DEEP RETROFIT

PAY FOR PERFORMANCE

A How-To Guide & User Manual for Commercial Customers

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energysolutions.seattle.gov/p4p

Seattle City Light

Seattle City Light

ACKNOWLEDGMENTS

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Thank you to all those who made this program a possibility by contributing time, expertise and support. And a special thank you to all of you who came to our stakeholder workshops and gave us your insight, making this program what it is today.

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Seattle City Light is dedicated to delivering customers affordable, reliable and environmentally responsible electricity services.

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Seattle City Light

Greetings and thank you for your interest in increasing your building's energy efficiency.

Seattle City Light has launched an innovative Pay for Performance program that gives building owners flexibility to design energy efficiency improvements that will maximize their return on investment by improving the comfort of their buildings, reducing electricity bills and earning financial incentives for the energy conservation that is achieved.

This manual will guide you through program details. In the meantime, let me share a few highlights.

The program is available for any commercial customer with at least 50,000 square feet of heated or cooled space where energy consumption can be modeled. Prime examples are large office buildings, schools, grocery stores, warehouses and senior housing.

Instead of prescribing a set list of upgrades, this program allows you to design the measures that you believe will provide the best return.

We offer contracts that will allow for a year of design and installation of the energy efficiency changes and have three or five years of incentive payments based on measured reductions in electricity consumption.

For customers with tight operational or capital budgets, targeted energy efficiency investments through this program can produce incentives, allowing you to move forward with more improvements you might want to make.

Along the way, improving a building's energy efficiency makes it a more comfortable space to work in, enhances worker productivity, reduces operating costs and increases the building's value.

We appreciate the time you are investing to explore these opportunities and we hope to work with you on a plan for your building soon. When you're ready, we're here to help.

Sincerely,

Craig Smith
Director, Customer Energy Solutions
Seattle City Light

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DEEP RETROFIT PAY FOR PERFORMANCE

Making a Case for Energy Efficiency and Pay for Performance

Seattle City Light's Deep Retrofit Pay for Performance (P4P) is an approach to energy efficiency in which incentive payments are made over time and based on actual energy savings measured at the electric meter. This differs from the standard approach of offering an upfront incentive payment based on the estimated energy savings from an energy conservation measure.

Since savings are measured at the meter in P4P, savings can come from building retrofits and equipment upgrades as well as from behavioral, operational and maintenance (O&M), and retro-commissioning activities. By allowing for integrated approaches, P4P teams can implement holistic and creative projects that promote greater energy savings and efficiencies.

Pay for Performance pays annual incentives for all electricity saved, rather than separate incentives for individual measures. Qualifying commercial Seattle City Light customers that implement whole-building energy retrofits receive a set incentive rate for measurable electricity savings that are achieved over the course of a defined performance period (either three or five years). Incentive payments are made at the end of each year of the performance period.

Benefits

- P4P can help you achieve energy savings of 15-20%
- Allows for creativity and flexibility when implementing projects
- Offers the same incentive for capital and non-capital measures
- Improves comfort of tenants
- Provides financial and technical support
- Decreases administrative burden
- P4P may meet your building's required tune-up
- Increase asset value

HOW TO USE THIS GUIDE

Who is Eligible

P4P is open to Seattle City Light commercial customers who own or operate buildings that have the following characteristics:

- 50,000 square feet or more of conditioned space
- Interval meter (access to hourly or 15-minute interval electricity usage data at the building level)
- Stable building energy use over the past year

Commercial buildings less than 50,000 square feet may also be eligible for P4P if they have high electricity use and access to hourly or 15-minute interval electricity usage data at the building level.

To be eligible for P4P, savings from your commercial building's planned capital equipment improvements (HVAC, lighting, envelope, etc.) must be identified as at least 15 percent of the building's baseline electric consumption. Seattle City Light customers interested in participating should complete the P4P Application to determine their building's baseline electric consumption and associated potential savings from planned capital equipment improvements. Seattle City Light's P4P Energy Advisors can assist in helping your team determine if P4P works with your scheduled facility and operations plans.

In addition to identifying the deep retrofit energy efficiency renovations your facility team plans to implement, the Seattle City Light P4P program specifies that all P4P program participants conduct continual monitoring and verification to track and assess all proven energy efficiency achievements. The P4P program relies on statistical regression modeling and analysis, therefore P4P participants creating or maintaining their own statistical regression model must have experienced analyst(s) to perform the modeling.

This manual introduces you to Seattle City Light's Deep Retrofit Pay for Performance program. Building owners, managers, facility staff, service providers, and vendors will find information that will help you determine if this program is right for your facility.

The Seattle City Light Deep Retrofit Pay for Performance Guide also serves as the go-to handbook once your project is underway, providing detailed information about the process - from applying to the program and establishing a baseline to implementing your chosen electricity saving measures and tracking its success. It also describes the Measurement and Verification protocols and reporting requirements you'll need to complete to successfully participate in Seattle City Light's Deep Retrofit Pay for Performance program.

To make navigating through this manual easier, we've added color bars to each section. In addition, the interactive Table of Contents allows you to navigate and jump between sections.

Deep Retrofit Pay for Performance. The first section - **blue** - targets Seattle City Light commercial customers curious about Deep Retrofit Pay for Performance programs. Seattle City Light initiated its P4P program based on extensive research including examining new technologies, conducting pilot projects in different types of commercial facilities, and obtaining feedback from Seattle City Light customers. Commercial building owners, property managers, facility staff, HVAC service providers and vendors will find information in the Deep Retrofit Pay for Performance manual that explains the purpose and requirements for the program.

Participant Guide. Section two - **green** - explains the P4P process from start-to-finish so that you and your facility team can determine if Deep Retrofit Pay for Performance is the right approach for your building. The Participant Guide outlines the application procedure, Seattle City Light's expectations, and how incentive payments are determined. Teams that are interested in participating in P4P must have at least one team member who is proficient in regression analysis and measurement and verification protocols.

Measurement & Verification Guidelines. Section three - **brown** - dives deeper into program nuts and bolts. Service providers and your P4P team lead(s) will find detailed information regarding program requirements and best management practices for measuring, tracking, and reporting on P4P measures.

We look forward to working with you.

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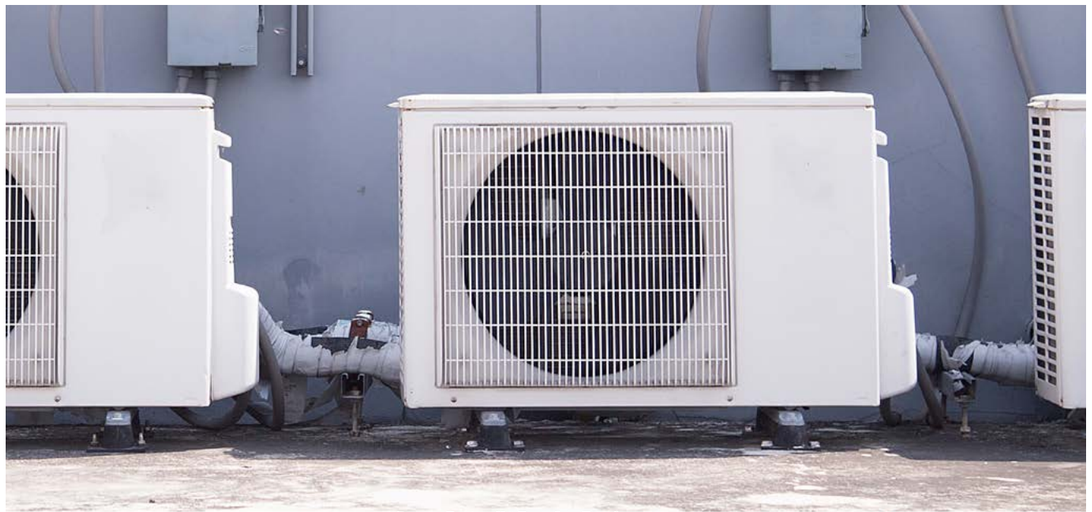
DEEP RETROFIT P4P

Background

Seattle City Light launched its Deep Retrofit Pay for Performance program to incentivize deep commercial building retrofits that can result in verifiable and significant electricity savings. Seattle City Light commercial and institutional customers who operate 50,000 square feet or more of conditioned space are eligible to apply for Seattle City Light's P4P program.

From 2013-2016, Seattle City Light piloted a limited Pay for Performance program to determine the feasibility and efficacy of instituting deep energy conservation measures to achieve 20-30% or more electricity savings. The three participating existing commercial buildings all completed deep retrofits which achieved between 13% and 20% savings during their Pay for Performance period. Subsequent stakeholder engagement meetings were held in 2017 to gather input on various design elements (such as the design of incentives, application, and reports) to incorporate into Seattle City Light's incentive program and the feedback was positive. Stakeholders welcomed the idea to offer incentives to building owners and operators who invest in capital improvements and operations and maintenance upgrades that achieve verifiable, normalized electricity savings.

The Seattle City Light Deep Retrofit Pay for Performance program offers its commercial and institutional customers the opportunity to participate and be rewarded for measured electricity savings as they occur during a pre-defined performance period (either a three-year or five-year option). Seattle City Light commercial customers that implement deep energy retrofit projects targeting more than 15% electricity savings through capital improvements can participate. To see if your project meets requirements, contact a City Light Energy Advisor at (206) 684-3800 or SCLEnergyAdvisor@seattle.gov, or visit energysolutions.seattle.gov/p4p.



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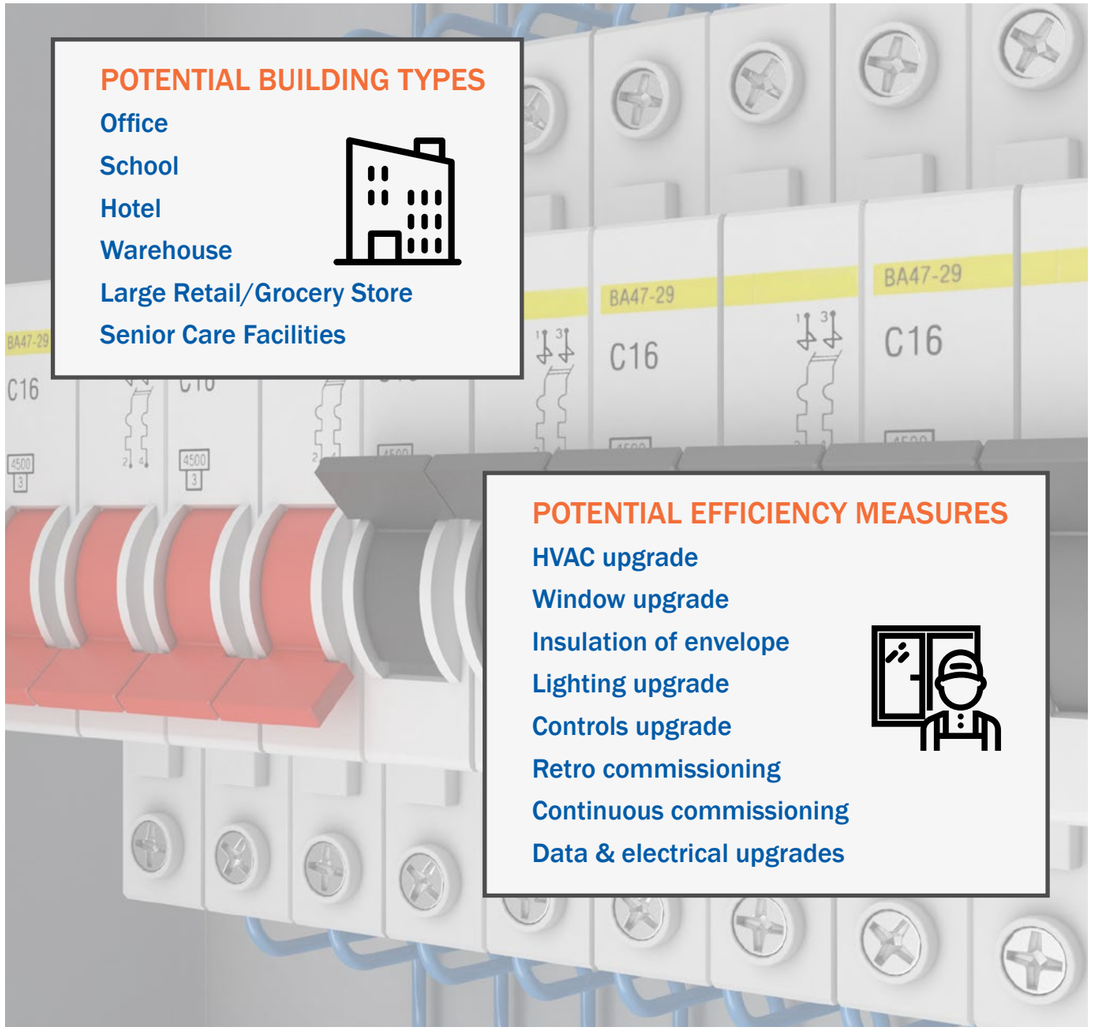
Eligibility

Seattle City Light commercial customers that operate in approximately 50,000 square feet of conditioned space and have consistent – and *measurable* – energy usage may be eligible for incentive payments. The lists below suggest potential types of commercial buildings and energy efficiency measures that meet Seattle City Light's Deep Retrofit Pay for Performance program, others could also be possible.



POTENTIAL BUILDING TYPES

- Office
- School
- Hotel
- Warehouse
- Large Retail/Grocery Store
- Senior Care Facilities

POTENTIAL EFFICIENCY MEASURES

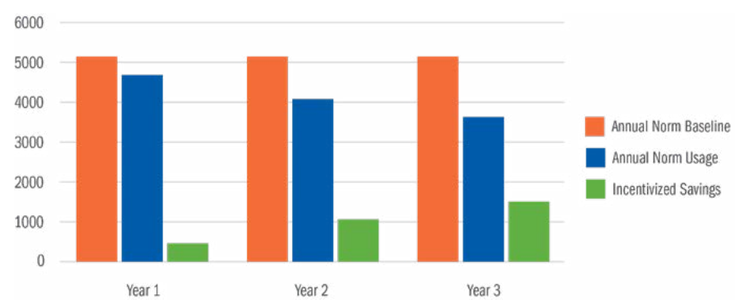
- HVAC upgrade
- Window upgrade
- Insulation of envelope
- Lighting upgrade
- Controls upgrade
- Retro commissioning
- Continuous commissioning
- Data & electrical upgrades

Program Options

Seattle City Light offers two incentive paths for P4P projects. You can participate in either a three-year performance period or agree to a five-year option.

The **Three-Year Performance Period** option offers an incentive rate of $0.08/kWh. Incentive payments are made on the normalized cumulative savings achieved over the baseline at the end of each year.

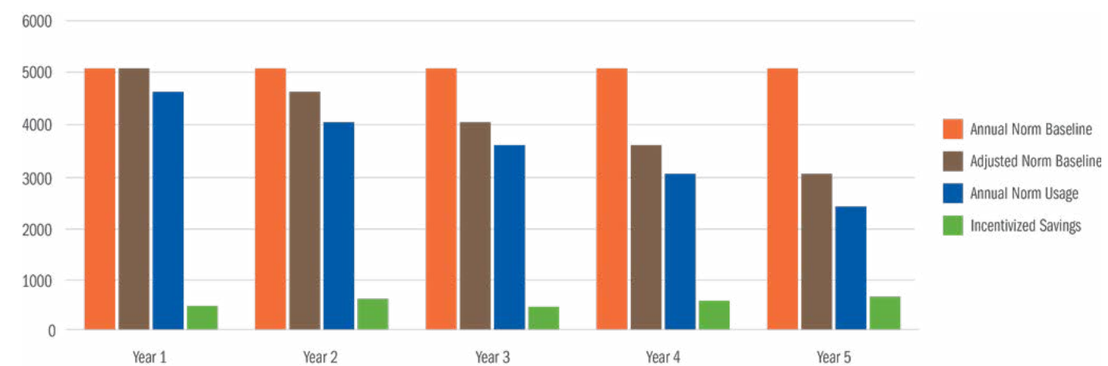
Three-Year Path



The **Five-Year Performance Period** option pays $0.18/kWh on the normalized incremental savings achieved year-over-year for each year of the performance period, with the baseline 'resetting' each year. Projects may also be eligible for a bonus incentive rate for deeper energy savings once cumulative energy savings for the project reach greater than 15 percent of the initial baseline.

Savings level at end of the performance year	Incentive paid on incremental savings
0 - 14.99%	$0.18/kWh
15 - 19.99%	$0.20/kWh
20 - 24.99%	$0.22/kWh
25 - 29.99%	$0.24/kWh
30 - 34.99%	$0.26/kWh
35 - 39.99%	$0.28/kWh
40 - 44.99%	$0.30/kWh
45 - 49.99%	$0.32/kWh
50 - 100%	$0.34/kWh

Five-Year Path



Pay for Performance

What is the process to participate?

Seattle City Light

energysolutions.seattle.gov/p4p

To learn if the P4P program is right for your commercial building, contact an Energy Advisor at (206) 684-3800 or SCLEnergyAdvisor@seattle.gov, or visit energysolutions.seattle.gov/p4p

Seattle City Light staff are dedicated to working with you to reduce your electricity use.

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PARTICIPANT GUIDE

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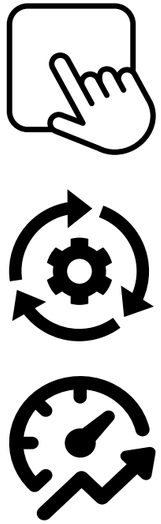
Introduction

The Deep Retrofit Pay for Performance (P4P) incentive program provides a payment incentive that is based on *verified* electricity savings achieved at the pre-approved participant site. The project upgrades and/or retrofits must occur during the term of an executed Participation Agreement.

The program is intended to encourage deep retrofits that result in significant energy savings of at least 15 percent of the building's baseline electric consumption from capital equipment upgrades. Upgrades include any and all types of value-added energy efficiency improvements, such as HVAC, lighting, envelope renovations, etc.

There are three distinct phases of the P4P program.

1. **Application** Phase:
    - Identify project
    - Apply online
    - Create baseline
    - Sign Participation Agreement
2. **Implementation** Phase:
    - Implement and test energy conservation measures (ECMs) prior to start of performance period
3. **Performance** Phase:
    - Measure and verify savings
    - Continue to implement ECMs
    - Model performance and report savings annually



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APPLICATION PHASE

1. To start the process, your management and facility team should identify the deep retrofit energy efficiency measures you intend to implement. The expected performance improvements from capital improvements must achieve a minimum of 15 percent electricity use savings.
2. Once that is determined, then your team must fill out and submit the P4P Application to Seattle City Light. Appendix G page 107 provides an example which is available online.
3. Seattle City Light will review the application to determine if your building meets the program's eligibility requirements.
    - This review will also include a preliminary determination as to whether the building's energy use can be modeled in a way that is consistent with Seattle City Light's Measurement & Verification Guidelines.
4. Seattle City Light will notify your team if the building is eligible to participate in the Deep Retrofit Pay for Performance Program.
5. If the building is eligible, Seattle City Light will provide your team with interval consumption data and weather (temperature) data to use to create your baseline energy consumption model, this assumes that Seattle City Light meters used on the premise are interval meters.

6. Once this first phase is completed and your team decides to proceed, then your P4P team must complete a more detailed baseline report and baseline energy consumption model that is consistent with the criteria outlined in the Measurement & Verification Guidelines.
    - If you do not have internal capability to produce your own baseline energy consumption model, you can request that Seattle City Light produce all baseline and performance models.
    - If Seattle City Light determines that your building's Measurement & Verification provider cannot provide an energy consumption model to the accuracy required for program participation, then City Light will conduct its own Measurement & Verification. In that event, you can use this Seattle City Light data to serve as your project's tracking and monitoring baseline model throughout the duration of the Agreement.
    - Regardless to whether your P4P team uses its own internal modeling and tracking system, it will be necessary to integrate your information into Seattle City Light's tracking form. In addition, your P4P team must share any supporting documentation required by the Measurement & Verification Guidelines.
7. If the baseline report and model are accepted by Seattle City Light, then City Light will prepare a Participation Agreement based on your intended program path (term and incentive structure).
    - Note that if the baseline model is not accepted by Seattle City Light, then your team can revise the model and resubmit OR agree to accept the results of the model created by Seattle City Light, provided that City Light's model meets the accuracy requirements.
8. Once the Participation Agreement package is finalized and signed by both parties, then the implementation period begins.
9. Buildings deemed not eligible for participation in the Deep Retrofit Pay for Performance program may still participate in other Seattle City Light incentive programs.

Program Disclaimer

Participants must comply with all P4P Program Requirements as a condition for receiving incentive payments from City Light. Seattle City Light retains absolute discretion to determine whether Participant has successfully met Program Requirements and whether the project is otherwise eligible for incentive funding. Seattle City Light reserves the right to withhold all or some incentive payment if it determines that the Participant has not followed some or all Program Requirements or that the project has not achieved Seattle City Light energy savings goals.

P4P Program Options

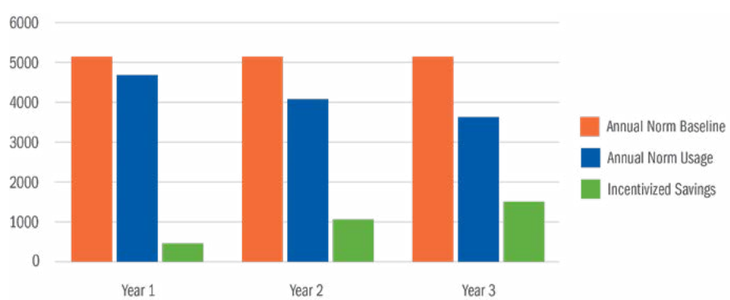
Seattle City Light provides financial incentives for *normalized* electricity savings (normalized using TMY3 weather data) achieved during a three- or five-year performance period. Incentive payments are made at the end of each year of the performance period. The incentive rate differs depending on the program path option selected by the customer.

Three-Year Performance Period (Persistence Path) The three-year path offers an incentive rate of $0.08/kWh. Incentive payments are made on the normalized cumulative savings achieved over the baseline at the end of each year.

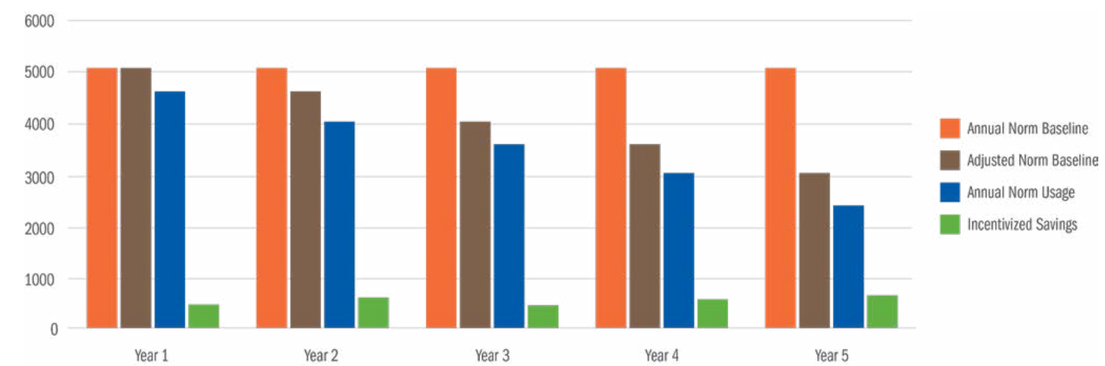
Five-Year Performance Period (Tiered Path) The five-year path pays $0.18/kWh on the normalized *incremental* (*new*) savings achieved year-over-year for each year of the performance period, with the baseline "resetting" each year. The baseline will be re-set at the prior year consumption level and then future incentives are paid out only on incremental savings above this new baseline. Projects are eligible for a bonus incentive rate once cumulative electricity savings for the project exceed 15 percent of the initial baseline.

For both options, funding is capped at 70 percent of the total project cost (capital investment and invoiced professional services related to energy conservation measures).

Three-Year Path



Five-Year Path



Savings level at end of the performance year	Incentive paid on incremental savings
0 - 14.99%	$0.18/kWh
15 - 19.99%	$0.20/kWh
20 - 24.99%	$0.22/kWh
25 - 29.99%	$0.24/kWh
30 - 34.99%	$0.26/kWh
35 - 39.99%	$0.28/kWh
40 - 44.99%	$0.30/kWh
45 - 49.99%	$0.32/kWh
50 - 100%	$0.34/kWh

Eligibility Requirements

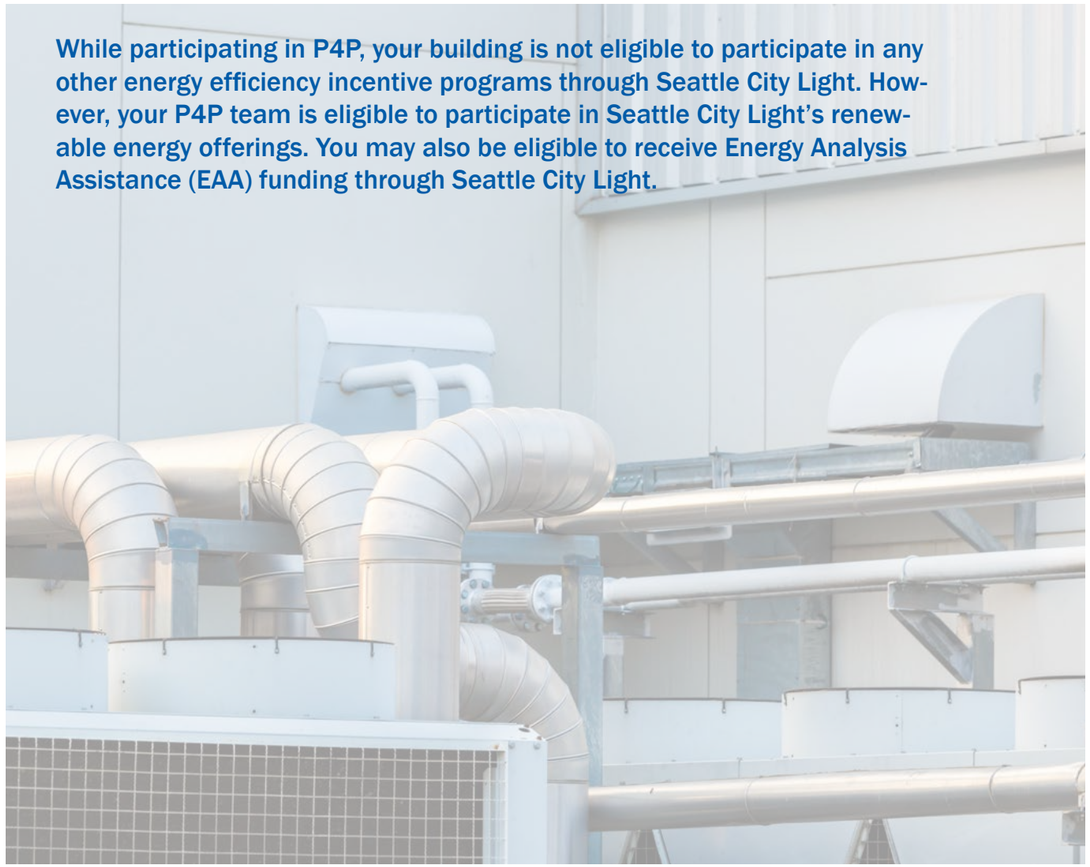
In order to participate in the Seattle City Light Pay for Performance Deep Retrofit program, your project must meet the following eligibility requirements:

- **Identify Project Site**. Proposed site is a commercial building with at least 50,000 square feet of conditioned non-residential space OR that, in Seattle City Light's determination, uses approximately 15 percent more energy than a typical building of the same type.
- **Establish Project Boundary**. A measurement boundary can be established to meter and track all energy used by the designated project site for the baseline, implementation, and performance periods.
    - Heating, cooling, or other energy supplied to the building from outside sources or suppled to other buildings from the project site must be metered sufficiently to track energy use within the project boundary and included in the regression model.
- **Create Deep Retrofit Plan**. Estimated annual potential electric savings from planned capital equipment improvements (HVAC, lighting, envelope, etc.) identified in the project application and intended to be installed during the P4P agreement term will meet at least 15 percent of the building's baseline electric consumption.
- **Use Interval Data**. Hourly or 15-minute interval data is available for the building's electricity consumption. Consumption data may come from either a utility meter, or customer-supplied building level interval data (BMS/pulse meter). Customer-supplied data is subject to validation and acceptance by Seattle City Light.
- **Create Model & Analyze**. Building energy use has been stable over the past year and in Seattle City Light's determination can be modeled using linear regression analysis. Baseline model must meet criteria detailed in the M&V Guidelines Appendix F, page 105, including goodness-of-fit metrics:
    - Normalized Mean Bias Error (NMBE) <0.005%
    - Estimated savings relative precision <25%
    - Coefficient of Variation, Root Mean Square Error (CV-RMSE) <25%
    - T-statistic for independent variable(s) larger than 1.282 for 80% confidence

The Deep Retrofit Pay for Performance program begins once the Participation Agreement is signed. Once signed, your team can implement the planned energy conservation measures that will count towards Seattle City Light's P4P incentive payments. Note that the performance period must begin within one year after you have signed the Participation Agreement.

Seattle City Light has created a thorough tracking system for Measurement and Verification. As a condition of participating in the Deep Retrofit P4P program, each participant must use Seattle City Light's P4P Workbook and create and maintain your own Energy Management Information System (EMIS). More information about the EMIS can be found.

While participating in P4P, your building is not eligible to participate in any other energy efficiency incentive programs through Seattle City Light. However, your P4P team is eligible to participate in Seattle City Light's renewable energy offerings. You may also be eligible to receive Energy Analysis Assistance (EAA) funding through Seattle City Light.



Implementation Details for Both Program Paths

1. **Install & Implement**. Start installing and implementing your P4P Team's planned energy conservation measures (ECMs).
2. **Have 12-month window**. The program includes a 12-month window, starting once the Participation Agreement is executed, to allow time to order and install equipment and implement ECMs, prior to the start of the performance period. However, you can request that the performance period begin at any time within those first 12 months.
3. **Start M&V**. The performance period automatically begins 12 months after the execution date of the Participation Agreement unless an earlier start date is agreed upon.
4. **Submit Report Three Months After Implementation Period Ends**. All P4P teams must submit an implementation period report using the P4P Workbook. The report should include all necessary supporting documentation at the conclusion of the implementation period that:
    - Summarizes ECMs completed in the implementation period.
    - Identifies any major changes to the building or non-routine adjustments that occurred during the implementation period.
    - Summarizes ECMs still in progress.

1. **Track & Monitor Performance**. Continue to implement ECMs as listed in the P4P Workbook's ECM Tracker tab.
2. **Generate Quarterly Reports**. Report quarterly summarizing status of energy conservation measures and log any significant changes in the building (non-routine events) once every three months.
    - Participating P4P teams must use the quarterly report template provided in the P4P Workbook.
    - The first quarterly report is due six months after commencement of performance period.
    - Subsequent quarterly reports are due every 90 days after initial quarterly report.
3. **Submit Annual Report**. Each P4P team participant must produce a normalized baseline and performance model and report for each performance year. Your team should use the P4P Workbook to report on the baseline and annual performance periods to Seattle City Light, and provide all supporting documentation as specified in the M&V Guidelines. The annual report will also include the modeling techniques used and demonstrate how the reported savings are associated with efficiency and conservation measures.
    - The annual report is due six months after end of each yearly performance period.
4. **Receive Annual Incentive Payment**. Seattle City Light will pay the participating City Light customer the annual performance incentive based on the verified normalized annual savings for each performance year based on the program options chosen during the application process.

Participant Obligations

The Seattle City Light Deep Retrofit P4P program relies on robust tracking, monitoring and analysis. As a condition of receiving P4P funding, your team must commit to establishing and maintaining an Energy Management Information System (EMIS) that can track progress and uses linear regression models for analysis. The Baseline and Annual reports must meet Seattle City Light Guidelines specified in the Participation Agreement regarding regression modeling, tracking, and analysis.

Assigning a dedicated team lead or staff person to the effort will ensure that measurement and verification systems are maintained and that your team maximizes the full financial and technical benefits from this program.

Seattle City Light requires that at least one member of your P4P team brings technical background and experience related to performance-based projects. Your P4P team lead should have sufficient knowledge and expertise in M&V protocols as demonstrated via:

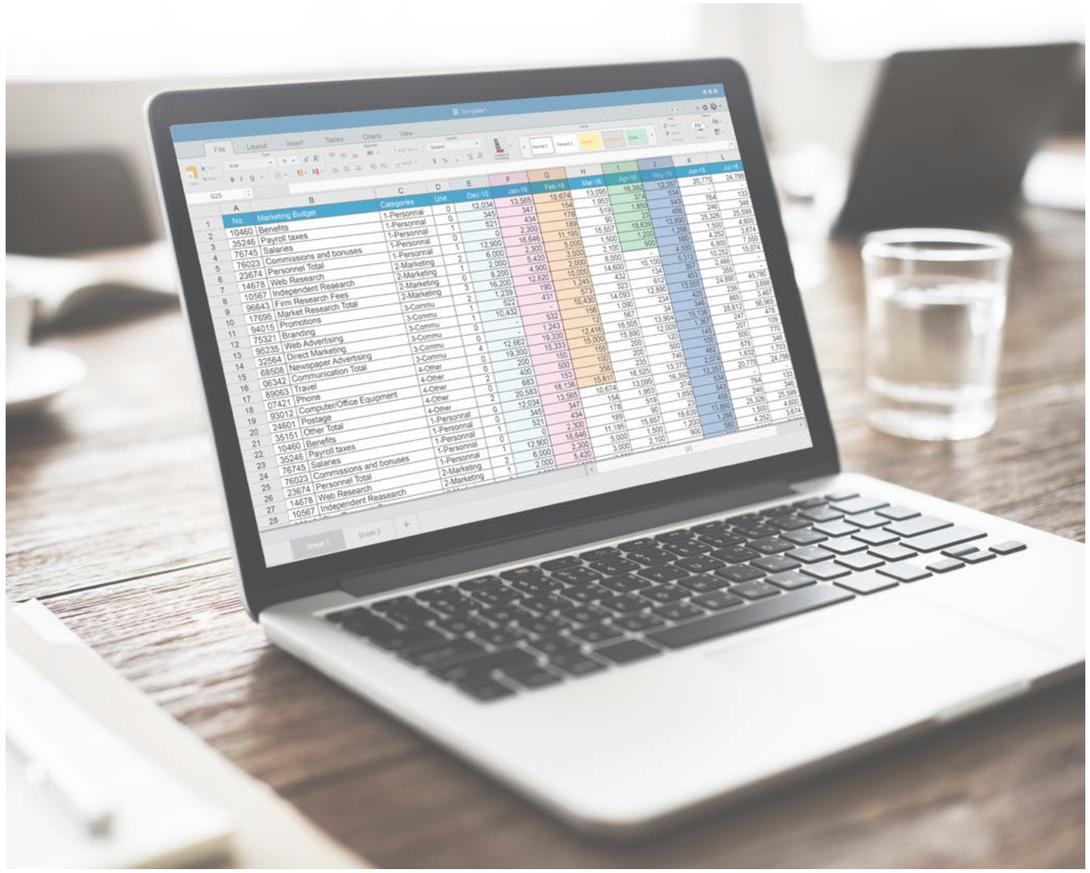
- M&V plans developed in accordance with International Performance Measurement & Verification Protocol (IPMVP) Option C
- Published reports or case studies of performance-based M&V projects and involvement in those projects
- Client references
- Relevant academic coursework and/or research in relation to performance-based M&V, such as Certified Measurement and Verification Professional (CMVP®), Certified Energy Manager® (CEM®), or similar industry qualifications
- Other types of relevant M&V training

Ideal M&V Team Lead

Ideally, the person who leads the monitoring and analysis will bring statistical knowledge and experience in energy efficiency monitoring. Specifically:

Dedicated team member who can create or maintain their own statistical regression model and demonstrated understanding and experience in:

- Best practice M&V techniques
- Knowledge regarding how weather and other possible independent variables and efficiency measures affect end use systems
- Know how to apply performance-based savings estimation techniques, particularly regression analysis



Conditions for Payment

Provided that all measurement and verification systems and reporting requirements meet expectations, Seattle City Light will issue your Incentive Payment. Incentive payments are based on verified electricity savings, normalized for weather, and will be paid annually.

Seattle City Light staff will review all documentation for completeness and accuracy. If Seattle City Light determines, in its sole discretion, that program requirements have been met, Seattle City Light will issue payment. Please note that due to administrative processing the incentive payment may take up to 8 weeks from the time of review completion.

The Fine Print

P4P Participants are NOT eligible for other Seattle City Light energy efficiency incentives, including direct Point-of-Sale incentives, during the duration of the Agreement. Solar incentives are permitted but will occur under a separate contract. Any on-site generation must be outside the project boundary and separately metered.

Any existing incentive agreements can be completed prior to execution of a P4P Participation Agreement, or existing incentive agreements can be terminated, and then incorporated into the Participation Agreement, if appropriate. Participant may choose which option to take, subject to approval by Seattle City Light.

Purchases of lighting or other products with direct point-of-sale utility rebates or incentives should be avoided, or incentives removed from the costs paid by P4P Participants.

Participants will be provided with notice of distributors and products that include Seattle City Light incentives at the point of sale, when the Participation Agreement is executed.

Participant submittals will be examined by Seattle City Light to determine if efficiency measure installed during the P4P contract period have already been incentivized at the point of sale.

Any point of sale incentives received by the Participant during the P4P contract period will be deducted from the annual incentive payment to prevent "double-dipping" of incentive funding.

Approved Seattle City Light Incentives will only pay for verified electricity savings.

Normalized electricity savings accepted by Seattle City Light as valid must exceed the savings uncertainty by a factor of 4 or greater (@ 80% confidence) for an incentive payment to be issued.

Incentive payment will be made for all verified savings Seattle City Light determines, in its sole discretion, are indicated by the model.

Incentive funding will not exceed 70% of costs incurred by the Participant for efficiency measures and invoiced professional services associated with their program participation.

Participants not implementing a mix of ECMs primarily composed of capital equipment upgrades are subject to termination from the program. The Deep Retrofit Pay for Performance program incentive rates are based on a mix of energy conservation measures with an average measure life of 10 years. Capital equipment upgrades have measure lives of 12 or more years, whereas O&M measures have a measure life of 3 or less years. Hence capital equipment upgrades are required to justify paying the program's incentive rates.

Incentives will not be paid for fuel switching per RCW 35.92.360. (Projects shall not be considered "a conversion from one energy source to another" which is limited to the change or substitution of one commercial energy supplier for another commercial energy supplier.)

Efficiency projects that potentially reduce electricity use by increasing use of another energy source (natural gas, steam, etc.), known as "fuel switching", will **have a "Mixed Fuel Analysis" conducted** as detailed in Section 2.8.1 of the M&V Guidelines. Results of this analysis will determine if fuel switching will reduce energy savings achieved and incentive payments.

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MEASUREMENT & VERIFICATION GUIDELINES

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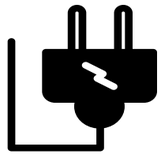
Seattle City Light designed its Pay for Performance program to encourage deep retrofits in commercial buildings which achieve savings from capital improvements greater than 15% of annual consumption. The deep retrofits should affect multiple end uses in the participating buildings. Improvements in building performance due to deep retrofits are best captured at the whole building meter level. Data-driven models use meter data and other variables to estimate performance-based savings.

1.1 Purpose

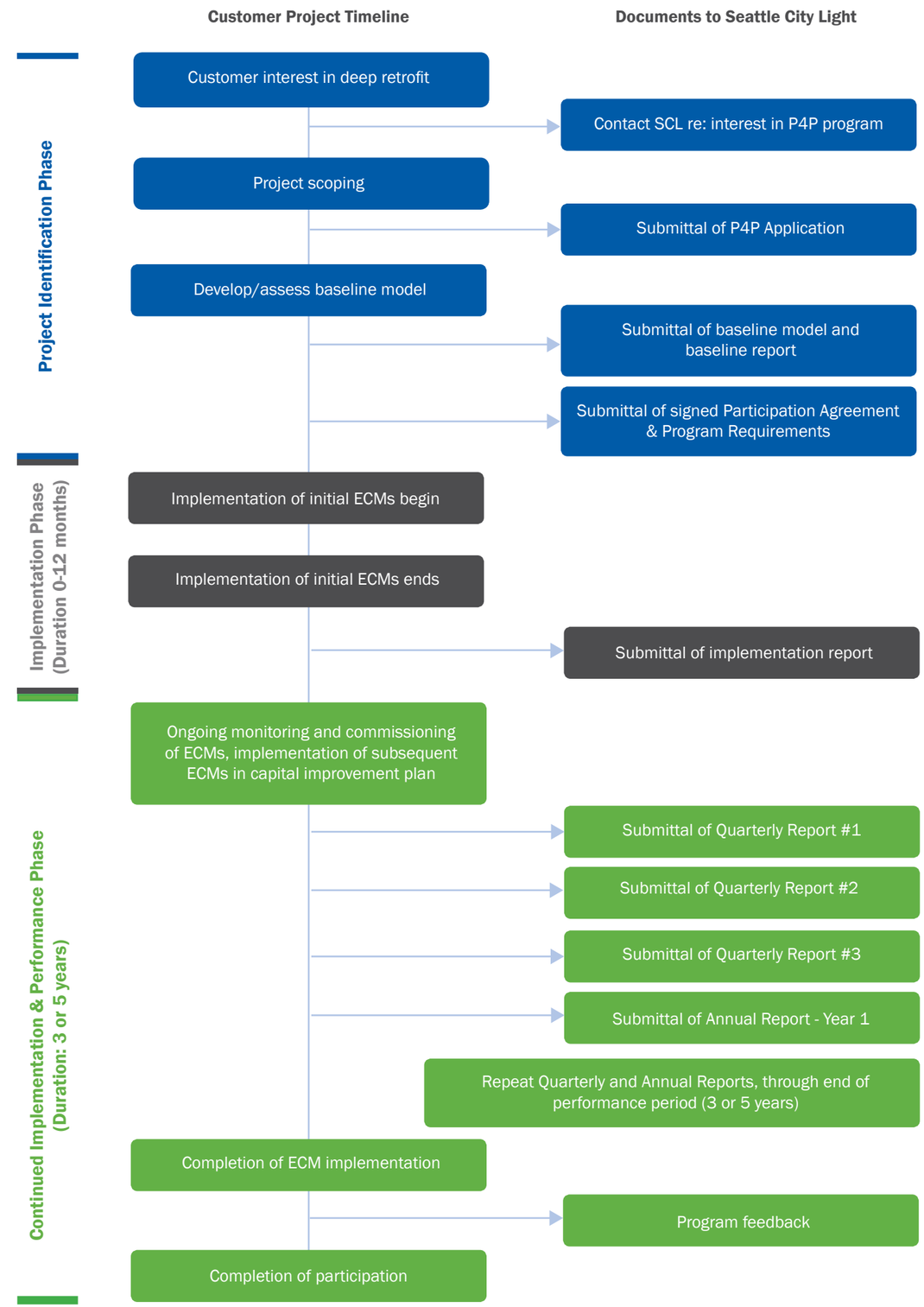


This document guides Seattle City Light's Pay for Performance program staff and participants through performance-based savings estimation at a whole-building or utility meter-level. These guidelines adhere to *International Performance Measurement and Verification Protocol (IPMVP) Option C, Whole Facility and the Bonneville Power Administration (BPA) M&V Protocols*. Per the IPMVP Option C definition, "The measurement boundary encompasses either the whole facility or a major section. This option determines the collective savings of energy conservation measures (ECMs) applied to the part of the facility monitored by the energy meter."[1] IPMVP Option C and these guidelines are for applications in which implemented measures,[2] as well as multiple independent variables such as weather or building occupancy, impact energy use.

These guidelines specify an empirical approach to estimate savings using regressions or other statistical or data-driven models. They are sufficiently prescriptive to be clear in what the program needs to have to ensure that estimated savings are acceptable, while minimizing review time.

The figure on the facing page illustrates the overall process flow. This document guides the analyst through the requirements as they pertain to M&V: Develop/assess baseline model, Ongoing monitoring of ECMs, and calculating savings to include in Submittal of Annual Reports.

1 International Performance Measurement and Verification Core Concepts, Efficiency Valuation Organization, October 2016
2 This includes capital measures as well as changes to operating practices, e.g., O&M and behavior.



1.2 Performance-Based Savings Estimation

Estimating savings from the meter is more involved than subtracting performance period consumption from baseline period consumption. Commercial building energy consumption varies with weather, occupancy, and other variables in how the spaces are used. Acceptable savings estimates from improvements incentivized by the program will come from data-driven models. These models depend on decisions about how the baseline period is defined, what type of model is used, the statistical criteria applied, the source and quality of data, the knowledge of non-routine events[3] occurring in the building, and other factors. This document will guide analysts through the many steps and decisions for sourcing data, developing models, adjusting for non-routine events, and finally estimating savings.

There are two types of savings metrics described in this document:

- *Normalized Savings* is the reduction in energy use or cost 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 a normal set of conditions. This is the metric used by the Pay for Performance program to determine savings for customer incentive payment.*
- *Avoided Energy Use* 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 weather and occupancy conditions.* This metric is used throughout the performance period to monitor changes in consumption and verify the participant is on track to meet savings goals.

3 See page 71 for thorough description of non-routine events.

1.3 Related M&V Documents

Seattle City Light's Pay for Performance M&V guidelines are consistent with industry best practices, including the BPA M&V Protocols[4], *International Performance Measurement and Verification Protocols (*Efficiency Valuation Organization, 2012*) Option C, and ASHRAE Guideline 14 (ASHRAE, 2014).*

Analysts should become familiar with these documents for more details on the savings estimation techniques this document describes.

4 Specifically, the documents Verfication by Energy Modeling Protocol and Regression for M&V Reference Guide (BPA M&V Protocols, 2011)

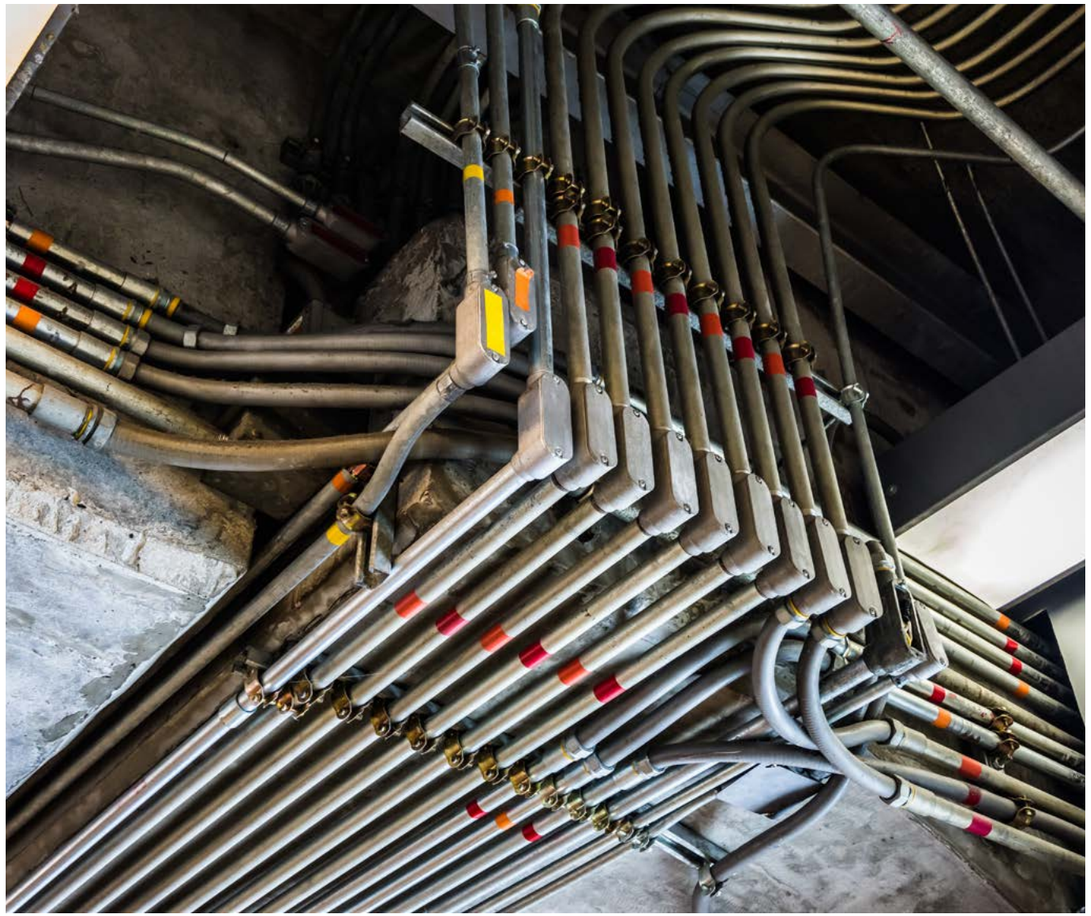
1.4 Practitioner Qualifications

Analysts developing savings models should be able to understand and apply performance-based savings estimation techniques, particularly regression analysis. "Performance-Based Savings Estimation" provides more detail about required experience and training.

2. PERFORMANCE-BASED SAVINGS ESTIMATION

This section describes how to estimate performance-based savings for Pay for Performance projects through statistical modeling of daily electricity loads (average daily demand or equivalently average daily kW).

The section first discusses the modeling periods, then describes how to develop energy models, applicable to both baseline and performance periods, and concludes with estimating savings from the modeled periods.



2.1 Project and Modeling Periods

The program structures Pay for Performance projects into three periods: baseline, implementation, and performance, with the performance period punctuated by quarterly reporting on progress and annual reporting on energy savings.

2.1.1 Baseline Period Modeling

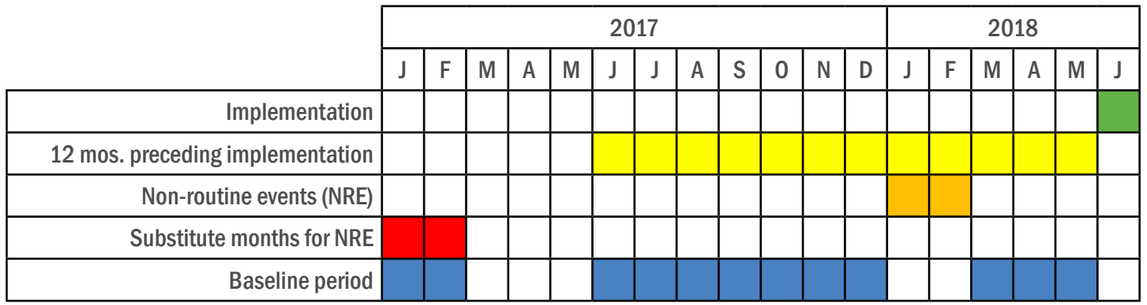
In most cases, analysts should estimate the baseline period average daily demand model from the 12 months immediately preceding the project implementation period.

When models include independent variables in addition to temperature and time (as page 57 discusses), a minimum of twelve months of baseline period data is typically necessary to ensure the model captures the normal variation of all variables.

Sometimes, the 12 months immediately preceding the implementation period includes a temporary non-routine event (as page 65 discusses). Analysts should select the baseline period in such situations to exclude the months with the non-routine event, while still including 12 unique months of data. Consequently, there will be a gap in the 12-month sequence.

Example: For Project A, the 12 months immediately preceding implementation are June 2017 through May 2018, yet there was a non-routine event during January and February 2018. The baseline period is from January 2017 through May 2018, excluding the periods March 2017 through May 2017 (which otherwise would duplicate the months) and January through February 2018 (the months with non-routine events). Stated differently, the baseline period is January 2017 through February 2017, June 2017 through December 2017, and March 2018 through May 2018. This is graphically depicted in Figure 3.

Figure 3. Adjust Baseline Period Dates Around Non-Routine Event



Shorter time periods may be acceptable if the only independent variables are outside air temperature and some component of time, such as day type (e.g., weekday, weekend, holiday). For models that use less than 12 months of data, there are coverage factor requirements[5] to ensure there is a sufficient range of weather conditions for a robust model. See Appendix A (page 85) for specifications of these coverage factors. The specifications in Appendix A provide a temperature coverage factor that exceeds guidance from Lawrence Berkeley National Laboratory (LBNL). To the extent that actual weather differs from typical conditions, the weather coverage could be somewhat reduced, but the Appendix A specifications are sufficiently conservative that the actual coverage should still meet the guidance from LBNL.

Analysts should review the residuals during baseline period modeling to identify whether energy use may have trended up or down during the baseline period in a manner unexplained by the independent variables. Residuals are measurements of the difference between the modeled and actual energy use. If the model residuals describe a statistically significant change in the energy use during the baseline period, the analyst should estimate savings relative to the rate of energy use (after accounting for the independent variables) at the end of the baseline period, rather than relative to the average rate of use during the baseline period. Handling this situation requires three general steps:

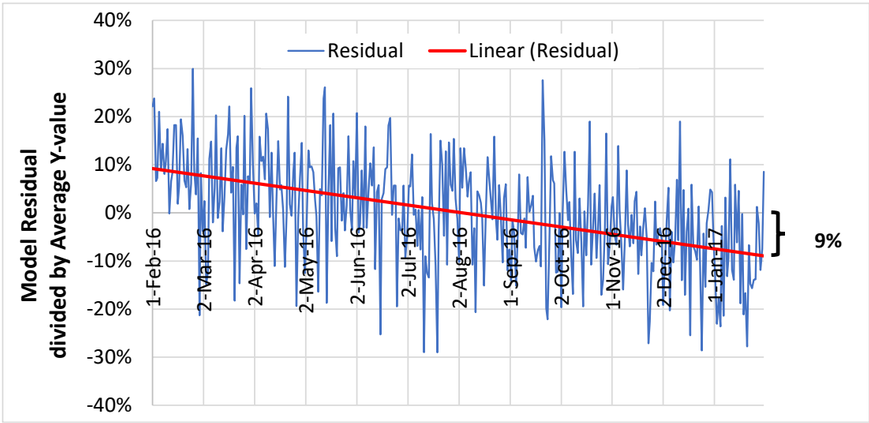
5 These requirements are based on analysis of the range of temperatures available for various date sequences in the TMY3 weather for Boeing Field.

1. Use a linear regression of the residuals versus time to establish the trend of energy use over time for the baseline period and to determine whether the trend is statistically significant, as indicated by a *t-statistic* page 106 for the slope of the trendline greater than 1.282.

2. Check whether the observed trend is due to seasonality of energy use, rather than an actual trend toward increasing or decreasing energy use. If more than one year of pre-program data is available, then analysts could model different years to see if the trend repeats each year, indicating it is seasonal. (Not all these years would be used for development of the baseline model; they are just used to check seasonality of energy use.) Also, review the treatment of holidays in the model. If holidays were included as part of the same model as other days, see if the trend persists with holidays excluded.

3. Adjust the baseline to use the rate of energy use at the end of the baseline period. Using the regression from the first step, analysts should check the percentage change from the midpoint of the regression (0% deviation from the model) to the end of the baseline period. An example of this is shown in Figure 4, where the regression of the residuals (shown in red) indicates that energy use in the baseline period was 9% lower than it was on average. In this example the adjusted baseline should be reduced by 9%. The slope of the regression line shown in Figure 4 has a t-statistic of 9.9. Since 9.9 > 1.282, this trend of decreasing energy is statistically significant.

Figure 4. Checking Residuals Trend for Changes to Energy Use Over Time



2.1.2 Implementation Period

The implementation period is the time between the contract signing and the start of the performance period, with a duration of the customer's choosing, but limited to 12 months. Participants do not need to track any non-routine events that begin and end within the implementation period and have no impact on energy consumption rates outside of that period. Non-routine events that span across baseline and implementation periods or implementation and performance periods need to be tracked (event and dates) and quantified (estimate of impact on average daily demand).

Participants should log the dates during the implementation period that each upgrade becomes operational. They should track average daily demand during the implementation period to verify the demand change closely follows the implementation of a significant energy improvement. In other words, they should be able to observe that the energy use changes as expected (direction and approximate magnitude) immediately following the implementation of an efficiency measure. This can serve as part of *verification* in M&V.

2.1.3 Performance Period Modeling

The performance period starts when participants complete the first major capital improvements, or when the maximum allotted time for the implementation period has been reached. Analysts should create a model of the performance period data as soon as a reasonable amount of data is available, as described below. They should not wait for the end of the performance period to develop the performance period model. Additionally, participants should log any non-routine events (description and date range) that occur during the performance period as they happen.

The analyst should take care to ensure that the baseline and performance models:

- Describe the same measurement boundary,
- Describe the same time period, and
- Use the same assumptions and calculations.

Analysts should begin tracking and analyzing energy performance in the early days, weeks, and months in the performance period. They can immediately begin tracking project performance by visually aligning the timing of energy use changes visible in the model with known changes in the building attributable to the Pay for Performance project. Analysts can also:

- Observe trends in energy use in the performance period,
- Look for non-routine events or gradual changes in energy use, and
- Identify whether any change points are different between baseline and performance and, if so, explore whether any observed differences make sense.

Sometimes an analyst's modeling activities uncover ways to improve project performance by revisiting the installation or adjusting its operation.

2.2 Dependent and Independent Modeling Variables

Linear regression models typically take the following form:

Dependent variable = f (independent variable)

The following sections describe the dependent and independent variables analysts should use for modeling energy savings in the Pay for Performance program.

2.2.1 Dependent Variable

The dependent variable is that which the model explains. Analysts should model average daily electricity demand (kW)[6]; that is, average daily demand is the dependent variable.

2.2.2 Independent Variables

Independent variables, also termed explanatory variables, are those whose variation drives the observed change in the dependent variable.

Many upgrade projects serve to reduce HVAC system energy use, which is strongly related to how cold or hot the weather is. Thus, outside air temperature is almost always an important independent variable (see Weather Variables, below). Models also commonly include day type.

Changing occupancy or intensity of building use can be an important consideration when there are large trends involved, such as seasonality. It is not necessary to capture the regular variation in occupancy over a day or week; day type commonly captures occupancy or intensity patterns among the days.

6 Average daily demand is preferred over daily total energy (kWh) because it is less susceptible to errors in calculations with bad or missing data.

Weather Variables

Models should only use outside-air dry-bulb temperature or degree-days for the weather variable, except in unusual cases, which must be justified. Note that, for a daily time basis, models based on degree-days are mathematically equivalent to models based on daily average outside-air temperature since the only distinction is the subtraction of a constant base temperature.

Other weather variables tend to have significant covariance with outside air temperature and usually add little to the model. In rare cases, a measure of humidity (e.g. wet bulb temperature[7]) may still be statistically significant when added to a model based on dry bulb temperature, but analysts should always include dry bulb temperature or degree-days first in a model.

Day Type

The analyst may observe that building loads vary from weekend to weekday, or perhaps among three day types, e.g., weekend/holiday, Monday/Friday, and Tuesday/Wednesday/Thursday. In this case, the model should include one or two binary variables for day type, where one binary variable would capture a weekend/weekday difference while two binary variables would capture three day types.)

Percent Occupancy

Percent occupancy can explain average demand for some building types, such as hotels and office buildings. Beds occupied, proportion of the floor space occupied, sales, and customers served onsite are examples of occupancy data.

When analysts suspect percent occupancy may be an important explanatory variable, they need to create several statistical models to determine if the final baseline and performance period models should include it. Appendix D (page 103) describes the steps for checking the importance of occupancy.

7 Wet bulb temperature is only applicable to buildings with cooling towers or other types of evaporative cooling, but it is not necessarily a statistically significant variable for every building with evaporative cooling.

2.3 Model Development

Analysts will develop two energy use models[8]: one for the baseline period and one for the performance period. Avoided Energy Use is the difference between the modeled baseline energy use at performance period conditions and metered performance period energy use. Analysts should use an Avoided Energy Use approach for performance monitoring in the initial days, weeks, and months of the performance period. This allows for immediate verification that the implemented measures are operating as expected.

Incentive payments for Pay for Performance projects will be based on Normalized Savings. The Normalized Savings approach adjusts the modeled energy use in the baseline and performance periods to reflect typical (i.e., normal) weather and operating conditions.[9]

The baseline and performance period energy models should provide accurate and transparent estimates of savings and precision. Models should follow industry and regional guidelines (see page 49).

- Models should use the fewest number of independent variables that still fit the data, as indicated by the goodness-of-fit statistics (see page 64).
- Analysts should document analyses and rationale for decisions made to ensure that all significant modeling choices are traceable.

8 Or more if there are multiple electric meters serving the building. Best practice is to develop individual models for each meter first, and this is particularly helpful for performance monitoring. Whether to develop models on aggregated meter data should be handled on a case-by-case basis.
9 The Normalized Savings approach is adherent with Option C.

2.4 Data Acquisition and Preparation

At a minimum, analysts will need to gather the following information before developing the models:

- Hourly (as-recorded) or daily average weather data for the relevant time periods (baseline or annual performance period)
  - All weather data will be from the Boeing Field NOAA weather station, which provides high quality, validated data as well as Typical Meteorological Year (TMY) historical weather data.
- Pre-implementation savings estimate, including a description of any anticipated variation in savings over time or by operating conditions
- Detailed description of all project-related activities and dates of activities
- Detailed description and dates of any significant non-project related changes to the building and its operations during baseline, implementation, or performance periods, such as tenant improvements or other capital projects, setpoint or scheduling changes, occupancy changes, or utility infrastructure failures (also known as non-routine events (see page 65 for more information).
- Data on percent occupancy or related conditions, if the modeler anticipates that average daily demand varies with occupancy
- Daily average demand (kW)[10]

Seattle City Light will provide extracts of interval consumption data to participants quarterly. Participants with MV-90 meters can use Seattle MeterWatch Green Button to access consumption data more frequently.[11]

10 Models can be based on daily average kW, which can be derived from kW observations or hourly kWh observations. Models of hourly data need to adjust for autocorrelation, and the estimation of uncertainty is challenging.
11 Visit www.greenbuttondata.org to learn more about Green Button data.

2.4.1 Cleaning Consumption Data

MV-90 meter data will require cleaning. Analysts should exclude zero values and clear outliers from the development of the baseline and performance period models. Analysts can best identify non-zero outliers using scatterplots developed for the different parts of the model (e.g., Daily Average kW vs. Daily Average Outside Air Temperature on a specific day type). Analysts should identify outliers visually by using the scatter plot, not by using percentiles. The use of t-scores or z-scores to eliminate outliers is also acceptable. The probability that a given data point is an outlier should exceed 99.95%. They can also detect outliers by plotting the hourly demand or energy data versus time. Analysts should note any obvious spikes or drops, especially to zero. They should eliminate zero values, and other obviously bad data, taking care not to eliminate rare but potentially correct values, such as high values that might occur if extra cooling equipment comes on during extra hot weather or low values that occur on weekends or holidays. Analysts should drop the timestamps with missing or bad data. As a final step to cleaning the data, analysts should corroborate the prepared consumption data with meter reads from monthly bills and address any discrepancies. Analysts should document all data points eliminated during cleaning, along with the justification.

Analysts should only build models on cleaned data. They should not fill in missing or bad data by interpolation or other means, but instead leave them incomplete. Since the model will estimate Normalized Savings, and the TMY3 weather data used for normalizing is complete, the models will estimate reasonable values for annual energy use, despite having some missing usage data. Each contract year will require a new performance period model and estimate of Normalized Savings.

2.5 Model Types

Linear regression models, including linear change-point models, are preferred for clarity. This section describes the preferred temperature change-point modeling approach.[12]

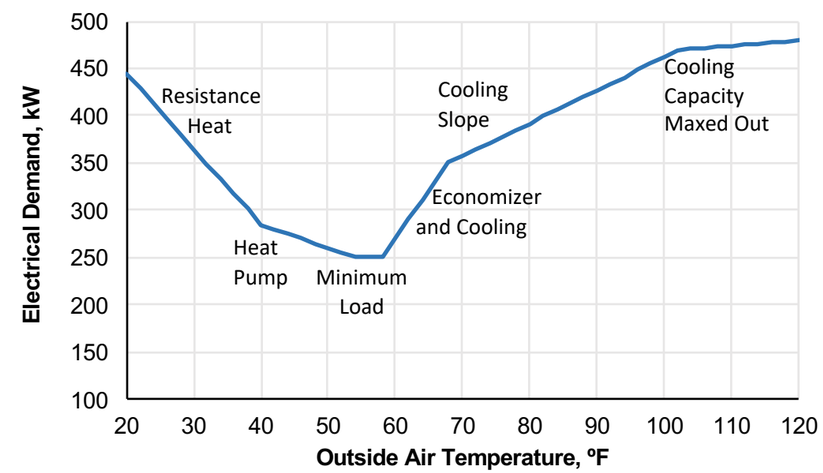
Change-point models are appropriate when there are multiple heating slopes or cooling slopes due to building physics, as will be typical for participating Pay for Performance buildings. Figure 5 illustrates possible change points between the operation of multiple types of HVAC equipment in use at a single facility. These include:

- Heat pump systems may have two relationships with temperature or degree-days: A lower slope at moderate temperatures and a higher slope at colder temperatures due to the less-efficient use of supplemental resistance heat.
- There may be a deadband between heating and cooling, with a change point at each end of the deadband.
- Most commercial building cooling systems have an economizer, and the relationship of cooling energy use to temperature has a higher slope in the range of temperatures where the economizer is active than at warmer temperatures.[13]
- If a cooling system has inadequate capacity at extremely hot conditions, the relationship of cooling energy use to temperature will have a lower slope at extremely hot temperatures.

For guidance on how to specify and estimate energy use models, the analyst should consult such sources as the BPA Verification by Energy Modeling Protocol, the BPA Regression for M&V Reference Guide, International Performance Measurement and Verification Protocols Option C, and ASHRAE Guideline 14.

12 Degree-day models are also allowed, but not preferred. Degree-day models typically include one heating-degrees base temperature and coefficient plus one cooling-degrees base temperature and coefficient.
13 At hot temperatures, the HVAC system is working hard and has a high demand. As temperatures cool, the load on the HVAC system reduces roughly linearly with temperature, and the system also becomes more efficient in an almost linear manner. When temperatures get sufficiently cool, that outside air can supplement the mechanical cooling; the load on the HVAC system drops much faster because of the outside air's contribution to cooling.

Figure 5. Change-Point Example



2.6 Assess Model Fitness

Analysts should use and report on the following statistics to ensure and demonstrate an acceptable model fit. The equations for calculating the specified statistical criteria are in Appendix F, page 105. These criteria will determine program eligibility and are necessary for the model to serve as an acceptable basis for estimating savings in the Pay for Performance program:

- Normalized mean Bias Error (NBE) < 0.005%, see Equation 1
- Estimated savings relative precision < 25%[14], see Equation 3
- Coefficient of Variation – Root Mean Squared Error (CV-RMSE) < 25%, see Equation 5
- t-statistics for independent variables should be greater than 1.282 for 80% confidence

When analysts conduct the baseline modeling, they should note that the Pay for Performance program determines project eligibility in part by an analysis of the estimate expected savings relative to baseline model uncertainty (see Equation 2). Uncertainty in the baseline model must be less than savings anticipated from capital measures. For example, if the anticipated savings from implemented capital measures is 19% of annual consumption, then the savings relative precision in the baseline model should be +/- 4.75% at 80% confidence, i.e., within 25% of the 19% savings estimate.

If the difference between the pre-implementation estimate of savings and the statistical estimate of savings exceeds two times that of the model uncertainty, then analysts should try to understand the difference.

When conducting the performance period modeling, the pre-implementation savings estimates will either provide corroboration of the modeled savings, or indicate a need for review of project implementation and operation. If the latter applies, then analysts should look for undocumented non-routine events or attempt to identify opportunities to improve project performance.

14 This is the uncertainty in the model predictions divided by the expected savings. ASHRAE Guideline 14 terms this the Fractional Savings Uncertainty. However, since Fractional Savings Uncertainty also describes a specific equation in Guideline 14 Annex B, and since these guidelines are not using that equation, these guidelines use the more general statistical term, relative precision.

2.7 Non-Routine Events

Non-routine events include significant, non-project related changes to the building or its operations during baseline, implementation, or performance periods. Participants will provide documentation in the quarterly reports to explain the data and/or corroborate the adjustments. They should log these events as they happen, describing what the change was, when it happened, the duration, and the anticipated impact on energy use. Ideally, participants can take advantage of tracking systems already in use in the building such as O&M jobs, capital projects, and tenant changes. Examples of non-routine events 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
- Fuel switching on water or space heat
- Temporary, one-time, or rare events, such as a software company adding one or two shifts for multiple weeks to meet a project deadline
- More examples in *LBNL Guidance on Requirements for Meter-Based IPMVP Option C Savings Claims* (LBNL 2017)

In addition to relying on logged changes to the building, analysts should review the statistical model to see whether the data reveal other time-related variation in the model residuals, indicating un-modeled changes in the building. Non-routine events that change the nature of the building's use, and thus making the baseline not representative as a predictive tool, may disqualify the building from the program.

2.7.1 Detection

Analysts may use the following approaches to detect non-routine events, as needed and available:

- Direct knowledge of the building or from the customer
- Tracking of model residuals over time
- Observations of outliers on a model scatter chart
- Calculations of the z-scores or t-scores for data points
- Program-provided algorithms

2.7.2 Characterization

Analysts should characterize each non-routine event based on:

- The time period in which it occurred
  - Baseline
  - Implementation
  - Reporting
- Whether it is a temporary or permanent change
- Its impact on energy use relative to the independent variables
  - Constant
  - Varying with time
  - Varying with weather
  - Varying with time and weather
- Varying with a different independent variable

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

2.7.3 Calculation

Analysts may estimate non-routine adjustments with statistical or engineering methods. When they use engineering calculations, the calculations should reside in the same workbook or document as the regression model so that the adjustments can easily be reviewed.

Engineering estimates for non-routine adjustments should follow the general guidance in the *BPA Engineering Calculations with Verification Protocol*.

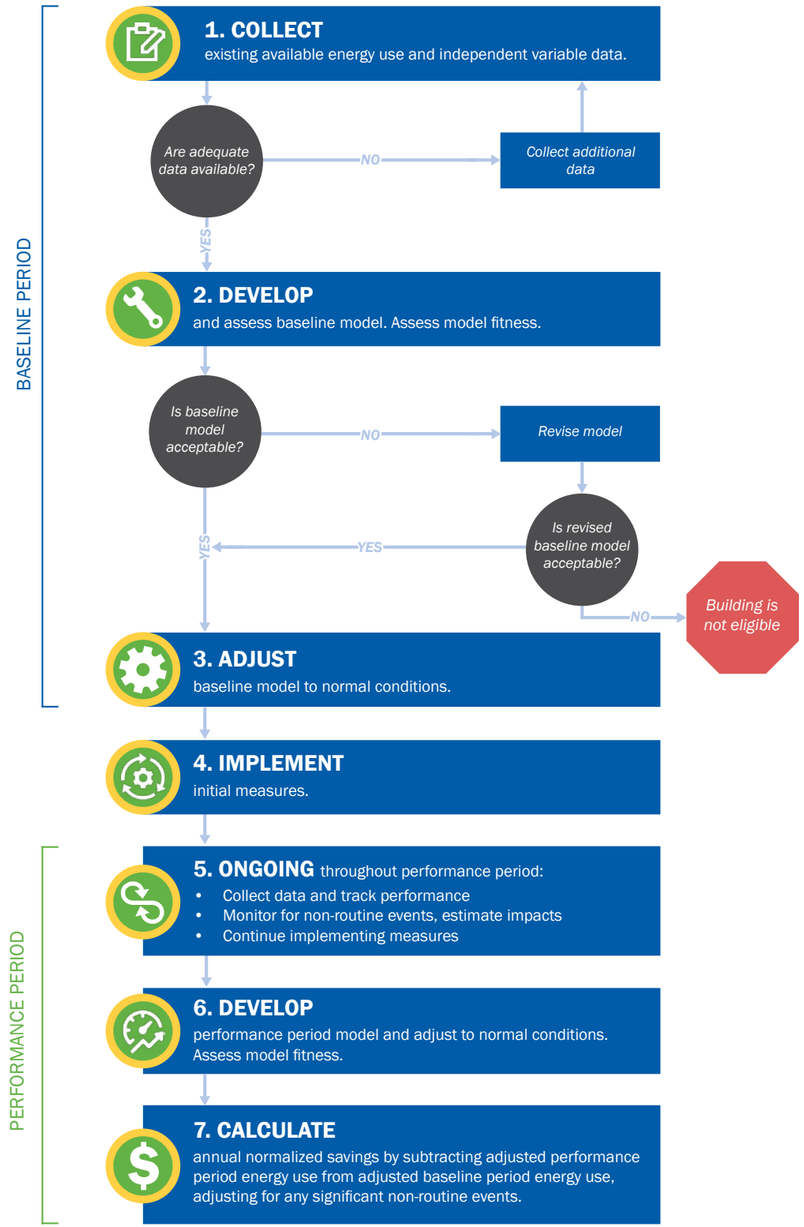
The BPA document *Potential Analytics for Non-Routine Adjustments* outlines multiple ways to estimate the impact of non-routine events from the data, and when such an approach is possible. Here is an excerpt:

If the timing of the non-routine change is not concurrent with other changes, and the signal-to-noise ratio in the data is sufficient for the quantification, there are multiple possible ways these changes can be quantified from the data, and they can include analysis of uncertainty. Here are some possibilities:

- Look at the time series of residuals for a model that includes the time period of change, and estimate the magnitude of the change from the change in the residuals.
- Treat the time periods around the non-routine change as a mini baseline and a mini post period, and model the change by subtracting the mini post period energy use from an adjusted baseline developed from the mini baseline period.
- Use a pre-post model that combines both the mini baseline and mini post periods, uses an indicator variable for the mini post period. The coefficient on the indicator variable is the non-routine event impact. This is simply a more robust method of looking at the time series of residuals.

2.8 Savings Estimation

Analysts follow the steps below to calculate Normalized Savings.



2.8.1 Mixed Fuel Analysis

During the Project Identification Phase, the participant will carry out the following additional tasks if the building heating system is mixed fuel or the project involves switching the fuel source for one or more end-uses (e.g., kitchen appliances, HVAC equipment, process heating or cooling equipment, etc.) from electricity to an alternate fuel (e.g., solar, natural gas, etc.):

1. Include "Fuel Switching" as a non-routine event and/or state that the building has mixed fuel heating in the Application. Also describe any alternate fuel efficiency measures being implemented during the performance period.

2. After developing the baseline electrical model, but prior to submitting it to Seattle City Light, estimate the contribution that fuel switching has on the overall expected electrical savings, and the overall expected increase in the use of the alternate fuel.

   a. If that contribution is less than the uncertainty of the baseline electrical model, then submit the Baseline Period Report and the baseline electrical model to Seattle City Light, which includes a statement that fuel switching is not expected to have significant impact on the electrical savings.

   b. If the contribution is greater than the uncertainty of the baseline electrical model, then, following the guidelines of Section 2:

      - If the alternate fuel was used during the baseline period, generate a baseline model for the alternate fuel.
      - Augment the Baseline Period Report with a statement that fuel switching is expected to have significant impact, and a section describing the baseline model for the alternate fuel model.
      - Submit the augmented Baseline Period Report, the baseline electrical model, and the baseline model for the alternate fuel to Seattle City Light.

For the Performance Phase, if analysts identified fuel switching during the Project Identification Phase as having a significant impact on the electrical savings, then, following the guidelines of Section 2:

1. Generate a performance period model for the alternate fuel. This step is necessary to identify if alternate fuel use increased due to fuel switching.

    a. If efficiency measures reduce consumption of the alternate fuel during the Seattle City Light P4P performance period, offsetting the increase due to fuel switching, then additional calculations are required to isolate the fuel switching impact (see "Non-Routine Events")

2. Augment the Performance Period Model Report with a section describing the performance period model for the alternate fuel.

3. Submit the augmented Performance Period Model Report, the performance period electrical model, and the performance period model for the alternate fuel to Seattle City Light.

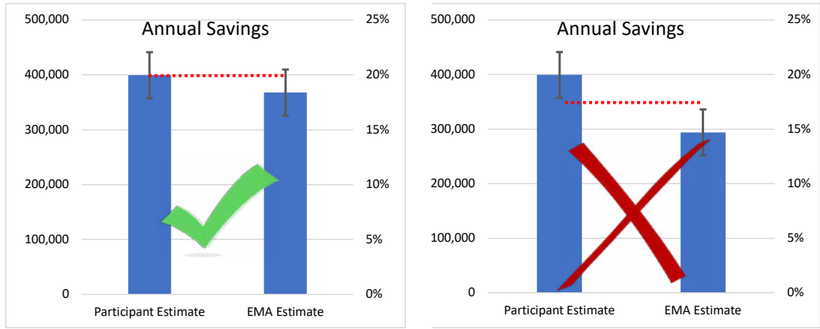
4. Augment the Performance Period Quarterly and Annual Reports with information about the impact of fuel switching on electrical savings.

2.9 Performance Monitoring and Savings Verification

Seattle City Light Energy Management Analysts (EMAs) will independently develop and maintain models for each Pay for Performance project using the methods described in this document. The EMAs will use these models to monitor performance, comparing them to expected outcomes during each quarterly performance period, and to verify savings estimates provided by participants at the end of each annual performance period.

The EMA will accept the participant-submitted savings estimate if the difference between the participant-submitted savings estimate and the EMA's savings estimate *is less* than the EMA's Uncertainty Interval, where the Uncertainty Interval is calculated by multiplying the EMA's normalized savings relative precision by two. If the participant-submitted savings estimate does not fall within the EMA Uncertainty Interval, then the participant can choose to redo their estimate or accept Seattle City Light's estimate. The EMAs model is maintained internally for verification purposes and will not be provided to participants unless Seattle City Light is providing energy modeling for the participant. Figure 7 illustrates examples of acceptable and unacceptable savings estimates.

Figure 7. Savings Estimates Within Uncertainty vs. NOT Within Uncertainty



2.10 Reporting Requirements

This section describes the reporting requirements for program participants as they pertain to and support savings estimation. Table 1 shows the intersection of the reporting guidelines and the reporting template.

More details about each component of the reporting requirements is described below.

Table 1. Reporting Guidelines & Reporting Template Cross Reference

"Reporting Template Sheet"	Reporting Requirements				
	Project Application	Baseline Period Model Reporting	Implementation Period Reporting	Quarterly Reporting	Performance Period Model Reporting
Application Project Summary	Facility description Measurement boundary Choose incentive option Capital improvements / energy efficiency project plan Anticipated changes that may occur outside of the Capital improvement Plan Document past non-routine events				
Participant Task List	Track reporting requirements	Track reporting requirements	Track reporting requirements	Track reporting requirements	Track reporting requirements
ECM Tracker		Efficiency measure planning and implementation tracker	Efficiency measure planning and implementation tracker	Efficiency measure planning and implementation tracker	Efficiency measure planning and implementation tracker
NR Activity Tracker		Document non-routine events	Document non-routine events	Document non-routine events	Document non-routine events
Occupancy Tracker		Document occupancy changes	Document occupancy changes	Document occupancy changes	Document occupancy changes
Period Report (Baseline, Implementation, Quarterly, and Annual)		Model fitness statistics Baseline Period Report survey Metered data time-series plots Modeled predictions time-series plots Normalized predictions time-series plots Scatter plots of average demand versus independent variables			Model fitness statistics Baseline Period Report survey Metered data time-series plots Modeled predictions time-series plots Normalized predictions time-series plots Scatter plots of average demand versus independent variables
Model files		Input data Model output Model graphics			Input data Model output Model graphics

2.10.1 Project Application

The Pay for Performance Project application requires the following items:

- Capital Improvement Plan
  - Description of measures including capital and operational/behavioral changes
  - Estimated implementation dates
  - Savings estimates
- Measurement boundary (i.e., which utility meters are subject to the project, all fuels)
- Facility description, including building type, building system types, space and water heating fuels, floor area by space use type, and operating schedules
- Major changes in the building during the baseline period, including recently implemented ECMs
- Anticipated changes in the building during the implementation and performance periods, other than those listed in the Capital Improvement Plan

2.10.2 Baseline and Performance Period Model Reporting

The reporting on Baseline Period Model and Performance Period Model will each clearly describe the models and their supporting data. This reporting will reference this guidance document to demonstrate how the baseline and performance period models and data comply with the requirements.

Participants must provide digital files[15] of the time series inputs and outputs for the baseline, implementation, and performance periods:

- Raw data (may have different time intervals from each other and the models)
  - Time-series of the dependent variable (actual electricity use) as received
  - Time-series of each independent variable as received
  - When relevant, time-series of alternate fuel(s) as received
- Model data (all at the same time interval)
  - Timestamps
  - Time-series of each independent variable
  - Time-series of actual electricity use or demand
  - Time-series of electricity use or demand predicted by the model
  - When relevant, time-series of actual and modeled use of alternate fuel(s)
- Model fitness statistics
  - Normalized Mean Bias Error
  - Model Uncertainty
  - Estimated savings relative precision (for performance period reporting)

15 The model data and fitness statistics should be included in the reporting workbook. The raw data may be included in separate sheets in the reporting workbook or provided in separate files if file size is very large.

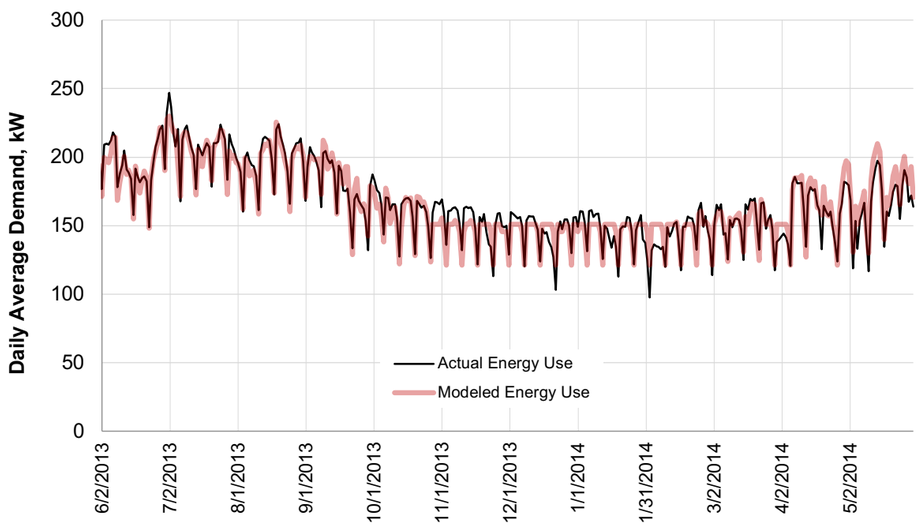
Model documentation must include time-series and scatter plots.

Time-series plots will include:

- Metered data:
  - Metered baseline period data
  - Metered performance period data
- Modeled predictions:
  - Modeled baseline period data
  - Modeled performance period data

Figure 8 below provides an example of a time-series plot of the baseline period.

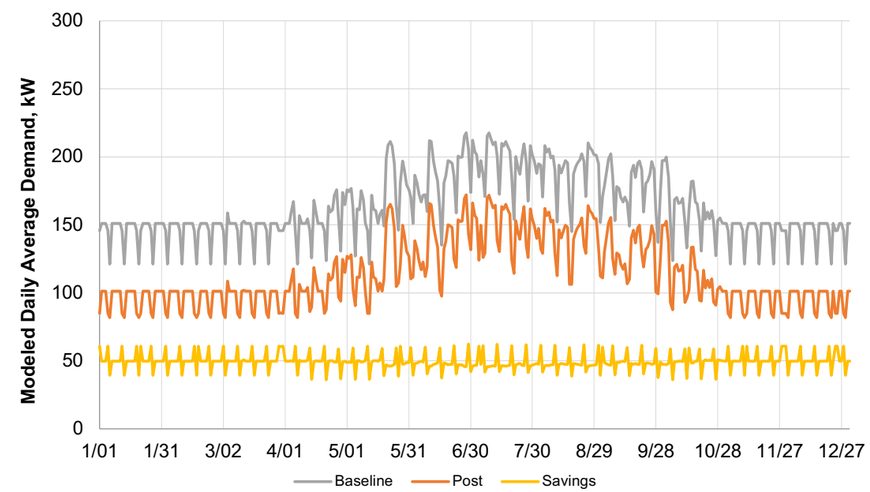
Figure 8. Average Demand and Model Predictions for the Baseline Period



- Normalized predictions:
  - Normalized baseline period data
  - Normalized performance period data

Figure 9 below demonstrates a time-series plot of the normalized savings model.

Figure 9. Normalized Use and Savings

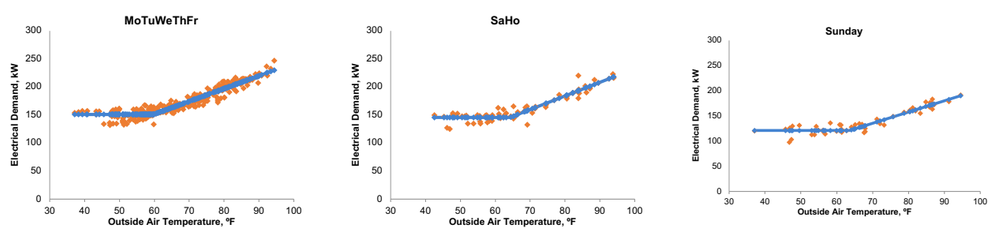


A scatter chart matrix is an effective visualization of the relationship of average demand or weather to each independent variable for ordinary linear regression with multiple independent variables (multiple regression). For models of buildings, the time variable is often categorical, rather than continuous (i.e. it could be a day type rather than a number). Analysts will provide separate scatter charts for each day type for these types of models, rather than a true scatter chart matrix. Scatter plots will include:

- Average demand versus outside air temperature or degree-days (a separate chart for each day type or occupancy period)
- Average demand versus any third independent variable (i.e., in addition to weather and time, such as percent occupancy)

Figure 10 presents an example of a scatter chart matrix.

Figure 10. Baseline Daily Average Demand vs. Temperature by Daytype[16]



16 SaHo is a daytype of Saturdays and Holidays

2.10.3 Baseline Period Report

The Baseline Period Report will include reporting on the Baseline Period Model. The report will also include a description of NREs that occurred during the baseline period as well as any impact on electrical energy consumption due to fuel switching.

2.10.4 Implementation Period Report

The Implementation Report will document each measure, including implementation and commissioning dates, as well as estimated savings. This report will also state the date when the implementation period ended and the performance period will begin. Additionally, the Implementation Report will document any non-routine events that started in the baseline period and ended in the implementation period or started, but did not end during the implementation period.[17]

2.10.5 Performance Period Quarterly Reports

At the end of Quarters 1, 2, and 3 during each annual performance period, the participant must report descriptions of the following:

- ECMs, including type, start and completion dates, and rough savings estimates for measures
  - Completed
  - Currently underway
- In planning
  - Non-routine events, including date ranges and approximate impacts on energy use

2.10.6 Performance Period Annual Reports

Each annual report will include reporting on the Performance Period Model described on page 75, as well as the resulting Normalized Savings estimate. The annual report will include a summary or compendium of quarterly reports (including a section for Q4), to provide an overview of ECMs and NREs that occurred during the performance year. It will also include any impact on electrical energy savings due to fuel switching.

17 Temporary non-routine events that started and ended during the implementation period are not required to be reported.

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M&V PRACTITIONER EXPERIENCE

In order to ensure quality of work under these guidelines, Seattle City Light requires participants' analysts to provide documented evidence of the following experience:

- Demonstrated understanding of:
  - Best practice M&V techniques
  - How weather and other possible independent variables and efficiency measures affect end use systems
- Demonstrated application of performance-based savings estimation techniques, particularly regression analysis

Examples of experience, training, and certification applicable to performance-based projects include:

- M&V plans developed in accordance with IPMVP Option C
- Published reports or case studies of performance-based M&V projects and involvement in those projects
- Client references
- Relevant academic coursework and/or research in relation to performance-based M&V, Certified *Measurement and Verification Professional (CMVP®), Certified Energy Manager® (CEM®), or similar industry qualifications
- Other relevant M&V training

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MEASUREMENT & VERIFICATION APPENDICES

APPENDIX A
GLOSSARY OF TERMS

The following definitions are from the *BPA Glossary for M&V: Reference Guide*.

Accuracy: An indication of how close the measured value is to the true value of the quantity in question. Accuracy is not the same as precision.

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. *Cost avoidance* is the monetary equivalent of *avoided energy use*. Both are commonly called *savings*. *Normalized savings* is another type of savings.

Autocorrelation, or Autocollinearity: The serial correlation over time of predictor values in a time series model. To calculate the lag-1 autocorrelation coefficient, R-squared is first calculated for the correlation between the residuals and the residuals for the prior time period. The lag-1 autocorrelation coefficient ρ is then the square root of this value.

Baseline Adjustments: The non-routine adjustments arising during the performance period from changes in any energy-governing characteristic of the facility within the measurement boundary, except the named independent variables used for routine adjustments.

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

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. See page 105 for the formula.

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 18°C (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.

Demand: The rate of energy use. Many utilities base a portion of their bills on the highest (or peak) demand they measure during each billing period. Peak demand values are sometimes referred to as simply demand. Electrical demand is normally expressed in kilowatts (kW). The sum of monthly billed kW quantities can be expressed in units of kW-months.

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).

Energy Conservation Measure (ECM): An activity or set of activities designed to increase the energy efficiency of a facility, system, or piece of equipment. ECMs may also conserve energy without changing efficiency. Several ECMs may be carried out in a facility at one time, each with a different thrust. An ECM may involve one or more of: physical changes to facility equipment, revisions to operating and maintenance procedures, software changes, or new means of training or managing users of the space, or operations and maintenance staff. An ECM may be applied as a retrofit to an existing system or facility, or as a modification to a design before construction of a new system or facility.

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

Energy Management and Information System (EMIS): A broad family of tools and services to manage commercial building energy use. These technologies include, for example, energy information systems, equipment-specific fault detection and diagnostic systems, benchmarking and utility tracking tools, automated system optimization tools, and building automation systems.

Fractional Savings Uncertainty: The uncertainty divided by 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. This is a term popularized by ASHRAE through Guideline 14 Annex B. It is twice the Relative Precision, if estimated similarly, since it covers the full confidence interval instead of half of the confidence interval. This Guideline uses Relative Precision, since it is not recommending the ASHRAE formula for Fractional Savings Uncertainty.

Fuel Switching: A conversion from one energy source to another to achieve a function fulfilled by a building system, in which there is a change or substitution of one commercial energy supplier for another commercial energy supplier; e.g., decreasing electric heating and increasing gas heating.

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).

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.

IPMVP Option C, Whole Facility: (Also known as the Whole Building Metered Approach.) Savings are determined by measuring energy use at the whole facility or sub-facility level. Continuous measurements of the entire facility's energy use are taken throughout the performance period.

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.

Measure: 1) (*noun*) an action or system modification intended to reduce energy use. 2) (*verb*) the process of quantifying a physical parameter using instruments.

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.

Measurement Boundary: A notional boundary drawn around equipment and/or systems to segregate those which are relevant to savings determination from those which are not. 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.

Model: A mathematical representation or calculation procedure that is used to predict the energy use and demand in a building or facility. Models may be based on equations that specifically represent the physical processes or may be the result of statistical analysis of energy-use data (see *regression model*).

Net Bias: Where there exists net bias, modeled or predicted energy usage will differ from actual energy usage for the period examined.

Net Bias Error, or Net Determination Bias Error: The percentage error in the energy use predicted by the model compared to the actual energy use. See Appendix E for the formula.

Normalized Savings: The reduction in energy use or cost 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 a normal set of conditions. These normal conditions may be a long-term average or those of any other chosen period of time other than the performance period. Normal conditions may also be set as those prevailing during the baseline period, especially if they were used as the basis for predicting savings. If conditions are those of the performance period, the term *avoided energy use*, or just *savings*, is used instead of *normalized savings*.

Outliers: Data points that do not conform to the typical distribution. Graphically, an outlier appears to deviate markedly from other members of the same sample.

Overspecified Model: A model with added independent variables that are not statistically significant or are possibly correlated with other independent variables.

Performance Period: The period of time following implementation of an ECM when savings reports adhere to IPMVP. This period may be: as short as the time for an instantaneous measurement of a constant quantity; long enough to reflect all normal operating modes of a system or facility with variable operations; the length of the financial payback period for an investment; the duration of a performance measurement period under an energy performance contract; or indefinite. Also known as *post-retrofit period* or *performance period*.

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 a confidence 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.

Projected Baseline: The baseline energy use or demand 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. A simple linear regression is calculated as:

$$y_i = \beta_0 + \beta_1 x_i + \varepsilon_i \quad \text{where } i=1,\ldots,n$$

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. Estimated by subtracting the predicted value (x_{hat}) from the actual value (x_i) in the data:

$$\hat{\varepsilon} = x_i - \hat{x}_i$$

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. See Appendix E for the formula.

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.

t-statistic: A measure of the probability that the value (or difference between two values) is statistically valid. 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, β, (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. The t-statistic is calculated as:

$$t_\beta = \frac{\beta}{s.e.(\beta)}$$

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 IPMVP Option C and ASHRAE Guideline 14 that determines energy and demand savings through the use of whole facility energy (end-use) data, which may be measured by utility meters or data loggers.

z-statistic: (Also known as the *Standard Score*.) The z-statistic indicates how many standard deviations an observation or datum is above or below the mean. It is a dimensionless quantity derived by subtracting the population mean from an individual raw score and then dividing the difference by the population standard deviation.

$$z = \frac{x - \mu}{\sigma}$$

Most of the documents included at least some information on most of the M&V Process topics. The review generally covered only whether the topics had any coverage, neither the extent of the coverage nor the details of the coverage. In most cases, the review covered only the most relevant portions of the documents, or specific individual documents within a larger body of work. The topics sought were:

M&V Process

Documentation requirements

Data requirements, including independent variables like weather

Data Quality Control

General Quality Control

Model selection

Model design

Model application

Non-routine events

Baselines

Model performance indicators, e.g., uncertainty

Application of avoided energy use vs. normalized savings

Timing of verification

Estimating measure life/persistence

Evaluation support

Training & Experience

Service Provider experience

Service Provider training

Service Provider approval criteria

International Performance Measurement and Verification Protocol Core Concepts

The IPMVP is foundational to most of the concepts in *The Guidelines*. As its name implies, it covers the concepts for M&V, and is less prescriptive than the other protocols and documents reviewed. IPMVP is strongest at describing the differences between avoided energy use and normalized savings, and the industry-wide use of those terms comes from IPMVP. It provides a few concepts to consider when choosing between avoided energy consumption and normalized savings. It also brought in the use of the terms routine and non-routine adjustments. The IPMVP provides explanations of non-routine adjustments, but does not provide calculation methods. It is specific that "Identifying facility changes that will require non-routine adjustments is the significant primary challenge associated with Option C, particularly when savings are monitored for long periods." The IPMVP recommends filling missing data, but flagging the savings associated with time periods of missing data. The IPMVP states that common independent variables are weather, production volume and occupancy, and includes occupancy hours and day types as possible occupancy-type variables. It discusses operational verification, but the operational verification approaches do not include detailed analysis of energy use data to verify that energy use changes match the timing of implementation. The IPMVP mentions regression in the context of Option C, but does not recommend specific models. Appendix B of IPMVP 2012 covers uncertainty, and correctly states that the methods shown for combining components of uncertainty request the components to be independent of each other. However, the example provided estimates of uncertainty by combining multiple model predictions that are not independent. Appendix B includes the statistic "mean bias error."

The Guidelines vary from IPMVP where it is out of date or not applicable to the Seattle City Light Pay for Performance program. *The Guidelines* do not recommend filling missing data since with the Normalized Savings approach estimating savings for a full (typical) year, there should be no missing independent variable data for the typical year. *The Guidelines* primary rationale for the use of Normalized Savings is different from anything mentioned in IPMVP while remaining consistent with the factors listed in the IPMVP. *The Guidelines* recommended approach for estimating uncertainty does not follow the IPMVP example; however, it is rigorous and correct for ordinary linear regression. Models used per *The Guidelines* will often not be simple ordinary linear regression, so the uncertainty estimates in *The Guidelines* still have shortcomings and are an improvement over IPMVP 2012 Appendix B. A forthcoming update to IPMVP in 2018 will supersede the IPMVP 2012 Appendix B on uncertainty. Further, IPMVP 2012 Appendix B's "mean bias error" (MBE) is similar to *The Guidelines* Net Bias Error (NBE), with the primary difference being that MBE is an average bias in the units measured (e.g. kW or kWh) while NBE is a percentage bias.

BPA M&V Protocol "Verification by Energy Modeling"

This document included information on most of the M&V Process topics but covers some topics only very briefly. Since this protocol focuses on IPMVP Option C methods, and is more prescriptive than IPMVP, it was the most relevant of all reviewed documents for *The Guidelines*. It has extensive information on documentation requirements, with emphasis on the M&V Plan. It has only limited information on data quality control and overall quality control. However, it has detailed information on reviewing and selecting the source for outside air temperature data. This protocol does not provide a prescriptive approach to model selection, but describes it as an iterative process and suggests ways of reviewing the data to help with model selection, including selection of the measurement boundary. There is very little information on non-routine adjustments. The protocol describes, in detail, the processes for both avoided energy use and normalized savings. The protocol does not cover the timing of verification, measure life, or evaluation support.

Overall, this document is foundational to *The Guidelines*. It provides detail on the use of independent variables and on model selection. *The Guidelines* embed the material throughout, not specifically in any one section.

BPA M&V Protocol "Regression for M&V: Reference Guide"

This document overlaps with the "Verification by Energy Modeling" protocol, since the Regression Guide is foundational to the Verification protocol document. It describes, in detail, the specific types of models recommended for *The Guidelines*, and hence provides information on model selection, design, and application. It provides brief mention about data outliers, and how they should be handled. This protocol's information on data preparation and pre-modeling analyses is the same as in "Verification by Energy Modeling". This protocol covers the simpler case of avoided energy use, and not normalized savings. Therefore, it describes the models in the context of a baseline. It does not cover non-routine events. The protocol is perhaps strongest in explaining statistical indicators of model performance, and the formulas for these indicators and precedent calculations. There is no coverage of measure life, persistence, or evaluation. The protocol includes the concept of categorical variables for non-numeric data, such as day types, as opposed to continuous or numerical variables, such as kWh: "Categorical variables include things like day type (weekday or weekend, or day of week), occupancy (occupied or unoccupied), and equipment status (on or off). As examples, occupancy status is a categorical variable, while number of occupants is a continuous variable."

The Guidelines follows this protocol's information on the handling of outliers. This protocol describes how the presence of multiple industry indices for bias is confusing, and suggests the use of just one. *The Guidelines* recommends the use of just this one bias index (Net Bias Error, also called Net Determination Bias Error.) The Guidelines overall recommendations for statistical indices also generally follow this protocol, although fewer indices are included in *The Guidelines*. *The Guidelines* mentions time variables as often being categorical, using day type as an example.

ASHRAE Guideline 14-2014, Measurement of Energy, Demand, and Water Savings

Guideline 14 is generally consistent with IPMVP, but goes into much more detail on requirements and the processes for meeting those requirements. It defines three approaches to determining savings that are related to the four IPMVP options: Retrofit isolation, which is related to IPMVP Options A and B, Whole Building or Whole Facility, which is the same as IPMVP Option C, and Whole Building Calibrated Simulation, which is the same as IPMVP Option D. In addition, for the Whole Building Approach, Guideline 14 describes two paths for savings determination: Prescriptive and Performance. A key distinction between the two is that the Prescriptive Path does not require estimates of uncertainty, but does have requirements for number of data points (minimum of 9 monthly points) and for a maximum CV(RMSE) of 20% with 9 to 11 months of baseline data, and 25% when a full year (minimum of 12 monthly points) of baseline data is available. The Performance Path has requirements that "The baseline data shall span the normal full range of all independent variables under normal facility operations" and that "The level of uncertainty must be less than 50% of the annual reported savings, at a confidence level of 68%."

Guideline 14 describes specific regression model types for the Whole Building approach, including linear regression, change point regression, and variable base degree-day models. It describes the tradeoff between short-interval or longer interval data in estimating savings uncertainty: "The uncertainty of regression models is inversely related to the number of points in the model, favoring a model with more granular data, but the aggregated data will have a reduced scatter and associated coefficient of variation of the root-mean-square error [CV(RMSE)], favoring a model with less granular data. Therefore, whether more or less granular data will be better is dependent on the number of points available and the scatter in the data for the chosen model type."

Guideline 14 also describes the use of categorical variables in developing energy models: "With more granular data, however, there is often a need to track more independent variables to model the energy use and demand. For example, with daily data, there may be a need to account for different day types, since energy use may be different on weekdays and weekends. Such categorical (non-continuous or nonnumeric) variables will often require separate models for each category."

"Informative Annex B" of Guideline 14, "Determination of Savings Uncertainty", provides a recommended approach and equations for estimating the uncertainty of regression-based savings models. It includes an introduction to autocorrelation (serial correlation) and a simplified means of accounting for it. "Informative Annex C Regression Techniques" also describes applicable types of regression models. Most importantly, it describes the use of "day-adjusted" models and weighted regression to handle non-uniform time intervals between energy use readings, such as with monthly billing data.

The Guidelines incorporates many aspects of Guideline 14, including the recommended model types, the use of categorical variables, the maximum Net Bias Error of 0.005%, and some of the recommended approaches to estimating savings uncertainty for these types of models. From Guideline 14's tradeoff of short-interval or longer interval data, one can infer that the ultimate determination of the best choice is based on the estimated uncertainty, rather than a specific value of CV(RMSE). *The Guidelines* applies this inference by not requiring CV(RMSE) as a statistical criteria to be met, but simply checking it as an informative metric. *The Guidelines* use a more rigorous equation than Guideline 14 for savings uncertainty estimates, while incorporating the approach to estimating the impact of autocorrelation by applying the Guideline formula for the lag-1 impact to a portion of the uncertainty calculations.

Uniform Methods Project (UMP) SEM Evaluation Protocol

This protocol is intended for utility Strategic Energy Management (SEM) programs, focusing on estimating savings for individual large commercial or industrial facilities. It "recommends the use of procedures similar to those in" IPMVP Option C, "but provides greater guidance on how to address the specific challenge of determining and evaluating energy savings achieved through SEM." Since commercial whole-building programs, including pay-for-performance, usually use Option C, this protocol was included in the review. The protocol "recommends using regression analysis to estimate the adjusted baseline because regression can account for changes in factors affecting facility energy consumption between the baseline and reporting periods." It recommends the use of daily data, and aggregating hourly data to the daily level. It states, "For most commercial buildings, candidate variables will only include cooling degree days (CDDs), heating degree days (HDDs), and possibly occupancy."

The UMP SEM Evaluation Protocol also gives recommendations of the data that the analysts should collect apart from energy and weather data, especially the SEM measures and other facility changes that affect facility energy performance. It provides detailed descriptions on defining baseline and reporting periods and developing the baseline model. It also discusses how to model alternate periods when the baseline and reporting periods do not cover the same range of operating conditions, and other topics related to model selection, design, and application. It states, "To be valid, a regression model need not exactly represent the physical energy consumption relationships in the facility. At most SEM facilities, particularly industrial facilities, these relationships are likely too complex to be represented exactly." Another valuable discussion covers automated or procedural ways to select the independent variables.

For model fit test, the protocol recommends inspection of "the model coefficient of determination (R), the regression F statistic, and the signs and statistical significance of the coefficients," but it also states, "a model with low R may still produce an unbiased, statistically significant savings estimate."

The protocol "presents five regression-based methods for estimating SEM savings," and gives examples of each. The five methods are Forecast models, Pre-post models, Normal operating conditions models, Backcast models, and Panel models. It notes that panel models (modeling aggregated groups of sites) are only "appropriate when the evaluator does not require facility-specific savings and when program populations or subpopulations have similar energy consumption characteristics." It does not provide a recommendation of avoided energy use ("Forecast Model") vs. normalized savings ("Normal operating conditions models)".

Regarding non-routine adjustments, the protocol recommends the avoidance of engineering estimates when possible, recommending "The evaluator should first attempt to account for the change in energy consumption in the regression model." For uncertainty of savings, the matrix algebra needed to estimate uncertainty for the forecast and pre-post methods is provided in Appendix A.

The Guidelines are almost completely consistent with the UMP SEM protocol. They recommend a model based on daily data. They recommend a regression method (Forecast, but using avoided energy use) and the uncertainty estimation approach is believed to be the same as presented in the UMP protocol. They recommend one weather variable, with general percentage occupancy sometimes needed. Related to the statement "a model with low R may still produce an unbiased, statistically significant savings estimate," *The Guidelines* do not require a minimum R value. They also suggest a regression approach to estimating non-routine adjustments, to the extent possible, following guidance in the forthcoming Potential Analytics for Non-Routine Adjustments document for BPA.

Where *The Guidelines* differ slightly from the UMP SEM protocol are in the use of the weather variable and in recommending temperature model types that have physical significance. For most commercial buildings, physical energy consumption relationships are not too complex to be represented well by regression models. Such models may provide not only excellent estimates of savings, but can contribute to savings by identifying operational issues. *The Guidelines* recommends the use of temperature directly, rather than the use of degree-days, but does not preclude the use of degree-days. The general rationale for recommending temperature change point models is included in *The Guidelines*, including the observation "that, for a daily time basis, models based on degree-days are mathematically equivalent to models based on daily average outside air temperature since the only distinction is the subtraction of a constant base temperature."

Evaluability Assessment for the BPA Commercial SEM Pilot Program

This document also covers many of the listed topics, and follows the prior first three listed documents. It follows BPA's plans and recommends procedures for their commercial SEM program, rather than developing completely new requirements. The SEM program will use avoided energy use. The Assessment states that the "SEM Program will use regression models as described in the BPA Verification by Energy Modeling Protocol." The document recommends that the participant document the timing of SEM (program) actions and statistical methods used to estimate non-routine adjustments when possible. It provides some general approaches to estimating non-routine adjustments using statistical methods. When engineering calculations are required for non-routine adjustments, the analyst should keep them in the same workbooks as the regression models.

In developing models, the assessment recommends that modelers

Use the fewest number of parameters that still fit the data

Always create a model of the reporting period data

Ensure that significant modeling choices are traceable

Document analyses and decision-making rationales

The Guidelines are consistent with the evaluability assessment, with the exception that *The Guidelines* recommend the use of normalized savings.

LBNL Guidance on Requirements for Meter-Based IPMVP Option C Savings Claims (draft)

This document was dated 9/7/2017 and marked draft. As a draft, we do not wish to go into detail regarding its content, but can provide a high-level summary of its contents and relationship to *The Guidelines*. The document includes recommended requirements for reporting, coverage factors for independent variables, model fitness, and charts. Appendix 1 in the document provides examples of the calculation of the fitness metrics for monthly and hourly data, and for outside air temperature coverage factor. Appendix 2 suggests "additional plots that may be useful when reviewing baseline models." Appendix 3 provides reference information on non-routine events and adjustments.

The Guidelines are generally consistent with this document, although it did not specifically cite them in their preparation. The most relevant topics were coverage factor and treatment of non-routine events. Two documents described next went into these topics in more detail and were referenced in *The Guidelines*.

Normalized Metered Energy Consumption Savings Procedures Manual (draft)

This document was an unpublished draft dated 8/23/2017. The relevant information regards weather coverage and was updated and provided by personal communication with Dr. David Jump 12/21/2017 and 12/22/2017.

The key improvement to weather coverage in this document was to include a time-based coverage component as well as a temperature coverage component. "The temperature coverage factor describes how much of the normal conditions temperatures are included within the range of the training period temperatures, expanded by 20% (10% above maximum and 10% below minimum range). The time coverage factor describes the percentage of time the temperatures in the normal conditions weather data set are within the baseline period extended temperature range."

The Guidelines based the Baseline Period Coverage Factor date ranges on meeting these requirements in a year that was the same as a TMY3 year at Boeing Field. Since an actual year would be different, *The Guidelines* set the date ranges to easily meet the requirements in a typical year, increasing the likelihood they would be met in an actual year.

Potential Analytics for Non-Routine Adjustments (draft)

This was a draft document for BPA, scheduled to be completed in first quarter 2018 and developed by the same authors as for *The Guidelines*. Building on a general framework by David Jump in the Normalized Metered Energy Consumption Savings Procedures Manual, this document recommends characterizing a non-routine event as to the time period in which it occurred (baseline, implementation, or reporting period), whether it is temporary or permanent, and its relationship to the independent variables (constant, varying with time, varying with weather, varying with time and weather, or varying with a different independent variable). Based on this characterization, it provides guidance on whether and how an adjustment calculation can be made using statistical or engineering calculations.

The Guidelines references this document and recommends its procedures.

CA AB802 and CA SB350

California's Assembly Bill 802 and Senate Bill 350 deal with the use of Normalized Metered Energy Consumption (NMEC), i.e., the use of IPMVP Option C-type models to estimate savings. Beyond that, they provide no information on the topics listed.

A section in AB802 says, the California Public Utility Commission shall, by September 1, 2016, "authorize electrical corporations or gas corporations to provide financial incentives, rebates, technical assistance, and support to their customers to increase the energy efficiency of existing buildings based on all estimated energy savings and energy usage reductions, taking into consideration the overall reduction in normalized metered energy consumption as a measure of energy savings. Those programs shall include energy usage reductions resulting from the adoption of a measure or installation of equipment required for modifications to existing buildings to bring them into conformity with, or exceed, the requirements of Title 24 of the California Code of Regulations, as well as operational, behavioral, and retro-commissioning activities reasonably expected to produce multiyear savings. Electrical corporations and gas corporations shall be permitted to recover in rates the reasonable costs of these programs. The commission shall authorize an electrical corporation and gas corporation to count all energy savings achieved through the authorized programs created by this subdivision, unless determined otherwise, toward overall energy efficiency goals or targets established by the commission."

Related language in SB350 says, "The energy efficiency savings and demand reduction reported for the purposes of achieving the targets established pursuant to paragraph (1) shall be measured taking into consideration the overall reduction in

normalized metered electricity and natural gas consumption where these measurement techniques are feasible and cost effective."

Also, "By March 1, 2010, the commission shall establish a regulatory proceeding to develop and implement a comprehensive program to achieve greater energy savings in California's existing residential and nonresidential building stock. This program shall comprise a complementary portfolio of techniques, applications, and practices that will achieve greater energy efficiency in existing residential and nonresidential structures that fall significantly below the current standards in Title 24 of the California Code of Regulations, as determined by the commission."

The language in AB802 and SB350 seems to say that existing conditions baselines should be used, without concern for code [1]. Seattle City Light plans to use existing conditions baselines for the Pay for Performance Program.

Guide for Measurement & Verification Professionals: Project Impact Assessment with Measurement and Verification Method

There were few published documents found specifically addressing M&V experience and training requirements, outside of the Association of Energy Engineers (AEE) M&V Professional certification program. Development of *The Guidelines* included reference to one document out of Australia which specified experience and training that were directly applicable to the types of qualifications an M&V analyst should possess to successfully estimate savings following the procedures in this document.

1 A subsequently released CPUC Staff White Paper on Energy Efficiency Baselines for Implementation of Assembly Bill 802 "discusses challenges in implementation of AB 802 and offers a proposal that strikes an appropriate balance between AB 802's explicit direction to define energy efficiency savings as based on existing conditions with its direction that the CPUC identify instances in which the existing conditions would not be an appropriate baseline.." The white paper was reviewed but found not to be relevant for The Guidelines since Seattle City Light is using existing conditions baseline for its Pay for Performance program.

APPENDIX C
REFERENCES

ASHRAE. 2014. *Guideline 14-2014 -- Measurement of Energy, Demand, and Water Savings*. Atlanta, Ga.: American Society of Heating, Refrigerating and Air-Conditioning Engineers. Purchase from: https://www.techstreet.com/standards/guideline-14-2014-measurement-of-energy-demand-and-water-savings?product_id=1888937

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BPA M&V Guidelines. 2011. *Regression for M&V Reference Guide*. Portland, OR.: Bonneville Power Administration. Download from: www.conduitnw.org.

California Assembly Bill 802, Chapter 590. California State 2015.

Clean Energy and Pollution Reduction Act of 2015, California Senate Bill 350, Chapter 547. California State 2015.

City of Seattle: Seattle City Light Department. November 2017. *Pay-for-Performance Pilot Program Support Final Report for One Union Square*. Prepared for Seattle City Light by Cadmus Group, Inc.

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City of Seattle: Seattle City Light Department. November 2017. *Pay-for-Performance Pilot Program Support Final Report for Lake Union Building*. Prepared for Seattle City Light by Cadmus Group, Inc.

Efficiency Valuation Organization. 2012. *International Performance Measurement and Verification Protocol – Concepts and Options for Determining Energy and Water Savings Volume 1*. Washington, D.C.: Efficiency Valuation Organization. Access via: https://evo-world.org/en/products-services-mainmenu-en/protocols/ipmvp

Energy Trust of Oregon. 2017. *Commercial O&M Measurement and Measurement and Verification Guideline for Energy Trust of Oregon's Commercial Strategic Energy Management (SEM) and Pay for Performance (PFP) Offerings*. Version 1.0 2017. Portland, OR: Author.

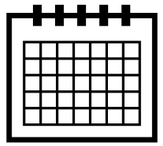
Independent Pricing and Regulatory Tribunal (IPART) of New South Wales. November 2016. Guide for Measurement & Verification Professionals: Project Impact Assessment with Measurement and Verification Method; Energy Savings Scheme. Sydney, New South Wales. Available at http://www.ipart.nsw.gov.au/

Lawrence Berkeley National Laboratory. 2017. LBNL *Guidance on Requirements for Meter-Based IPMVP Option C Savings Claims Draft*. Version 9/7/2017.

NREL. 2017. *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures, Chapter 24 SEM Evaluation Protocol*. Golden, CO: National Renewable Energy Laboratory, U.S. Department of Energy. Download from: https://www.nrel.gov/docs/fy17osti/68316.pdf.

Southern California Edison. December 2017. *Normalized Metered Energy Consumption Savings Procedures Manual*. Version 1.01. Prepared for Southern California Edison by kW Engineering. Oakland, CA.

APPENDIX D
BASELINE PERIOD COVERAGE FACTORS



For models built using less than 11 months of data, there are coverage factor requirements to ensure there is a sufficient range of weather conditions for a robust model.

For models built using less than 7 months of data (6 months minimum), the baseline period must start at these times:

- Between May 20 and September 20

For models built using 7 to 8 months of data, the baseline period must start

- Between April 10 and August 25

For models built using 8 to 9 months of data, the baseline period cannot start

- Between February 20 and March 15
- Between August 25 and November 30

For models built using 9 to 10 months of data, the baseline period cannot start

- Between August 25 and October 30

For models built using 10 to 11 months of data, the baseline period cannot start

- Between August 25 and September 30

APPENDIX E
STATISTICAL SIGNIFICANCE OF OCCUPANCY

The steps for checking the importance of occupancy are as follows:

Create the regression model normally, excluding occupancy, e.g., $y = m_1 + b$, where y is energy use, m_1 is the relationship of energy use to outside air temperature (x_1), and b is the energy use at $x_1=0$.

Create a linear regression model with the independent variable being the difference between Percent Occupancy and Average Percent Occupancy and the dependent variable being the residuals (errors) from the model without occupancy. That is, the model to adjust for occupancy would be $\Delta = m_2 \times \Delta x_2$, where m_2 is the coefficient for the change in energy use with occupancy estimated in the second step, and Δx_2 is the deviation from average occupancy during the modeled period.

The slope coefficient is the percent occupancy relationship to energy consumption. If the t-statistic for the slope is greater than the critical t-statistic for the confidence level and number of points (1.282 for 80% confidence), occupancy is statistically significant.

If the occupancy is statistically significant, add the additional intercept and coefficient to the model. The final model becomes:

$$y = m_1 \times x_1 + b + m_2 \times \Delta x_2$$

APPENDIX F
STATISTICAL CRITERIA EQUATIONS

The equations presented below apply to the baseline and performance model periods.

Equation 1. Normalized mean Bias Error =

$$NBE = \frac{\sum_{i=1}^{n}(E_i - \hat{E}_i)}{E}$$

where:

E_i is the measured energy use at time *i*

$\hat{E}_i$ is the predicted energy use at time i

E is the total energy use in the modeled period

Equation 2. Model Uncertainty =

$$t_{statistic} \times SE_{predictions}$$

where:

Std Error in Model Estimates

$$SE_{model} = RMSE \times \frac{m}{\sqrt{n}}$$

Std Error due to Model Noise

$$SE_{noise} = RMSE \times \sqrt{m \times \frac{n}{n'}}$$

Total Std Error of Predictions

$$SE_{predictions} = \sqrt{SE_{model}^2 + SE_{noise}^2}$$

Equation 3. Savings Precision =

$$\frac{\textit{Model Uncertainty}}{\textit{Savings}}$$

where:

n is the number of points in the modeled period

n' is the number of points in the modeled period, adjusted for lag-1 correlation

m is the number of points in the performance period

$t_{statistic}$ is the t-statistic evaluated at *n* - *p* at a confidence level of 80%, and *p* is the number of parameters in the model. The t-statistic should be assumed to be 1.284 for an 80% confidence level.

Equation 4. Normalized Savings Precision =

$$\sqrt{\left(t_{statistic} \times \frac{SE_{predictions}}{savings}\right)^2_{baseline} + \left(t_{statistic} \times \frac{SE_{predictions}}{savings}\right)^2_{performance}} = \frac{t_{statistic}}{savings}\sqrt{(SE_{predictions})^2_{baseline} + (SE_{predictions})^2_{performance}}$$

Equation 5.

$$CV\,(RMSE) = \frac{\left(\frac{\sum_{1}^{n}=1(E_i - \hat{E}_i)^2}{(n-p)}\right)^{1/2}}{\frac{\sum_{1}^{n}=1(E_1)}{(n)}}$$

APPENDIX G
SAMPLE APPLICATION FORM

Revised 06/23/2018

EMA:		Supv:	
Proj. #:		Date Assigned:	
Project Name:	P4P		
Facility Type:			
Facility Use:		Use Code:	
For Internal Use Only			

Seattle City Light

Customer Energy Solutions - Pay for Performance Program Application

Please enter information & send to SCLEnergyAdvisor@seattle.gov or the assigned Seattle City Light Energy Management Analyst. Questions? Call 206-684-3800.

Project Information & Site Address

Facility Name:			
Facility Address:			
City:		Zip:	

Customer Information

Company name (as it appears on W-9):				SCL Account #			
C/O (alt business name):							
Mailing Address:		City:		State:		Zip:	
Authorized Signer:		Project Contact:					
Position:		Position/company:					
Phone:		Phone:					
Email Address:		Email Address:					

Service provider information (if applicable)

Contractor Name:							
Address:		City:		State:		Zip:	
Contractor Contact:		Phone:					
Position:		Email Address:					

Measurement & Verification provider information (if applicable)

Do you plan to contract with a third party or provide your own regression model to measure and verify energy savings?			
If "Yes" then provide details on the individual responsible for creating and maintaining your regression model below.			
M&V Provider Name:		Phone:	
Organization		Email Address:	

M&V providers must be experienced in regression modeling of energy consumption. **Provide a brief summary of the modeler's experience and relevant qualifications/ certifications to demonstrate that they have the requisite experience to report valid results in the Pay-For-Performance Program (**See M&V Guidelines Section 3).

Energy consumption data security

Seattle City Light understands the value of personal and energy usage information and works to protect the information that we collect from the public. City Light can share energy usage information with account holders, but requires a signed energy consumption report release form before sharing with 3rd parties. **If energy consumption data for your project will be shared with a 3rd party (service provider, energy modeler, etc.) please complete and return an energy consumption report release from the link below.**

City Light - Energy Usage - Data, Reporting, and Compliance - https://www.seattle.gov/light/accounts/energyusage/

Incentive Option

Deep Retrofit Pay-For-Performance program participants must choose either a 3-year or 5-year incentive option. Each option has a different incentive structure. Participants in each case will have up to 12 months to install efficiency measures before the performance measurement period begins. Once a participation agreement is signed the participant must remain in the selected program option for the duration of their agreement. Complete details regarding the structure of the two options are available in the Program Requirements document and the P4P Frequently Asked Questions (FAQ) document.

Pay-For-Performance Program Documents: https://energysolutions.seattle.gov/your-business/pay-for-performance/

Program Option Choice:	Five-Year Option	Incentive Rate:	**$0.18** /kWh
Incentive Option Notes:	Annual incentive is based on normalized incremental savings achieved year-over-year for each performance year. The baseline "resets" each year". Incentive rate will increase once cumulative savings exceed 15% of baseline. Incentive increases by $0.02/ kWh per 5% reduction (>15%) from original baseline to a maximum of $0.34/ kWh. See Program Manual for details.		

Page 1 of 3

Seattle City Light

Customer Energy Solutions - Pay for Performance
Program Application

Building Information

Building systems description (HVAC systems, lighting controls, fuel types, server loads, etc.)	
Annual Electric Consumption (kWh) (if known)	
SCL Account number(s)	
SCL meter #s in project boundary (if known)	
Meter data type to be used in analysis (SCL-provided, pulse meter, submeter, etc.)	

	Building Space Use	sf (estimate)	SCL Meter #(s) Serving Space	Est. occupancy (%)	Ann. Operating Hrs.
Primary					
2° (if applicable)					
3° (if applicable)					
4° (if applicable)					

Major changes to space use, bldg systems, or occupancy over **past 2 years**	
Expected major changes to space use, bldg systems, or occupancy over **next 3-5 years**	

Energy Efficiency Project Plan

Enter a high level summary of planned energy efficiency improvements. Include an estimate of the estimated annual kilowatt hour (kWh) savings from each project.

Energy Conservation Measure (ECM) Description	Type	Est. Ann. kWh Savings	Est. Completion (Qtr., Year)
Total Estimated kWh Savings			

Seattle City Light

Customer Energy Solutions - Pay for Performance
Program Application
Legal disclosures

By placing my name below, I am requesting Seattle City Light to verify my participation and eligibility for the Program, and I acknowledge that I have fully read and understand the below terms and conditions.

Program Participant:		Date:	

This form needs to be submitted to Seattle City Light by the SCL program participant.

1) By submitting this Program Application Form, Seattle City Light ("SCL") may contact the Program applicant to evaluate project information, proposed energy conservation measures, estimate energy savings, and to request of applicants to submit all Program Forms and supporting documentation. Once SCL determines a Program applicant's eligibility for program participation, Program applicant is referred to as a "Program Participant" by SCL and may then voluntarily implement the energy conservation measures (ECMs) in accordance with applicable Program Specifications, Requirements and other Program policies and guidelines for participation in the Seattle City Light Business Conservation Program. Implement shall take its ordinary meaning, including but not limited to the installation, commissioning, replacement, or improvement of equipment or building systems for the purpose of conserving energy, or participation in any program aimed at reducing energy consumption. If, and only if, sufficient Program funding is available, and SCL can administratively verify the Program Participant's completion of all Program Forms and the implementation of the conservation measures according to Program Specifications, Requirements and other Program policies and guidelines, then SCL may issue an incentive payment to the Program Participant. **Program information, Forms, Specifications and Requirements are publicly accessible on the Seattle City Light Website for the Business Conservation Program.**

2) Since the Program is **voluntary**, Program Participant acknowledges the freedom to choose to implement any energy conservation measures in their facilities, or none at all. However, Program Participants may only receive an incentive payment if SCL determines such measures are eligible for the Program, are verified by SCL, and the project meets Program Specifications, Guidelines and other Program policies and requirements. The Program is not an entitlement program and requires complete participation and performance by the Program Participant.

3) Program Participant understands, has notice of, and voluntarily assumes any risks of injury or property damage that may arise during the implementation of energy conservation measures by Program Participant or by any third party contractor. SCL does not recommend any contractor or equipment used to implement energy conservation measures. Program Participant acknowledges that any list of past participating contractors provided by SCL is for informational purposes only.

4) **Program Participant must at all times comply with all applicable codes, ordinances, laws and regulations for all conservation measures implemented at the Site Address to be eligible for this Program**. Program Participant and/or any third party contractor selected and used by Program Participant are solely responsible for ensuring compliance with applicable codes, ordinances laws and regulations, and not SCL.

5) Program Participant acknowledges that SCL's verification process of Program Participant's project information or the implementation of energy conservation measures is not, and shall not be construed as any type of certification of compliance with any applicable codes, rules or regulations, and is for informational and Program purposes only.

6) Program Participant acknowledges that SCL does not recommend any brand or type of equipment for Participant's facility or Site Address. SCL makes no promises, representations or warranties to Program Participant of any efficiencies of conservation measures, nor of any potential or actual energy savings, nor of any merchantability or fitness of operation, use, or for any other purpose.

7) For Program Participant to be eligible to receive an incentive payment, Program Participant shall grant permission and access to SCL, during the duration of the agreement to visit the Participant's Site Address to verify existing conditions and engage in the collection of usual and customary Business Conservation Program information related to Program Participant's implementation of the energy conservation measure(s) at the Site Address. The Program Participant understands that all documentation regarding this Program is subject to a City of Seattle Public Disclosures Request and could be provided to external parties determined by state law.

8) The Program is a limited public utility subsidy that is subject to availability of funds, and any incentive amounts are subject to change or adjustment at the discretion of SCL, in accordance with applicable Program Requirements, rules, regulations, and applicable city, state or federal law.

9) Program Participant understands that a Program prerequisite to receipt of any SCL incentive payment shall be for Program Participant to read, sign and agree to the terms and conditions of the **Program Participation Agreement and Program Requirements.**

APPENDIX H
PROGRAM PARTICIPATION AGREEMENT

Seattle City Light

CUSTOMER ENERGY SOLUTIONS
PARTICIPATION AGREEMENT

SEPTEMBER 21, 2018

PROJECT NUMBER	PROJECT NAME
ESS18-XXXXX	XXXXX
CUSTOMER NAME	**SITE ADDRESS**
XXXXX	XXXXX

TERMS & CONDITIONS

This Program Participation Agreement is entered into by and between the City of Seattle, doing business as Seattle City Light (hereinafter referred to as "the City") and Customer/Program Participant" (hereinafter referred to as "Customer" or "Participant"). Customer is voluntarily participating in the Seattle City Light Business Conservation Program ("hereinafter "Program") to implement or complete energy conservation measures, including energy evaluations, behavioral, operations and maintenance, or capital installations (collectively referred to as "Measures") at the Site Address and other locations as identified on Program documents, (collectively referred to as "Project") applicable to Participant's Program Application and Project information for the opportunity to receive an incentive payment from the City for estimated energy savings and conservation purposes. All references to Customer or Participant shall mean the legal property owner, corporate officer, agent or representative of the business entity named in this agreement, notwithstanding any use of any inconsistent terms referenced herein. In consideration for Customer's participation and full performance in the Program, both parties agree to the following:

1. **Term of Agreement.** This Participation Agreement shall become effective on the date of execution and shall remain in effect for 7 years subject to any terms set forth herein. This term will consist three sequential phases: Year 1 Measure Installation, 3 or 5 (remove what is not applicable) Years Payment Term, and 3 or 1 (remove what is not applicable) Years Post Project Evaluation.
2. **Entire Agreement**. This Participation Agreement shall incorporate as terms and conditions to this agreement all attachments thereto including: The Program Requirements, M&V Guidelines, Baseline Report, and Authorized Signer Customer Reference Sheet. In the event of any conflict or inconsistency between this Participation Agreement and attachments, this Participation Agreement shall be controlling.
3. **Amendments.** If either party desires a change in the items specified in this Participation Agreement an amendment must be requested through written notice. Changes to this Participation Agreement will only be effective if set forth in a document signed by authorized representatives of both the City and the Participant.
4. **Voluntary Participation/Assumption of Risk.** Participant is fully aware of the risks and hazards connected with the activities of implementing Measures, and Participant is aware that such activities include the risk of injury and even death, and Participant hereby elects to participate voluntarily in the Program knowing that the activities may be hazardous to Participant's property and person. Participant voluntarily assumes full responsibility for any risks of loss, property damage, or personal injury, including death, which may be sustained by Participant, or any loss or damage to property owned by Participant, as a result of being engaged in such activities, to the fullest extent allowed by law.
5. **Equipment Selection, Operation and Maintenance.** Implementation of the Measure(s) shall be the sole responsibility of the Customer. Neither the City nor any of its departments, subsidiaries, affiliates and officers, directors, employees, agents, representatives or volunteers are responsible for determining whether the design,

engineering and implementation of the Measures are proper or compliant with any particular laws, codes, or industry standards. Participant understands and agrees that he/she is solely responsible for all aspects related to the Measures, energy model selections, energy model implementation, and project work at the Site Address, including but not limited to: selecting the equipment; selecting contractors to perform any Project work; inspecting the Project work and the equipment; ensuring that the equipment is in good working order and condition; ensuring that the equipment is of appropriate manufacture, design specifications, size and capacity, and that the equipment and Project are safely and properly installed and suitable for Participant's purposes; and otherwise performing and meeting all Program requirements and applicable laws, regulations and codes. Participant acknowledges and agrees that the City is not a manufacturer of, or regularly engaged in the sale or distribution of, or an expert with regard to, any equipment that Participant selected, purchased, replaced, retrofitted and/or installed under this Program.

6. **Installation and Payment.**
   a. Once an energy model for the Site Address has been verified and approved per M&V Guidelines, Participant shall implement measures at the Site Address in accordance with the Program Requirements and M&V Guidelines. Participant will provide detailed and accurate documentation to the City regarding measure installation as detailed in the Program Requirements. The City will not evaluate whether Participant is eligible for an incentive payment until implementation activities have been performed, and modelling documentation and detailed progress reports have been received by the City.
   b. The City is not obligated to pay any incentive or incentive amount until the City has performed a post-installation verification and analysis of energy savings for conservation program purposes and determined in its sole discretion that all Program Requirements and M&V Guidelines have been fulfilled to the satisfaction of the City. The City will pay the Participant the City's Program Rate as defined in the Program Requirements, unless City funding becomes unavailable, or the Program Requirements, Guidelines, and other Program policies change or limit the incentive payment, in which case the City may reduce or eliminate the payment otherwise due to the Participant. The incentive calculation rate and methodology, and the method and timing of disbursement under the Program shall at all times be in the City's sole discretion and is subject to change.
   c. Participant shall be responsible for payment of any applicable federal, state or local income and corporate tax liability associated with Participant's receipt of the City's Incentive Payment. This Participation Agreement applies to only the Program Participant and the Project at the Site Address. Should additional projects be requested by the SCL customer, new program forms must be submitted and approved by the City in accordance with all applicable Program Requirements, Guidelines and other Program policies and specifications.

7. **Building Size or Occupancy Changes.** Participant agrees to notify the City in writing of any proposed site expansions, building additions, or changes in primary facility use type for the term of this agreement. Participant also agrees to notify the City of any occupancy changes as detailed in the M&V Guidelines. A change in the structure, use or occupancy of the Building may change the incentive amount available under this Participation Agreement.

8. **Verification Inspection & Data Collection.**
   a. The Participant shall grant the City permission and access to the Site Address on request by the City following notice of one business day and during reasonable hours so that the City may perform pre- and post-installation monitoring and visual verification of the implemented Measures for the duration of this agreement. The purpose of this monitoring and verification is for the City to determine the energy savings, and if necessary, to verify Participant's compliance and performance obligations under this Participation Agreement. **The Customer understands that the scope of any visual verification and review performed by the City under this Participation Agreement does not include any kind of safety, code, or other compliance review or inspection, and is for administrative and verification purposes only.** Failure to grant permission and access to the City for the purposes set out in this section shall constitute a breach of this Agreement by Participant and may result in loss of incentive payment.

b. Participant acknowledges that the City collects and compiles certain energy information, building design specifications and the results of the design assistance, for purposes of evaluation and preparing of energy conservation reports and case studies under the Business Conservation Program. Should this energy use information not be available without tenant approval or consent following occupancy, Participant grants permission and consent to the City to obtain such information from the tenants for the same consecutive period. If the City is unable to perform monitoring or verification due to a tenant failing to provide approval of consent, the City may withhold incentive payment to the Participant regardless of whether the Participant was at fault for the failure to obtain consent from tenants.

9. **Public Records Act Compliance** – The City may release documents and records related to this Participation Agreement when the City determines it is required to do so by Washington's Public Records Act, RCW Chapter 42.56, or other disclosure laws. Additionally, as a party contracting with a governmental entity, Participant may have obligations under disclosure laws. Participant is responsible for understanding and complying with any applicable disclosure requirements.
10. **Compliance with Laws.** Participant represents and warrants that Participant, Participant's agent and employees, or any contractors retained to install or maintain the equipment, are familiar with, and at all times will comply with all applicable federal, state and local laws, codes, ordinances, rules and regulations, Program Specifications, Guidelines and other Program policies and requirements, including but not limited to those pertaining to the implementation of Measures at the Site Address.
11. **The City of Seattle Disclaimer.** THE CITY DISCLAIMS, ANY AND ALL IMPLIED OR EXPRESS WARRANTIES, including without limitation, ANY REPRESENTATIONS OR PROMISES WITH RESPECT TO THE MEASURES, MATERIALS OR LABOR REQUIRED FOR THE implementation OF THE MEASURES ON CUSTOMER'S SITE, OR THE COST OF SUCH equipment, MATERIALS AND LABOR, OR ANY ENERGY SAVINGS THAT MAY ACCRUE FROM THE IMPLEMENTATION OF SUCH MEASURES. THE CITY MAKES NO IMPLIED OR EXPRESS WARRANTIES REGARDING THIS PROGRAM, ITS POLICIES, PROCEDURES, ITS ADMINISTRATIVE VERIFICATIONS, AND / OR ANY OWNER INSTALLED equipment, OR equipment INSTALLED BY A CONTRACTOR, AND SPECIFICALLY DISCLAIMS ANY WARRANTY OR MERCHANTABILITY OR FITNESS OF SUCH equipment FOR ANY PARTICULAR PURPOSE. Any required maintenance, repair or replacement of the equipment shall be the sole responsibility of, and at the expense of the Customer. THIS DISCLAIMER SHALL SURVIVE ANY CANCELLATION, COMPLETION, TERMINATION OR EXPIRATION OF THE CUSTOMER'S PARTICIPATION IN THE PROGRAM.
12. **Indemnity/Limitation of Liability.**

a. Participant acknowledges and agrees: (i) participation in this Program is voluntary, (ii) that the City is providing limited incentive payments for estimated energy savings and conservation purposes only, and (iii) that the City assumes no liability for Participant's decision to enter into this Agreement, for the Measures selected by Participant, any third parties selected by Participants to implement such Measures, or any disputes arising out of repair or replacement of the equipment installed hereunder. To the fullest extent allowed by law, Participant agrees to release, and defend, indemnify, and hold the City, its departments, subsidiaries, affiliates and officers, directors, employees, agents, representatives or volunteers, from any and all claims, losses, harm, costs, liabilities, damages and expenses (including attorney's fees) of any nature whatsoever, or allegations thereof, arising directly or indirectly out of any act, omission, fault or negligence of Participant or any third party selected by Participant in connection with this Agreement, or the purchase, installation, or use of the equipment applicable under this Agreement, except to the extent that any such claims, losses, harm, costs, liabilities, damages and expenses are caused by the City's negligence or willful misconduct. Participant's indemnity, protection, and hold harmless obligations shall include any demand, claim, assignment, suit or judgment for damages to property or injury to or death of persons, or for any incentive payment by the City, or for any payment made under or in connection with any Workers' Compensation law or under any plan for employees' disability and death benefits. Participant expressly waives by mutual negotiation, all immunity and limitation on liability under any industrial insurance act, including Title 51 RCW, other Workers' Compensation Act, Disability Benefit Act, or other Employee Benefit Act of any jurisdiction, which would otherwise be applicable in the case of such claim.

b. To the fullest extent allowed by law, the City's liability shall be limited to paying only the City approved incentives in accordance with this Participation Agreement. The City, and its departments, affiliates and officers, directors, employees, agents, representatives or volunteers shall maintain no liability to the Participant or any other party for any other obligation under the Program. In no event, whether as a result of breach of contract, tort, or any other theory of recovery shall the City be liable in connection with this Participation Agreement or the Program for any or all special, indirect, incidental, penal, punitive or consequential damages of any nature.

13. **Governing Law and Venue.** This Agreement shall be construed and interpreted in accordance with the laws of the State of Washington. Any action at law or in equity to enforce the terms and conditions of this Agreement shall be brought solely in a court in King County Superior Court.
14. **Survivability.** The provisions of Sections 3, 4, 5, 6, 8, 9, 10, 11, and 12 shall survive the expiration, termination, or completion of the Customer's participation in the Program.
15. **Severability.** If any provision of this Participation Agreement, in whole or in part, is deemed invalid by any court or administrative body of competent jurisdiction, then these provisions shall be construed as reformed to the extent necessary to render such provision valid, and the remaining provisions shall remain in effect as reformed. The Customer and the City agree that all provisions of these Terms and Conditions are severable.
16. **Termination.** If through any cause Participant fails to comply with the obligations under this Agreement this will result in a breach of contract, and the City shall have the right to terminate this Agreement by giving written notice to Participant of such termination. Upon receipt of written notice, Participant will have 60 calendar days to cure the noncompliance or produce substantial evidence of Participant's efforts to cure. If Participant fails to do so, then the City shall terminate this Agreement.
17. **Assignment.** Neither party may assign its rights and obligations in and under this Agreement without first obtaining prior written consent of the other party. If the Participant sells the Building prior to expiration of this Agreement, consent from the City to an assignment of rights and obligations to the new owner will be contingent on executing an amendment to this Agreement identifying the new owner as the sole Participant within 30 days of the property sale. The former Participant will be prorated for any payments that owed based on final closeout report of project.

By signing this Participation Agreement, I acknowledge that I have fully read, understand, and agree to be bound by the above Terms and Conditions of this Participation Agreement for participation in the Seattle City Light Business Conservation Program.

I certify or declare, under penalty of perjury, under the laws of the State of Washington that I am the Seattle City Light customer and Program Participant, or the legal property owner, corporate officer, agent or representative of the business entity listed below, who is authorized on behalf of the Seattle City Light customer and Program Participant, to execute and agree to the terms and conditions of this Participation Agreement for participation in the Seattle City Light Business Conservation Program.

Authorized Signature of Program Participant: _____ Date: _____

Printed Name of Authorized Signer of Program Participant: _____

Title: _____