on Avoided Energy Use will be made on an annual basis although City Light may elect to address them sooner. Each month detected NREs will be logged and stored in the project files for future reference and potential adjustments during the annual true-up. For more information on how NRAs will be performed and which NREs can warrant an NRA please refer to Step 13.

Step 10. Determine Monthly Avoided Energy Use

During the performance period, the M&V Consultant shall use the monthly Adjusted Baseline Energy Use and the actual performance period energy for a given month to determine the monthly Avoided Energy Use. This includes:

- Ensuring each billing period covers time periods which match current billing dates.

- Confirming data from all energy meters included in the measurement boundary, where automatic uploads have been established, are included in the monthly calculations.

- Making adjustments due to missing performance period energy data if needed. Where more than four hours of a day's energy data is missing, the savings for that day will not be assessed and the monthly baseline energy values will be based on the data available for complete days.

Monthly Avoided Energy Use will be determined using Equation 5 established for the project.

Equation 2: Monthly Efficiency Energy

*Monthly Avoided Energy Use (kWh) = [Monthly Adjusted Baseline Energy Use – Performance Period Energy Use] – (IT Actual*1.45 – IT Allowance) - (Onsite Generation Actual[13] – Any Generation Allowance) – (Sub-metered NREs)*

These results will be revisited during the annual true-up in Step 14.

Each Performance Period's monthly Avoided Energy Use defines the Efficiency Energy, which is used to determine the fees and payments to Participants and EE Developers.

Step 11. Determine Efficiency Energy Fees and Payments

Each month, City Light will charge each Participant an EE Service Fee, which is the EEaS Charge times the Efficiency Energy determined in Step 10. The EEaS Charge is described in the EEaS Program Manual in Section 5.2 and set for each project in the Participation Agreement. EE Service Fees will be added to the Participant's monthly bill in the month following the month the Efficiency Energy was determined, as specified in the EEaS Program Manual and Participation Agreement.

Each month, the EE Developer will receive a payment from City Light for the Efficiency Energy generated in the previous month. The PPA Payment is the PPA Price times the Efficiency Energy. The PPA Price is described in the EEaS Program Manual in Section 5.2 and set for each project in the Power Purchase Agreement. PPA Payments will be made in the month following the month the Efficiency Energy was determined, as specified in the EEaS Program Manual and Power Purchase Agreement.

[13] This applies if generation is within the measurement boundary. All on-site electric generation will be separately metered using a City Light meter, per the EEaS Program Manual.

The M&V Consultant will provide a monthly report to City Light for each EEaS Project that includes:

- The Efficiency Energy in kWh and as a percent of the monthly billing period Adjusted Baseline Use, determined for the current monthly billing period.
- Dates and number of days covered in billing period.
- The EE Service Fee to be charged to the Participant on their next monthly bill.
- The PPA Payment to be paid to the EE Developer.
- Descriptions of submeters used in calculations as well as data issues and modifications required.
- Supporting data, calculations, and charts (e.g., time series cumulative savings summation charts)

City Light will provide each Participant and EE Developer with their monthly memo.

Step 12. Update Project Records

The M&V Consultant will update project data files, live calculations, and documentation in each project's folders on a monthly cadence or when other action related to a project is executed.

For each EEaS project, a log of NREs will be maintained. This NRE log will include approximate dates the NREs were detected, how they were detected, and descriptions of their significance. This log will serve as a reference for the annual true-up process each year.

These electronic project records will be accessible to City Light.

Step 13. Verify and Adjust for Non-Routine Events

At the end of each performance year (i.e.,12-month increments from start of the performance period) the M&V Consultant will assess the need for any non-routine adjustments (NRAs) to the baseline energy and recommend specific adjustments to City Light, where appropriate.

The M&V Consultant will review the project's NRE Log, the EE Developer's quarterly reports, responses to pertinent RFIs, energy use data, monthly billing data, weather, and other data as

needed. Additional clarifications related to the review may be requested from the EE Developer and Participant.

NRAs for new construction projects are generally limited to those described below (see also SEC Section C401.3), but others may be considered. In some cases, the use of a regression-based energy model (such as those used to develop the EEaS baseline model for existing buildings described in Section 4 above) may be recommended. In this case, the energy use data from the energy model and the performance periods prior to the NRE(s) may be used to monitor the site's stability and to determine adjustments to baseline energy values if needed.

Generally, NRAs may be required where:

- Variation in operating hours and leased square feet for each retail space included in the measurement boundary per SEC C401.3.10.
- Changes in building occupancy type, which is based on changes in the use-type, such as space changing from office to retail or retail to restaurant based on leased square footages per SEC C401.3.8.
- Significant weather fluctuations resulting in unusually cold years per SEC C401.3.9.
- Installation of electric vehicle (EV) charging infrastructure or other significant unplanned load.
- Temporary, one-time, or rare events that fall outside of regular operating conditions, such as power loss or emergency operations.
- Expansion or reduction of conditioned building floor area.
- Other unforeseen significant changes reported or determined from energy data assessment conducted in Step 9.

Procedures which apply to all projects under SEC 2015 and SEC 2018 include:

1. <u>Change in retail operating hours:</u>
   The annual hours of operation for the retail spaces included in the measurement boundary will be assessed using the published hours of operation. If the weighted average annual hours for retail spaces exceeds the hours assumed in the energy model by more than 4 percent, the annual baseline energy use (kWh) for the retail space use only is permitted to be increased by 1% for each 4% increase in such hours. (See also SEC C401.3.10.)

2. Unusually cold years:
   If the heating degree days (HDD) recorded by the National Weather Service for the Seattle-Tacoma International Airport exceeds 4885 HDD for the 12-month demonstration period (4% above the average 4697 HDD at 65°F base), the annual baseline energy (kWh) will be increased by 1% for that year (See also SEC C401.3.9). HDDs for the year will be the sum of the daily HDDs which equal 65°F minus the average daily temperature, where 0 is the minimum allowable result (See also SEC C401.3.9.). No other weather-based adjustments will be made.

3. Change in overall building occupancy:
   Occupancy changes between 100% and 75% of overall conditioned area that is leased or owner-occupied will not require a non-routine adjustment. Below 75% occupancy, the project's M&V activities will be suspended.

4. Other changes:
   Although only the NREs listed above will generally trigger a non-routine adjustment, a custom adjustment for other NREs such as those identified in Step 9 may be recommended, if the M&V Consultant determines it is significant. Preferred methods to make adjustments for NREs are similar to those for Existing Buildings. In some cases, non-routine adjustments to the baseline may require the EE Developer install energy submetering. In others, the energy simulation models may need be modified by the EE Developer.

Other procedures which are unique to either SEC 2015 or SEC 2018 follow.

SEC 2015:

1. Change in Occupancy Type:
   The maximum allowable building energy use shall be adjusted to reflect the actual occupancy types for the performance year using the new weighted average 'energy use target' as described in Step 3 and the baseline energy values recalculated. If the distribution of occupied space changes among use types, or new use types are present, a new weighted average maximum allowable energy use will be determined. If the new weighted average is significantly different than the current value, the M&V Consultant will adjust the Baseline Energy Values for the year in kWh.

2. Adding or removing conditioned building floor area:

Any change in conditioned building area requires an adjustment to the annual baseline energy. The determination of the new annual baseline energy will follow procedures described in Steps 1 and 3.

Where any new occupancy is not listed in Section C401.3.2, either City Light shall assign it an energy use target based on the best-performing local examples of that occupancy type, or a metering system capturing any additional energy loads for the change in occupancy can be used. City Light meters are preferred but sub-metered energy may be considered.

-End SEC 2015-

SEC 2018:

1. Change in Occupancy Type:

The maximum allowable building energy use shall be adjusted to reflect the actual occupancy types for the performance year as described in Step 3 and the baseline energy values recalculated. If the distribution of occupied space changes among use types, or new use types are present, a new weighted average maximum allowable building performance factor (BPF) will be determined.

The BPF from the baseline simulation model will be compared to the actual planned Maximum Allowable BPF, and if substantially different the simulation model will need to be updated and re-submitted to account for changes. The M&V Consultant will make this determination based on the change in BPF, the modeling details provided in Step 2, the cause of the change, and the results of the model's sensitivity analyses described in SEC C401.3.4.

Where any new occupancy is not listed in Section C407.3(2), either City Light shall assign it an energy use target based on the best-performing local examples of that occupancy type, or a metering system capturing any additional energy loads for the change in occupancy can be used. City Light meters are preferred but sub-metered energy may be considered.

2. Adding or removing conditioned building floor area:

Any change in conditioned building area may require an adjustment to the annual baseline energy. The determination of the new annual baseline energy will require new simulation model results be provided by the EE Developer following procedures described in Steps 1 and 3.

-End SEC 2018-

If the overall impacts of NREs during the performance year are significant enough to warrant a non-routine adjustment (NRA), the M&V Consultant will make a specific recommendation to City Light which includes details on recommended adjustments to the annual baseline energy use (kWh).

If approved, City Light will provide the proposed NRA and adjusted baseline energy to the EE Developer and Participant for review. The M&V Consultant will proceed with calculations using the recommended NRA in the annual true-up. The details and amount of any adjustments approved will be documented.

Step 14. Perform Annual True-Up

The M&V Consultant shall apply any adjustments determined in Step 13 to the annual baseline energy value. In addition, all required 'routine' adjustments described below will be made in this step, if needed. Once all adjustments required have been applied, the adjusted monthly Baseline Energy Values for the current year are determined and an annual M&V report for the project will be issued to City Light.

The following 'routine' adjustments will be evaluated and determined:

1. Adjustment for sub-metered loads such as data center energy use.

Where allocations for sub-metered loads have been included, actual metered loads will be used to determine the annual and monthly Adjusted Baseline Energy Use (kWh). This includes determining monthly adjustments for sub-metered energy loads related to data centers, or other sub-metered loads. The monthly energy savings and cumulative effect on financial payments will be determined where there are differences with the reported values.

2. Adjustment to monthly allocation of the annual baseline energy use.

After other adjustments are made, the shape of the baseline curve (i.e., percent of electricity used per month) for the next year will be adjusted using the previous 12-months of billing data. After 12 months, the actual percentage of the Year 1 total kWh used is determined. The percentage used per month is multiplied by the annual baseline energy (kWh) to set the Year 2 monthly Baseline Energy Values. This is process is applied each year based on the prior 12 months of data.

An example of allocating monthly baseline energy for Years 1 and 2 is shown in Table 6 and in Figure 3 below.

Table 6: Example of Monthly Baseline Energy Allocations for Years 1 and 2

Source:	*From Proposed Simulation Model*	*Calculated in Step 1*	*Year 1 Data*		*(% of Year 1/Month)x (Annual baseline kWh)*
Month	**% of Annual Electricity Use - Estimated (% / Month)**	**Year 1 Baseline Energy (kWh)**	**Actual Year 1 Energy (kWh)**	**% of Year 1 Electricity Used per Month (% / Month)**	**Year 2 Baseline Energy Values (kWh)**
Jan	12%	267,222	185,454	12%	256,087
Feb	12%	260,541	178,854	11%	242,785
Mar	10%	220,458	182,585	10%	222,685
Apr	8%	178,148	135,255	9%	200,416
May	6%	134,724	98,785	6%	138,107
Jun	5%	111,342	83,507	5%	113,356
Jul	4%	93,528	80,002	5%	108,599
Aug	4%	89,074	78,585	5%	106,675
Sep	8%	178,148	125,654	8%	170,569
Oct	9%	210,411	145,454	9%	197,446
Nov	9%	207,765	158,785	10%	215,542
Dec	12%	275,491	187,545	11%	254,583
Totals:	**100%**	**2,226,850**	**1,640,465**	**100%**	**2,226,850**

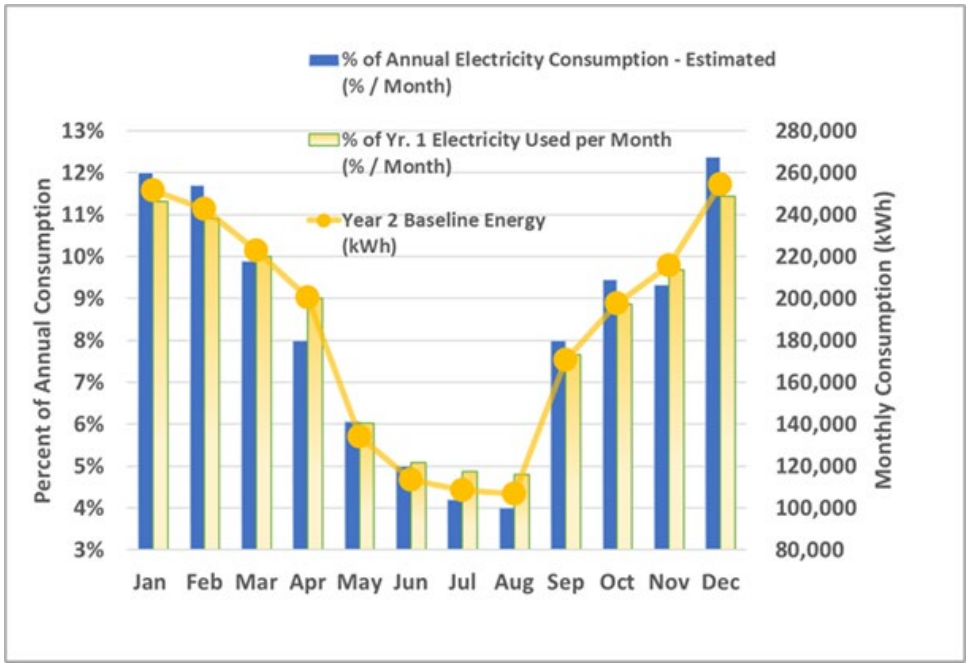

Figure 3: Example of Monthly Baseline Energy Allocations for Years 1 and 2

The M&V Consultant will provide an annual report per building to City Light, every 12 months after the start of its performance period, including:

a. Monthly and annual efficiency energy per site, including total kWh savings and percent of baseline energy saved.

b. Use of non-electric fuels and other energy sources at the site, if present, based on ENERGY STAR data, identifying any significant year-over-year changes.

c. Summary of the NRE Log for the site.

d. Inventory of permanent and temporary NRAs recommended and made at each site.

e. Monthly adjusted baseline energy use after true-up activities are completed, will be recorded in a summary table such as shown in Table 7.

f. Annual and Monthly Baseline Energy Use expected for the new 12-month performance period.

Table 7: Final Monthly Adjusted Baseline Energy for Each Performance Year

Monthly Adjusted Baseline Energy Use (kWh)													
Performance Year	1	2	3	4	5	6	7	8	9	10	11	12	**Annual Total**
1													
2													
3													

Step 15: Update Project Records

The Project Records will be updated to include the Annual Report and Annual and Monthly Baseline Energy Use expected for the new 12-month performance period, along with other relevant materials.

Steps 7 through 15 will be repeated, as required. The Annual Reports and Monthly Efficiency Energy Calculations will continue for the duration of the EEaS Performance Period for the project, or until the M&V Consultant is notified by City Light to cease.

6. Data Preparation

The data preparation procedures described in this section apply to both existing buildings and new construction projects.

M&V Consultant will conduct data quality control procedures on energy, weather, and other variable data used in analyses. The data must be reviewed and prepared for analysis, which includes checking the data for reasonableness, missing or repeated values, and outliers. All activities used to prepare raw data will be documented in the project files.

The following requirements provide additional information on data quality checks and data preparation procedures that will be used by the M&V Consultant:

- Energy data from meters serving equipment within the same measurement boundary shall be combined after the raw data is checked and reviewed for completeness.
- Repeated data points in the data sets must be eliminated. Repeated points are characterized as having the same time stamps and /or energy values
- Interpolated data may be used to fill in hourly data gaps which are less than two-hours apart. If more than four hours of data for the day is missing, the energy use for that day will not be included. The Adjusted Baseline Energy Use (from the baseline model for existing buildings or the Baseline Energy Values for new construction) will be adjusted in the monthly Avoided Energy Use calculation to assure it is based on the same number of data points as the Actual Energy Use.
- No more than 10% of the data may be unusable after completing the data quality checks. Additional data must be collected and checked to assure this requirement is met.
- Outliers in the energy data shall be identified and investigated. Use of charts and scatterplots should be used to identify outliers visually. Outliers may be determined using rules such as those data points that are greater in value than three standard deviations from the median value. In cases when a large number of outliers occur on any one day, they will be investigated again after the data is summed or averaged over the daily time interval.

- For identified outliers, the reasons for removing them from the data set must be documented. Such reasons may include reading or recording data error, non-typical event in the building, impossibility of value, etc.

- Other bad data points due to obvious meter misreads or transcription errors may be documented and eliminated.

- The collected short-time interval data shall be summed over each monthly billing period and compared with City Light's monthly billing period values to assure a close match between the data from the two data sources.

- All sub-daily time interval data will be converted to daily intervals. Energy data will be summed to determine the daily total energy use, temperature and weather data may be averaged over each day to obtain average daily data. Other independent variable data will be summed or averaged as appropriate.

- Weather data from the NOAA Integrated Service Database (ISD)[14] for the Boeing Field weather station for all projects in the EEaS Program.

- Hourly weather data may have many missing values, either recorded as blanks, NaN, NA, or other non-numerical characters. Missing weather data may be interpolated over no more than four hours in a day. If more than four hours of weather data are missing in any day, the entire day of data must be removed from the data set or backfilled with data from secondary weather data sources to be identified by City Light.

Results of all data quality checks, including documentation of missing and repeated values and treatment of outliers will be recorded in the project files.

[14] NOAA's Integrated Service Database is a central database of historical weather data from NOAA weather stations. Its quality control procedures address many typical raw weather data file issues resulting in weather datasets with very low percentages of missing, outlier, and repeated values. https://www.ncdc.noaa.gov/isd

7. Description of Modeling Algorithms

Types of Energy Models

There are multiple public-domain modeling algorithms available that may be used to develop baseline energy models. The most common algorithms that may be used in the EEaS Program are described below.

- The time-of-week and temperature modeling algorithm (TOWT), which develops coefficients for each time-of-week and piecewise linear temperature segments specified in the model. TOWT accounts for the influence on energy use from the time-of-week as well as the ambient temperature. It may only be applied in EEaS using daily time interval data. This modeling algorithm was originally developed by Lawrence Berkeley National Laboratory[15] and has been modified and updated to include additional independent variables.

- Modeling algorithms described in ASHRAE Guideline 14-2014, Table 5-1, which include the collection of temperature-dependent change-point models from ASHRAE Research Project 1050's Inverse Modeling Toolkit (IMT). These algorithms may be applied with average temperatures or with heating or cooling degree days as the independent variable and may be applied with daily data.

Table 8 - Eligible Models from ASHRAE Guideline 14-2014.

Name	Independent Variables	Form	Examples
No adjustment/ constant model	None	$E = E_b$	Non-weather sensitive demand
Day-adjusted model	None	$E = E_b \times day_b / day_c$	Non-weather sensitive use
Two-parameter model	Temperature	$E = C + B_1(T)$	

[15] Mathieu, et. at. 2011.

Name	Independent Variables	Form	Examples
Three-parameter models	Degree-Days/ temperature	$E = C + B_1(DD_{BT})$ $E = C + B_1(B_2 - T)^+$ $E = C + B_1(T - B_2)^+$	Seasonal weather-sensitive use or demand
Four-parameter models	Temperature	$E = C + B_1(B_3 - T)^+ - B_2(T - B_3)^+$ $E = C - B_1(B_3 - T)^+ - B_2(T - B_3)^+$	Seasonal weather-sensitive-use buildings with two cooling or two heating modes
Five-parameter models	Degree-Days/ temperature	$E = C - B_1(DD_{TH}) + B_2(DD_{TC})$ $E = C + B_1(B_3 - T)^+ + B_2(T - B4)^+$	Heating and cooling supplied by same meter
Multivariate models	Degree-Days/ temperature, other independent variables	Combination form $E = c_0 + c_1x_1 + c_2x_2 + \ldots + c_n x_n$	Energy-use-dependent non-temperature-based variables (occupancy, production, etc.). Linear model form shown.

Modeling Strategies

Different modeling strategies may be used to develop the baseline energy model. This includes use of indicator variables for periods of time with different building operations, or non-routine events (NREs). Additional independent variables may be used if they are demonstrated to have statistical significance and their data is available throughout the project engagement with the EEaS Program. Additional independent variables may be used to explain the low-occupancy period during of the COVID-19 pandemic, or other non-routine events in the building.

Another modeling strategy that may be used is to filter the energy data by distinct building operation modes and develop separate energy models for each mode, with the final baseline model comprising of all the models for each operation mode in the year. An example of an operation mode may be occupied hours and unoccupied hours, weekdays, weekends, or other day-types, or periods when building HVAC operations have been altered. Care must be made to assure these independent operation periods are properly applied to determine Avoided Energy Use in the Performance Period.

A. Glossary

Accuracy: An indication of how close a singled measured value is to the true value of the quantity in question.

Adjusted Baseline Energy Use: What the baseline energy use would have been if the project ECMs had never been installed, under the same set of post-retrofit conditions.

Advanced Metering Infrastructure (AMI): An integrated system of smart meters (AMI meters), communication networks, and data management systems that enables two-way communication between utilities and customers. Among other capabilities, AMI meters enable measurement of energy use in short time intervals, such as 15 minutes, hourly, or daily, providing better insights into building operations, compared to monthly billing data.

AMI Data: Data produced by AMI meters.

Avoided Energy Use: The reduction in energy use that occurred in the performance period, relative to what would have occurred if the facility had been equipped and operated as it was in the baseline period, but under performance period operating conditions. For EEaS, these are the site-level savings and are also called Efficiency Energy.

For Existing Buildings, the reduction in energy use or demand that occurs in the performance period, relative to the baseline period, as adjusted by routine and non-routine adjustments, for the performance period conditions.

> Avoided Energy Use (or Energy Savings) = Adjusted Baseline Energy - Performance Period Energy +/- Non-Routine Adjustments

For new construction, the difference between the Seattle Energy Code target energy use (C401) and the Participant's actual performance period energy use shall be considered the Avoided Energy Use.

Baseline Data: The measurements and facts describing facility operations and design during the baseline period. This will include energy use and parameters of facility operation that govern energy use.

Baseline Model: A mathematical representation or calculation procedure that is used to predict the energy use in a building or facility (or Adjusted Baseline Energy) had no ECMs been

implemented. Models may be based on equations that specifically represent the physical processes or may be the result of statistical analysis of energy-use data.

Baseline Model Equation: The specific mathematical representation or equation governing the prediction of energy use (or Adjusted Baseline Energy) had no ECMs been implemented at the Site.

Baseline Period: Period of time chosen to represent the operation of the facility before the implementation of an energy efficiency measure.

Coefficient of Determination R^2: The coefficient of determination (R^2) is the measure of how well future outcomes are likely to be predicted by the model. It illustrates how well the independent variables explain variation in the dependent variable. R^2 values range from 0 (indicating none of the variation in the dependent variable is associated with variation in any of the independent variables) to 1 (indicating all of the variation in the dependent variable is associated with variation in the independent variables, a "perfect fit" of the regression model to the data).

Coefficient of Variation of the Root-Mean Squared Error [CV(RMSE)]: A measure that describes how much variation or randomness there is between the data and the model, calculated by dividing the root- mean squared error (RMSE) by the average y-value.

Confidence Interval: Confidence intervals define the range of values that is expected to include the true value within a specified probability. For example, "we are 90% confident that the true value lies between 1,000 and 1,200."

Confidence Level: The confidence level is the probability that the true value is within the confidence interval. For example, the true value is estimated to be within the interval 1,000 kWh ±200 at the 90% confidence level.

Degree Day (heating degree day, cooling degree day): A degree-day is a measure of the heating or cooling load on a facility created by outdoor temperature. When the mean daily outdoor temperature is one degree below a stated reference, or balance point, temperature such as 64°F, for one day, it is defined that there is one heating degree day. If this temperature difference prevailed for ten days, there would be ten heating degree-days counted for the total period. If the temperature difference were to be 12 degrees for ten days, 120 heating degree-days would be counted. When the ambient temperature is below the balance point temperature, it is defined that heating degree-days are counted. When ambient temperatures are above the balance point, cooling degree-days are counted. Any balance point temperature may be used

for recording degree-days, though it is usually chosen to reflect the temperature at which a particular building no longer needs heating or cooling.

Dependent Variable: The variable that changes in relationship to alterations of the independent variable. In energy efficiency, energy usage is typically treated as the dependent variable, responsive to the manipulation of conditions (independent variables). In the case of Energy Efficiency as a Service, the dependent variable shall be expressed as the average usage per day (UPD) for a billing period.

Efficiency Energy: The calculated Avoided Energy Use harvested at the site by the EE Developer, which is quantified by the M&V Consultant as the difference between the Adjusted Baseline Use and Actual Energy Use in the performance period.

Energy Conservation Measure (ECM): An ECM is any type of energy efficiency or energy conservation project or activity related to the installation, repair, or replacement of energy-efficient equipment or building systems, implementation of capital projects, operational and maintenance (O&M) improvements, or new means of training or managing users of the space, intended to improve the energy productivity of or generate Efficiency Energy at the site.

Energy Use: The amount of energy consumed in the form in which it is acquired by the user. The term excludes utility generation and distribution losses.

Energy Efficiency Developer (EE Developer): The party who holds the Power Purchase Agreement with City Light for the sale of the Efficiency Energy to City Light from the Avoided Energy Use at the site.

Estimate: The average, or expected, y-value, given a specific x-value. The uncertainty in a regression estimate is a confidence interval.

Fractional Savings Uncertainty: The uncertainty divided by the savings. It must always specify the confidence level associated with the savings, where uncertainty is measured as the quantity of savings from the upper confidence limit to the lower confidence limit surrounding a savings estimate.

Independent Variable: Also termed an explanatory or exogenous variable; a factor that is expected to have a measurable impact on the dependent, or outcome variable (e.g., energy use of a system or facility). In the case of Energy Efficiency as a Service, independent variables may be continuously changing, such as ambient dry-bulb temperature, humidity, and occupancy rate,

or may be categorical and represent operation modes of a building, such as occupied and unoccupied periods, or days of the week, etc.

International Performance Measurement and Verification Protocol (IPMVP): The IPMVP provides an overview of current best practice techniques available for verifying results of energy efficiency, water efficiency, and renewable energy projects in commercial and industrial facilities. It may also be used by facility operators to assess and improve facility performance. The IPMVP is the leading international standard in Measurement and Verification protocols. It has been translated into ten languages and is used in more than 40 countries.

Measurement Boundary: A boundary drawn around whole-building meters and systems to segregate those which are relevant to savings determination from those which are not. It encompasses the portion of the building or facility that is included in the energy savings model. All energy uses of equipment or systems within the measurement boundary must be measured or estimated, whether the energy uses are within the boundary or not.

Measurement and Verification (M&V): The process of using measurements to reliably determine actual savings created within an individual facility by an energy management program. Savings cannot be directly measured, since they represent the absence of energy use. Instead, savings are determined by comparing measured use before and after implementation of a project, making appropriate adjustments for changes in conditions.

M&V Plan: A well-defined and implemented M&V Plan encourages comprehensive project design by including all M&V costs in the project's economics. It increases the transparency and credibility of reports on the outcome of efficiency investments and can be the basis for documenting performance in a transparent manner and subjected to independent verification.

Measurement and Verification Consultant (M&V Consultant): An independent third-party who will develop and implement an approach to use data-driven models with meter data and other variables to estimate baseline energy use, which will be used to determine the Avoided Energy Use of the Site.

Net Determination Bias (NDB): The ratio of summation of differences between model-predicated and actual dependent variable values to summation of actual dependent variable values.

Net Determination Bias Test: Savings resulting from applying the baseline period's independent variable data to algorithms for savings determination. Data so applied must reflect all exclusions or adjustments to actual measured data as documented for the baseline model.

New Construction: (1) construction of a new building or structure, (2) an extension or increase in the conditioned floor area or height of a building or structure, or (3) major changes in space use type.

Non-Routine Adjustments (NRAs): Adjustments to the baseline to account for changes in energy use, which occurred during the performance period and that cannot be modeled using the considered independent variables.

Non-Routine Events (NREs): Changes in building energy use that are not attributable to changes in the independent variables used in the baseline model nor to the efficiency measures that were installed. In the case of a significant NRE, the Avoided Energy Use may be adjusted by making non-routine adjustments.

Occupancy: In the case of Energy Efficiency as a Service, "occupancy" specifically means leased square footage of the total available leasable space. It is not adjustments for weekly occupancy schedule or holiday schedule, nor number of employees.

Participant: The party who owns the Site or an entity working as their agent, granted authority by the site owner to enter into the Participation Agreement.

Performance Period: The period of time after the EE Developer has implemented initial energy conservation measures at the Site resulting in a reduction of monthly energy use at least 10% relative to the baseline model.

Precision: The indication of the closeness of agreement among repeated measurements; a measure of the repeatability of a process. Any precision statement about a measured value must include aconfidence level. A precision of 10% at 90% confidence means that we are 90% certain the measured values are drawn from samples that represent the population and that the "true" value is within ±10% of the measured value. Because precision does not account for bias or instrumentation error, it is an indicator of predicted accuracy only given the proper design of a study or experiment.

Precision, Relative, as applied to a savings estimate: The ± uncertainty in savings divided by the savings. If the savings are 10,000, and the uncertainty is ±1,000 at an 80% confidence level, the relative precision is 1,000 ÷ 10,000 = 10% at the 80% confidence level.

Prediction: The specific y-value that may accompany a specific x-value. The uncertainty in a regression prediction is a prediction interval.

Projected Baseline: The baseline energy use applied to the post-retrofit period and conditions.

Regression Analysis: A mathematical technique that extracts parameters from a set of data to describe the correlation of measured independent variables and dependent variables.

Regression Model: A mathematical model based on statistical analysis where the dependent variable is regressed on the independent variables which are said to determine its value. In so doing, the relationship between the variables is estimated from the data used.

Retrofit: Energy conservation measure or measures installed and/or implemented as a single project at a specific time in an existing facility.

Residual: The difference between the predicted and actual value of the dependent variable, i.e., the portion of energy use that is not explained by the model.

Root Mean Squared Error (RMSE): (Also known as the Standard Error of the Estimate.) An indicator of the scatter, or random variability, in the data, and hence is an average of how much an actual y-value differs from the predicted y-value. It is the standard deviation of errors of prediction about the regression line.

Site: The actual building location that the energy efficiency work will take place. The project boundary shall be the utility account and corresponding meters, which make up at least 90% of the site's electricity use

Standardized Residual: A residual divided by its Standard Error (RMSE). This is a regression analog for a z-score, the number of standard deviations a value is away from the sample mean.

Static factors: The characteristics of a facility that affect energy use within the chosen measurement boundary, but which are not used as the basis for any routine adjustments. These characteristics include fixed, environmental, operational, and maintenance characteristics. They may be constant or varying. This includes conditions such as operating schedules, occupied square footage levels or density, setpoints, condition space and volume, control strategies, etc.

t-statistic: A measure of the probability that the value (or difference between two values) is statistically significant. The calculated t-statistic can be compared to critical t-values from a t-table. The t-statistic is inversely related to the p-value; a high t-statistic ($t>2$) indicates a low probability that random chance has introduced an erroneous result. Within regression, the t-statistic is a measure of the significance for each coefficient, (and, therefore, of each

independent variable) in the model. The larger the t-statistic, the more significant the coefficient is to estimating the dependent variable.

Uncertainty (e.g., of Savings): The range or interval of doubt surrounding a measured or calculated value within which the true value is expected to fall within some stated degree of confidence. Uncertainty in regression analysis can come from multiple sources, including measurement uncertainty and regression uncertainty.

Whole Building Metered Approach: The savings measurement approach defined in ASHRAE Guideline 14 that determines energy and demand savings using whole facility energy (end-use) data, which may be measured by utility meters.

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