Southern California Edison

Behavioral,

Retrocommissioning

and Operational

Program Guidelines

Version 6

June 1, 2019

1.0 Executive Summary

BRO (Behavioral, Retrocommissioning and Operational, formerly RCx) is a systematic process for investigating an existing building's operations (energy-using systems) and identifying opportunities to improve occupant comfort, save energy, and lower electricity bills. BRO seeks to improve how building equipment and systems function together. Depending on the age of the building, BRO can often resolve problems that have developed throughout the building's life. In all, the BRO program improves a building's operations and maintenance (O&M) procedures to enhance overall building performance.

BRO projects are distinctly different from retrofit projects. Both seek to improve the overall energy efficiency of the facility, retrofits involve replacing inefficient or outdated equipment, while BRO focuses on improving the efficiency of the existing systems and equipment via operational non-routine maintenance or repairs. On BRO projects, the existing system always represents the baseline for determining the savings, whereas with a retrofit, building code or industry standard baselines typically need to be considered.

There is also an important difference between BRO and routine or standard maintenance. Typically, the primary goal of standard maintenance is to make repairs or address wear and tear that rectify performance degradation attributable to aging equipment. These maintenance projects are not considered BRO and are not eligible for incentives. While BRO projects may affect production as well, the primary goal of a BRO project is to increase energy efficiency and to improve upon the pre-existing operations.

BRO (Retrocommissioning) is an individually administered statewide program that provides financial incentives for energy savings resulting from permanent automated operational improvement of equipment or systems. Qualifying non-residential customers that make permanent operational changes are eligible for energy efficiency incentives based on calculated energy savings and permanent peak demand reduction.

Incentives are paid on the energy savings and permanent peak demand reduction over baseline energy performance as determined by the Utility, which in some cases include State-mandated codes, Federal-mandated codes, industry-accepted performance standards, or other baseline energy performance standards as determined by the Utility. Incentives for gas-related energy savings are eligible only in Southern California Gas Company (SCG)/SCE overlapping service territories.

Eligibility

BRO Providers must ensure that both the building and the project scope are eligible for incentives in the SCE BRO Program.

Project Start and Screening

BRO Providers working in the SCE BRO Program must be aware of program eligibility requirements. The Provider will gather information during the Project Start to confirm that candidate buildings meet Program requirements and make good candidates for operational improvements. The Customer contracts with the Provider to move forward with this process.

Section 3 of this document provides an overview of the optional screening process and the primary screening documents. Please note that the *Screening Checklist* cannot predict every question or issue uncovered during the screening process. This section should be used as a general guide for gauging a facility's suitability for BRO and the *Checklist* is a useful tool for determining if a building is a good candidate.

Investigation

During the BRO investigation, the BRO Provider conducts a rigorous analysis of the building operations. Through observation, targeted functional testing, and analysis of trend and portable logger data, the BRO Provider identifies deficiencies in the operation of the mechanical equipment, lighting, and related controls, and determines opportunities for corrective action and other opportunities that reduce energy consumption and demand.

The BRO Provider should coordinate with the building Owner to involve any primary service contractors that may be key implementers later in the process, such as their controls contractor. This will ensure that the Owner and facility staff understand what to expect and the frequency with which the BRO Provider will be visiting the facility. As a reference, the Program provides a checklist of topics to cover with the Owner before the BRO Provider begins an intensive investigation of the building (see **Attachment B: Checklists**).

It is especially important that the BRO Providers gather information on the current facility requirements, so as to be sensitive to building schedules, functions, and processes during the investigation. The Program provides a form for the Provider to use to collect this information (see **Attachment C: Current Facility Requirements Data Collection Table**).Whenever appropriate or feasible, the BRO Provider should use the building automation system trending or portable data loggers to obtain baseline data that demonstrates the problem or opportunity.

At the end of the Investigation, the BRO Provider is required to submit the Incentives Application via SCE's Online Application Tool (https://www.sceonlineapp.com/). Supporting information must be uploaded to the Online Application Tool, including all calculations and assumptions, trend and portable logger data, functional test results, building simulation parameters and results, site visit reports, photographs that were used to identify the problem or opportunity, etc. Upon approval, the BRO Provider presents the results of the investigation to the Owner, and assists the Owner in selecting the best improvements for implementation.

Implementation

BRO implementation should begin with a meeting between the BRO Provider and all project participants, including building staff and key contractors. This meeting gives the Provider an opportunity to present the approved investigation findings to the building staff and to assist and encourage the building staff in selecting a suite of measures to implement.

Verification

After measures have been implemented, the BRO Provider revisits the building to gather supporting information to verify that measures were implemented properly. The Provider uses this data to update the measures in the Installation Report with final energy and cost savings and implementation costs. All measures must have verification data; some measures will also require updated savings calculations. When feasible, verification data should include trends or functional test results, though other methods such as copies of invoices, site visit reports, and before/after photos may be acceptable.

The Provider's final task is to conduct a training session that marks the project's end – the hand-off phase. The training discusses the investigation process and results, measures that were implemented, and requirements for ongoing maintenance and monitoring. To verify the training was completed, the Provider submits the *BRO Training Completion Form* to the Program, which includes when the training was held and who attended.

2.0 Eligibility

Before starting work on a BRO investigation, the BRO Provider should make sure that both the building and the project scope are eligible for BRO incentives. The eligibility requirements should be reviewed and confirmed during project screening (see following section), and the BRO Provider must ensure that all measure eligibility requirements are met.

2.1 Building Eligibility Requirements and Characteristics

Every building is different, and should be evaluated individually for the BRO Program. Buildings will be considered on a case by case basis; however the following serve as good rules of thumb in determining a good candidate.

Minimum Requirements

- Building must be an SCE customer paying the California public goods charge
- Building must be at least 25,000 SF

Desired Characteristics

- 100,000 SF or more of conditioned space
- Energy Use: >15 kWh/SF per year
- Controls: direct digital control (DDC) system in place
- Condition of equipment: good operating condition, not in need of repair, replacement, or significant retrofit
- Commitment: committed ownership, management, and building operators
- Routine maintenance items should be done by the Owner prior to the BRO investigation. Examples of routine maintenance items include:
    - Replace or clean air filters
    - Clean evaporator coils and condenser coils
    - Mechanical components such as economizer actuators/linkages/dampers must be functional and in good working order

2.2 Measure and Project Eligibility Requirements

SCE recently introduced BRO measures for the Program. BRO stands for Behavioral, Retrocommissioning and Operational.

Behavioral measures are designed to influence customer behavior without the installation of equipment, i.e. energy audits or reports.

- Behavioral measures are not yet available.

BRO measures are designed to employ a systematic process for identifying and implementing maintenance improvements in a building to ensure persistent increased performance over time, or to bring a measure back into compliance (code). Replacement of major components such as chillers or package units would be categorized as a different installation type.

Operational measures are designed to ensure long-term business practices to maintain efficiency, i.e. establishing and following regular maintenance schedules.

BRO measures are not interchangeable. Each individual measure will have a single specific designated measure type.

Routine Maintenance

Any routine maintenance or repair activities must be completed before the BRO Provider collects data and other documentation regarding the building's baseline energy use.

Eligible BRO measures typically cover tuning the following types of systems:

- HVAC
- Lighting
- Domestic Hot Water (DHW)
- Misc. Pumps (Booster pumps, fountains, etc.)
- Refrigeration

The goal of the Program is to implement the following types of tuning measures:

- Fix problems with existing controls
- Enhance the control and operation of existing equipment

Most commonly, measures will apply to tuning the following HVAC system components and operational situations: chillers, cooling towers, economizers, air handlers, pumps, simultaneous heating and cooling, and controls.

The following items are specifically excluded from the BRO Program, but can be recommended to the owner as a courtesy:

- Retrofits. In most cases, incentives for retrofits should be pursued through the Express and Customized Solutions offerings; refer to the Solutions Directory for more information. Select retrofit measures are eligible through the BRO Program if they can meet the requirements of the accelerated replacement (AR, formerly early retirement or RET) measure classification category; these measures are labeled in the Solutions Directory with an "[AR ONLY]" tag. The CPUC gives the following definition for the AR category:
    - The Accelerated Replacement (AR, previously known as early retirement or RET) category includes measure installations where there is a preponderance of evidence that an energy efficiency program activity induced or accelerated equipment replacement. Early retirement measures must provide justification that the existing equipment being replaced would have continued to function and perform its original design intent for a period of time in absence of the replacement. This period of time is either the RUL (of not less than one year) based on actual existing equipment installation dates or the DEER default RUL. An installation date based RUL by itself will not be acceptable unless evidence of functionality to support that claim is provided. If existing equipment installation dates cannot be obtained justification of continued equipment operation for the duration of the DEER default RUL must be provided. Thus, the burden of proof to claim program-induced early retirement is not merely the need to demonstrate RUL of at least one year. A dual baseline energy savings calculation, full measure cost, incremental measure cost for the second baseline, a measure EUL with justification, existing equipment installation dates (if not using DEER default RUL), and an existing measure RUL with justification is required for this installation type. The second baseline for early retirement measures is the known

code that will be in existence when the second baseline becomes effective. The second baseline will become effective after the initial RUL period is exhausted, which could be one or more years after project installation is completed. In some cases the second baseline will not become effective until many years from now where the future governing code may not be defined. In these instances, use the latest completed code for the second baseline calculations (for example, 2016 Title 24 until a later version is completed).
(Note: Refer to the Statewide Customized Offering Procedures Manual for Business manual for additional details on the AR measure classification.)

- Lamp, ballast, and fixture replacements.
- Replacement of existing motors with premium efficiency motors.
- Major plant or distribution system conversions.
- Routine maintenance items, including:
    - Replace or clean air filters.
    - Clean evaporator and condenser coils.
    - Clean condenser scale or cooling tower media.
    - Replace cooling tower water filter or water treatment.
    - Adjust or refit fan belts.
    - Lubricate motors, pumps or fans.
- Fuel switching measures.
- Measures that don't save energy; however recommendations uncovered during the investigation that improve other items (e.g. IAQ) should be indicated in the report.

The BRO Provider should check equipment warranties, in case there are any limitations on system modifications that may be carried out. This is referenced in the Kick off Meeting checklist (**Attachment B: Checklists**).

If a previous system modification within the last 5 years was carried out using incentives (from utility or other publicly funded program), then similar measures are not eligible under this program. For example, if a VFD was installed using incentives from Customized Solutions, then optimizing those VFDs per the original incentivized scope of work is not eligible under this program. If there is doubt over the whether a measure is eligible with regard to this limitation, consult with the Program.

The BRO program is designed to upgrade existing buildings and systems by identifying instances where prevailing codes and standards were not followed at the time of the construction of the building and making the necessary changes to meet or exceed those requirements. It is recognized that there are opportunities to make changes beyond code levels with certain code measures while other measure requirements may be limited or impossible to do so. Wherever code levels can be exceeded, efforts should be made to do so. It is also recognized that each situation is different and should be evaluated on a case by case basis. Consequently, the BRO Provider should contact SCE to determine the eligibility of BRO measures that will bring a building into compliance with the building or energy code that was required at the time of the building's construction date. SCE reserves the right to evaluate the eligibility for projects based on the following considerations:

1. Whether a measure can go above and beyond code.
2. How integral is this measure to the overall package of measures?
3. What was the building or energy code requirement at the time of the building's construction?
4. Whether the proposed measure was identified in the original building design.
5. Why the proposed measure was not installed in the original building design.
6. Whether the proposed measure will only meet or exceed the original building or energy code requirement.
7. What is the payback of the proposed measure?

While testing, adjusting, and balancing (TAB) is not considered part of the scope of the Program, it may be part of a larger scope of work negotiated with the Owner. In these cases, the BRO Provider should record savings associated with the TAB work following these requirements:

- The TAB work is done because of the BRO Program and would not otherwise be done
- The TAB work corrects a deficiency and results in energy savings

While the BRO investigation focuses on low-cost improvements with short paybacks, major capital improvement opportunities may also be identified. Most add-on equipment measures (AOE, previously retrofit add-on or REA) are beyond the scope of the BRO Program; therefore, in these cases, the BRO Provider will direct the Owner to SCE's Customized and Express Solutions offering to complete the retrofits. Similarly, the BRO Provider may learn that the Owner is interested in SCE's Demand Response Program. This information should be conveyed to the SCE Account Representative.

3.0 Project Start

The project starts by the customer and a BRO Provider coming together to discuss a possible project and enter into a contract to conduct the work. In order to conduct successful projects that meet cost-effectiveness criteria for Customers, Providers, and the utility, it is important to ensure that candidate buildings meet all Program criteria and exhibit potential for high energy savings.

The Provider may want to conduct a screening during this phase in order to assess the potential for energy savings. Screening is optional but may be a desired component of the Project Start Phase of a project in the BRO Program.

The Project Start phase breaks down into two key tasks:

- Confirm Eligibility Requirements and Characteristics
- Conduct On-Site Screening if desired, using *Screening Checklist* as a guide

3.1 Provider Authorization Process

Southern California Edison's BRO program no longer utilizes program specific authorized vendors. All BRO vendors must complete the same Trade Professional training as a vendor who participates in SCE's Express and/or Customized Solutions incentive programs. For more information on becoming a Trade Professional, go to the Trade Professional tab at https://www.sceonlineapp.com.

All BRO Providers must be an approved Trade Professional before they apply for BRO incentives. All Trade Professionals must complete and/or attend all required program trainings.

All BRO program participants (SCE non-residential customers and Trade Professionals) must work with their assigned SCE account representative on every project.

3.2 On-Site Screening

The overall purpose of candidate screening is to confirm eligibility for the Program and assess the building's potential for cost-effective BRO opportunities. This is an optional step, but can help document building system and equipment information and help identify any issues that may preclude Program participation.

Screening can also help identify other projects underway (or planned) at the site that would conflict with an BRO project. If major equipment upgrades are planning or underway (e.g. chiller replacement), the Provider may elect to delay the BRO process until after this work is completed to avoid lost opportunities and/or wasted effort. Consult the Program in these cases.

On-site Screen

The Provider may conduct the screening to identify key characteristics about the building that reveal its potential as a cost-effective BRO project.

The Program has developed a *Screening Checklist* (see **Attachment A: Screening Checklist**) as a tool for the Provider to use during screening as a guide to support the collection of data at the Customer site before and during the BRO Investigation. This document does not need to be provided to the Program.

Benchmarking

Energy benchmarking a building can give an indication of its suitability for BRO. Benchmarking is often used to set investment priorities and track energy use over time, but it can also be used to give a rough potential for energy efficiency projects. If a facility uses more energy than its peers (i.e., buildings of similar use and size in a similar climate zone), it may have more opportunities for energy savings. Conversely, if a facility uses much less energy than its peers, then it may not be cost-effective for the Customer to pursue BRO if energy savings is the primary goal for the project.

The US EPA's ENERGY STAR® *Portfolio Manager* is one of the most widely used tools for energy benchmarking. ENERGY STAR can be used to benchmark a building to give a better idea of its energy savings potential. If the Customer doesn't already have an ENERGY STAR account, the Provider may want to help set one up in order to get an idea of the building's energy use relative to its peers.

3.3 Deliverables

This section summarizes the required and optional deliverables for this phase.

3.3.1 Required Deliverables

The Provider is not required to develop or submit any deliverables for this phase.

3.3.2 Optional Deliverables

The deliverables listed below are sometimes developed during an BRO process. However, the Provider is not required to develop or submit these deliverables for the SCE BRO program. If

the Provider's scope of work with the customer includes development of any of these deliverables, the SCE BRO program would be interested in seeing them; they would not be reviewed by the program, but they may help the program reviewer better understand the project.

- *Screening Checklist.* See the "Conduct On-site Screening" section above, and **Attachment A: Screening Checklist.**
- *Screening Report.* This is a summary of the on-site screen, and could include a facility description, historic energy use analysis, identified measures / indicators of opportunity, and a copy of the *Screening Checklist.*
- *BRO Plan.* Defines the goals, scope, schedule, team member roles and responsibilities, and deliverables for the BRO process.

4.0 Investigation Guidelines

4.1 Incentives

Implementation Incentive

All approved BRO measures will be eligible for an Implementation Incentive. The total Implementation Incentive will be capped at 50% of the total *project* implementation cost. Incentives will be paid at the following rates:

- $150/kW
- $0.06/kWh
- $0.75/therm (Southern California Gas Company customers only)
- Note: For the purposes of calculating implementation cost, in-house labor can be included if proof of direct project hours and costs are provided.

4.2 Required Documentation for Measures

All calculations or modeling parameters and results must be submitted for Program review, as well as the supporting trend or logged data and analysis. The Program will use this data as the baseline performance to prove implementation and verify savings for those measures that are implemented by the Owner.

Documentation for the individual findings (problems) and corresponding measures (fixes) must be detailed in the Incentives Application. Backup documentation external to the Online Application Tool is also required, including savings calculations, and BRO Providers should identify the file names for all supporting documentation uploaded to the Online Application Tool.

4.2.1 Guidelines for Documenting BRO Measures

High-quality, consistent documentation of measures is an extremely important aspect of the Program. Not only does it measure the overall success of the Program, but it also adds to the industry's body of knowledge about the benefits and cost effectiveness of BRO. For this reason, the BRO Findings Descriptions and Documentation Guidelines were developed to define field procedures and calculation methods for measuring and verifying the pre- and post- conditions for measures commonly implemented through the Program. BRO Providers are required to follow these guidelines and work with the Program to ensure that measures are properly documented and savings are verified.

A variety of measures may be implemented as a part of the Program and, with each type of measure, there may be different documentation requirements for:

- **How the issue was found** (a description of how the problem was detected should be included with the associated savings calculations);
- **How the measure is to be implemented and will save energy** (a description of the process/equipment that the measure is being applied to and how the energy savings are to be achieved should also be included with the associated savings calculations);
- **How the savings are determined;** and
- **What evidence of implementation will be provided post implementation** (the evidence of implementation should be included with the Installation Report (IR) package).

The BRO Documentation Guidelines present the requirements for each of these steps for potential BRO measures. In all, the BRO Providers must demonstrate to the Program that the measures they identify during BRO investigation are practicable and cost-effective, and collect **baseline data** in support of each measure. Before approving the *measures*, SCE will review all **savings calculations** to verify assumptions, appropriateness of the calculation, and reasonableness of the result. This will include a review of the implementation cost estimates. Then, once measures are implemented, the BRO Provider is responsible for verifying that measures have been properly installed and must provide **evidence of implementation** in order to receive the Program incentive.

The BRO Provider shall indicate a reasonable method to implement the measure that ensures the highest level of persistence that can reasonably be accepted by the Owner and operator; this information should be included with the associated savings calculations. For instance, if a measure identifies that the chilled water reset strategy had the improper setting in the BAS user screen, the simple measure would be to recommend that the setting be fixed. However, it is quite likely that the improper values will be input again. In this case, the Provider should indicate the proper setpoints and recommend that these inputs are password protected or have some type of separate input screen so that they would not be accidentally overridden. A more extreme measure would be to hard code this, although this may not be acceptable to the building operator. The BRO Provider shall indicate the chosen persistence strategy post implementation via the Installation Report (IR).

4.2.2 BRO Finding Descriptions and Documentation Guidelines

Findings Descriptions:

The BRO Solutions have been grouped into 21 common finding types, broken down into the main categories shown below. The number in parentheses is the number of finding types described within each category.

- Equipment Scheduling and Enabling (3)
- Economizer/Outside Air Loads (2)
- Controls Problems (4)
- Controls: Setpoint Changes (4)
- Controls: Reset Schedules (4)
- Equipment Efficiency Improvements / Load Reduction (4)
- Variable Frequency Drives (VFD) (1)

For a complete list of currently available BRO Solution Codes, refer to SCE's Solutions Directory available on the SCE Online Application Tool (https://sceonlineapp.com/). BRO Providers are encouraged to identify other problems or system operational enhancements that are not explicitly described in the *Guidelines*. Presumably, these findings will fit into one of the categories above, and the information within the category is sufficient to provide documentation guidance for the measure. If questions or issues arise concerning other findings, SCE will work with the BRO Provider to define the documentation requirements.

All BRO providers will be accountable for reviewing and following the Customized Calculated Savings Guidelines which is available on the BRO tab of the SCE Online Application Tool (https://sceonlineapp.com/).

- ***Finding Examples –*** Specific examples of each finding type are included for reference. Keep in mind that the examples provided do not include all possible findings in each category. Any questions that arise regarding the classification of a finding type should be communicated to the Program.
- ***Method for Finding the Problem –*** Common methods for identifying the problem are included for reference. For some measures, trending or data logging may be used to both find the problem and collect the baseline data.
- ***Calculating Energy, Demand, and Cost Savings –*** Measure-specific recommendations for calculation methods are provided, including the general strategy for custom calculations. See **Section 4.3** below for general calculation guidelines for all measures. Savings for some of the measures are independent of weather and depend only on kW and hours of operation. For measures that depend on weather, calculations of savings most often involve bins of hourly temperature data or approved simulation models. If there is potential demand reduction, the Program requires an estimate of the measure's impact on peak demand.

Guidance for Documentation:

For each finding type, the Statewide Customized Savings Calculated Guidelines (available for download on the Manuals and Guides tab at sceonlineapp.com) also describe acceptable methods for establishing a baseline and for verifying implementation of the measures. The allowable methods are separated into the order of preference. The preferred method generally involves trending or logging of actual system performance. Trending is generally the preferred method as it gives a true indication of system performance over a range of operating conditions (occupied / unoccupied, warm-up / shutdown, cool / warm OA temps, etc.). Other documentation methods are also acceptable, but require Program consent in advance of collecting the data for approval. Some findings also allow for a reduced level of rigor for documentation requirements when savings are small (less than 75,000 kWh and less than 5,000 therms).

For visual spot verification that actual system performance matches that indicated by the EMS, provide brief documentation of observations. E.g., "On 5/4/17, toilet exhaust fan EF-1 was visually observed to be off when commanded to be off at the EMS. Same exhaust fan was visually observed to be on when commanded to be on at the EMS."
Note that other data beyond that indicated in the table may need to be trended / measured for the savings calculations. For example, besides trending equipment status (on/off), the kW power draw of the equipment would need to be spot measured (for constant load equipment) to calculate savings.

Trend data may be collected using data loggers or the trending capabilities of the building's EMS. See **Sections 4.2 and 4.3** for general measurement guidelines.

Program administration must have appropriate pre-implementation baseline data. Certain data will be required for every finding, regardless of size (kWh and therm savings). The purpose is to provide documentation that demonstrates each finding and supports the savings calculations. This is essential for program quality control.

The data presented should plainly describe the deficiency or problem in such a way that a third-party reviewer who is not familiar with the building or systems can understand the details of the situation.

For example, pre-implementation requires collection of baseline energy usage data prior to any program intervention. Likewise, the post-installation data must be collected to support the derived energy savings as a result of program intervention.

4.2.3 Presentation of Trend Data Analysis

Trend data should be presented in a format that is intuitive and can be quickly and easily understood by the reviewer ("trend data" includes both BAS trend data and data logger data). Raw trend data should be provided with the supporting calculations / verification data; however an analysis of the data should also be included and charts should be developed wherever possible that clearly indicate the message(s) being delivered by the data.

Analysis

Typically, raw trend data must be analyzed before it can be utilized for calculations and presentation. Analysis techniques include:

- Filter the data as necessary to isolate only the useful data. E.g., filter data based on equipment on / off or occupied / unoccupied periods.
- Line up date / time stamps if necessary, utilizing a program such as *Universal Translator.*[1]
- Clearly distinguish between baseline data and post-implementation data.

Charts

Develop charts that include the filtered trend data and graphically represent the data in a truthful and concise format. Charts should be able to stand on their own with no further explanation beyond what is included in the charts. The following guidelines can be used when developing charts:

- Title the chart appropriately.
- For the horizontal and vertical axes:
    - Label each axis appropriately, including units.
    - Scale the axis appropriately for the data being presented (minimum, maximum, and interval). Set the interval to a relevant value. E.g., don't use a 5-day interval for three months of trend data – a 7-day (one week) interval may be easier to view and understand.
    - Ensure that the axis labels are easy to read (font size, alignment, rotation).

[1] Available for free at www.utonline.org

    - Use a secondary vertical axis where appropriate when charting multiple data sets.
- Use lightweight gridlines and a white plot area background.
- Use either time-series (date / time on the horizontal axis) or x-y scatter plots where appropriate. Scatter plots may be more appropriate for some data, and for developing correlations.
- Annotate the graphs with notes, using text boxes and arrows pointing at the data points. Annotations can be used in lieu of a legend. They also can be used to highlight changes in equipment operation, and to note differences between baseline and post-implementation operation.
- Include both baseline and post-implementation data and graphical representation on one chart, if possible / applicable. Presenting the information on one chart makes it easier to see the change in operation resulting from the implemented measure.
- Use different colors for emphasis. However, ensure that the message being conveyed by the chart is still clear when printed black and white.

These are only a few of the main recommendations for graphical representation of data. As a general rule, maximize ink and minimize junk. For additional techniques, we recommend consulting other resources.[2]
The following figures show examples of both insufficient and preferred trend data presentation.

Figure 1. Insufficient representation I (Raw trend data must be analyzed)

Baseline		Post-implementation	
Date / Time	Fan start / stop	Date / Time	Fan start / stop
Fri 8/8/08 00:00	1	Fri 5/1/09 00:00	0
Fri 8/8/08 00:15	1	Fri 5/1/09 00:15	0
Fri 8/8/08 00:30	1	Fri 5/1/09 00:30	0
Fri 8/8/08 00:45	1	Fri 5/1/09 00:45	0
Fri 8/8/08 01:00	1	Fri 5/1/09 01:00	0
Fri 8/8/08 01:15	1	Fri 5/1/09 01:15	0
Fri 8/8/08 01:30	1	Fri 5/1/09 01:30	0
Fri 8/8/08 01:45	1	Fri 5/1/09 01:45	0
Fri 8/8/08 02:00	1	Fri 5/1/09 02:00	0
Fri 8/8/08 02:15	1	Fri 5/1/09 02:15	0
Fri 8/8/08 02:30	1	Fri 5/1/09 02:30	0
Fri 8/8/08 02:45	1	Fri 5/1/09 02:45	0
Fri 8/8/08 03:00	1	Fri 5/1/09 03:00	0
Fri 8/8/08 03:15	1	Fri 5/1/09 03:15	0

[2] Edward R. Tufte. (2001). *The Visual Display of Quantitative Information.* Cheshire, CT: Graphics Press LLC.

Figure 2. Insufficient representation II (Charts must be properly labeled and scaled)

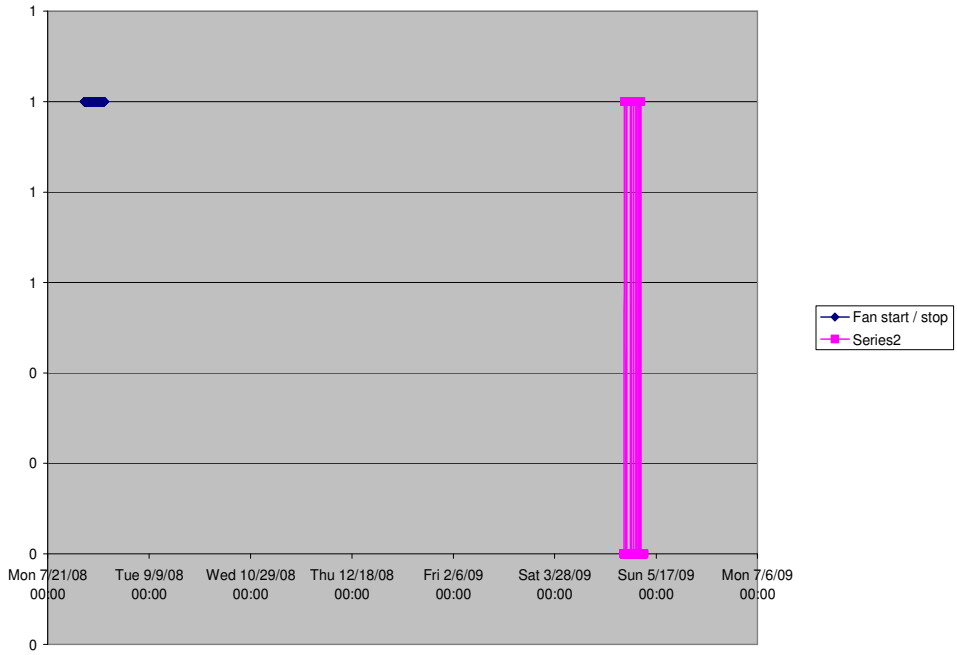


Figure 3. Preferred representation I (Pre and post data displayed on the same chart with annotations, labels and easy-to-read scale)

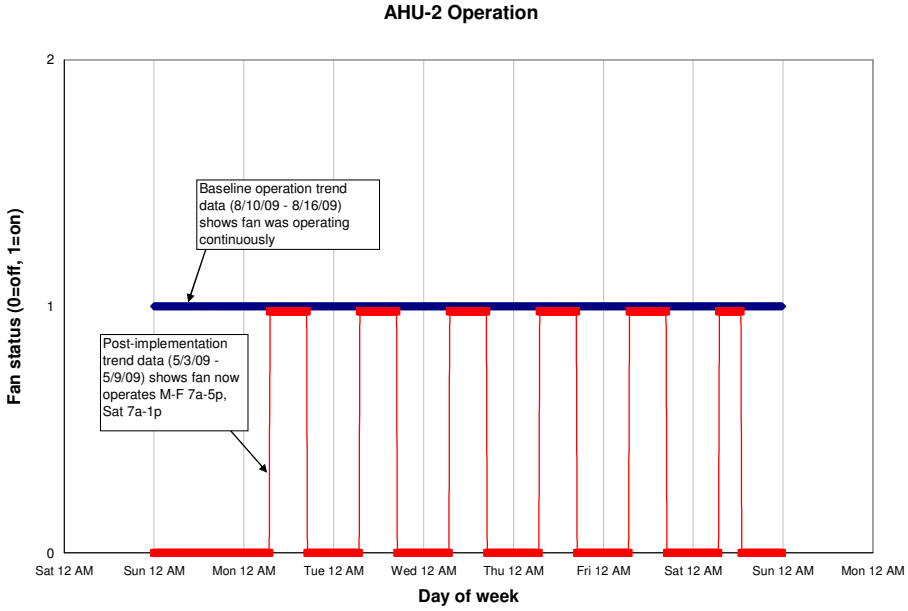
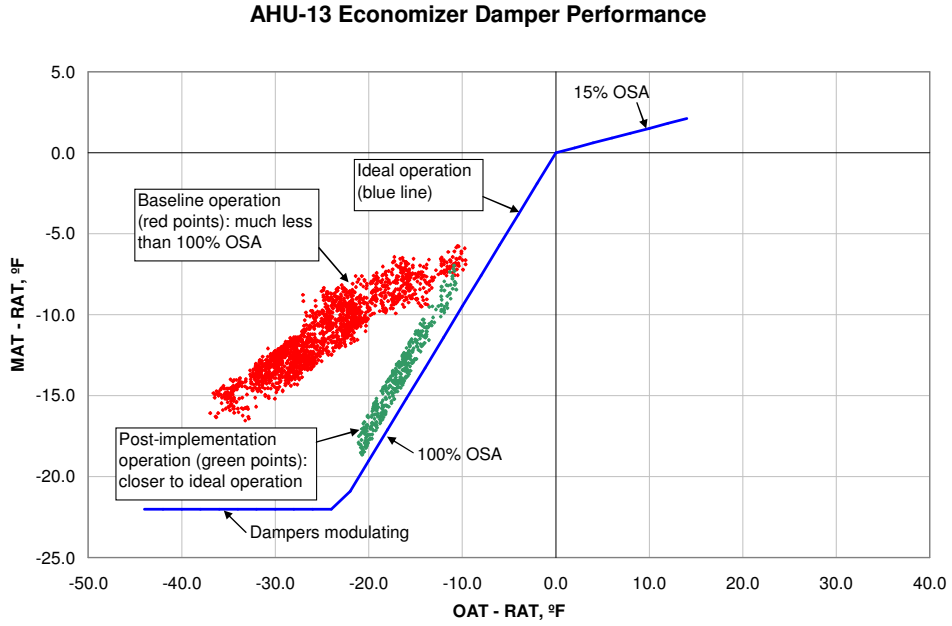


Figure 4. Preferred representation II (Pre and post data displayed on the same chart with annotations, labels and easy-to-read scale)



4.2.4 Measurement Guidelines

Baseline data for energy savings calculations can be gathered through trending, spot measurements, data logging, from manufacturer's data, or a combination of these methods. The following guidelines apply to collection of baseline data and, where applicable as indicated inthe Statewide Customized Savings Calculated Guidelines (available for download on the Manuals and Guides tab at sceonlineapp.com).

Trending

For trending and data logging, collect a minimum of one week of data for non-temperature dependent data, and two weeks of data for temperature-dependent data. Whenever possible, data should be collected during operating conditions that are applicable to the measure. Trended or logged data used for implementation verification should be the same type as the baseline data.

If it is not possible to collect trend data for implementation evidence during applicable operating conditions, e.g., if the outside air temperature is too high to verify proper economizer operation, then another method should be used for verification of measure implementation.

To gather time-series data, BRO Providers may use the building automation system to trend data or may install portable data loggers. In all instances, the data collection method used must provide accurate values. This means that the accuracy of EMS and data logger sensors must be verified. The following table shows the preferred format for trend data collection:

Data Format and Availability	Importable to Microsoft Excel® as .txt, .csv, .xls or .xlsx files for the Program management team.
Duration	Minimum of one week of data; two weeks preferable.
Sampling Rate	15 minutes preferred. For fast acting controls, or evaluation of control loop stability, short interval data may be required.

The Program recognizes that there may be instances where collecting time-series data for a measure may be inappropriate or unfeasible, and may accept alternate proof that a measure is appropriate. Other forms of proof include: trending using a lower sampling rate (when the BAS cannot support 5-minute or shorter intervals), functional test results, written observations or site reports, and photographs. BRO Providers are expected to note and explain any such data collection limitations and provide the methodology used for collecting baseline data during the investigation in the Incentives Application. The technical reviewer will determine whether submitted baseline data meets the Program's EM&V needs for implemented measures.

Power Measurements

Energy savings estimates will be based on baseline data collected during the investigation. For collection of electricity data to be used in these calculations, power can be measured directly or estimated based on measurements of voltage, current, and power factor. Measurements must also contain the proper points to calculate the performance of respective equipment (COP, EER, or kW/ton of refrigeration). Whether for a spot measurement or trending, the following guidelines apply, in order of preference:

1. Trend or log RMS power directly.
2. For constant load equipment, spot measure RMS power. For variable load equipment associated with savings initially estimated at less than 75,000 kWh/year, spot measure RMS power. Record location, time, and date of spot measurements.
3. Trend or log current, spot measure voltage, and apply a power factor to calculate power. Voltage may be spot measured at the motor control center or electrical panel related to each piece of equipment being trended (see Power Factor, below).
4. For equipment with available part load efficiency curves, this data may be used as a surrogate for actual trending of power data if a trend data-based load profile is available. Verify and perform the following:
    a. Actual operation of the equipment is consistent with the assumptions in the data.
    b. The load data covers the relevant range of operating conditions.
    c. Supply the data as part of the analysis. A reference may be used if DOE-2 or a similar readily available data source is used.
    d. Spot measure the power, along with relevant operating data, to establish the consistency of the curve fit with actual operating conditions. If a discrepancy is found, apply a correction factor to the curve fit.
5. Use nominal manufacturer's values for equipment with a constant nominal load (e.g., non-dimmed lighting, resistance heaters). Perform the following:
    a. Spot measure random samples of the installed equipment, to ensure that the installed equipment meets the specifications. Measuring groups of identical equipment at an electrical panel is preferred over measuring individual pieces of equipment.
    b. Determine, from inspection or spot power measurements, any variable adjustments that impact load, e.g., ballast factors.

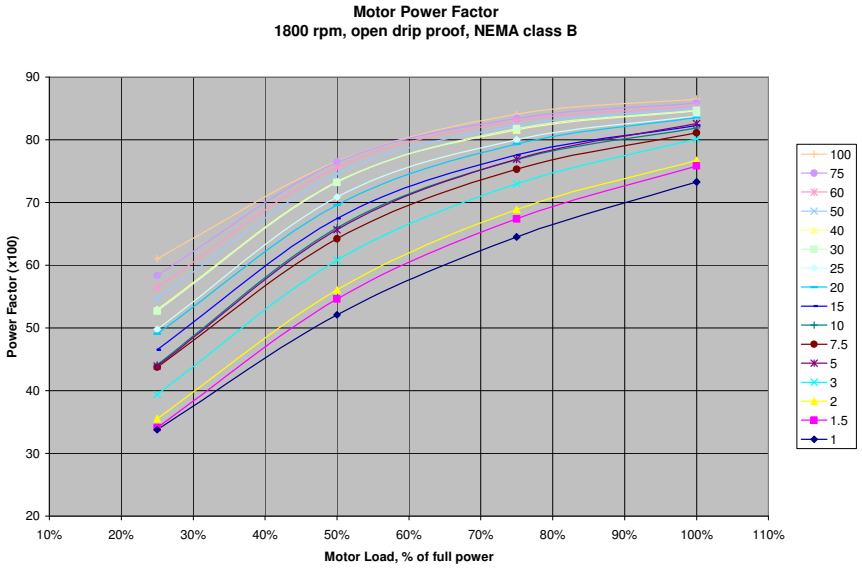
For spot measurements, record the location, time, and date of measurements. For spot measurements of voltage on three phase power, measure the voltage of all three legs and use the average in the energy use calculations.
Wherever energy use calculations are used as a means of implementation verification, perform the same method of power measurement for both the baseline data collection and implementation verification.

Power Factor

Provide justification for the power factor value used in custom calculations, e.g., measured values, motor manufacturer's curves, lighting cut sheets. Constant power factors may be used for constant load equipment or for measures with estimated savings of less than 75,000 kWh/year.

The following chart shows power factor as a function of motor load and motor horsepower, for motors typically used in HVAC systems (1800 rpm, open drip proof, NEMA class B). These values may be used in power calculations when voltage and current are being measured / trended and the actual power factor cannot be readily measured.

Figure 5. Power factor as a function of motor load and motor horsepower



Source: *MotorMaster+ version 4.00.06 motor database.* Developed for the U.S. Department of Energy by the Washington State University Energy Program, 2007.

Sampling

For large numbers of similar equipment with similar operating characteristics, sampling may be used. In this case, the Provider should group equipment with similar operating parameters into usage groups. Samples should be representative of the rest of the population in the usage group. Provide supporting documentation, including a diagram of the various usage groups and a written description of the usage groups and their operational parameters.

Sampling can be used for:

- Testing the performance of multiple pieces of equipment, to determine the performance of the usage group.
- Documenting baseline performance of the usage group.
- Verifying post-implementation performance of the usage group.

For specific guidelines related to sampling, including the minimum number of units to include in the sample sizes, see SCE's *Customized Calculated Savings Guidelines* on SCE's Online Application Tool (https://sceonlineapp.com/). Under the **Help** menu of SCE's Online Application Tool, select the **Documents** link to navigate to the **SCE Document View Page**. Under **View**, select **Manuals/Guides**, and select **SCE's Customized Calculation Guidelines**. SCE's Customized Calculation Guidelines stipulate that a coefficient of variation of 0.5 be used, and provide an accompanying table of sample sizes for various populations, which is reproduced here. Refer to SCE's Customized Calculation Guidelines for more details.

Sample Size Table based on Usage Group Sampling, cv=0.5*

Population *N*	Sample Size 90/10 *n**
4	4
5	5
10	9
12	11
13	12
14	12
15	13
16	14
17	14
18	15
19	16
20	16
21	17
22	17
23	18
24	19
25	19
26	20
27	20
28	21
29	21
30	22
50	29
75	36
100	41

200	51
300	56
500	60

*This table is valid for 90% confidence level and 10% precision, with a cv (y) of 0.5 and using a finite population correction factor.

Equipment Runtimes

For equipment that operates based upon demand, trend run times if the trending can cover typical annual operational characteristics (e.g. air compressor). If the trending cannot cover typical annual operational characteristics (e.g. chiller operation), the Provider should estimate run times with bin engineering calculations or a building simulation.

For runtimes obtained by trending of BAS data, there should be verification that the BAS data is correct. Status feedback data (AI/DI points) is preferable to Enable/Disable command data (AO/DO points).

Correlations

Include the development procedure for any correlations used in the custom calculations. Correlations are used to estimate system characteristics based on known values, e.g., chiller load as a function of outside air temperature (load profile). Correlations should be based on measured/trended data whenever possible.

Assumed load factors / nominal equipment efficiencies may be used for measures with a savings estimate of less than 75,000 kWh/year or 5,000 therms/year.

Short term trend data may or may not be adequate to collect loads that can be used to extrapolate energy savings. The following are recommended methods, in order of preference, to develop correlations:

- Use trended data to create correlations between loads and relevant variables, e.g., fan speed as a function of outside air temperature. If these correlations are developed using inadequate data, i.e., if the data was not obtained during relevant operating conditions or over a sufficient range of the expected outside air temperatures, collect additional data later, prior to implementation, and update the savings calculations accordingly.
- Perform load calculations / simulations using software to establish annual load profiles.

Gas Boiler Efficiency

When available, use combustion test or boiler check-up test results to establish boiler efficiency for custom calculations. Include a copy of the report if possible, or at least the date of the test and other test reference information. If combustion test data is unavailable, nameplate efficiency is acceptable as an alternative.

Adjust this efficiency number as necessary to account for site-specific supply and return water temperatures, cycling of the boiler, and shell losses. Consult manufacturers' efficiency graphs as necessary.

4.3 Calculation Guidelines

4.3.1 Measure Savings Calculation Baseline Determination

Measures for existing buildings will be classified into one of three categories in relation to baseline performance, for purposes of estimating energy and demand savings:

- Add-On Equipment (AOE, formerly REA or Retrofit Add-On) – A measure that adds a control component (new equipment) to an existing host (system) improving the nominal efficiency of the host system. The AOE must not be able to operate on its own and the existing host system must:
    - be operational without the AOE
    - continue to operate as the primary service equipment for the existing load, and
    - be able to fully meet the existing load at all times without the add-on component.
- Normal Replacement (NR, formerly ROB or Replace on Burnout) – A measure that replaces equipment that is either non-functional or has less than one year of remaining useful life.
- Accelerated Replacement (AR, formerly RET or Early Retirement) – A measure that replaces equipment with greater than one year of remaining useful life.

The measures in the BRO program will fall into the "Retrocommissioning or Operational" categories. For these categories, the baseline condition is the existing performance of the system.

For Replace on Burnout or Retrofit Early Retirement measures, where equipment is being replaced, contact the SCE BRO program to determine the baseline condition and the approach for estimating savings. For Replace on Burnout measures, the baseline is either current industry practice or the code minimum performance requirements. For Early Retirement measures, the baseline is a combination of existing performance and current industry practice / code minimum performance ("dual baseline").

4.3.2 Supporting Documentation

Present savings calculations in a manner that is clear and easy to follow. In general, all calculations shall be self-documented, or reference another document that summarizes assumptions. Verbal documentation is **inadequate**, as is documentation included in emails/memos**.** Guidelines for savings calculations include:

- **Document and justify each input assumption used**. Examples include: energy cost; boiler efficiency; annual operating hours; chiller staging changeover temperature. If an assumption deviates from a measured value that is used for the basis, clearly indicate the rationale.
- **Include binned assumptions for savings and occupancy**. For bin calculations, include the binned weather hours for the project's climate zone in a table; the total binned weather hours shall be 8,760 hours/year. Clearly indicate the equipment operating schedule, and account for this schedule in the binned weather hours for use in the calculations. The basis for the binning shall be clearly indicated. The load and savings calculations should be next to the binned weather data.
- **Provide justification for input values that vary as a function of another parameter**. Examples include: chart of VFD efficiency as a function of speed, obtained from previous

research; chiller efficiency as a function of cooling load, obtained from chiller manufacturer.

- **Show each equation used, including any constants, and all intermediate calculations** for spreadsheet calculations, and use additional columns where necessary for intermediate calculations.
- **Include units for each input and output value**, e.g., Btu/h, % efficiency.
- **Include one-line system diagrams of relevant systems**, e.g., chilled water system piping schematic.
- **Provide the following documentation for relevant equipment**:
    - Nameplate information for major pieces of equipment
    - HP of all relevant motors (fans, pumps, etc.)
    - For pumps and fans, nameplate information that indicates the flowrate at the rated RPM and head in feet at nameplate flowrate.

The Program will grant exceptions where it may be impractical to obtain the data (e.g., the nameplate cannot be read, the motor is not readily accessible). These circumstances must be fully documented and, in these cases, conservative values should be used as a proxy for the nominal value.

Additional supporting documentation that could be provided as support for the savings calculations includes:

- Equipment cut sheets, for atypical equipment or to document data used in the calculations.
- Photos, clearly labeled with relevant information, and date/time-stamped.
- Copy of maintenance logs that document operating conditions, spot measurements, repeating problems, etc.
- Reference to tenant complaints relayed during the investigation work.
- Reference to historical equipment repair/replacement invoices
- Reference to original design intent and/or current facility requirements
- Point to point checks
- Equipment calibration certification/documentation

4.3.3 Accounting for Interactions

The energy and demand savings from combinations of measures is usually different than the sum of savings from individually evaluated measures due to the fact that the savings of some measures may interact with each other. Any measure-related interactions or impacts with other building systems should be accounted for in the original savings calculations, e.g., reduced chiller energy use as a result of a lighting control measure that lowers lighting power usage (and, therefore, the cooling load) should be accounted for in the measure savings calculations. For interior lighting measures within a conditioned space, DEER interactive effects factors may be used to account for impacts with other building systems.

At the pre-implementation phase a BRO Provider usually can't be certain of which combination of measures will end up being successfully implemented. For this reason, an interaction factor should be estimated based on engineering judgment and the operational characteristics of the measures expected to be implemented. Interaction factors can be estimated specifically per

measure, or a default of 0.85 may be used. Interaction factors may range from 0.7 to 1.0, depending on characteristics such as systems affected, climate zone, and ratio of internal to external load. Calculation reviewers will evaluate the reasonableness of the factor, or how interactive effects are handled.
If building simulations are utilized, interactive effects will be included implicitly in model outputs, and an interaction factor of 1.0 should be used. For all measures with interaction factors other than 1.0 (for building simulations), provide justification for the interaction factors used. The application of the chosen interaction factor should be clearly indicated in the submitted savings calculations. The savings calculations results (net of the interaction factor) should be input via the Online Application Tool in order to determine the associated incentive.

An example of a measure that would have an interaction factor less than 1.0 is restoring operation of economizer dampers, if a separate measure related to increasing chiller efficiency through condenser water temperature reset is also being implemented. If the chiller efficiencies used in the economizer damper savings calculations were the baseline efficiencies used in the condenser water temperature reset measure, then the realized savings related to the economizer dampers would be less if both measures were implemented, since the chiller efficiency would be higher.

Even when the Owner has not yet chosen the package of measures to implement, accounting for interactions is important because the cost savings calculation must be sufficiently accurate to determine which measures will be implemented. After measures are implemented, calculate updated annual savings, including interactions of the selected group of measures, and submit any changes via the Installation Report. If a group of “interactive” measures is not implemented as originally planned, then the interaction factors need to be adjusted accordingly.

4.3.4 Savings Calculation Methods

This section describes the various calculation methods that could be used for estimating energy and demand savings. See **Section** Error! Reference source not found. above for allowable calculation methods for Tier 1 and Tier 2 measures.

4.3.4.1 Custom Spreadsheets

Customized spreadsheet calculations should include hours of operation, load, and temperature by location, in table format. The guidelines for determining energy and cost savings are as follows:

1. Calculate the baseline and proposed energy usage. The energy savings is the difference between the two. Energy usage is calculated by applying the operating profile (the times of day and year when the equipment is operating) to the load profile (calculated as a function of the time of day and year) to generate the resulting energy usage in each time of use period.
2. The annual energy dollar savings is calculated by multiplying the resulting energy savings in each time of use period (generated in #1 above) by the corresponding energy charge for that period. Cost savings calculations are discussed in **Section 4.3.5** below.

In addition to energy savings, structure the spreadsheets to calculate demand savings and report these peak demand savings in the OAT.

For 8,760-based spreadsheet calculations, calculate the peak demand savings as the average kW reduction over the appropriate nine-hour window (2:00 p.m. to 5:00 p.m. for three consecutive days per the table below[3]). If used in the calculations, day types should be chosen to align with the 2009 reference year for the DEER peak demand periods.

Climate Zone	Start Date		Weekday
CZ01	Sep	16	Wed
CZ02	Jul	8	Wed
CZ03	Jul	8	Wed
CZ04	Sep	1	Tue
CZ05	Sep	8	Tue
CZ06	Sep	1	Tue
CZ07	Sep	1	Tue
CZ08	Sep	1	Tue
CZ09	Sep	1	Tue
CZ10	Sep	1	Tue
CZ11	Jul	8	Wed
CZ12	Jul	8	Wed
CZ13	Jul	8	Wed
CZ14	Aug	26	Wed
CZ15	Aug	25	Tue
CZ16	Jul	8	Wed

For temperature bin-based spreadsheet calculations, calculate the peak demand savings as the kW reduction associated with the highest bin temperature. When structuring bin-based calculations, group the outdoor temperatures into 5°F bins (or less).Note that the DEER peak demand savings may differ from the monthly peak demand savings used to calculate demand cost savings. E.g., for temperature-dependent measures, the demand savings may vary from month to month.

4.3.4.2 Whole Building Energy Modeling

Energy modeling can provide a powerful and robust manner for estimating energy savings associated with proposed measures. Not only do energy models allow for interaction of building systems with loads and weather conditions, they also simulate the potential interactive affects between proposed measures, when packages of measures are run together. They can also apply the utility rate structure to calculate energy costs.

[3] Source: DEER for 2014 Update, Table 6.2.1 Comparison of DEER Peak-Demand period definitions, http://deeresources.com/files/DEER2013codeUpdate/download/DEER2014UpdateDocumentation_2-12-2014.pdf#Page=23. (Note: A list of CZ by Zip Code is available from the California Energy Commission: http://www.energy.ca.gov/maps/renewable/Climate_Zones_Zipcode.pdf.)

However, it can be challenging to simulate improper or sub-optimal operation using a simulation program. Therefore, energy modeling can be used as a tool to estimate energy, demand, and cost savings for a project within the Program, provided the following criteria are adhered to:

- Energy models must be developed using the DOE-2.2 or later building energy simulation program.
- Energy models must use the latest DEER prototypes.
- All input, building description language (BDL), and output files are submitted for review.
- For reporting peak demand savings in the OAT, enter the average demand savings during the DEER peak kW reduction period. Peak kW reduction periods vary by climate zone (CZ), and are defined as the period between 2:00 p.m. and 5:00 p.m. during the three consecutive weekday periods containing the weekday temperature with the hottest temperature of the year, as summarized in the table in **Section 4.3.4.1.** (Note: A list of CZ by Zip Code is available from the California Energy Commission: http://www.energy.ca.gov/maps/renewable/Climate_Zones_Zipcode.pdf.)

  Calculate the average demand savings as the average kW reduction over the appropriate nine-hour window. Note that the reference year in the table in **Section 4.3.4.1** is 2009; for whole building energy modeling software, ensure that the simulation year is set to 2009 so that the day types align with the DEER peak periods. For whole building energy modeling software such as eQUEST, the hourly reporting feature can be used to obtain hourly demand data.

  Note that the DEER peak demand savings may differ from the monthly peak demand savings used to calculate demand cost savings. E.g., for temperature-dependent measures, the demand savings may vary from month to month.
- The following inputs (at a minimum) are included in the report (presented in the following tables, with examples). This information must be provided separately from the DOE2.2 input files to facilitate review by the Program.

Description of Schedules and General Information

Item	Sample Inputs
Floor Area	16,800 ft^2
Building Type	Office
Occupancy Schedules for: Lighting, Plug Loads, HVAC – All Areas	9 a.m. to 5 p.m. (M-F); 7 a.m. to 6 p.m. (M-F) Reduced schedules weekends and holidays

Description of Lighting, Equipment, and Envelope Assumptions

Item	Sample Inputs
Lighting (W/ft^2)	
Conference	1.5
Mechanical	1.3
Bath	1
Lobby	1.8
Break	1.4
Open Office	1.3
Office	1.5
Gift	3.7
Hall	0.7
Active Storage	0.3
Lighting Control	
Occupancy Sensors	None
Daylight Dimming Control	None

Item	Sample Inputs
Equipment (W/ft^2)	
Office/Admin EPD	1.5
Other EPD	Varies by space
Envelope	
Wall Insulation R-value	R-13 (0.089)
Roof Insulation R-Value	R-30 (0.034)
Floor U-Value	N/A
Glazing U-Value (E,W)	0.57
Glazing U-Value (N)	0.57
Glazing U-Value (S)	0.57
Glazing SHGC (E,W)	0.39
Glazing SHGC (N)	0.49

Item	Sample Inputs
Glazing SHGC (S)	0.39
Window Shading	No Shading
Window to Wall Ratio	10-20%
HVAC Systems	
System Type	VAV
Fan Control	Inlet Guide Vanes
Supply Air Temp. Reset	Based on OA
Outdoor Air Minimum Flow	0.3
Demand Control Ventilation	None
Outdoor Air Economizing	Based on OA temp up to 75 F
Natural Ventilation	None

Building models should be calibrated to within 10% of the monthly utility data using utility data covering a recent period of at least one year (12 months). Spot and short-term measurements of key building system components should also be used wherever possible to further calibrate the model. At a minimum, the trend data collected for identifying the finding and creating the baseline operating condition (e.g., heating and cooling loads and the HVAC system's responses to these loads) should be used in calibrating the model. Typical spot and short-term measurements for use in model calibration may include: lighting and HVAC equipment operating schedules, lighting fixture power, space temperatures, supply duct static pressures and temperatures, fan and pump operation (preferably power) and motor power.

The model should be calibrated, whenever possible, using a weather file based on actual weather from a nearby weather site from the same time period, while analysis of the measures should be performed with CZ2010 data.

Any variables adjusted in the model for the purposes of calibration need to be documented and submitted through the SCE Online Application Tool. This information will include:

- The KEYWORD that was used for the calibration
- The baseline (un-calibrated model) input value used for the KEYWORD
- The calibrated model input value used for the KEYWORD
- The reasoning behind the adjustment of this KEYWORD value

Similarly, the KEYWORDS used in the measure analysis should also be similarly documented. This information will also be submitted in the OAT, and will include:

- The measure number and name
- The KEYWORD(s) that was used to simulate the measure
- The baseline input value(s) used for the KEYWORD(s)
- The input value(s) used for the KEYWORD(s) to simulate the measure
- The source of the value used to simulate the measure

4.3.5 Determining Energy Cost Savings

The information in this section is for the benefit of the Provider. Determining energy cost savings is an important step in BRO projects, but energy cost savings calculations are not required per the Program. Once the energy savings (kWh, kW, and/or therms) have been calculated, the Provider should calculate the energy cost savings ($$) to be presented to the Owner. The BRO Provider should model the energy cost savings using the tariff (rate schedule) to account for variances in energy and demand charges during different time of use periods. This results in more accurate cost savings when a measure's energy savings are not distributed across all time of use periods.

Cost data may need to be obtained from multiple sources. If a Customer obtains a portion of the electric service from a third-party provider (other than SCE), then the full kWh usage will be listed on the SCE bill but the full cost will not. The cost associated with the third-party portion will need to be obtained directly from the third-party.
The energy cost going forward may be higher than the energy cost from the past year. If the cost of energy going forward is known, use the new cost for energy calculations rather than the historical cost.

Below is the SCE website link for tariff information:
https://www.sce.com/wps/portal/home/regulatory/tariff-books/rates-pricing-choices/business-rates/

4.3.6 Implementation Cost Guidelines

Implementation costs should be estimated during the investigation phase and updated with actual implementation costs after implementation. For the investigation phase implementation cost estimates:

1. Provide backup documentation for each measure's cost estimate(s), submitted in the OAT. At a minimum, this documentation should include material costs, labor hours and estimated hourly rates. In order of preference, documentation could include:
    a. Quotes
    b. Cost estimating documentation (RS Means, etc.)
    c. Published studies
2. Base costs on Owner's expectations. When estimating implementation costs, consideration should be given to the building owner's expectations for the quality of work carried out – whether they require 'premium quality,' 'standard,' etc. Costs should include only those items that directly contribute to the energy savings, not the 'optional extras' (unless those optional extras are standard procedure and considered essential by the building owner).
3. Include in-house labor if a measure is intended to be implemented by in-house staff, and provide proof of direct project hours and costs.
4. Be accurate. It is important that the cost estimates provided be as accurate as possible.

5. Each measure will be eligible for an incentive based on that measure's energy savings (kW, kWh, and therm) and its implementation cost. In general, the incentive for an individual measure will be capped at 50% of that measure's implementation cost. However, the total *project* incentive will be capped at 50% of the total *project* implementation cost. In some cases, an individual measure may receive an incentive in excess of 50% of its cost if the total project incentive is still at or below 50% of the total project cost.
6. Measures can be grouped if one or more measures are pre-requisite of another measure or group of measures. If measures can be independently implemented, they count as separate measures. If measures are grouped into a single measure for the purpose of implementation, the energy savings need to be combined as well.

Implementation costs should not include the BRO Provider's fee related to the investigation, identification, or verification of measures, unless the Provider is directly involved in the implementation and has fees associated with the implementation or implementation support. Only then may those fees may be included. The overall Provider fee for the BRO Investigation and Verification should not be included in the implementation cost calculation.

4.3.7 SCE Review

Savings calculations and implementation cost estimates will be reviewed by SCE for reasonableness, accuracy and soundness. The Program may de-rate savings estimates for savings calculations that contain a high degree of uncertainty. Instances where a de-rating factor may be applied include:

- Sufficient backup documentation is not provided with the calculations
- Correlations are based on very limited trend data
- Interactive effects have not been accounted for
- System characteristics used in the calculations are based on assumed values, not trended / verified

The amount of de-ration applied will correlate with the degree of uncertainty in the calculations. BRO Providers that consistently submit savings calculations that contain a high degree of uncertainty and, thus, often have their savings calculations de-rated will be re-reviewed for approval as qualified lead Providers for the Program.
A certain number of applications are selected for pre-inspection. If a pre-inspection is required, a qualified SCE contractor will contact the applicant to arrange for pre-inspection of the existing equipment and operating characteristics. Upon passing SCE review, the applicant will receive a Project Approval (PA) letter, along with a blank Installation Report (IR) to be completed and submitted after measure implementation and commissioning have been completed.

4.4 Deliverables

This section summarizes the required and optional deliverables for this phase.

4.4.1 Required Deliverables

The Provider is required to develop and submit the following deliverables for this phase:

- Baseline data. **See Section 4.2, Required Documentation for Measures.**
- Savings calculations. **See Section 4.3, Calculation Guidelines.**
- Cost calculations. **See Section 4.3.6, Implementation Cost Guidelines.**

- *Incentives Application*, via the Online Application Tool.

4.4.2 Optional Deliverables

The deliverables listed below are sometimes developed during an BRO process. However, the Provider is not required to develop or submit these deliverables for the SCE BRO program. If the Provider's scope of work with the customer includes development of any of these deliverables, the SCE BRO Program would be interested in seeing them; they would not be reviewed by the program, but they may help the program reviewer better understand the project.

- *Current Facility Requirements.* See **Attachment C: Current Facility Requirements Data Collection Table**
- (Sample template)*Investigation Report.* This report may include a facility description, historic energy use summary, description of methods used during the investigation, identified findings and measures, a summary of the estimated costs, savings, and financial payback associated with the identified measures, a summary of the baseline data related to the identified measures, and recommended next steps for the project.

5.0 Implementation Guidelines

5.1 Measure Selection

Once the measures are approved, the Provider and Owner should meet to review all identified measures and plan implementation. The Provider should be prepared to answer any questions and address any concerns from the Owner regarding implementation. For example, the Owner and Provider should discuss any operational constraints that might conflict with one or more measures, and ways of overcoming these obstacles. The Provider and Owner should discuss who will perform the work required to implement each measure.

5.2 Implementation Roles and Responsibilities

The Provider's role during implementation is dependent on the contract between the Provider and Owner. At a minimum, the BRO Provider may want to review any contractor bids, ensuring that the contractor scopes of work adequately reflect the intent of the measure recommendations. If needed, the BRO Provider will answer questions that arise during implementation and provide clarification or advice on measures being implemented.

The SCE BRO Program allows flexibility in how the Owner wishes to implement the selected measures. For instance, the Owner may utilize in-house building staff, hire the BRO Provider to implement, contract with outside service contractors, or any combination of the above.

5.3 Deliverables

This section summarizes the required and optional deliverables for this phase.

5.3.1 Required Deliverables

The Provider is not required to develop or submit any deliverables for this phase.

5.3.2 Optional Deliverables

The deliverables listed below are sometimes developed during a BRO process. However, the Provider is not required to develop or submit these deliverables for the SCE BRO program. If the Provider's scope of work with the customer includes development of any of these deliverables, the SCE BRO program would be interested in seeing them; they would not be reviewed by the program, but they may help the program reviewer better understand the project.

- *Implementation Report.* This report may include a description of the implemented measures, including the final settings (control setpoints, valve positions, VFD speeds, etc.).

6.0 Verification Guidelines

6.1 Implementation Verification

The Program is a verified energy efficiency savings program funded by California ratepayers and administered by Southern California Edison under the auspices of the California Public Utilities Commission. Therefore, all projects will be subject to careful scrutiny by SCE and an independent EM&V contractor to evaluate the claimed savings. It is imperative that every project have appropriate pre-implementation baseline data and post-implementation evidence showing that measures were implemented.

The final measures must be supported by evidence that the measures were implemented and, where applicable, that acceptance criteria were met. Acceptable methods for verifying implementation, where applicable and in order of preference include:

1. Gather and analyze trend data. The format of the verification data should align with the baseline data submitted and approved during the BRO investigation. Trend data should show the system functioning in each operating mode and over a sufficient range of operating conditions, to demonstrate that the measure has been implemented and the system is functioning as expected. Measures related to controls resets must use this method wherever possible.
2. Functional performance test, documented with a form.[4]
3. Screen shots of system operation at multiple operating conditions.
4. Screen shots of control logic that show all relevant operating conditions.
5. Before and after photos of visual measures with date and time stamps.

The last two only apply to measures with savings of less than 75,000 kWh/year and 5,000 therms/year or measures that cannot be readily trended by any means (e.g., valve leakage). The program will grant exceptions when there are significant problems in getting the data (e.g., the customer's chiller can't be shut down to setup the logger). These circumstances must be documented and, in these cases, conservative values should be used as a proxy for the trended value.

Additional supporting documentation includes:

- Copies of itemized invoices indicating installation date, installer company info, installed equipment/procedure, and cost. In cases where individual measure costs may not be obvious in the supporting invoices, BRO Provider should make an effort to demonstrate that the claimed final costs for each measure are reasonable.
- Photos, clearly labeled with relevant information, and date/time-stamped.

See **Section 4.2.2** for additional information regarding documentation requirements. The Program is available to answer any questions that the Provider may have regarding the requirements to document specific measures.

[4] Template forms are available at www.ftguide.org.

6.2 Updated Savings Calculations and Costs

Similarly, it is important that the savings calculations performed during the BRO investigation are updated post-implementation where necessary. The updated savings should incorporate modifications to the engineering calculation or model used to estimate savings:

- Revise Tier 1 savings with any changes as appropriate (e.g., size of equipment, operating time, temperatures, etc.).
- To update the interactive effects between the measures that have been implemented
- To reflect the actual scope of the implementation of the measure (e.g., economizer upper limit set to 65ºF rather than a two degree differential from return and temperature).
- To correct or update major assumptions made during the investigation calculations that have a large impact on final savings. (e.g., the addition of a VFD was expected to reduce pump speed to minimum during low load conditions, but actual post-implementation speed was only reduced by 30%).

Beyond those circumstances, Providers may also update the savings calculations if they notice a difference between investigation-phase assumptions and post-implementation trend data. Any differences in savings between the investigation-phase calculations and the post-implementation calculations must be documented.

After measure implementation has been verified, Providers should update the implementation cost estimates with the actual implementation costs. Providers should then include these updated costs in the Incentives Application and provide copies of the invoices as supporting documentation. The invoices should clearly indicate the work that was performed, and should not include any other non-BRO project work. If the invoices do include non-BRO project work, the BRO provider must break out the costs related to BRO project work.

For projects containing multiple solution codes, each invoice should be itemized by solution code. In cases where this is not possible or difficult to obtain, the Provider should provide a cost breakdown per end use (lighting, motors, pumping, etc.) Then allocate the cost breakdown for each solution code (analyze the percent of kWh savings that each solution code contributed to the total end use kWh savings and use this to approximate the cost). All claimed project costs must be justified (either by a memo for internal labor costs or an invoice for everything else).

6.3 Trend Data Analysis and Graphical Representation

As discussed in **Section 4.2**, trend data should be presented in a format that is intuitive and can be quickly and easily understood by the reviewer ("trend data" includes both BAS trend data and data logger data). With regard to post-implementation data, raw data should be provided with the supporting calculations / verification data; however an analysis of the data should also be included and charts should be developed wherever possible that clearly indicate the message(s) being delivered by the data. Be sure to clearly distinguish between baseline data and post-implementation data. Include both baseline and post-implementation data and graphical representation on one chart, if possible / applicable. Presenting the information on one chart makes it easier to see that a measure has been implemented.

6.4 Building Operator and Owner Training

The BRO Provider is also responsible for conducting a training session for the Owner and the appropriate building operations personnel (or subcontractors). The training should cover the investigation (audit) process and results, measures that were implemented, and requirements for ongoing maintenance and monitoring.

3 Year Maintenance Plan or Service Contract

- The BRO Vendor must provide a maintenance plan for the duration of at least three years for the incentivized measure(s).
- The Customer must supply evidence of the training taking place, or of a maintenance contract for the duration of at least three years for the incentivized measure(s).
- When building staff is not available or trained to perform maintenance tasks, owners may have a maintenance service contract in place with an equipment vendor, installing contractor, or a maintenance service contractor.
- Most companies providing service contracts focus on maintenance of equipment, and building owners and managers need to specifically request requirements that address operating issues in service contracts.
- If included in the BRO Plan, the commissioning team can review any existing service contracts and make recommendations on how to enhance the current level of service to address efficient operation.
- The maintenance contract may be contracted with the BRO Provider or another third party.
- The service plan or maintenance contract must be submitted during Implementation Review and Approval.
- Up-to-date building documentation, including O&M Manuals, Sequences of Operation, and System Diagrams, are produced through the BRO process and are essential to maintaining and troubleshooting equipment. The Preventive Maintenance Plan and a Recommissioning Plan should describe in detail the human and financial resources that are necessary to maintain the benefits of the BRO process for many years.

6.4.1 Schedule Training

The training should be scheduled after the improvements have been made and far enough in advance for the O&M staff and Owner to make arrangements to attend. The training should take place on-site in the retrocommissioned building if possible and, depending on the complexity of the building, last 2-4 hours.

6.4.2 Prepare Training Materials

The BRO Provider is responsible for customizing the outline for the training and developing the training materials. Before preparing the training outline and materials, the BRO Provider should assess the related level of knowledge of the building operators, to set up the training accordingly. For reference, the Program provides the following sample outline for the training:

- Background on the energy use of this particular building
    - Present Energy Utilization Index
    - Compare present ENERGY STAR benchmarking score to other similar types of buildings, if available
    - Describe operating schedules and current facility requirements
- BRO investigation process used in this building
    - Describe the methods used to identify problems and deficiencies
    - Review the approved measures list
- Implementation process in this building
    - Describe the measures that were implemented and by whom

- Walk around the building to look at any physical changes or step through the new control sequences at the operator workstation
- Provide as many details about implementation as necessary to describe what was done
- Describe improved performance that these measures will create (show trends if available)

- O&M Requirements
  - Describe the O&M requirements needed to keep these improvements working
  - Describe how the staff can be aware of energy efficiency opportunities and begin looking for additional savings potential

The BRO Provider should follow the outline to prepare materials, as necessary, to hand out at the training session.

6.4.3 Conduct the Training

The BRO Provider conducts the training for the operators and Owner. To the extent possible, the training should incorporate hands-on activities and the attendees should have the opportunity to inspect the treated equipment and systems, discuss what was done and how to maintain the improvements.

6.4.4 Submit BRO Training Completion Form

At the conclusion of the training the BRO Provider submits the *BRO Training Completion Form* electronically to the Program. A template for the *Training Form* is included as **Attachment D: BRO Training Completion Form**. The BRO Provider should also submit any materials that were handed out to the training attendees.

6.5 Deliverables

This section summarizes the required and optional deliverables for this phase.

6.5.1 Required Deliverables

The Provider is required to develop and submit the following deliverables for this phase:

- Verification data as evidence of implementation. See **Section 4.2, Required Documentation for Measures.**
- Updated savings calculations, if applicable. See **Section 6.2, Updated Savings Calculations**.
- Copies of invoices for implementation, as proof of the Owner's implementation costs.
- *BRO Training Completion Form,* including the training agenda, training materials, list of attendees, and measure persistence strategies. See **Attachment D: BRO Training Completion Form**.
- *Installation Report*, including the above supporting documentation (verification data, updated savings calculations, copies of invoices, *BRO Training Completion Form).*

6.5.2 Operations and Maintenance Plans

A typical O&M or process management (PM) plan consists of a checklist of maintenance task and a schedule for performing them. Checklists are kept for each piece of equipment and updated after maintenance tasks are performed.

Incorporating operations into the maintenance plan entails similar rigor for recording setpoints, settings, and parameters for control strategies. It also means that operators regularly review and update the Owner's Operating Requirements as occupancy or operational changes are made, and continuously ask questions such as:

- Have occupancy patterns or space layouts changed?
- Have temporary occupancy schedules been returned to original settings?
- Have altered equipment schedules or lockouts been returned to original settings? Is equipment short-cycling?
- Are time-clocks checked monthly to ensure proper operation?
- Have any changes in room furniture or equipment adversely affected thermostat functions?
- Are new tenants educated in the proper use and function of thermostats and lighting controls?

A preventive O&M plan differs from a typical PM plan in that it calls for periodically checking operational and control issues and investigating issues that affect efficiency. To facilitate this, a reference list of operational parameters and the building's adjustable settings can be developed to help monitor and maintain the proper settings for the facility. The commissioning team can be tasked with developing this list, or as part of the BRO scope of work.

6.5.3 Optional Deliverables

The deliverables listed below are sometimes developed during an BRO process. However, the Provider is not required to develop or submit these deliverables for the SCE BRO Program. If the Provider's scope of work with the customer includes development of any of these deliverables, the SCE BRO Program would be interested in seeing them; they would not be reviewed by the program, but they may help the program reviewer better understand the project.

- *Systems Manual.* This is a brief manual that includes key information for day-to-day operations of the facility. Could include a description of the building's HVAC and lighting systems, *Current Facility Requirements,* a description of the location of key documentation (construction as-builts, controls drawings, etc.), controls sequences, preventive maintenance schedule, etc. This could be an updated version of an existing *Systems Manual,* or a new *Systems Manual* if one did not exist previous to the BRO project.
- *Ongoing Commissioning Plan.* This plan describes the scope, schedule, activities, roles and responsibilities, and deliverables related to an ongoing commissioning process.
- *Final Report.* This is a complete summary of all phases of the BRO project. The *Final Report* typically includes all of the main reports developed during the BRO project, as well as key training materials. It is a concise and complete record of the BRO project.

6.5.4 SCE Post-Installation Visits

- Both the Applicant and Provider may be required to complete a Post-Installation Consent Form during Project Application that obligates the Provider to make follow-up visits to the project site as requested by SCE.
- If deviations from post-installation performance specifications or other deficiencies that adversely impact energy savings are found, the Applicant is required to restore rebated measure to the conditions verified at implementation review.
- The frequency of post-installation visits may vary.

In addition to the post-installation visits by SCE, the Applicant may also be subject to further inspections by the CPUC or its designated entities.
To complete this task, the BRO Provider must:

- Schedule a time to train the O&M staff members and Owner after the improvements to the systems are complete.
- Prepare materials for the training.
- Deliver the training session to the O&M staff and Owner.
- Complete the BRO portion of the Installation Report (IR) upon application approval to indicate that the training was completed Schedule Training.
- The training should be scheduled after the improvements have been made and far enough in advance for the O&M staff and Owner to make arrangements to attend. The training should take place on-site in the retrocommissioned building if possible and, depending on the complexity of the building, last 2-4 hours.

Attachment A: Screening Checklist

BRO PROGRAM SCREENING CHECKLIST
Commercial & Institutional Buildings

This document is provided as a guide to support the collection of data at the Customer site before and during the BRO Investigation. It is not required to be submitted to the program.

BRO Provider Completing this Form	
Name	Firm

Building Overview			
Building Owner and/or Manager Contact Information (Person Interviewed)			
Name			
Company			
Telephone			
Email			
Building Information			
Building Name			
Address			
City		Zip	
Building Area (square feet)			
Building Type (office, hotel, etc.)			
Building Operating Hours			
Year Constructed			
Leased or Owned?			
Climate Zone			
Tenant Sub-metering? (Yes/No)			

Energy Use Overview	
Annual Electricity Consumption (kWh)	
Summer Peak Demand (kW)	
Annual Gas Consumption (Therms)	
Electric Energy Utilization Index (kWh/SF/yr)	Building: CEUS avg:
Gas Energy Utilization Index (kBtu/SF/yr)	Building: CEUS avg:

Facility History and Plans	
Facility History and Maintenance	
Was the building commissioned after construction?	
Has facility been retrocommissioned in the last three years? If yes, describe.	
Has facility undergone major HVAC or lighting replacements in the last three years? If yes, describe.	
Has facility participated in other SCE rebate programs or offerings? Is the facility *planning to participate* in other programs? If yes, describe.	
Does the facility have blueprints and other documents such as Sequence of Operations? Describe what is available.	
Has the facility participated in LEED or is it planning to participate in LEED?	
Is there a preventive maintenance plan?	
Do building operators receive tenant complaints? What are common complaints (hot/cold, etc.) and how frequent are they?	
Future Plans	
Does the owner plan to sell the building in the next two years?	
Are there plans to replace the HVAC or control systems in the building in the next two years? If yes, describe.	

Facility Equipment			
HVAC System			
Water-cooled chillers	☐ Yes ☐ No	Size:	Age:
Air-cooled chillers	☐ Yes ☐ No	Size:	Age:
Water-cooled DX	☐ Yes ☐ No		
Other		Size:	Age:
Pump VFD (note type of pump)	☐ Yes ☐ No	Size:	Age:
Cooling Tower VFD (including type and location)	☐ Yes ☐ No	Size:	Age:
Air Distribution System			
Fan VFD	☐ Yes ☐ No	Size:	Age:
Economizer	☐ Yes ☐ No		
Do you employ reset strategies? If so, which systems?			
When were the resets last inspected?			
How often do the mechanical systems receive repairs / major maintenance?			
What major projects were completed on the mechanical systems in the last two years?			
Control Systems			
Make and model			
Type of Control System	☐ Pneumatic ☐ DDC ☐ Hybrid		
If hybrid, describe			
Is there a main access/computer terminal?			
Does control system have trending capability? Can the EMS trend major equipment? Can the EMS trend individual building zones?			
How easy is it to modify control sequences / reprogram the control system? Has the system been reprogrammed in the last year?			
Lighting Systems			
Types of indoor lighting			
Is lighting controlled through the EMS or time-clock?			
Are the lights programmed to turn off outside of working hours?			
Are the lights connected to motion sensors or photo sensors? Are there any issues with this equipment?			
Types of outdoor lights			
Are the outdoor lights connected to time-clock or photo sensors?			

Attachment B: Checklists

Topics for BRO Investigation Kick-Off Meeting (sample)

- ☐ Introductions to appropriate building staff, including key contact for day-to-day work
- ☐ Overview of BRO Provider approach to investigation process
- ☐ Deliverables and expected schedule
- ☐ Owner's (current) operating requirements
- ☐ Information on BAS (type, interface, trendability, on staff expertise, controls firm, etc.)
- ☐ Building entrance procedures
- ☐ Keys or access cards
- ☐ Identification requirements
- ☐ Parking permits
- ☐ Off-limits areas, or areas needing escort or prior notification to enter
- ☐ Permission to take photographs
- ☐ Document checkout/copying procedures

Operations and Maintenance Topics and Tasks (sample)

- ☐ Analyze electricity utility usage / demand data (provided by the Owner), at least two years of monthly data and one year of interval data. Obtain any additional utility data needed or desired for analysis from the utility or Owner.
- ☐ Review current maintenance protocols to establish the level of capability on site.
- ☐ Review historical equipment repairs / replacement costs to identify recurring issues.
- ☐ Review history of tenant complaints.
- ☐ Review major equipment operating logs.
- ☐ Review equipment warranties, to determine if there are any limitations on modifications that may be carried out.
- ☐ Review any equipment that was installed or upgraded using utility program incentives

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Attachment C: Current Facility Requirements Data Collection Table

(Sample template)

Item	Area A i.e., office	Area B i.e., conference	Area C i.e., computer	Area D Other	Area E Other
Temperature requirements and limitations					
Humidity requirements and limitations					
Pressure relationship requirements and limitations					
Filtration requirements and limitations					
Air change requirements and limitations					
Sound and noise level requirements and limitations					
Normal operating schedule for occupancy and/or protection					
Process and office equipment status during evening/night time hours					
Process and office equipment status during holiday hours					
Process and office equipment status during scheduled maintenance shutdowns					
Normal schedule for building cleaning crews					

Attachment D: BRO Training Completion Form

Southern California Edison
BRO Training Completion Form

Program Use Only

Project ID

Facility Information

Company Name	Building Name(s)		
Facility Address	City	State	Zip
Mailing Address	City	State	Zip

Training Details

Location	Date
BRO Provider/Trainer	

Materials Attached

☐	Agenda
☐	Materials used for training
☐	List of individuals who attended
☐	Measure persistence strategies

BRO PROVIDER SIGNATURE

By signing this Training Completion Form, I verify that this training took place with the listed attendees.
BRO Provider (print name):
Signature: Date:

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Checklist of subjects discussed at training

Explain investigation process and how measures were identified	☐
Describe implemented measures, and how they are reducing energy usage	☐
Building walkthrough to show implemented measures	☐
Methods for monitoring and maintaining system performance related to the implemented measures. Complete the "Measure Persistence Strategies" section below.	☐
Describe scenarios where system setting changes would be required, and how to maintain optimum energy efficiency, e.g., seasonal-based manual adjustments to setpoints.	☐
If available, review targeted documentation including BRO Final Report, O&M Manual, building plans ("as-builts"), BAS programming, and equipment manuals.	☐

List of Individuals Who Attended

Name	Title	Contact Information (e-mail and/or phone number)

Measure Persistence Strategies

Measure #	Finding Description	Measure Description	Persistence Strategy[5]

[5] O&M strategies for keeping the improvements working. Could include new preventive maintenance tasks, regular observation of system performance, regular trend data analysis, or other methods.