Local Government Energy Efficiency Resources

Guidebook 6: Post Project Implementation

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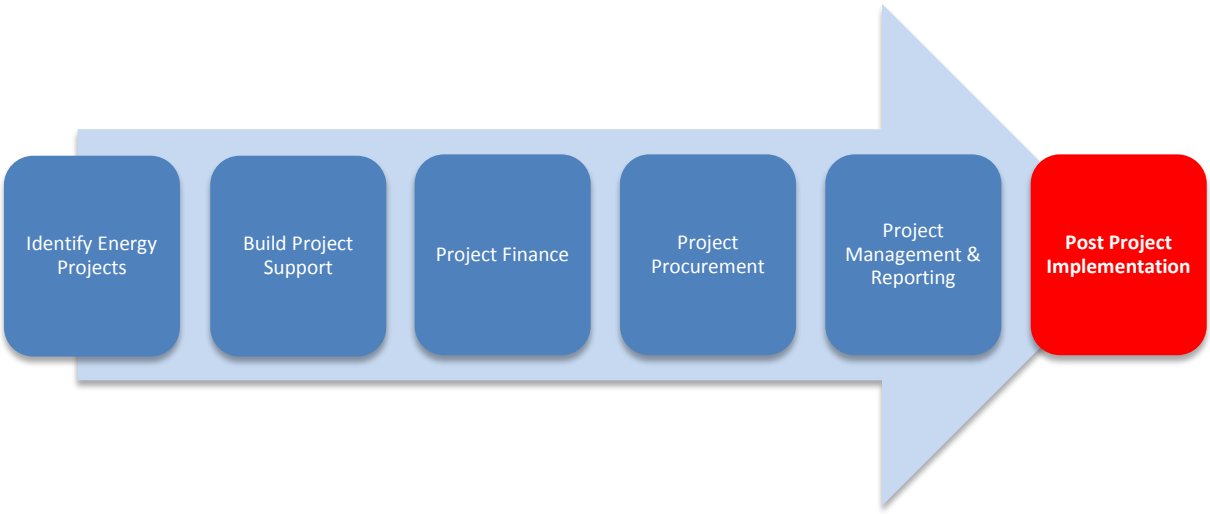

ABOUT THE ENERGY NETWORK

The Energy Network was created by the California Public Utilities Commission (CPUC) in 2012 to harness the collective power of residents, businesses, and the public sector to achieve an unprecedented level of energy savings across Southern California. The pilot phase is funded through the end of 2014.

The Energy Network provides free technical resources and expertise to qualifying public agencies. At no cost to your agency, The Energy Network Public Agency Program identifies energy-saving measures and works side-by-side with your staff from design all the way through construction to help you accomplish your energy efficiency projects. Your agency pays for construction. We also help you arrange financing and process utility rebate and incentives. We are your objective, third-party experts. For public agencies it's also about using public funds wisely and being role models for their communities.

GUIDEBOOK 6: POST PROJECT IMPLEMENTATION

This guidebook provides information and resources in order to properly close out energy projects. This is a commonly overlooked, yet important step to verify and track energy - and money - savings that should be planned for early in the energy project process.

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Introduction

The Energy Network was established to develop a regional, collaborative approach to providing energy efficiency services for local governments. This is the last in a series of six guidebooks developed to assist local government staff in developing and managing energy management programs, including the identification of energy projects, building project support, financing, procurement, project management and project closeout. This guidebook provides information and resources to assist local governments in properly closing out energy projects.

Post-project implementation activities are the last phase in the project lifecycle. Proper project closeout begins with the commissioning of all new equipment and systems, and happens prior to the Project Manager accepting the that the project has been satisfactorily completed in accordance with the contracted Scope of Work. Project closeout activities include the following:

- Technical Closeout (including Commissioning of New Equipment and Measurement & Verification (M&V))
- Financial Closeout
- Administrative Closeout

Proper project closeout is important to ensure that all contractual requirements are met and that the project Scope of Work is fully accomplished. It is during this phase when staff training is accomplished on the new systems and equipment and turnover of all documentation on the equipment, including as-built drawings, O&M manuals and warrantee information occurs. M&V is accomplished to verify energy savings and is required by the utility to receive rebates or incentives. This M&V may also be used to determine project payments for a performance contract or to determine how much savings are attributed to an internal revolving energy loan fund.

Technical Closeout

Project technical closeout includes commissioning of new systems and equipment, M&V and turnover of equipment and documentation to appropriate operations and maintenance staff. Each of these steps is important to ensure that the project has been competed in accordance with the contracted Scope of Work, the equipment is properly tested and operating as designed, and that staff is fully trained on proper operation and maintenance of the equipment to ensure sustained energy savings over time.

Commissioning of New Equipment and Systems

Project commissioning is one of the first steps in project closeout. Commissioning is a systematic process of assuring that systems and components of a building, new equipment, or an energy system are designed, installed, tested, operating, and maintained according to the designed operational requirements. The commissioning process is comprised of procedures to check, inspect and test each operational component of new systems from individual functions, such as instruments and equipment, to more complex systems such as central plants, direct digital control systems or entire new buildings. Commissioning also ensures that staff has received proper training on system operations and proper O&M procedures are put in place to maintain the systems performance over time.[1]

The project's Scope of Work should clearly delineate the commissioning requirements for the system or project including the industry standards by which commissioning should be completed. Table 1 lists the most common standards for the commission of new energy systems.

Table 1: Typical Standards and Guidelines Used for Commissioning

Project	Standards or Guidelines
Building New Construction	California Energy Commission, California Commissioning Guide: New Buildings, (2006). ASHRAE/USGBC/IESNA Standard 189.1, Standard for the Design of High Performance Green Buildings ANSI/ASHRAE/IES Standard 90.1-2010 (Energy Standard for Buildings Except Low-Rise Residential Buildings). ASHRAE Guideline 0-2005 (The Commissioning Process)
Heating, Ventilation and Air Conditioning (HVAC): Central Plants	ASHRAE Guideline 1.1-2007 (HVAC&R Technical Requirements for The Commissioning Process).
Electrical/ Lighting Systems	National Electrical Contractors Association (2004) NECA 90-2004 – Recommended Practice for Commissioning Electrical Systems

[1] http://www.cacx.org/resources/documents/CA_Commissioning_Guide_New.pdf

As part of the commissioning process, all equipment should undergo functional and performance tests that operate the equipment observing, measuring, and recording its performance in all key operating modes. In some cases, it is not possible to conduct performance tests for all operating regimes. Operations or maintenance staff should witness all functional tests. This is a good opportunity for the contractor to provide training for staff on how to operate and maintain the system.

Each functional test should have an assigned test protocol. A test protocol is a test form that describes exactly how a particular test will be carried out. The test protocol includes:

- Purpose of the test
- Instructions for carrying out and documenting the test
- Equipment required
- Acceptance criteria
- Prerequisites for testing
- Detailed procedural steps for testing
- Procedure for returning to normal
- Analysis required
- Required sign-offs

Functional testing can also be used to check and calibrate control points, occupancy or temperature sensors. The functional tests typically involve forcing the system into a series of operating modes and observing the system's response. A Verification Checklist should be associated with each test. It is used to document the steps that must be taken to verify the readiness of a piece of equipment for functional testing. This checklist should also be used to record all activities and observations during the testing process.

During functional testing, the contractor should use an "Issues Log" to track any performance issues that may arise and their resolutions. As equipment or systems come on line, their performance can begin to be monitored. The use of meters, portable data loggers, and the building's energy management control systems (EMCS) gather data that allow for observation of the building's performance under various modes and operating conditions.

An *Issues Log Template* can be found in Appendix A.

Data Logging

There are two methods of collecting trend data during functional testing: using an Energy Management Control Systems (EMCS) and portable data logging. Trend logging capabilities vary considerably among EMCS systems. Data collected could include temperatures, pressure, current, humidity, or other operational information. The extent of these capabilities determines the extent to which the EMCS can be used for diagnostics.

Portable data loggers can be an extremely useful diagnostic tool, especially if the EMCS has any limitations in its ability to collect, store, or present data. Portable data loggers are battery-

powered, small, light, and easily installed and removed without disrupting building occupants. Many come with sophisticated software allowing data to be downloaded, graphed, and analyzed on a computer in a variety of ways. Because they are portable, these data loggers can be applied where they are needed (a shortcoming of monitoring that uses an EMCS, whose sensors are already in place). Portable data loggers can be an excellent way to supplement EMCS monitoring.

Reporting

After all equipment commissioning and functional testing is complete, the Contractor should deliver a Commissioning Report to City Staff. The Commissioning Report is an essential document that summarizes the commissioning effort and certifies that each piece of equipment meets the project's design specifications.

KEY POINTS AND CONSIDERATIONS: PROJECT COMMISSIONING

- Commissioning of new equipment and systems are essential to ensure proper installation, calibration and operations.
- Staff training should be accomplished during commissioning of new equipment and systems.
- An "Issues Log" should be maintained during the commissioning process to ensure proper resolution of all identified problems or issues.

Measurement and Verification (M&V)

Determining Energy Savings

There are several methods to determine energy savings for a project (which are normally employed during the energy audit). The two primary methods are 1) engineering calculations (or modeling), and 2) deemed savings. For projects that install relatively simple measures or when it is impractical to actually measure project savings, a "deemed savings" approach is generally used. Deemed savings are predetermined savings values that are tabulated and found in the Database for Energy Efficiency Resources (DEER)[2] published by the CPUC. For projects that are more complex, require more variables to determine energy savings, or have higher operating hours (e.g., HVAC systems, high operating hour lighting projects, VFD pumping projects), energy savings can be determined using engineering calculations, or in some cases modeling a building to understand and quantify complex system interactions. Determining energy savings requires a high degree of expertise. The technical consultant that performs the audit or proposes the energy project should use and recommend the most appropriate method to determine energy savings.

Measurement and Verification (M&V) is the process of verifying savings as a result of an energy efficiency measure being implemented. There are several reasons that M&V may be required or desired:

[2] http://www.deeresources.com/

- Utility rebate and incentive programs require M&V to verify project savings
- Some financing programs require M&V to ensure the terms of the financing are met (e.g. project payback does not exceed the term of the loan)
- The need to credit energy cost savings to an internal "energy revolving fund"
- An "energy performance contract" (e.g., ESCO) bases project finance payments on an agreed-upon M&V approach that establishes project savings.

Utility M&V Requirements

Utility rebate programs that base incentives on energy savings typically require some form of project M&V. M&V requirements differ between programs, so it is important to always consult the project agreement to ensure you understand the M&V that is required of your specific project.

Guidelines for project M&V:

- For the "Customized Solutions Program (Incentives),"[3] M&V is comprised of a pre-installation and a post-installation inspection.
- For the "Express Solutions Program (Rebates)," M&V is comprised of a post-installation inspection only and which may be random or mandatory (specifics are outlined in the approved project application).
- You should anticipate being contacted by the inspector within a few weeks after your application is approved to accommodate the M&V inspection. Inspectors will make three attempts to contact you to make inspection arrangements. If you are unreachable, the application may be denied.
- Inspections normally do not take much time (depends on the size and complexity of the project) and are conducted during normal business hours (8 a.m. to 5 p.m. Monday through Friday).
- If the equipment is not installed or operational at the time of the inspection, the application may be declined and a re-inspection fee assessed at a future inspection.
- If equipment is only partially installed, a partial customer incentive will be paid. Further energy efficiency upgrades – from making equipment operational or from additional installation – will require a new customer incentives application.

For more complex projects, if the energy savings calculations in the project application cannot be easily substantiated, a "Measured Savings" M&V approach may be necessary. This would require that the project applicant (i.e. normally the project contractor or consultant) develop an M&V Plan and submit the plan for review and approval by the utility.

If Measured Savings M&V is required, the M&V Plan will be developed in accordance with the following references:

[3] http://www.sce.com/business/ems/customized-solutions/

- International Performance Measurement and Verification Protocol (IPMVP), Concepts and Options for Determining Energy and Water Savings, Volume 1 (EVO 10000 – 1:2012)[4]; and
- ASHRAE Guideline 14-2002: Measurement of Energy and Demand Savings[5].

The IPMVP's fundamental approach to M&V is based on the fact that energy savings cannot be measured directly. Savings effectively are the absence of energy use (or "avoided energy use") that would have occurred without the energy efficiency measures (EEMs) being installed. To properly document the impact of EEMs, a baseline energy use profile is established prior to installation of the EEMs. Following installation of the EEMs, this baseline relationship can be used to estimate how much energy would have been used each month had the EEMs not been installed (referred to as the "adjusted baseline energy"). The savings, or "avoided energy use," is the difference between the adjusted baseline energy and actual energy use during the time period following implementation of the EEMs when energy savings are to be measured and verified.

The IPMVP provides guidance on best practices in quantifying and reporting savings based on energy measurements and analysis. It provides four options to calculate and report a project's savings:

1. Option A: Retrofit Isolation: Key Parameter Measurement
2. Option B: Retrofit Isolation: All Parameter Measurement
3. Option C: Whole Facility
4. Option D: Calibrated Simulation

Options A and B draw measurement boundaries around individual systems or equipment. Option C draws the measurement boundary around the whole building or facility. Option D's energy-use simulations are typically applied at the whole-building level, but may be used at the equipment or system level. While IPMVP options require measured energy data, Option A allows certain non-key parameters to be estimated based on well-documented sources, however it requires that the key parameters be measured.

As in IPMVP, ASHRAE Guideline 14 requires that baseline and post-installation energy-use measurements be compared under the same set of conditions to estimate the savings. It provides detailed guidance on measurements, analysis, and quantification of energy and demand savings, including estimates of the resulting savings uncertainties. It has four compliance paths—one prescriptive path and three custom paths that are similar to IPMVP's Options B, C, and D.

M&V Report

The M&V Report should include the following:

- A detailed description of the measure or project.
- A detailed description of analysis methodology used to calculate savings.

[4] Efficiency Evaluation Organization. http://www.evo-world.org/
[5] http://webstore.ansi.org/RecordDetail.aspx?sku=ASHRAE+Guideline+14-2002

- Details on all assumptions and sources of data, including all stipulated values used in calculations.
- Equations and technical details of all calculations made.
- Details of any baseline or savings adjustments made.
- Energy rates used to calculate cost savings.
- Expected annual savings

KEY POINTS AND CONSIDERATIONS: M&V

- Proper accomplishment of M&V is required to qualify for rebates and incentives. It is important to make yourself available for utility project inspections and M&V to ensure rebate and incentives applications can be processed without delay.
- More complex projects may require an M&V Plan to be developed by your project contractor. An experienced project contractor should understand if and when an M&V Plan may be required or you should consult your utility representative.

Turnover to Operations

Physical turnover of control of the hardware or equipment delivered by the project to the appropriate personnel within operations, maintenance, or public works ensures staff has a good working knowledge of the equipment, including proper operation and maintenance procedures to ensure persistence of energy savings. Turnover and acceptance activities are the point at which staff assumes responsibility for the ongoing operations and support of the equipment. The steps include training, documentation transfer and physical transfer of the equipment. A formal acknowledgement of receipt (acceptance) of the equipment is executed by the Project Manager.

Training

The training of operational and maintenance personnel on the new equipment and systems is one of the most important aspects of project closeout. This should be accomplished during the commissioning stage of the project.

Document Turnover

An important part of the turnover process is ensuring that all project documentation is provided to staff, including:

- Systems Manual
- Equipment Operations and Maintenance Manual
- Warranty data
- Operating procedures
- Maintenance procedures
- Operation check lists
- Maintenance check lists

- Lists of recommended spare parts
- As-built drawings
- Construction and installation inspection reports
- Commissioning reports including set points
- Completed verification checklists and functional tests (if applicable)
- Performance test reports including test and balance reports
- Trial run reports including operating parameter readings

Technical Closeout Checklist

The following checklist ensures that all technical elements of project closeout have been completed:

☐ All aspects of the project have been formally accepted in accordance with the Scope of Work.

☐ All equipment has been properly installed and tested for proper operation.

☐ Any issues identified during test and commissioning and noted on the “Issues Log” have been addressed and corrected.

☐ All required commissioning activities have been completed and a commissioning report has been delivered to staff.

☐ All M&V requirements and inspections are complete.

☐ The appropriate equipment documentation has been turned over to staff, including: Operations and maintenance manuals, operations procedures and checklists, warranty information, lists of recommended spare parts, as-built drawings, commissioning reports including set points, completed verification checklists and functional tests (if applicable), and performance test reports including test and balance reports.

☐ Training has been completed on the new equipment and equipment has been formally turned over to operations and maintenance staff.

Financial Closeout

Financial closeout is the process of completing and terminating the financial and budgetary aspects of the project. Financial closure includes both (external) contract closure and (internal) project account closure. First, all project requirements must be reported as being met in accordance with the project Scope of Work. All expenditures and invoices must be accounted for and reconciled with the project account. When financial closure is completed, all expenditures made during the project have been paid as agreed in the contract or purchase order.

In order to close a contract it is important to collect all of the pertinent documentation for review. This will include all of the original contracts and supporting documentation such as schedules, contract changes, invoices and performance reports. This documentation needs to be reviewed thoroughly against the Scope of Work to ensure there are no unrealized contract issues that could result in legal liability. A thorough review of the procurement and contracting documents must include contract milestones, operational assumptions for energy savings calculations, services provided, or deliverables and documentation delivered.

To formally close a contract, the city must provide the contracted company or organization with a formal written notice stating the completion of the contract.

An equally important part of project financial closure is processing any rebate or incentive applications that are tied to the project. In most cases, rebate applications must be submitted within 30 days of the completion of the project. Typically an invoice stamped “paid” needs to accompany an installation report. For a Customized Incentive, the Installation Report (IR)template is included in the Project Approval (PA) Package. For Express or Deemed Solutions, an Installation Report still needs to be submitted to the utility company.

Some financing is provided on a reimbursable basis, so invoices and reports may need to be made available to the funding authority as activities are completed and invoices from contractors are received. If the operational dollar savings are assigned to repaying project costs, a schedule of payments should be reviewed and verified with the vendor and/or lender. For On-Bill Financing, the utility will calculate the repayment schedule and payment values. If the city has a revolving loan fund, consult the language in the fund terms and conditions to apply cost savings toward the project cost. The M&V section above can also be used as a guide to measure , predict and verify both energy and cost savings.

Financial Closeout Checklist

The following checklist ensures that all financial elements of project closeout have been completed:

- ☐ All invoices have been received, approved and processed for payment.
- ☐ Completed rebate applications and supporting documentation have been submitted to the utility for processing.
- ☐ All financing documentation has been completed and submitted to the financing entity.
- ☐ If an energy revolving loan is in place, documentation of energy savings has been established and the loan reimbursement mechanism via energy savings has been approved and established.

Administrative Closeout

Administrative closure of a project includes collecting, and archiving project records, and contract closure. As a tip, before and after photos should be collected, and public-facing

language to describe the community impact of a project should be created for marketing purposes.

Historic project data is an important source of information to help improve future projects. Typically, the following project data is archived for future reference:

- Project notebook
- Project Plan
- Project management and oversight review records
- Correspondence
- Meeting notes
- Status reports
- Contract file
- Technical documents, files, program, tools, etc.
- Project Photos
- Excerpts from the M&V Plan for ongoing Project Success Documentation

Administrative Closeout Checklist

The following checklist ensures that all administrative elements of project closeout have been completed:

☐ All project records been completed and archived.

☐ A final project report has been drafted (including lessons learned) and routed to management for review.

A comprehensive project closeout checklist can be found in Appendix B.

APPENDIX A: ISSUES LOG TEMPLATE

Issue No.	Issue Description	Date Identified	Contractor Responsible	Date Contractor Notified	Action Taken	Issue Resolution (Open/	Resolution Date

APPENDIX B: PROJECT DOCUMENTATION CHECKLIST

At the conclusion of the project, the contractor should ensure all relevant project documentation is provided to staff. This checklist includes the most common documentation items, including:

- ☐ Systems Manual
- ☐ Equipment Operations and Maintenance Manual
- ☐ Operations Procedures
- ☐ Warranty data
- ☐ Maintenance procedures
- ☐ Operation check lists
- ☐ Maintenance check lists
- ☐ Lists of recommended spare parts
- ☐ As-built drawings
- ☐ Construction and installation inspection reports
- ☐ Commissioning reports including set points
- ☐ Completed verification checklists and functional tests (if applicable)
- ☐ Performance test reports including test and balance reports
- ☐ Trial run reports including operating parameter readings

APPENDIX C: PROJECT CLOSEOUT CHECKLIST

Item	Status	Notes
Has all equipment been properly installed and tested for proper operation?		
Have all commissioning activities been complete?		
Have all M&V requirements been complete?		
Have all aspects of the project been formally accepted?		
Are there contingencies or conditions related to the acceptance? If so, describe in the comments.		
Has operations management formally accepted responsibility for operating and maintaining the equipment?		
Has all documentation relating to operation and maintenance of the equipment been delivered to, and accepted by, operations management?		
Has training of the operations organization been completed?		
Have any rebate applications been submitted to the utility for processing?		
Have all financial accounts been reviewed and closed?		
Have all project records been completed and archived?		
Have the successes of the project and lessons learned been documented?		