

Retrocommissioning Program Toolkit for Local Governments



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The California Sustainability Alliance (the Alliance) is an innovative market transformation program funded by California utility customers under the auspices of the California Public Utilities Commission. The Alliance leverages action on environmental initiatives such as climate, smart land use and growth, renewable energy, waste management, water use efficiency and transportation planning to help the State of California achieve its aggressive energy efficiency goals more effectively and economically. In partnership with public and private organizations throughout California, the Alliance precipitates widespread market transformation by tackling major barriers to sustainability.

For information about the California Sustainability Alliance, go to:

www.sustainca.org

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The RCx Program Toolkit

The [California Sustainability Alliance](#) has created this RCx Program Toolkit to help local government staff develop and implement a municipal facility retrocommissioning program. The RCx Toolkit complements existing portfolio management tools and utility management systems, helping the user take the “next step” once a decision has been made to incorporate retrocommissioning into municipal facility standard operating procedures.

Included in this Toolkit is a description of the RCx Program development process, as well as necessary tools and resources to implement the program such as documenting and tracking results, references to common RCx resources and procedures, model RFP language, and finally, the RCx Dashboard, a spreadsheet tool that allows the user to enter basic building information to identify potential RCx candidates and track RCx program accomplishments.

The RCx Toolkit is designed to be flexible enough to be a complementary resource for an energy manager in a large local government or to be the sole RCx Program management tool for facility and public works staff in smaller jurisdictions. You may use the Toolkit to facilitate RCx for your entire portfolio of buildings, or for a self-defined subset, such as all fire stations or libraries. Alternatively, you may wish to use only certain procedures to guide your staff through retrocommissioning those measures for which your team is responsible, or to provide to your maintenance contractor.

Depending on your specific situation, you may use the RCx Dashboard to prioritize buildings and identify RCx candidates. Alternatively, you may use data or analyses from other tools such as Portfolio Manager, or a Utility Management System to prioritize the buildings, in which case, you may still use the Toolkit as a resource library and tracking tool. For example, if you are planning a heating, ventilation, and air conditioning (HVAC) system replacement, the Toolkit includes sample retrocommissioning request for proposals (RFP) language to ensure the contractor performs functional tests and provides the required documentation to the project team. If you are planning a project, such as a lighting replacement, which internal staff will complete, you may wish to use the RCx functional tests included in the RCx Toolkit to document proper installation and operation of the newly installed lighting system.

What is Retrocommissioning?

Retrocommissioning is “a systematic method for investigating how and why an existing building’s systems are operated and maintained and identifying ways to improve overall building performance¹.” Retrocommissioning helps building owners ensure that energy efficiency features and equipment specified in the building design are installed and operating as intended.

The term commissioning typically refers to completing this formal set of activities in a newly-constructed building, although it is also used as a general term encompassing all

¹ CA Commissioning Guide: Existing Buildings, California Commissioning Collaborative, June 2006. http://www.cacx.org/resources/documents/CA_Commissioning_Guide_Existing.pdf

types of commissioning activities. Retrocommissioning (RCx) is generally reserved for performing commissioning in an existing building that was never formally commissioned.

Ideally, commissioning is fully integrated into the entire design and construction process for both new construction and retrofit projects. Commissioning is often confused with performance testing, which is just one component of a commissioning process. Formal commissioning includes documenting the design intent, design review and integration, performance testing, operations staff training, and providing complete systems manuals and related documentation for facility manager reference and use. The RCx Program Toolkit is focused on the performance testing and documentation components, but also includes resources, such as model commissioning specifications, to facilitate the entire commissioning process.

What are the Benefits of Retrocommissioning?

Retrocommissioning is a relatively quick and low-cost way to ensure building systems and controls operate properly, as intended, and as required to meet occupants' needs. RCx results in a building that operates at optimal levels and meets the needs of the owner and occupants. The retrocommissioning process can yield fast paybacks and savings that persist over time. As the owner and operator of most of its facilities, a local government can often plan more strategically than private builders, allowing it to invest in a more comprehensive suite of features that together produce greater savings than implementing a subset of short-payback measures. Retrocommissioning ensures that savings from these investments persist over time. In addition, pro-active government agencies position themselves as leaders in the commercial community by serving as an example of environmentally and fiscally responsible building portfolio management.

Some retrocommissioning benefits include:

- energy and cost savings,
- improving occupant comfort and productivity,
- optimizing building performance,
- improving the accuracy of facility equipment documentation,
- improving indoor environmental quality, and
- preparing for the addition of renewable and/or on-site energy generation.

Most buildings undergo many changes throughout their lifecycles: occupants change, operations patterns and activities shift, and with them, the amount and types of energy- and water-using equipment. Retrocommissioning ensures that controls and energy-using equipment work properly, and that the full savings potential is realized and maintained. According to a study conducted by Lawrence Berkeley National Labs² under the California Energy Commission's (CEC) Public Interest Energy Research (PIER) Program, retrocommissioning in several local government buildings resulted in an average savings of 14.3% of the total building energy usage, and an average payback time of 3.5 years. Note that savings varies tremendously depending on the climate, and the type and size of the facility.

Retrocommissioning History and Background

Growth of Retrocommissioning

As the importance of energy efficiency, environmental stewardship, and sustainable practices receive more widespread recognition, industry experts have started to look beyond simple equipment-based solutions to further reduce energy use. Both private and public organizations have completed studies which confirmed suspicions that commercial buildings often don't work as designed, not only after years of operation, but from the time of initial occupancy.

With the tremendous advances in electronic and digital capabilities, a wide variety of automated controls are employed in commercial buildings, ranging from simple occupancy sensors and timers to advanced energy management and control systems (EMCS). Collectively, we adopt standards that require

Many government buildings are historical buildings, built before computers became commonplace, and prior to modern lighting and HVAC equipment. The transition from paper to electronic media also changed lighting needs in offices from requiring high ambient lighting for paperwork to a combination of lower ambient lighting for work on computer monitors, supplemented with individual task lighting. A modern design employing advanced lighting technologies and controls enables us to automatically control the electric lighting. With properly operating controls, one can automatically dim electric lighting in response to the available natural daylight, as well as turn lights off in key areas such as restrooms and conference rooms when there are no occupants. In addition, modern control systems can automatically turn off equipment and task lighting when an individual isn't at a workstation. These automated controls can save significant energy and money, but they must work seamlessly or they will be disabled by occupants or facility staff. Oftentimes, disabled controls result in greater energy usage than no control at all. Even worse, occupants that have had frustrating experiences with poorly functioning controls are reluctant to try them again in the future.

²Mills, E., H.. 2009. "Building Commissioning: A Golden Opportunity for Reducing Energy Costs and Greenhouse Gas Emissions", California Energy Commission. <http://cx.lbl.gov/2009-assessment.html>

them, engineering designs specify them, and contractors install them in nearly every commercial building. However, the installations are often untested or not calibrated, documentation is sparse or non-existent and often, facility managers don't receive training to correctly operate the equipment and control sequences used at their facilities. Unfortunately, these design and construction practices have resulted in many controls being disabled or overridden; and buildings that are like an old VCR that was never programmed, its display endlessly flashing 12:00, but sitting idly, unable to utilize its inherent ability to automatically perform the functions for which it was intended.

Policy Drivers

Both federal and state agencies have adopted codes or policies encouraging or requiring commissioning and retrocommissioning to save energy and money, reduce greenhouse gas emissions, and optimize facility performance. There are several different initiatives underway at both levels that are driving the recent surge in RCx activities. Each agency has a slightly different objective, but the one common denominator is that they rely on local governments to implement the policies. Despite a desire to do so, smaller jurisdictions often lack the resources required to implement many of the initiatives and goals established by the state.

At the federal level, the Department of Energy (DOE) periodically adopts building standards detailing the minimum energy performance for commercial and residential buildings and requires that each state certify that the state codes are at least as stringent as federal codes. The current federal commercial building code, [ASHRAE 90.1-2010](#), requires commissioning for new buildings, with two tiers depending on the building size. In addition, the American Society for Heating, Refrigeration Air Conditioning Engineers (ASHRAE), in collaboration with the International Code Council (ICC) and United States Green Building Council (USGBC), recently developed a high performance green building code [ASHRAE 189.1-2011](#), that includes energy-related requirements in addition to Standard 90.1 and expands the scope to include other green building requirements such as water and resource efficiency, and site sustainability. The 2012 [International Green Construction Code \(IGCC\)](#), created by the ICC is similar to ASHRAE's Standard 189.1, and both are similar to CALGreen, California's green building code.

California is developing both long- and short-term strategies to mitigate the impacts of climate change throughout the state. The policies originate from a variety of sources within the state including the governor, legislature, and several state agencies such as the California Public Utilities Commission (CPUC), California Energy Commission (CEC), and Building Standards Commission (BSC), working both independently and collaboratively.

One example is [CALGreen](#), the Building Standards Commission's Green Building code (Title 24, Part 11), the first mandatory green building standard in the nation which became effective in January 2011. CALGreen requires all new nonresidential buildings 10,000 square feet or larger to implement select elements of commissioning in the building design and construction process.

The CEC adopted the energy-related portions of CALGreen's requirements into the Building Energy Efficiency Standards, (Title 24, Part 6), effective January 2014. Permit applicants must provide documentation related to commissioning, including a summary of commissioning requirements, the owner's project requirements, and basis of design, design

review, and a commissioning plan. In addition, permit applicants must complete functional performance tests, prepare training materials, conduct operator training, and prepare a commissioning report.

State level policies such as the [California Long Term Energy Efficiency Strategic Plan](#) (CALTEESP) recommend that all local governments adopt retrocommissioning policies and implement retrocommissioning activities to reduce energy use within government facility portfolios. However, most jurisdictions in the state serve relatively small populations and do not own a portfolio of large, complex buildings typically targeted for retrocommissioning. For example, the City of Santa Barbara has a population just under 100,000 people. The City owns and maintains approximately 100 facilities. Of those facilities, only one is the size commonly considered the most cost-effective for retrocommissioning (50,000-100,000 square feet), and about 15 facilities (if newly constructed) would be within the scope of the CALGreen commissioning requirements.

More than 80% of local governments in California serve communities with populations of 100,000 or fewer, and about 50% have 30,000 or fewer people.

CA Dept of Finance, Population Estimates for Cities and Counties, January 1, 2012

Many communities have committed to upgrading municipal facilities, either as part of a Climate Action or Sustainability initiative, or more informally, short of actually adopting a policy mandating it. For example, some jurisdictions routinely specify that municipal facilities include CALGreen voluntary measures, or obtain LEED certification through the USGBC's Green Building rating system.

Refer to the [Government Retrocommissioning Policy and Activity Highlights Table](#) for a summary and brief description of some key policies behind the tremendous growth in the commissioning industry over the past decade.

Technology Drivers

As the building landscape evolves, and electronic control systems become more automated, they are also becoming more complex to properly operate and maintain. As buildings become more dependent on automation, it is increasingly important that the systems function properly. In some emergency services facilities, such as police or fire stations, it's crucial for security and public safety that the equipment and controls operate properly. In addition, many municipal facilities serve multiple purposes and must be capable of running under various operating conditions, and with different operators of varying skill levels.

Demand response technologies are growing rapidly and have the effect of increasing the grid capacity at peak times. One of the most dependable ways to ensure load will be dropped when needed is to aggregate and automate the responses of many smaller systems. The equipment must be regularly commissioned to ensure it is functioning properly and capable of responding to various energy-related (or price-related) conditions and requirements.

As population grows and energy demand continues to rise, the grid will need to transform into a more advanced, communication-rich system that uses a much larger volume of smaller, distributed generation systems. Renewable energy generating systems, because they are dependent on natural forces, have varying output capacity over the day, and year.

The transition to a more diverse, widely-distributed system elevates the importance of ensuring that energy-using equipment and especially, controls, operate correctly to allow building operators to adjust as necessary to match varying supply.

Government Retrocommissioning Policy and Activity Highlights

	Policy/Driver	Building Types	Sustainability Scope	Voluntary / Mandatory	Description
Federal	ARRA	All	Comprehensive	Voluntary	Funding for states and local governments to conduct many activities and develop and implement policies.
	Building Codes	All	Energy Only	Mandatory	
State	AB32	All	Comprehensive	Mandatory	Economy-wide cap on California greenhouse gas emissions at 1990 levels by no later than 2020
	CA LTEESP	All	Energy Only	Voluntary -private sector. Mandatory - implementers (utilities, government).	Strategy and activities for achieving state's energy efficiency policy objectives with near, medium, and long-term goals.
	Governor's Executive Order S-3-05	All	Comprehensive	Mandatory	Reduce GHG emissions in CA: By 2010: to 2000 levels By 2020: to 1990 levels By 2050: to 80% below 1990 levels
	Governor's Executive Order B-18-12 (replaces EOS-20-04)	State-Owned	Comprehensive	Mandatory	All state-owned buildings reduce emissions by 10% by 2015, and 20% by 2020 (2010 base), plus other requirements
	CALGreen	Commercial, Residential	Comprehensive	Mandatory (with voluntary options)	California's Green Building Standards
	AB 1103 (Benchmarking)	Commercial	Energy Only	Mandatory	
	AB 758	Existing only	Energy Only		Existing buildings
Local	Climate Action Plan (CAP)	All	Comprehensive	Either	
	Energy Action Plan (EAP)	Municipal or All	Energy Only	Either	
	Municipal Facility Energy / Climate-Related Policies	Municipal or All		Either	Energy Action Plans, Retrocommissioning Policies, Municipal Green Building Policies
	Local Ordinances (Reach Codes)	All, or any subset		Mandatory (may contain voluntary components)	

Planning and Preparation

Before you begin a retrocommissioning program, the following considerations and preparatory activities will help ensure the process goes smoothly, and that savings resulting from the program persists over the long-term.

Confirm Municipal Savings Goals and Local Policies

Many local governments have adopted savings goals for their municipal facilities as part of Climate or Energy Action Plans, or through other mechanisms. Prior to beginning your retrocommissioning program, identify any formal savings goals and coordinate with the team to ensure your achievements are documented and that you report consistently. For example, many plans reference a specific year for determining the baseline energy usage (and related GHG emissions). You may also be able to leverage work done through the Climate Action Planning processes to facilitate project initiation. For example, if another department is responsible for tracking and reporting the savings, they may have already created a facility inventory.

If your jurisdiction has adopted savings goals, it may have also adopted policies to support activities required to achieve those goals. Some examples of local policies that could support a retrocommissioning program include Climate Action or Energy Action Plans, Environmentally Preferable Purchasing (EPP), and Municipal Energy Efficiency or Green Building policies. You may wish to consider adopting a resolution declaring the jurisdiction's intent to initiate a retrocommissioning program for municipal facilities. These types of policies can be helpful to provide support for the incremental cost of adding retrocommissioning to a retrofit project, or for the resources necessary to initiate and implement a retrocommissioning program. If your jurisdiction hasn't adopted a Climate Action Plan or formal savings goals, the following resources may be of assistance.

Actions:

Identify existing municipal goals, coordinate reporting. If no existing plan, review reporting protocols and establish reporting consistent with recommended formats for greenhouse gas emissions reductions.

Tools and Resources:

California Air Resources Board (CARB), [Climate Action Planning](#).

CARB, [Local Government Operations Protocol \(LGOP\) for Greenhouse Gas Assessments](#).

California Sustainability Alliance's LGOP toolkit provides [additional information and detail regarding each section in the protocol](#).

California Statewide Energy Efficiency Collaborative, a partnership between Local Government Commission, ICLEI, Institute for Local Government, PG&E, SCE, SDG&E, and So Cal Gas to help support governments in [increasing energy efficiency and reducing greenhouse gas emissions](#).

California Air Pollution Control Officers Association (CAPCOA), [Quantifying Greenhouse Gas Mitigation Measures](#).

US EPA [Environmentally Preferable Purchasing \(EPP\)](#).

Natural Resources Defense Council, Smarter Business, [Greening Advisor](#).

CalRecycle, [Environmentally Preferable Purchasing](#).

Click here for a [Sample Retrocommissioning Resolution](#).

Identify Current Projects That Include Retrocommissioning

It's also important to consider any current portfolio-wide initiatives such as implementing a Utility Management System (UMS), as well as specific facilities that are currently pursuing the ENERGY STAR label or LEED certification. LEED, or Leadership in Energy and Environmental Design, is a green building rating system developed by the United States Green Building Council (USGBC) that spans several sustainability categories including energy and water efficiency.

Actions:

Identify existing buildings currently pursuing Energy Star or LEED certification, and all current or upcoming new construction projects. Coordinate retrocommissioning plans and activities with project schedules to avoid lost opportunities or duplication of efforts.

If a project is ahead of your RCx Program timeline, you may use the dashboard to identify some RCx recommendations, or simply use the model specifications to ensure RCx is included in the project.

Tools and Resources:

US EPA, [Energy Star for Buildings](#).

United States Green Building Council, [LEED Rating Systems](#).

Click here to download the [RCx Dashboard](#).

Click here for [Model RCx Specifications](#).

Determine Initial RCx Program Scope

Customize your RCx Program scope to suit your local conditions. To minimize staff resources and incremental costs associated with initiating and running a RCx Program, consider adding buildings to the program in concert with planned equipment upgrades, moves, functional or occupancy changes.

Ultimately, it's ideal to include all or nearly all your facilities in a retrocommissioning program, though you will need to adjust the scope of the retrocommissioning activities consistent with the facility size and type to ensure the activities remain cost-effective. Larger, more complex projects are likely to require more comprehensive retrocommissioning and also to result in greater savings opportunities than smaller projects. As most jurisdictions don't have the resources to establish a comprehensive program for all facilities at one time, to minimize extra resource requirements, roll out the program in phases, and where possible, integrate new RCx work scopes with related activities, such as equipment retrofits or occupant moves. As you complete equipment retrofit projects, or initiate or

renew maintenance or preventive maintenance contracts, continue adding facilities to the RCx Program. You may even consider including storage facilities and other small buildings used to house pumping or other equipment. Although these facilities typically use only a small amount of energy for lighting, when controlled properly, they can save a significant amount of energy in aggregate. Facilities with the following features tend to offer the most savings opportunities:

- Complex HVAC or lighting equipment
- Central HVAC or lighting controls,
- Large process loads,
- High energy use intensities (EUI),
- Known operational difficulties, and
- 10,000 sqft or larger. Smaller facilities can also benefit from limited RCx activities, especially those with long and/or intermittent operating hours, emergency and public safety operations, and facilities used for community gatherings.

New Construction: New construction projects offer a unique opportunity to integrate commissioning into the entire design and construction process. Commissioning is now required by Title 24, Part 6 for all new construction projects greater than 10,000 square feet of conditioned space. You may integrate commissioning activities into new construction projects by referencing the requirements in [CALGreen](#) (effective 1/1/2014), and using the sample RFP language and specifications as a basis from which to draft your project RFP. For smaller projects, also consider including a subset of requirements, which include functional performance testing, documentation and operator training.

Actions:

Review existing data and the facility inventory if one exists, obtain feedback from staff, assess available resources, and determine the initial scope for the RCx Program.

Tools and Resources:

Green California, [Commissioning Toolkit for Small Buildings](#). Toolkit includes descriptions and samples of commissioning documentation and functional performance tests.

Construct the RCx Program Team and Identify a Champion

There are many ways to construct a retrocommissioning program team. Often, the RCx program team lead or champion is a Facilities Management or Public Works department staff member. In some municipalities, the champion may be the entire team. In larger cities, the team may also include a liaison, a technical lead, project managers, and an intern or entry-level support person. The RCx champion is responsible for ensuring the program moves forward, communicating with other departments regarding audits and occupant needs and plans, equipment and service procurement, and documenting and reporting savings.

Regardless of the team structure, a RCx liaison working with building occupants both before and after a retrocommissioning project is critical to the RCx Program success. Informing building occupants of an upcoming project and coordinating with them to minimize

disruptions to their work space helps obtain their buy-in, and ensure the project runs smoothly. Occupants are valuable resources regarding building operations and equipment performance (or lack thereof), and understanding their needs is crucial to setting up the systems and controls for optimal operation.

To ensure the program will be sustained, try to integrate RCx into the natural project flow. In other words, to the extent possible, make RCx business as usual. Initiating the program will require the most staff resources as there are several activities required to get the program started and to ensure the activities are documented properly. The amount of time will vary depending on the program scope, launch schedule, and the availability of data. Refer to [Create Data Infrastructure](#) for additional details. Once the program is up and running, most of the time required will be for adding new buildings to the program, implementing RCx projects, and tracking and reporting.

Actions:

Create the RCx Program team, assign roles and responsibilities, and work with management to ensure team has the resources and support it needs to succeed.

Tools and Resources:

Click here to see [RCx Program Team Roles and Responsibilities](#).

Create Data Infrastructure

Complete a Facility Inventory

It is helpful to have an inventory of municipal buildings from which to begin developing your data set. It is highly likely that someone has already created an inventory that you can use as a starting point. However, note that inventories are done for many different reasons and an existing list may or may not meet your retrocommissioning needs. For this purpose, it's important to include the facility name and address, primary use, floor area (conditioned and unconditioned), ownership and maintenance structures, and a contact person with which you can work to schedule audits or other RCx activities.

A facility inventory is one of the first steps in the tracking and documentation process.

Actions:

Create a complete inventory of all building in the portfolio, including general building information, such as construction date, building type, and floor area.

Tools and Resources:

Click here to see a [Sample Building Inventory Spreadsheet](#).

Confirm Availability and Location of Building Data

Once you complete your inventory of facilities that will be included in the RCx program, you may wish to locate basic building records and documentation required to initiate the program. Most buildings were originally constructed decades ago, when records were

maintained primarily as hard copy (or, if one is fortunate, microfiche records are available). Over time, buildings undergo many changes. Occupants change, equipment is replaced, entirely new systems are added (such as internet or communications systems), walls are moved, removed, or replaced, and unfortunately, records often get lost or destroyed. Assembling building documentation can be a challenge in the best of cases. You will likely discover that in the rare cases when plans do exist, they are outdated. Similarly, equipment purchase and maintenance records can be difficult to locate and are frequently not current.

The Building Data Collection Checklist is a convenient tool to document the existence and location of the data and supporting documentation you'll need to initiate the RCx program. It is helpful and generally more cost-efficient to gather and prepare the information relevant to all the buildings at one time rather than gathering it "on the fly", while you are populating the Dashboard or a benchmarking tool. You will need to be a bit of a detective to find (if you haven't already) which meters serve each building, if there are multiple meters (or sub-meters for different tenants within a building), associated account numbers to obtain usage and cost data, plans and other equipment, and maintenance records.

The initial data required for the RCx Program Toolkit is similar to that required for the EPA Portfolio Manager. You may use the data collected for either purpose to help begin populating the data for the additional tool.

Actions:

Locate and gather the basic building and energy usage data required for all facilities in the RCx Program to prepare for data entry in the RCx Dashboard. You may use the RCx Data Collection Worksheet below. If you haven't already completed benchmarking for the facilities and you plan to use EPA's Portfolio Manager, you may use the data collection checklist below to streamline the process.

Tools and Resources:

Click here to download the [RCx Dashboard](#).

Click here for a Building [Data Collection Worksheet](#).

Collect Baseline Data

Purchase or Install Portfolio Management System

The RCx Toolkit is designed to complement and coordinate with a portfolio management system. While it does include some capability to track RCx activities and the impacts, it is limited to RCx, and isn't able to track other metrics such as water usage. In order to know the results of the RCx Program and other energy efficiency or sustainability initiatives, it's important to use a portfolio management system. There are a variety of different portfolio and utility management tools available for purchase.

In addition, the EPA has developed a free tool called Portfolio Manager that continues to gain in popularity, especially in the municipal sector. In addition to the tool being free, many utilities have worked with EPA to set up a process to automatically import detailed energy usage data, saving a significant amount of time and labor costs to maintain the system once you've set it up. One of the other advantages to using Portfolio Manager is

that it is directly linked to the EPA ENERGY STAR Building program which allows you to compare the performance of your building to others nationwide. To earn the ENERGY STAR label, a building must score at least 75 out of 100 points, which means the building performs better than 75% of all similar buildings nationwide.

The initial data required for the RCx Program Toolkit is similar to that required for the EPA Portfolio Manager. You may use the data collected for either purpose to help begin populating the data for the additional tool.

Actions:

Acquire and install a portfolio management system to facilitate tracking and reporting the savings resulting from all energy efficiency and sustainability initiatives.

Tools and Resources:

[US EPA Portfolio Manager](#). Track and assess energy and water consumption across your entire portfolio of buildings.

Click here for the [Building Data Collection Worksheet](#).

Complete Benchmarking

Initiating a benchmarking program is a labor-intensive process as it requires locating and gathering a significant amount of data and manually entering the data into the benchmarking software or tool. Once that initial effort is complete, it requires only a fraction of the time to maintain the system. Many municipalities have exploited interns to cost-effectively gather data and populate the benchmarking system. This has several advantages in that it provides interns an opportunity to acquire real-world experience, become familiar with energy-using equipment as it's employed in the field, facility structures and occupant considerations, and to work with utility account and billing information. In addition, the municipality minimizes the cost of initiating a benchmarking program, conserves staff time and resources, and is also able to conduct a trial run with the intern to assess his or her abilities and whether they are a good fit with the rest of the team.

Benchmarking has many benefits from a portfolio management perspective, primarily, as a tool to compare the performance of buildings across the portfolio. In the case of EPA Portfolio Manager, you may also benchmark your buildings against other similar buildings nationwide. If the system is maintained, it can help control energy and water usage and costs, document greenhouse gas emissions and reductions, and identify usage trends as well as anomalies, such as a sudden spike in energy or water usage at a particular facility. Benchmarking may also help document the impacts of the comprehensive suite of sustainability and energy-savings projects on the whole portfolio.

Actions:

Initiate a benchmarking program. Consider working with local colleges to use an intern to collect data and complete the initial system population.

Tools and Resources:

Green California, Benchmarking: [Measuring a Building's Energy Performance](#).

[Building Benchmarks](#). This site provides a high-level, simplified estimate of the energy use intensity and annual energy usage of a building based on location, building type, vintage and size.

LBNL's [Energy IQ Benchmarking Tool](#).

LBNL [Energy Benchmarking for Buildings and Industries](#).

US EPA [Benchmarking](#).

Populate RCx Dashboard and Analyze Data

The RCx Dashboard is a focused spreadsheet tool designed to help facility managers initiate and implement a comprehensive retrocommissioning program. The RCx Dashboard is designed to complement the variety of existing tools available, filling a gap in the resources for facility managers in small jurisdictions.

The RCx Dashboard allows facility managers to initiate a program without having to conduct detailed audits throughout the portfolio. The Dashboard uses high level building information to:

- Identify buildings that are likely to benefit from retrocommissioning,
- Recommend retrocommissioning opportunities within a building,
- Provide links to existing resources and functional tests to facilitate recommended retrocommissioning activities, and
- Provide a record of retrocommissioning activities completed at each facility.

The RCx Dashboard complements other portfolio management tools such as EPA's Portfolio Manager, or a Utility Management System. Refer to the RCx Dashboard section below for additional information about the [RCx Dashboard](#).

You may also skip the Dashboard and complete your own prioritization process. There are many ways to prioritize buildings and retrocommissioning opportunities. Some options include:

- a. Largest energy users
- b. All similar buildings (fire stations, offices, libraries, etc.)
- c. Largest buildings
- d. Low ENERGY STAR score
- e. Large process loads
- f. Highest EUI
- g. Centralized controls, or
- h. Known operational difficulties

If you prioritize the buildings outside the RCx Dashboard, you may still use the Toolkit to develop your RCx Action Plan, to create a record of retrocommissioning activities, and also for reference to functional tests and other tools. However, if you use the Dashboard, it

automatically generates recommendations, and summary graphs that allow you to easily compare buildings to other buildings within your portfolio, as well as to similar buildings nationwide.

Actions:

Populate the RCx Dashboard and complete analyses of the retrocommissioning opportunities in preparation for the RCx Action Plan.

Tools and Resources:

Click here to download the [RCx Dashboard](#).

Implement Retrocommissioning Program

Create a Retrocommissioning Action Plan

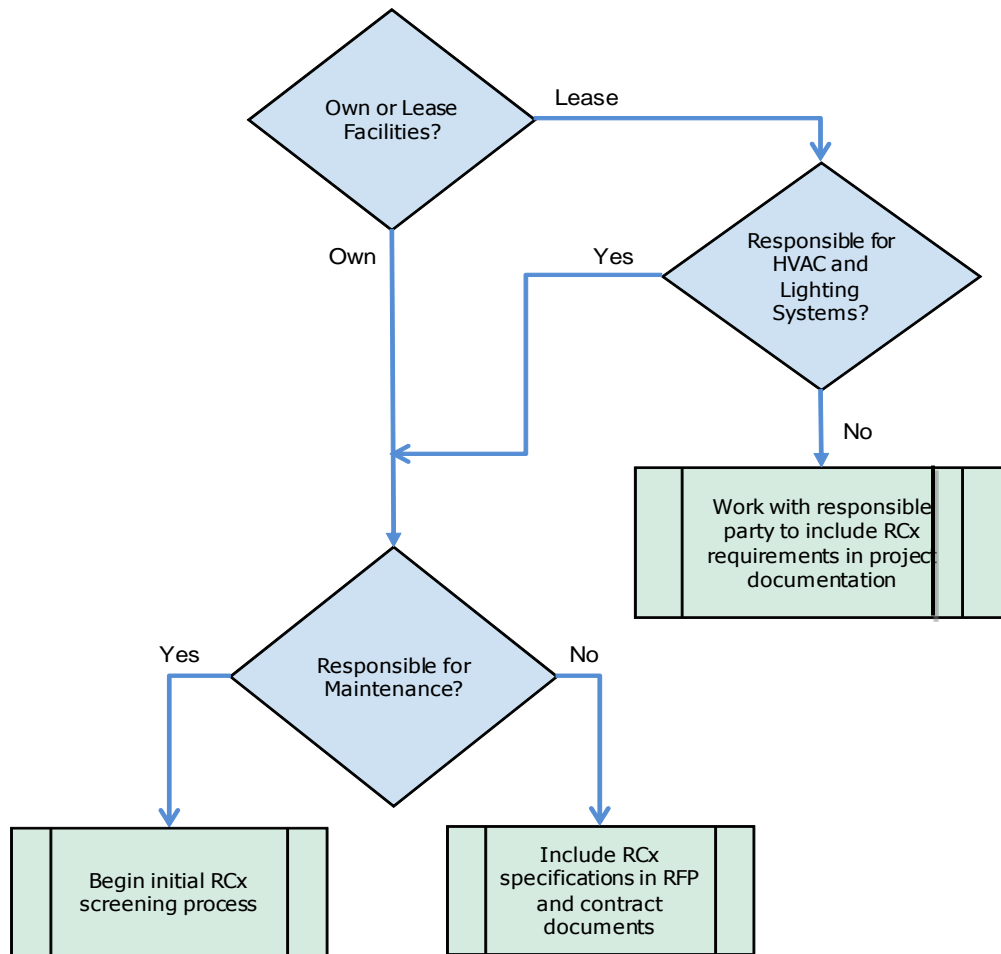
Now that you've completed the facility inventory, benchmarked the buildings that will initially be included in the RCx Program and analyzed the data, it's time to develop your RCx Program Action Plan. The RCx Action Plan documents the primary program objectives, and outlines the strategies and actions the program team will take to achieve those objectives.

An Action Plan has several components, and should include a description of the proposed activities, who will be responsible for implementing them, potential barriers, strategies for overcoming them, and a timeline. Begin with high-level strategies, then further break each strategy into its major tasks and action steps. Customize your RCx Action Plan to suit the specific circumstances in your jurisdiction. The Sample RCx Action Plan includes examples of potential implementation strategies, metrics and milestones.

The ownership and management structure of the facilities included in the RCx Program will impact the structure of the RCx Action Plan. Jurisdictions operate under many different circumstances, and have varying ownership and management structures for their facilities. In many cases, the jurisdiction owns all or nearly all of the facilities within which it conducts its activities. However, there are also many jurisdictions that lease either privately-owned facilities or space within a facility owned by another jurisdiction. In addition, maintenance and repair work may be performed by internal staff or may be done via external contracts, or a combination of both. Though there are many similarities across each structure, the differences result in different paths in pursuing RCx opportunities.

If you do most maintenance work internally, consider placing your initial focus on those systems with which staff has the most experience and expertise. If maintenance is primarily done by an external contractor, it may be more advantageous to begin with the largest buildings and facilities with the highest energy use.

Facility Ownership and Management Structure



Actions:

Develop and implement a RCx Action Plan that clearly articulates the strategies and activities required to achieve the RCx Program goals.

Tools and Resources:

Click here to download a [Sample Action Plan](#).

California Commissioning Collaborative: The [California Commissioning Guides for new and existing buildings](#) present an introduction to the goals, costs and benefits of commissioning and Existing Building Commissioning, and provide detailed information on the processes, team structure and persistence strategies that lead to successful projects.

Identify Potential RCx Providers

It's important that the RCx Provider (also called the RCx Authority or RCx Agent) is familiar with the concept of commissioning as a formal, comprehensive process spanning the entire design and construction cycle, and has experience working on projects that include comprehensive commissioning. A RCx Provider often plays the role of coordinating the various design professionals and contractors, and thus must have a wide knowledge and experience base. He or she must understand not only the equipment and controls and how they interact, but also the coordination, documentation and training processes.

As the commissioning industry has matured in the last decade, several industry organizations have emerged that offer commissioning-related training and certification programs. Some, such as the University of Wisconsin, offer multiple certifications, depending on focus and expertise. The Accredited Commissioning Process Manager certification is designed for those who work for a government agency or other organizations that manage a portfolio of buildings. The certification requires training as well as experience managing commissioning projects.

Depending on your specific situation and the structure of your organization, you may wish to develop some RCx expertise in-house. Even an experienced technician will likely benefit from a class focused on retrocommissioning to ensure activities are carried out consistent with RCx best practices and that they are documented sufficiently for future reference.

Actions:

Research RCx Providers to identify those with the skills and expertise required to lead a comprehensive RCx process and provide documentation and training to staff.

Tools and Resources:

California Commissioning Collaborative (CCC): Offers several resources on [selecting a Provider](#), including things to consider, qualifications, and a Provider list.

Organizations that Offer Certifications in Commissioning:

The CCC provides a matrix of commissioning and retrocommissioning certifications that includes eligibility and education requirements.

[Building Commissioning Association \(BCA\)](#): A nonprofit organization of commissioning professionals from across the commercial building industry. BCA offers education and certification programs.

[University of Wisconsin](#): Offers courses in commissioning and a certification program through the Department of Engineering Professional Development. Courses are offered throughout the country and online.

[AABC Commissioning Group \(ACG\)](#): Non-profit association dedicated to the advancement of professional, independent 3rd party commissioning and energy management services through education, training, and certification of qualified individuals.

[Association of Energy Engineers](#): A nonprofit professional society of over 16,000 members in 89 countries. The mission of AEE is *"to promote the scientific and educational interests of those engaged in the energy industry and to foster action for Sustainable Development."*

[ASHRAE](#): A building technology society with more than 50,000 members worldwide. The Society and its members focus on building systems, energy efficiency, indoor air quality and sustainability within the industry.

[National Environmental Balancing Bureau](#): An international certification organization focused on commissioning, HVAC system testing adjusting and balancing (TAB), and other functional performance testing.

[Testing, Adjusting and Balancing Bureau](#): The TABB certification program is designed to ensure that HVAC systems are set at the optimal limits to protect the welfare of the general public and those who work in buildings with commercial heating, ventilation and air conditioning systems.

Initiate RCx Projects

Use your Retrocommissioning Action Plan to begin prioritizing your facilities and RCx projects. Refer to and refine your RCx Action Plan frequently to provide overall guidance and direction to the Program team as you begin implementing RCx projects. In addition, the RCx Dashboard can provide assistance with the facility prioritization.

Some common retrocommissioning measures and opportunities include:

- Simultaneous heating and cooling
- Economizers
- Occupancy and motion sensors
- Daylighting controls
- Nighttime setbacks
- Scheduling
- Temperature setpoints
- VFDs for pumps and motors

Financial Incentives: Most energy utilities offer financial and/or technical assistance for retrocommissioning and equipment retrofit projects. Many programs require a detailed pre-project verification of the field conditions to receive a rebate; contact your local utility early to investigate program offerings and eligibility requirements.

Actions:

Begin implementing retrocommissioning projects based on your action plan and facility priorities. Leverage the RCx process to build facility and equipment documentation and expertise. Investigate rebate offerings from all local utilities before beginning each project.

Tools and Resources:

Energy Design Resources, [Commissioning Assistant](#). A web-based tool that allows the user to identify commissioning scope, evaluate costs, and develop sample documents and specifications specific to a project.

Green California, [Commissioning Toolkit for Small Buildings](#). Toolkit includes descriptions and samples of commissioning documentation and functional performance tests.

California Commissioning Collaborative, [Retrocommissioning Toolkit](#), includes a checklist of preferred building characteristics, a building staff interview form, a comprehensive ongoing commissioning plan, and more.

Request for Proposal (RFP) [Checklist for Existing Building Commissioning Services](#).

Ensure Savings Persistence

Develop and Maintain Documentation

Access to current plans and documentation of building features and energy-using systems, equipment and controls is essential to operating and maintaining facilities efficiently and consistent with the design intent. Leverage the retrocommissioning process to help you build a new set of records that you can continue to fill in over time.

At the beginning of each project, it's important to formally document the Owner's Project Requirements (OPR) and the project Basis of Design (BOD). The OPR describes the operational and functional requirements of a project, expectations of how the facility will be used and operated, and equipment and system expectations and requirements, as defined by the Owner. The OPR is prepared by the project team, in concert with the facility owner. This document provides an explanation of the ideas, concepts, goals, success criteria, and supporting information for the project. The BOD is the documentation of design criteria and assumptions for systems, components, and methods chosen to meet the Owner's Project Requirements and applicable regulatory requirements, standards, and guidelines. The document includes narrative descriptions of each system to be commissioned. The BOD is prepared by the Design Professionals.

Require the Retrocommissioning Agent to provide complete project documentation at the end of the retrocommissioning process. The final Commissioning Report contains all the retrocommissioning-related documentation collected throughout the process, including the results of all functional performance tests, and any outstanding issues. In addition, obtain a Systems Manual which includes the final BOD, single line diagrams, as-built controls drawings and sequences of operation and O&M manuals. Final documentation should also include an ongoing commissioning plan, with recommendations for operational and maintenance activities to keep the facility operating optimally.

Actions:

Integrate the documentation process into every project to build a set of current facility and system information. Require the retrocommissioning team to provide as-built documentation as part of the final Commissioning Report.

Tools and Resources:

Green California, [Commissioning Toolkit for Small Buildings](#). Toolkit includes descriptions and samples of commissioning documentation and functional performance tests.

University of Wisconsin, [Developing the Owner's Project Requirements course](#).

California Commissioning Collaborative: [Templates and sample documents for existing building commissioning](#).

Provide Operator and Occupant Training

Always include facility operator training requirements in retrocommissioning (and equipment retrofit) project specifications. You may wish to refer to the [Model RCx Specifications](#) in this Toolkit for sample language. Ensure that the training is accompanied with full documentation as described above.

For more general facility management training, consider a course such as The Building Operator Certification (BOC[®]) Program, run by the Northwest Energy Efficiency Council (NEEC). The BOC[®] Program is a widely-recognized training program for facilities management personnel. The program includes classes on how the various systems in a facility work together, how to operate them in the most efficient manner, preventive maintenance, and diagnostics for various systems.

Many cities and counties have policies requiring municipal facilities to achieve certification through the USGBC's LEED rating system. The University of Wisconsin offers classes on the commissioning process for LEED projects and commissioning in existing buildings.

Running a building at its peak efficiency and performance is a partnership between the facility operators and its occupants. To achieve and sustain the savings and other benefits from retrocommissioning a facility, you must also have the occupants' contribution and support. In addition to coordinating with the occupants, it's important to communicate the benefits of the project as well as the project's contribution to the overall municipal greenhouse gas emissions reduction or energy efficiency goals. In addition, consider preparing an FAQ and a list of actions that occupants can take to sustain and even increase the projects' impact. Taking the time to inform and educate building occupants is invaluable and can be a very significant contributor in ensuring you continue to enjoy the benefits of retrocommissioning for many years to come.

Actions:

Ensure all retrocommissioning projects include requirements to train facility operators and participate in additional training opportunities when possible.

Tools and Resources:

[Building Operator Certification Program](#): The BOC is a nationally-recognized, competency-based training and certification program that offers facilities personnel the improved job skills and knowledge to transform workplaces to be more comfortable, energy-efficient and environmentally friendly.

University of Wisconsin, [Accredited Commissioning Process Manager](#): Certification for individuals that manage commissioning projects on behalf of a building owner with a portfolio of buildings. Requires both education and experience.

Track Results and Review Periodically

Document and track your activities and results to definitively measure the RCx program's success. Is the program producing the anticipated savings? Have the number of occupant complaints received from a "problem" building or area diminished?

One of the main weaknesses of many retrocommissioning activities is that the savings often deteriorates after a short period of time as the measures are overridden or disabled. Many RCx measures are controls-based, and are accessible to occupants, who may not be familiar with the building systems. In addition, sometimes facilities management personnel override a control in order to respond quickly to an occupant complaint.

Thus, it's extremely important to track all RCx activities and periodically confirm that the controls remain functional and properly tuned in order to continue to reap the RCx program benefits. You may use the Dashboard to track RCx activities and results or if you are already using another tracking system, you may wish to use that system if it has the capacity and will streamline analyses and reporting. For example, if you use an equipment maintenance software program (such as Maintenance Connection or Maintenance Pro), or Utility Management System software, integrating your project tracking may be more efficient than maintaining an independent tracking system.

If you use the Dashboard for tracking, track both recommended and completed RCx projects and activities for each facility using the Record of Retrocommissioning Activities tab. The Dashboard automatically populates the initial information, including a list of recommended RCx opportunities based on the data provided for the facility. The tab also allows you track estimated and actual savings from each project.

Set a regular review schedule to review the status of your RCx projects and the resulting energy savings. Look specifically for energy usage spikes, increasing trends, or changes in energy usage not associated with weather or operations. You can integrate your review with facility and equipment maintenance schedules, as well as with the changing seasons, since many facilities such as community pools and recreation facilities operate seasonally. Coordinating with other regular maintenance allows you to investigate any energy use anomalies while you're already at a site rather than scheduling separate trips. In addition, savings from many projects is seasonal and reviewing your activities at that time provides timely feedback regarding the results.

Actions:

Use the Dashboard or another tool to track the results of each retrocommissioning project you complete. Review RCx Program results periodically and investigate unusual or unexpected energy usage to ensure you continue to reap the full benefits from the RCx Program.

Tools and Resources:

California Commissioning Collaborative, [Existing Buildings Savings Calculations and Energy Analysis Tools](#). Spreadsheet-based tools to estimate savings and analyze and record data.

Retrocommissioning (RCx) Dashboard

The RCx Dashboard uses high-level building information to:

- Identify buildings that are likely to benefit from retrocommissioning,
- Recommend RCx opportunities within a building,

- Provide links to existing resources and functional tests to facilitate recommended retrocommissioning activities, and
- Provide a record of recommended retrocommissioning measures as well as the retrocommissioning activities completed at each facility.

The data used in the RCx Dashboard includes general building characteristics, HVAC system data, lighting controls, documentation available, energy usage, and known issues and factors that may influence the recommendations. The RCx Dashboard allows the user to enter up to 30 different building types, including several new function types for government-related buildings available in the EPA Portfolio Manager in the 2013 upgrade. You may enter a single building in the RCx Dashboard or import multiple buildings simultaneously via the import function.

Once you enter all the facility data, the RCx Dashboard creates a summary comparative graph of the buildings in the portfolio, sorted by Energy Use Intensity (energy used per square foot of conditioned floor area). The tool also displays a tabular summary of the selected buildings' energy usage, size, vintage and the year of the most recent renovation. This summary allows the user to quickly and easily compare buildings across the entire portfolio, or focus only on specific buildings or building types, for example, all offices or parks and recreation facilities. The RCx Dashboard also includes a graph of energy use and cost data for a specific building or group of buildings.

The RCx Dashboard identifies and recommends potential RCx opportunities based upon the high-level data, including equipment types, controls, energy use, occupancy and operational patterns, and other common indicators of sub-optimal performance. Each measure recommended links to a sample functional test developed by utilities and other organizations.

Use the RCx Dashboard to track your activities, any utility incentives associated with the project, and to compare the estimated savings to the actual savings achieved. The Dashboard allows you to easily know at-a-glance which measures have been completed and which remain for each facility. You may also sort the potential opportunities by the opportunity name. For example, if you are doing a lighting controls project, you can easily see all the lighting control systems that will likely benefit from retrocommissioning should you wish to group projects that way.

Click here to download the [RCx Dashboard](#).

Retrocommissioning Resource List

Planning and Preparation

California Air Resources Board (CARB), [Climate Action Planning](#).

CARB, [Local Government Operations Protocol \(LGOP\) for Greenhouse Gas Assessments](#).

California Sustainability Alliance's [LGOP toolkit](#) provides additional information and detail regarding each section in the protocol.

California Statewide Energy Efficiency Collaborative, a partnership between Local Government Commission, ICLEI, Institute for Local Government, PG&E, SCE, SDG&E,

and So Cal Gas to help support governments in [increasing energy efficiency and reducing greenhouse gas emissions](#).

California Air Pollution Control Officers Association (CAPCOA), [Quantifying Greenhouse Gas Mitigation Measures](#).

US EPA [Environmentally Preferable Purchasing \(EPP\)](#).

Natural Resources Defense Council, Smarter Business, [Greening Advisor](#).

CalRecycle, [Environmentally Preferable Purchasing](#).

US EPA, [Energy Star for Buildings](#).

United States Green Building Council, [LEED Rating Systems](#).

RCx Toolkit, [RCx Dashboard spreadsheet](#).

RCx Toolkit, [Model RCx Specifications](#).

Green California, Commissioning [Toolkit for Small Buildings](#). Toolkit includes descriptions and samples of commissioning documentation and functional performance tests.

RCx Program Toolkit, [RCx Program Team Roles and Responsibilities](#).

Create Data Infrastructure

RCx Program Toolkit, [Sample Building Inventory Spreadsheet](#).

RCx Program Toolkit, [RCx Dashboard spreadsheet](#).

RCx Program Toolkit, [Data Collection Checklist](#).

US EPA [Portfolio Manager](#). Track and assess energy and water consumption across your entire portfolio of buildings.

Green California, Benchmarking: [Measuring a Building's Energy Performance](#).

[Building Benchmarks](#). This site provides a high-level, simplified estimate of the energy use intensity and annual energy usage of a building based on location, building type, vintage and size.

LBNL's [Energy IQ Benchmarking Tool](#).

LBNL [Energy Benchmarking for Buildings and Industries](#).

US EPA [Benchmarking](#).

Implement RCx Program

RCx Program Toolkit, [Sample Retrocommissioning Action Plan](#).

California Commissioning Collaborative: The California [Commissioning Guides for new and existing buildings](#) present an introduction to the goals, costs and benefits of commissioning and Existing Building Commissioning, and provide detailed information on the processes, team structure and persistence strategies that lead to successful projects.

California Commissioning Collaborative (CCC): Offers several resources on [selecting a Provider](#), including things to consider, qualifications, and a Provider list.

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[University of Wisconsin](#): Offers courses in commissioning and a certification program through the Department of Engineering Professional Development. Courses are offered throughout the country and online.

[AABC Commissioning Group \(ACG\)](#): Non-profit association dedicated to the advancement of professional, independent 3rd party commissioning and energy management services through education, training, and certification of qualified individuals.

[Association of Energy Engineers](#): A nonprofit professional society of over 16,000 members in 89 countries. The mission of AEE is *"to promote the scientific and educational interests of those engaged in the energy industry and to foster action for Sustainable Development."*

[ASHRAE](#): A building technology society with more than 50,000 members worldwide. The Society and its members focus on building systems, energy efficiency, indoor air quality and sustainability within the industry.

[National Environmental Balancing Bureau](#): An international certification organization focused on commissioning, HVAC system testing adjusting and balancing (TAB), and other functional performance testing.

[Testing, Adjusting and Balancing Bureau](#): The TABB certification program is designed to ensure that HVAC systems are set at the optimal limits to protect the welfare of the general public and those who work in buildings with commercial heating, ventilation and air conditioning systems.

Energy Design Resources, [Commissioning Assistant](#). A web-based tool that allows the user to identify commissioning scope, evaluate costs, and develop sample documents and specifications specific to a project.

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[Request for Proposal \(RFP\) Checklist for Existing Building Commissioning Services](#)

Ensure Savings Persistence

[University of Wisconsin, Developing the Owner's Project Requirements course.](#)

California Commissioning Collaborative: [Templates and sample documents for existing building commissioning](#).

[Building Operator Certification Program](#): The BOC is a nationally-recognized, competency-based training and certification program that offers facilities personnel the improved job skills and knowledge to transform workplaces to be more comfortable, energy-efficient and environmentally friendly.

[University of Wisconsin, Accredited Commissioning Process Manager](#): Certification for individuals that manage commissioning projects on behalf of a building owner with a portfolio of buildings. Requires both education and experience.

California Commissioning Collaborative, [Existing Buildings Savings Calculations and Energy Analysis Tools](#). Spreadsheet-based tools to estimate savings and analyze and record data.

General Commissioning and Retrocommissioning Resources

CA Commissioning Collaborative

CA Commissioning Guides

[The California Commissioning Guides for new and existing buildings](#) present an introduction to the goals, costs and benefits of commissioning and Existing Building Commissioning, and provide detailed information on the processes, team structure and persistence strategies that lead to successful projects.

[Request for Proposal \(RFP\) Checklist for Existing Building Commissioning Services](#).

California Department of General Services: [Commissioning guidelines and other resources](#).

LBNL Building Commissioning: [Commissioning cost-benefit analyses plus other resources](#).

National Conference on Building Commissioning (NCBC): Annual conference on building commissioning. [Archive containing presentations from past conferences](#).

EPA

[Environmentally Preferable Purchasing](#): The EPA runs the federal government's EPP program. The web site includes the federal policy and guidance as well as green purchasing tools and references.

[Portfolio Manager](#): Portfolio Manager is an interactive energy management tool that allows you to track and assess energy and water consumption across your entire portfolio of buildings in a secure online environment.