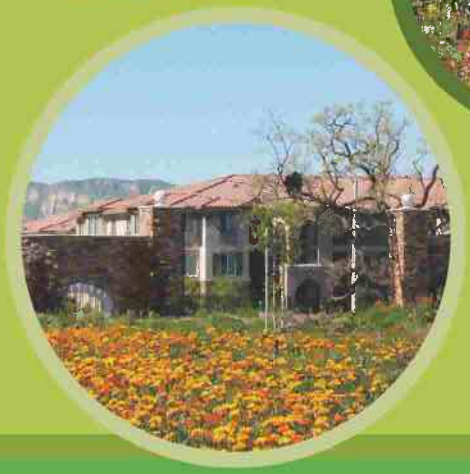
CITY OF SIMI VALLEY



Retro-Commissioning
POLICY

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ACKNOWLEDGEMENTS

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This policy supports the California Long Term Energy Efficiency Strategic Plan Goal 3: "Local governments lead by example with their own facilities and energy usage practices." The policy specifically implements Strategic Plan Task 3.2.4: "Develop a policy for commissioning and retro-commissioning of municipal facilities." The policy meets the Task 4.C. requirements as described in the "Strategic Plan Strategy Program" Statement of Work as approved by the Simi Valley City Council.

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Table of Contents

EXECUTIVE SUMMARY 1
RETRO-COMMISSIONING POLICY STATEMENT 3
Policy 3
Relationship of Retro-Commissioning Policy to Other City Policies 4
Implementation Plan 4
RETRO-COMMISSIONING BACKGROUND AND PURPOSE 7
Definition and Purpose of Retro-Commissioning 7
Benefits of Retro-Commissioning 8
RETRO-COMMISSIONING OPPORTUNITIES & REQUIREMENTS 11
General Criteria for Determining Retro-Commissioning Opportunities 11
Common Retro-Commissioning Opportunities 12
Utility Program Requirements for Retro-Commissioning Incentives 13
SCE Retro-Commissioning Program Overview 14
Opportunities for Retro-Commissioning in City Facilities 16
RETRO-COMMISSIONING PROGRAM IMPLEMENTATION GUIDE 25
RETRO-COMMISSIONING PROCESS 27
Overview of Retro-Commissioning Process 27
Planning 28
Investigation 31
Implementation 33
Project Hand-Off 34
Integration with Other Processes 36
RETRO-COMMISSIONING TEAM 39
Retro-Commissioning Team Members and Their Responsibilities 39
Selecting a Retro-Commissioning Lead 40
Involving a Third-Party Provider 40
REFERENCES 43

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EXECUTIVE SUMMARY

The City of Simi Valley has long been a champion of energy efficiency, by demonstrating a commitment to reducing energy use in its own facilities, and leading by example in the community. The City's commitment includes finding better ways to improve the energy performance of its operations and reduce spending on energy. This Retro-commissioning (RCx) policy will continue to support the City's energy efficiency principles by ensuring that the City maximizes the operational efficiency of improvements made to our buildings during construction or remodeling, and by detecting and correcting problems in existing buildings early, before they become costly maintenance or safety issues.

RCx is a systematic process for improving an existing facility's performance by identifying and implementing relatively low-cost operational and maintenance improvements; helping to ensure that the facility's performance meets owner expectations [2]. Through the RCx process, improvements to building systems and operations are identified. It has been proven that RCx can result in significant energy savings, improved occupant comfort and enhanced building performance, which can result in reduced demand for electricity during peak demand periods. With RCx, energy savings up to 20 percent can be achieved, and payback periods are typically less than five years.

The Commissioning process falls into three categories:

1. Commissioning (Cx): A quality assurance process applied to new buildings, prior to occupancy, to ensure that system operation meets owner criteria and design intent. *The 2011 renovation of the Transit Maintenance Facility involved this type of commissioning activity.*

2. Retro-Commissioning (RCx): A quality assurance process applied to existing buildings to ensure that system operation meets owner criteria and design intent. In this case, it is assumed that the building was not commissioned prior to occupancy. Un-commissioned buildings often do not meet operational goals or requirements. It is also common for operation to deteriorate over time as space and system changes are made and system functionally degrades. *Existing City facilities that have high occupancies, such as City Hall, and the Senior Center may benefit from this type of commissioning activity.*

3. Re-Commissioning (ReCx): A quality assurance process applied to existing buildings to ensure that system operation meets owner criteria and design intent. In this case, it is assumed that the building was commissioned prior to occupancy. The decision to re-commission may be triggered by a change in building use or ownership, the onset of operational problems, or some other need. *This type of commissioning activity would only apply to the Transit Maintenance Facility at some point in the future, if needed.*

Implementing this RCx Policy will involve staff from the Public Works, Administrative Services and Environmental Services Departments, as well as an outside consultant to perform the RCx activities. Buildings that would first be considered for RCx would be those that could also qualify for incentives from Southern California Edison (SCE). The City Hall, Police Department, and Senior Center facilities may be good RCx project candidates that will meet SCE criteria for incentives, and will be the initial RCx projects submitted to SCE's RCx Program to determine candidacy. Any potential RCx activities will be evaluated by the City Manager and the Director of Public Works prior to approval.

The goals of the RCx Policy will be to identify building operation, controls, comfort or maintenance problems that are costing the City money and unnecessary labor, and correcting these issues to achieve measurable energy savings and reduced operating costs. Benefits will include improved equipment performance and longevity, improved indoor air quality, and increased worker satisfaction and productivity.

By establishing an RCx policy and implementing projects, the City is leading an effort that will assist other local governments and the Simi Valley community in better understanding and utilizing RCx. In addition, this policy will serve as a reference document for current and future City staff to understand and use the RCx process to continue to manage energy use in City facilities.

RETRO-COMMISSIONING POLICY STATEMENT

Policy

The City of Simi Valley will develop and enhance its expertise in building energy management by demonstrating the value of retro-commissioning (RCx) to decision-makers and the community by implementing the RCx process in facilities that meet the criteria established by the California Commissioning Collaborative guidelines, and as recommended by Southern California Edison. Through implementation of this RCx Policy, the city will work to reduce its demand for electricity during peak hours, and to improve the operation, lower the costs for maintenance and increase the comfort of the people who work in and visit City facilities.

The City will use its RCx efforts to lead by example by understanding the way energy is used in municipal facilities, and demonstrating the value of RCx as part of effective management of facility energy and equipment use. The before and after data results developed through the RCx process will be used to improve City operations and to identify future energy reduction measures for implementation. The City will periodically evaluate the operational performance of its main facilities, and will employ the expertise developed through RCx to identify areas of improvement. Facilities that do not undergo a formal RCx process will be considered for maintenance tune-ups, investment grade energy audits or control system upgrades.

The City has developed the RCx Policy to support the California Long-Term Energy Efficiency Strategic Plan goal that local governments will lead by example in the use and management of energy in their facilities. The City will use RCx to support energy efficiency objectives in the Green Community Action Plan, energy conservation policies in the General Plan, and reduction in greenhouse gas emissions through energy efficiency as identified in the Climate Action Plan. The City will use this RCx Policy to contribute to advancing the progress of the City in the Southern California Edison Energy Leader Partnership (ELP) by supporting the overall Energy Action Plan goal of achieving a 20% energy use reduction, on an aggregate basis for City facilities, by 2020 as compared to 2006.

City staff from Public Works, Administrative Services and Environmental Services will work together to develop the RCx approach, will identify financial incentives and procurement vehicles and develop a standard procedure for the RCx of City facilites, following the process outlined in the Implementation Plan and using standard tools developed by the California Commissionng Collaborative. The City Manager will support and monitor the efficacy of the RCx Policy and the procedures used by staff to implement the policy. In all cases, RCx will be implemented in the most cost-effective manner to maximize its value to the City and the community.

The City Council will evaluate the usefulness and implementation of the RCx Policy on an annual basis. City staff will develop an annual report for the City Council to include a description of the results for any buildings that received RCx in the previous year, and how RCx was used to: identify and correct under-performing facilities; track and report progress toward the City's Energy Action Plan and

Greenhouse Gas reduction goals; and, receive utility incentives. This report will also include the status on energy savings and payback period.

City staff will use the RCx Policy Appendix as a reference for the RCx process through planning, investigation, implementation, and hand off phases. It also describes the process of assembling the RCx project team, their roles, and responsibilities. These summarize and are consistent with statewide RCx guidelines published by the California Commissioning Collaborative.

Relationship of Retro-Commissioning Policy to Other City Policies

The City of Simi Valley has a long-standing commitment to reducing energy usage, costs and GHG emissions. RCx is another tool to help in achieving these City goals. Other policies that are tied to this RCx policy and should be referred to for further information are described below. The logical progression is to 1) benchmark facilities-to gain an understanding of performance, 2) where appropriate, implement RCx to tighten the control of facilities and 3) to implement energy conservation measures-to put more efficient equipment in place-as outlined in the Energy Action Plan.

1. **Benchmarking Policy.** ENERGY STAR Portfolio Manager accounts have been established for the eight facilities listed previously and contain monthly utility data from 2006 to the present. These accounts are automatically updated with utility data and can be used to measure the effectiveness of RCx and resulting energy savings compared to the 2006 baseline year. General facility data, such as operating hours, number of occupants, etc. are also housed here. Benchmarking is required to receive Southern California Edison (SCE) incentives for RCx.

2. **Energy Action Plan (EAP).** The EAP outlines energy conservation measures (ECMs) that have been completed from 2006 to the present and also recommends ECMs for future implementation. A comprehensive background on City energy use can be found here. The Energy Action Plan is the overarching strategy for reducing energy use in the City by 20 percent by 2020. RCx will assist in achieving EAP goals.

3. **Greenhouse Gas Inventory Policy and Reduction Strategies.** These documents provide background on GHG emissions tied to energy use in City facilities and makes recommendations for how they can be reduced. RCx will assist in achieving GHG reduction goals.

Beyond these policies, additional resources that may be helpful to the RCx process will be outlined in more detail in subsequent sections.

Implementation Plan

The City operates eight facilities that will be considered for RCx or for performance evaluations and improvements. These eight City facilities are: City Hall, Cultural

Arts Center, Development Services, Police Department, Senior Center, Sanitation/Waterworks, Public Services Facility and Transit Facility.

City staff from the Public Works, Administrative Services and Environmental Services Departments will develop the RCx approach and staff responsibilities, budgets and services needed to implement the RCx process.

1. Initially, City facilities that are eligible for incentives under Southern California Edison's (SCE) RCx Program will be retro-commissioned. These facilities include City Hall, Police Department and the Senior Center.

    - The data for these facilities will be submitted to SCE's RCx Program to determine eligibility, using the master list of findings spreadsheet (Table). This table will also be used to track necessary RCx measures. City staff will review these measures prior to implementation to ensure that they are practical and consistent with actions related to the City's Benchmarking Policy and Energy Action Plan. The master list of findings format is identical to the City's "standardized energy conservation measure (ECM) tracking spreadsheet," used in the Benchmarking Policy and Energy Action Plan.

2. A third party provider, having experience relevant to the chosen projects, will perform retro-commissioning services.

3. Facilities that will not be retro-commissioned will be considered for maintenance tune-ups, investment grade energy audits or control system upgrades.

4. New City building designs in excess of 10,000 square feet of floor area will be commissioned at the time of construction.

5. Facilities that are eligible for incentives under Southern California Edison's (SCE) RCx Program will be considered for re-commissioning every five years or when major changes are made, such as a renovation or change in operating conditions.

6. An annual report will be presented to the City Council, documenting the findings that result from the actions described above.

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RETRO-COMMISSIONING BACKGROUND AND PURPOSE

Definition and Purpose of Retro-Commissioning

The commissioning process falls into three categories:

1. **Commissioning (Cx):** A quality assurance process applied to new buildings, prior to occupancy, to ensure that system operation meets owner criteria and design intent. *The 2011 renovation of the Transit Maintenance Facility involved this type of commissioning activity.*

2. **Retro-Commissioning (RCx):** A quality assurance process applied to existing buildings to ensure that system operation meets owner criteria and design intent. In this case, it is assumed that the building was not commissioned prior to occupancy. Un-commissioned buildings often do not meet operational goals or requirements. It is also common for operation to deteriorate over time as space and system changes are made and system functionally degrades. *Existing City facilities that have high occupancies, such as City Hall, and the Senior Center may benefit from this type of commissioning activity.*

3. **Re-Commissioning (ReCx):** A quality assurance process applied to existing buildings to ensure that system operation meets owner criteria and design intent. In this case, it is assumed that the building was commissioned prior to occupancy. The decision to re-commission may be triggered by a change in building use or ownership, the onset of operational problems, or some other need. *This type of commissioning activity would only apply to the Transit Maintenance Facility at some point in the future, if needed.*

Retro-commissioning (RCx) as defined by the California Commissioning Collaborative is "a systematic process for improving an existing facility's performance by identifying and implementing relatively low-cost operational and maintenance improvements, helping to ensure that the facility's performance meets owner expectations" [2].

More simply put, RCx is the process of tuning up a facility so that it operates as designed and as efficiently as possible. RCx commonly identifies control, scheduling and other operational parameter opportunities that can be resolved at no or low cost.

Typically, some type of control system must be in place to achieve this. These opportunities are often significantly more cost-effective than implementing equipment retrofits. However, understanding why and how systems are operated and how they interact can be complex. RCx helps to discover energy and cost savings opportunities and establishes the systematic approach necessary to take advantage of these low and no cost energy conservation measures.

Benefits of Retro-Commissioning

The benefits of RCx have been established by numerous studies. RCx can resolve operational problems related to the initial design and construction of a building or issues that have resulted over time. The main benefits of RCx include:

- Reduced energy costs.
- Increased equipment lifetimes.
- Reduced labor costs.
- Enhanced thermal comfort and indoor air quality.
- Increased occupant productivity.
- Increased documentation and understanding of facility systems and operations, leading to better facility management.

A Lawrence Berkeley National Laboratory study of RCx, conducted in a population of 100 buildings, resulted in a median project cost of $0.27/SF, whole-building energy savings of 15 percent and an average payback time of 0.7 years (Figure 1). In this study, the savings from RCx came from both energy and non-energy cost reductions, and ranged from $0.21-$1.17/SF (Table 1). The nature of these non-energy benefits, for a population of 36 buildings, are shown in Figure 2.

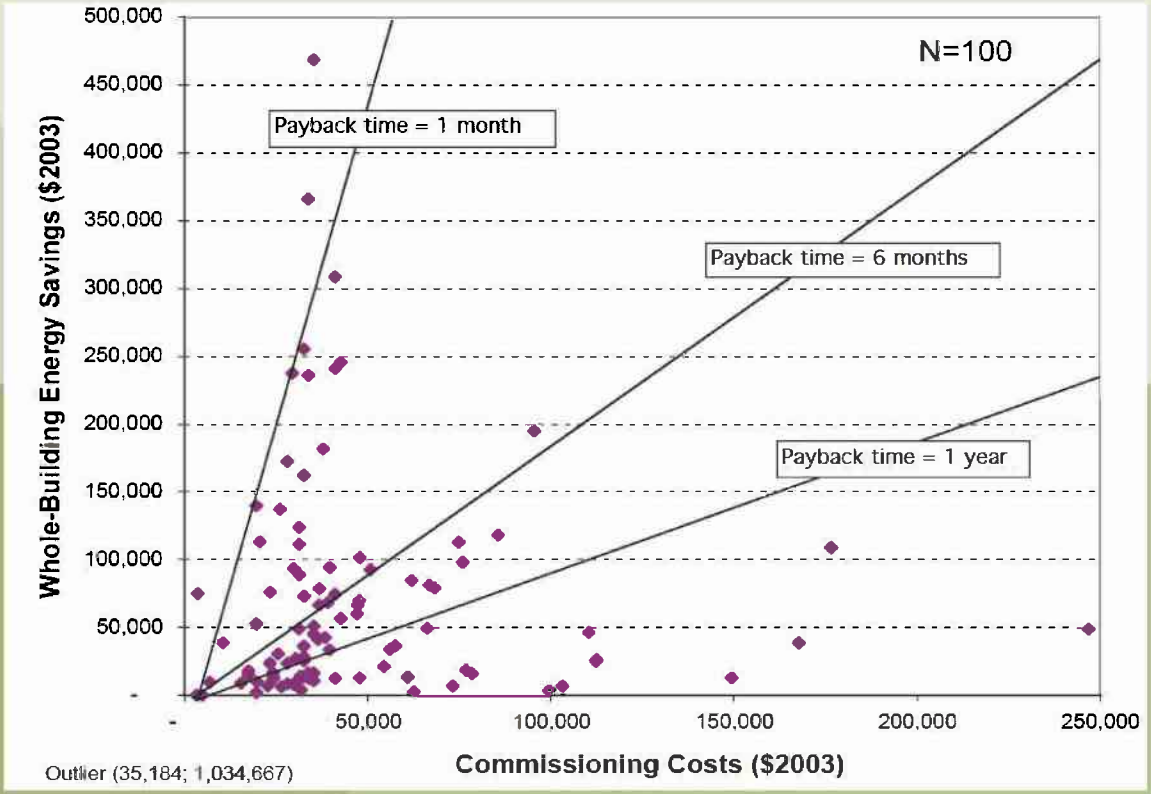

Figure 1. Retro-commissioning savings vs. costs (Source: LBNL).

Table 1. Retro-commissioning cost saving range (Source: LBNL).

Description	Range of Values
Value of Energy Savings	$0.11 - $0.72/SF
Value of Non-Energy Savings	$0.10 - $0.45/SF

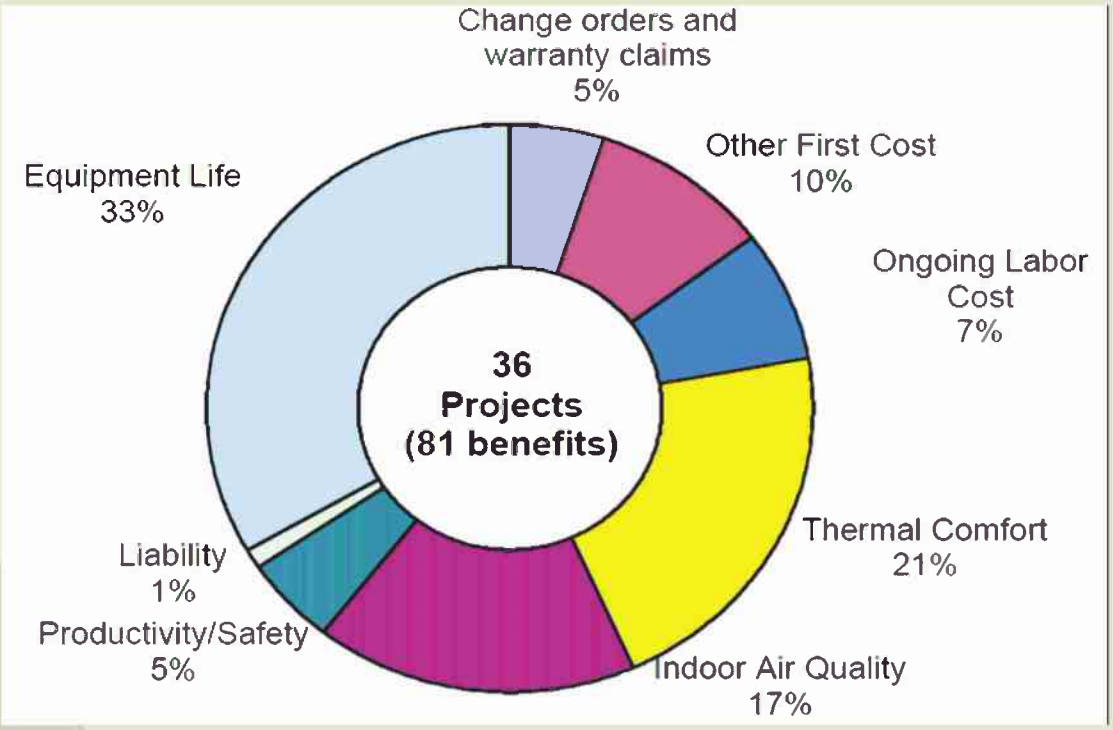

Figure 2. Non-energy related benefits of RCx (Source: LBNL).

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RETRO-COMMISSIONING OPPORTUNITIES & REQUIREMENTS

General Criteria for Determining Retro-Commissioning Opportunities

The major criteria for determining when and where RCx opportunities exist are:

- Abnormally high energy use or unexplained increases in energy use.
- Occupant discomfort and persistent complaints related to temperature and air flow.
- Consistent equipment or system failures.
- Facilities with energy management systems (EMS) are generally better candidates than those without them.
- Facilities with complex mechanical systems with direct digital controls (DDC). Facilities with simple or pneumatic controls and only a few rooftop package HVAC units are often better served by maintenance tune-ups than by RCx.
- Newer buildings that were never commissioned and have good control systems, such as an EMS or DDC.
- Facilities that will not be renovated in the near future in a way that will negate RCx improvements.
- Facilities that have operators with expertise in using the EMS.
- Facilities with good, up to date documentation.
- Cost-effective RCx projects may not necessarily be found at the worst performing facilities.

Additionally, if utility incentives are sought, facilities will need to meet criteria established by the utilities. These criteria are described in greater detail in subsequent sections.

Common Retro-Commissioning Opportunities

There are many issues that can be resolved through RCx. The unique nature of a facility's use type, design, age and control systems as well as its climate zone, point to a variety of RCx opportunities.

Issues and opportunities that are commonly identified and remedied by RCx include:

- Operating schedules that are poorly aligned with actual occupancy or processes, leading to unnecessary heating, cooling, lighting or operation of equipment.
- Control sequences that are not optimized.
- Equipment and sensors that are out of calibration.
- Under-utilized EMS control.
- Unexplained increases in energy use or demand.
- Opportunities to adjust HVAC temperature and pressure set-points and resets.
- Simultaneous heating and cooling.
- Heating or cooling equipment that runs unnecessarily in the off-season.
- Poorly functioning economizers.
- Poorly functioning dampers and valves.
- Short cycling of equipment.
- Improperly sized equipment.
- Air and water distribution equipment that needs testing and balancing.
- Use of throttling valves where variable frequency drives (VFD) can be used.
- Improperly programmed VFDs that operate at 100% when not necessary.
- Improper building pressurization.
- Compromised envelope, leading to issues such as air infiltration.
- Poor indoor air quality.
- Identification of equipment that has reached the end of its useful lifetime and opportunities for retrofits.
- Improper utility rate schedule.

- Need for greater staff knowledge regarding controls and opportunity for training.
- Effectiveness of current preventative maintenance plan and areas where it can be improved.
- Opportunity to modify building occupant and maintenance behavior based on insights brought by RCx.

In addition to these commonly identified building and occupancy issues, there are many other issues and opportunities that can be resolved by RCx. RCx professionals can often find such opportunities.

Utility Program Requirements for Retro-Commissioning Incentives

Both utilities that serve the City of Simi Valley, Southern California Edison (SCE) and Southern California Gas (SCG), offer incentives for RCx at the time of writing. This section outlines some of the current incentive requirements. As part of the City of Simi Valley's Partnership with SCE, it is eligible to receive RCx incentives that are greater than the base rate for RCx projects. These incentives will help expedite the payback timeframe for RCx projects. It will be necessary to review the status of utility requirements and incentive rates prior to undertaking an RCx project.

SCE's [4] and SCG's [5] current requirements for receiving incentives are:

- Must be an SCE or SCG customer paying the California public goods charge on their utility bill.
- Must own or operate a commercial building that has at least 25,000 square feet of conditioned space with a direct digital control system and central plant mechanical equipment in relatively good condition.
- Must be committed to implementing agreed upon RCx Program measures with greater than one year payback within 12 months of approval of corresponding incentive application.
- Must commit to implement all required RCx measures having a one year or less payback within 6 months of written identification by the RCx Provider. A cap will be set at project start for the maximum amount of customer's commitment for implementing required measures. The commitment is capped at 10% of annual utility costs for a specific service account. For example, if the City pays $100,000 per year on a service account, it must commit to implementing $10,000 worth of RCx measures that meet the payback criteria.
- Owner must have an ENERGY STAR Portfolio Manager (ESPM) account or be willing to set one up.

SCE Retro-Commissioning Program Overview

A description of SCE's RCx program is provided below. The program is divided into seven phases that take 7-12 months to complete [6], [7].

1. **Project Start (1 week):** A Program Application is submitted with general information to determine candidacy. ENERGY STAR Portfolio Manager information must also be submitted.

2. **Candidate Screening (1-2 weeks):** The Program Application is screened. If the screening finds adequate RCx opportunities, the owner will be asked to select an SCE-approved RCx provider to conduct scoping.

3. **Candidate Scoping (2-4 weeks):** Scoping involves inspecting the building and its equipment, an analysis of historic energy use and outlining preliminary findings. The RCx provider will prepare a Scoping Report with a list of the preliminary measures found. If adequate and cost effective RCx opportunities are found, the owner proceeds to Agreement Development.

4. **Agreement Development (2-4 weeks):** Once accepted, the owner is required to sign SCE's RCx Owner Program Agreement (OPA), confirming an understanding of, and agreement to the program's requirements, terms, conditions, and process, and the owner's obligation to proceed with the RCx Investigation. The OPA will set forth the incentive levels for RCx measures having a payback of greater than one year available to eligible owners as well as the incentive levels for RCx Providers (Investigation costs and follow-up). The owner must further agree, at owner's cost, to implement all RCx measures identified during the RCx Investigation that have a payback of one year or less (subject to a dollar cap) or otherwise be obligated to reimburse SCE for the RCx Investigation costs. The RCx provider is issued a Contractor Work Assignment, which outlines the RCx provider's commitment and obligations for the project.

5. **Retro-commissioning Investigation (12-16 weeks):** During the investigation, the RCx provider analyzes the building's operations and determines opportunities for corrective action and other operational and maintenance improvements that reduce energy consumption and demand and records them in the Program's Findings Workbook. The results of the RCx investigation are summarized in the Master List of Findings, which is presented to the owner in a meeting with an SCE Program Representative. The RCx provider and SCE Program Representative assist the owner in selecting measures that have the greatest energy savings opportunities and best meet the owner's needs and budget. An Incentive Application and Agreement sets forth the estimated amount that the owner will receive in incentives for recommended measures that pay back in greater than one year. The final package of improvements is presented to the owner in the RCx Draft Final Report. The Draft Final Report is a narrative report detailing information from the Master List of Findings, which includes the selected measures for implementation, the cost, the energy savings and payback calculations, and recommendations for implementation. Upon timely completion of the deliverables, the RCx Investigation incentive is paid directly to the RCx Provider, 50% upon

completion and approval of the Master List of Findings and the remaining portion upon submission and approval of the RCx Draft Final Report.

6. **Implementation (12-20 weeks):** The RCx Draft Final Report is used for implementation. There is flexibility in how the owner implements the selected measures. A portion of the RCx provider's follow-up incentive is designed to assure that owner or contractor questions are answered regarding measures being implemented and to verify measures, update savings calculations, and produce the Implementation Summary Table. Specifically, the tasks include:

    - Review of contractor bids to ensure that scopes of work adequately reflect the intent of the original recommendations and include verification of performance sufficient to meet the program's requirements. If needed, answer questions that arise during implementation, and provide clarification or advice on measures being implemented.

    - Provide regular updates to SCE via email regarding the status of each measure.

    - If needed, attend implementation progress meeting(s).

    - Verify completion of each measure and update Findings Workbook including final savings, costs, and payback calculations to produce the Implementation Summary Table (included in the Findings Workbook).

Upon SCE's approval of the Implementation Summary Table and after a final SCE inspection that verifies the installation of all required and selected RCx measures, SCE will pay the implementation incentive payment to owner (or its designee) and the RCx provider receives 50% of the follow-up incentive payment.

7. **Follow-Up (2-4 weeks):** After implementation, it is essential for the building owner and operators to have the resources they need to ensure that the RCx savings persist over time. The program's protocols provide consistent methods for documenting all RCx measures. The RCx persistence plan for each facility shall contain the following minimum elements:

    - Targeted Documentation: The RCx provider is responsible for developing an RCx Final Report describing the implemented measures, including: new or improved sequences of operation; the energy savings impact of the measures; the requirements for ongoing maintenance and monitoring of the measures; and contact information for the RCx provider, in-house staff or contractors responsible for implementation.

    - Training: Before handing over the targeted documentation, the RCx provider and contractors provide follow-up training for the owner and the appropriate building operations personnel on the new documentation and implemented measures. The training covers the measures that were implemented and requirements for ongoing maintenance and monitoring.

Upon receipt and approval of the RCx Final Report, the RCx provider receives the remaining 50% of the follow-up incentive payment.

Opportunities for Retro-Commissioning in City Facilities

This section focuses on RCx opportunities specific to City facilities. Investigating the City's annual electricity usage on a percent basis in 2011 (Figure 3) shows that the top six highest use sources are the Waterworks (which delivers 60% of Simi Valley's potable water), the Sanitation facility (the City's waste water treatment plant-the master electrical meter at this site also includes a number of unrelated buildings), street and traffic lighting, the Police Department, City Hall and the Senior Center.

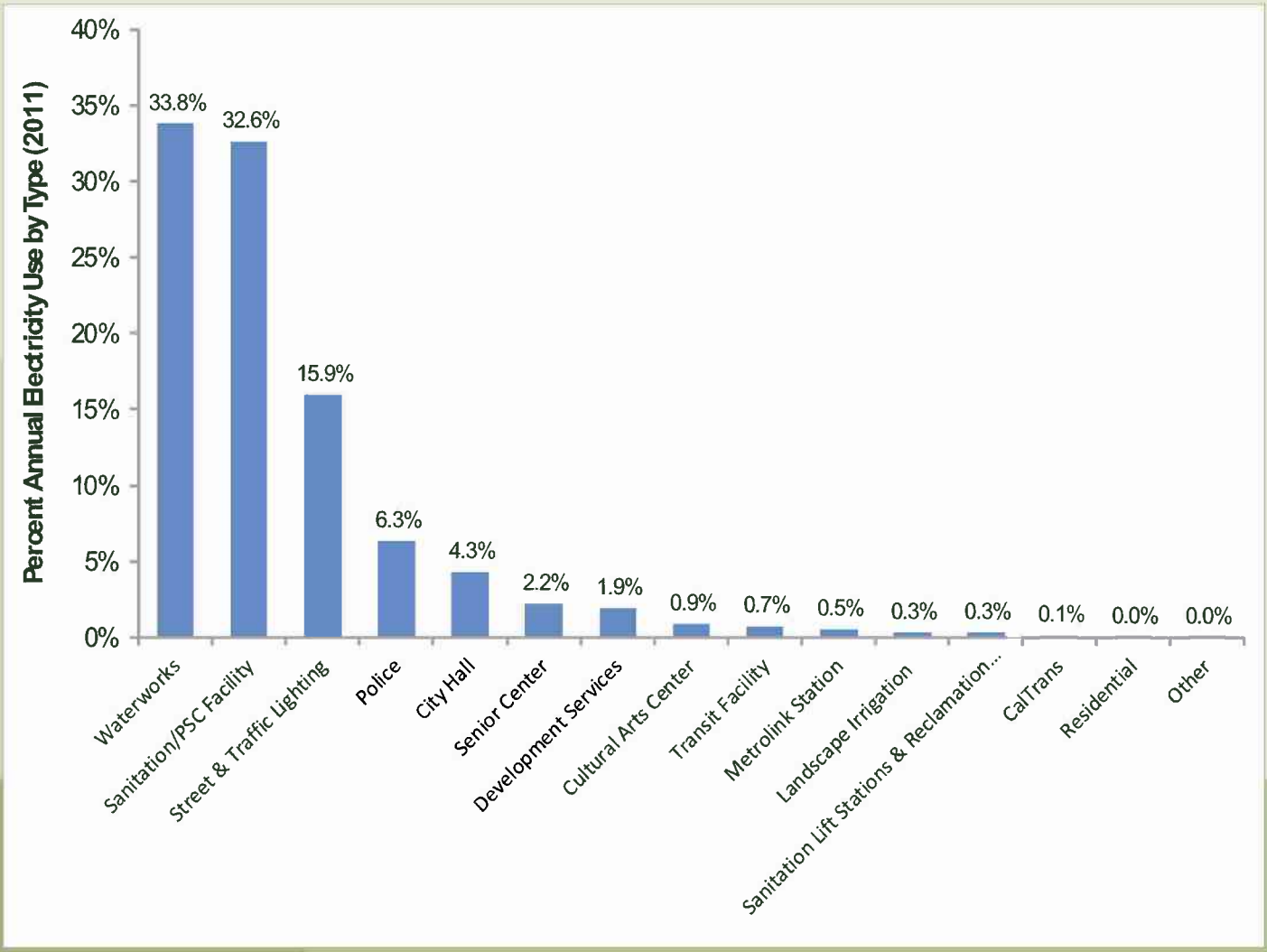

Figure 3. City of Simi Valley annual electricity use by source type (2011).

The eight main facilities within the City are shown in Table 2, along with criteria to establish eligibility for performing RCx.

Table 2. City facility information (Numerical data sourced from Portfolio Manager).

	City Hall	Cultural Arts Center	Developme nt Services	Police Department	Public Services Facility	Senior Center	Transit Facility	Sanitation/ Waterworks
Building GSF	43,771	12,105	18,125	50,000	18,150	29,559	12,720	18,174
Year of Constructio n	1982	1910	1977	1998	1977	1984	1988	1962
Year of Renovation or Expansion	1987	1995	NA	NA	1996	1991 & 2006	2012	1972, 1987 & 2004
Portfolio Manager Account	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

	City Hall	Cultural Arts Center	Developme nt Services	Police Department	Public Services Facility	Senior Center	Transit Facility	Sanitation/ Waterworks
Control System	Yes/DDC	Yes/ DDC	No	Yes/DDC	No	Yes/DDC	Yes/DDC	No
Eligible for SCE RCx Program?	Yes	No	No	Yes	No	Maybe	No	No
2011 Annual Electricity Usage (kWh)	971,067	197,647	433,840	1,430,850	Electricity on Sanitation Meter	500,880	166,046	7,374,786
2011 Annual Electricity Cost ($)	$128,299	$35,597	$63,242	$171,088	NA	$70,284	$30,746	$701,309

	City Hall	Cultural Arts Center	Developme nt Services	Police Department	Public Services Facility	Senior Center	Transit Facility	Sanitation/ Waterworks
2011 Annual Natural Gas Usage (Therms)	10,062	1,367	6,322	27,637	3,214	8,682	280,392	60,872
2011 Annual Natural Gas Cost ($)	$7,793	$1,489	$5,658	$20,271	$2,924	$6,961	$144,588	$40,882
Total Energy Usage (kBTU)	4,320,452	811,269	2,112,896	7,647,191	321,400	2,577,703	28,605,915	31,257,345
Total Energy Cost ($)	$136,091	$37,086	$68,900	$191,359	$2,924	$77,244	$175,334	$742,190

	City Hall	Cultural Arts Center	Developme nt Services	Police Department	Public Services Facility	Senior Center	Transit Facility	Sanitation/ Waterworks
Energy Use Intensity (kBTU/SF)	99	67	117	153	18	87	2,249	1,720
Energy Cost Intensity ($/SF)	3.1	3.1	3.8	3.8	0.2	2.6	13.8	40.8
Notes	HVAC retrofit in 2011	Partial DDC	Local controls	EMS may be replaced in future	Local controls	No control points on main D/X unit. Partial DDC	Facility commission ed in 2012	Local controls

Of the eight facilities, only the City Hall, Police Department and the Senior Center meet the 25,000 gross square foot (GSF) and control system requirements for SCE RCx eligibility. However, because less than 25,000 GSF is controlled by direct digital controls (DDC) at the Senior Center eligibility needs further investigation. The Police Department is considering upgrading its energy management system and any RCx efforts will be coordinated with this change. These three facilities will be submitted to SCE's RCx Program to determine candidacy. A third party provider, having experience relevant to the chosen projects, will perform RCx services.

The remaining facilities do not meet SCE's size, or control system, requirements and will not be considered for RCx. RCx will not be performed at the Development Services, Public Services or Sanitation/Waterworks facilities because these buildings do not have control systems. Although the Cultural Arts Center and Transit Facility have digital controls, the Cultural Arts Center's minimal operating hours do not justify RCx expense, and the Transit Facility was recently commissioned as part of LEED certification.

Facilities where RCx will not be performed will be considered for maintenance tune-ups, investment grade energy audits or control system upgrades. New City building designs in excess of 10,000 square feet of floor area will be commissioned at the time of construction. Facilities that are eligible for incentives under Southern California Edison's (SCE) RCx Program will be considered for re-commissioning every five years or when major changes are made, such as a renovation or change in operating condition.

All numerical data in Table 2 was sourced from Energy Star's Portfolio Manager accounts, which are automatically updated with monthly utility data. Existing City resources that can be leveraged for RCx purposes include:

- Energy Star's Portfolio Manager accounts (described in detail in the City's Benchmarking Policy).
- Facility equipment lists.
- The Enterprise Energy Management Information System (EEMIS) accounts (described in detail in the City's Benchmarking Policy).
- The City of Simi Valley Energy Action Plan, which provides historic energy use data and further information on past and planned energy conservation measures at City facilities.
- 15-minute interval power demand data, which exists for the Sanitation/Waterworks, City Hall, Police Department and Transit Facility electrical service accounts.

When RCx is performed, potential energy conservation measures (ECM) will be tracked in the master list of findings (discussed in further detail in the Appendix) using a standardized spreadsheet template (Table 3). This will allow the City to better understand the impact and value of specific ECMs. City staff will review these

measures prior to implementation to ensure that they are practical and consistent with actions related to the City's Benchmarking Policy and Energy Action Plan.

Table 3 shows three generic examples of ECMs that fall into the broad categories of controls optimization, component replacement and retrofit. All the fields that are input manually are shown in white and those that are calculated automatically are shown in yellow. This spreadsheet can be used to estimate and rank the value of future ECMs using engineering analysis calculations or be used when implementing and measuring the impact of actual ECMs.

Table 3. Master list of findings format and required information.

Facility Name	SCEdison Service Account #	SCGas Service Account #	Measure Name/ Description	Details	Measure Status (Month & Year Implemented)	Annual Energy Savings (kWh/yr)	Annual GHG Emission Reduction (Lbs CO_2/ year)	Annual Energy Cost Savings ($/yr)	Installed Cost- Before Rebates($)	Rebates($)	Installed Cost- After Rebates ($)	Payback Period (Years)	Estimated Project Lifetime (Years)	Return on Investment (%)
City Hall	3-000-9628-04	NA	Controls: Optimized scheduling of HVAC operation	EMS used to schedule HVAC to operate on City "flex" schedule	9/2013	5,000	3,173	$ 600	$ 500	$ -	$ 500	0.8	5	500%
City Hall	3-000-9628-04	NA	Component replacement: Economizer dampers replaced	5 rusted out dampers replaced	9/2013	15,000	9,519	$ 1,800	$ 12,500	$ 1,500	$ 11,000	6.1	7	15%
City Hall	3-000-9628-04	NA	Retrofit: HVAC unit replaced	1 new 5 ton rooftop package unit replaced with 15 SEER unit	9/2013	10,000	6,261	$ 1,200	$ 10,000	$ 1,000	$ 9,000	7.5	15	100%
					Totals & Averages	30,000	18,953	$ 3,600	$ 23,000	$ 2,500	$ 20,500	5		205%

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RETRO-COMMISSIONING PROGRAM IMPLEMENTATION GUIDE

The Program Implementation Guide of this policy outlines the RCx process through planning, investigation, implementation and hand off phases and is consistent with statewide RCx guidelines published by the California Commissioning Collaborative. It also describes the process of assembling the RCx project team. The goal of this general guidance is to provide an understanding of the RCx process so that the advantages of RCx are more widely attained.

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RETRO-COMMISSIONING PROCESS

Overview of Retro-Commissioning Process

Due to the unique nature of facilities, there is no single RCx formula that can always be applied. The RCx process must be adapted to the needs of the facility. However, there are general guidelines that can help structure the process. Typically, the process can be broken into phases consisting of planning, investigation, implementation and hand-off.

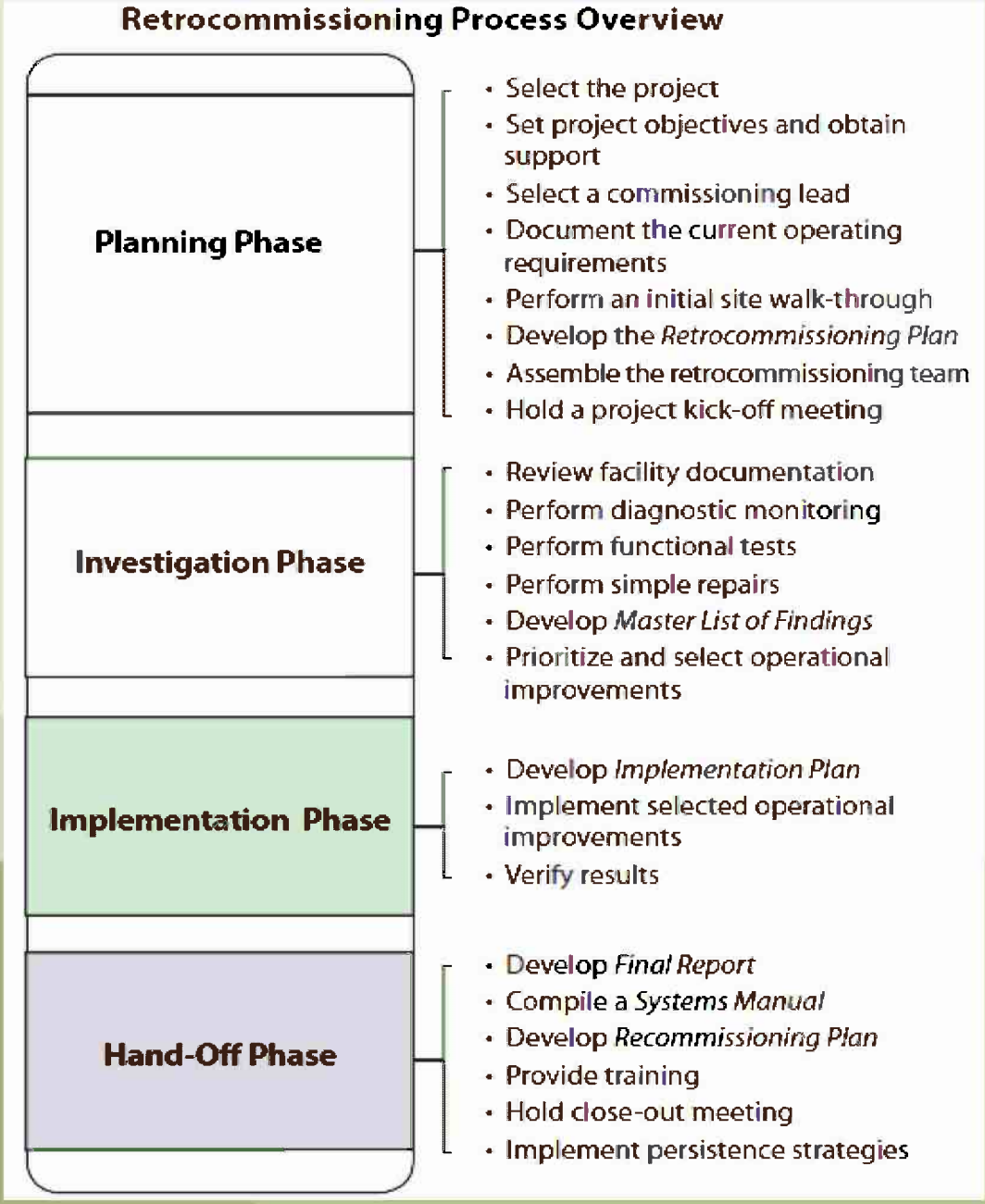

Figure 1. Retro-commissioning process flow (Source: CCC). [2].

Planning

Effective planning is critical to achieving a successful RCx project. This section provides further details on the planning phase steps listed in Figure 4.

1. **Selecting a project.** First, it must be determined if a facility is a good candidate for RCx. Some selection criteria to determine if a project is cost-effective include:

    - Abnormally high energy use or unexplained increases in energy use.
    - Occupant discomfort and persistent complaints related to temperature and air flow.
    - Consistent equipment or system failures.
    - Facilities with energy management systems (EMS) are generally better candidates than those without them.
    - Facilities with complex mechanical systems with direct digital controls (DDC). Facilities with simple or pneumatic controls and only a few rooftop package HVAC units are often better served by energy audits or maintenance tune-ups than by RCx.
    - Newer buildings that were never commissioned and have good control systems, such as an EMS or DDC.
    - Facilities that will not be renovated in the near future in a way that will negate RCx improvements.
    - Facilities that have operators with expertise in using the EMS.
    - Facilities with good, up to date documentation.
    - Cost-effective RCx projects may not necessarily be found at the worst performing facilities.
    - Additionally, if utility incentives are sought, facilities need to meet criteria established by the utilities. These criteria are described in greater detail in previous sections.

2. **Set project objectives and obtain support.** After a candidate RCx project has been selected, the objectives must be clearly defined and communicated to the project team. Support should be secured from both upper management and building staff. Sufficient funds, staffing and time should be allocated for the project. Occupant participation may also play a role in project success.

3. **Select a commissioning lead.** A project leader may be selected from inception or after the project has been defined and has internal support. Selecting the project lead from internal staff or an external pool of providers will depend on

internal resources and project complexity. Ultimately, the project lead will have to work closely with facility staff and ensure that project objectives are met. A project lead should be an effective communicator and be qualified in areas that are relevant to the project. Typically, the RCx project lead should have experience with facility equipment and systems, troubleshooting, testing and analysis, diagnostic monitoring and determining the most cost-effective paths and solutions.

4. **Document the current operating requirements.** To determine the viability of implementing RCx measures, the facility's operating requirements must be known and should be shared with the project team. Building owners and operators typically determine these requirements based on operational needs. This includes understanding occupant or facility needs, operating schedules and ranges for temperature, humidity and air flow rates. Requirements may vary by space in a facility. Diagnostic RCx testing should not be disruptive to facility operations and occupants should be notified prior to testing. This testing may include operation of equipment over a range of functions and potential individuals responsible for performing the tests are outlined in the section on retro-commissioning team. Owner operating requirement templates can be found at the California Commissioning Collaborative [8].

5. **Perform an initial site walk-through.** A walk-through of the facility will familiarize the project lead, and other team members as appropriate, with the age, condition, operation and control of the facility's equipment and systems. It is useful to determine where energy is being used, opportunities for energy reduction, preventative maintenance procedures, performance problems and the need for further information. An interview with the facility's operator(s) should be conducted in conjunction with the walk-through. Utility data should also be investigated to determine trends over at least one year. These data can be found in either the City's Portfolio Manager accounts or the City's Energy Action Plan.

6. **Develop the retro-commissioning plan.** The RCx plan is developed by the project lead. It defines the project team, roles and responsibilities, objectives, scope, schedule and documentation requirements. The RCx plan serves to guide the team and should include:

    - Project team members, their roles, responsibilities and contacts.
    - Goals and objectives of the project.
    - Scope and schedule.
    - Required documents and responsible parties.
    - General building information (operating requirements, equipment, controls, historic energy use, etc.).

RCx plan templates can be found at the California Commissioning Collaborative [8].

7. **Assemble the retro-commissioning team.** The RCx team member requirements will be established as part of the planning process. Individuals should be chosen based on project needs and relevant experience.

8. **Hold a project kick-off meeting.** The RCx project lead initiates a kick-off meeting with all team members to make formal introductions, review the RCx plan and establish each member's responsibilities.

9. **Planning phase deliverables:**

   - Owner's operating requirements. Developed by the building owner/operators with assistance from the RCx project lead [8].

   - Retro-commissioning plan [8].

Investigation

The investigatory phase consists of analyzing facility performance, by way of observation, measurement, data trending, document review and O&M practice review. Results are summarized in a master list of findings. This section provides further details on the investigation phase steps listed in Figure 4.

1. **Review facility documentation.** Where available, the project team should review the following documentation:

    - Design record documents (original and renovations, with a focus on mechanical and electrical design).
    - Equipment lists with nameplate information (with a focus on energy consuming equipment such as that associated with HVAC, lighting and process loads).
    - Controls systems (with a focus on EMS records, control diagrams, control point lists and sequences of operation)
    - Operation and maintenance manuals and work order logs.
    - Testing, adjusting and balancing reports.
    - Historic energy use data from utilities.
    - Other reports, such as previous commissioning reports or energy audits.
    - Other City policies, such as the Benchmarking, Energy Action Plan and Climate Action Plan policies.

2. **Perform diagnostic monitoring.** Monitoring is used to characterize performance and verify whether or not equipment or systems are operating properly and to identify opportunities for improvement. Diagnostic monitoring is typically carried out through use of either an EMS or portable data loggers. Data must be trended over a relevant time period to determine when equipment operates and how it operates under various conditions. It is valuable to trend:

    - Energy use (electrical energy, electrical demand, gas, steam and chilled water).
    - End uses (cooling, heating, ventilation, lighting, process, cooking, plug, data centers, etc).
    - Operating parameters (temperature, humidity, flow rates and pressures).
    - Equipment status and runtimes.
    - Valve and damper positions.
    - Setpoints.

- Weather data.

A combination of EMS and portable data logger trending may be necessary depending on EMS capabilities. Diagnostic monitoring plan templates can be found at the California Commissioning Collaborative [8].

3. **Perform functional tests.** Diagnostic monitoring may reveal a problem but not identify the cause. Functional testing may be necessary to expose the origin of the problem. Functional testing typically consists of operating the equipment through a range of modes and measuring and documenting the resultant performance and comparing it to normal operation. Prior to testing, a well-defined test protocol must be developed, control points should be checked and sensors should be calibrated. Building operators should be involved in functional testing to gain a deeper understanding of the process and their facility. Functional testing templates can be found at the Portland Energy Conservation, Inc. (PECI) [9].

4. **Perform simple repairs as the project progresses.** There may be cases where it is possible or necessary to implement changes in the investigation phase. For example, if setpoints need to be modified or sensors need to be calibrated in order to perform functional testing, these simple repairs may be best executed during the investigation phase. However, facility operators should be consulted before any changes are made.

5. **Develop the master list of findings.** Once diagnostic and functional tests are complete a master list of findings document should be compiled by the project lead. This is one of the most important deliverables in the RCx process. It serves as a decision making tool for determining which measures to move forward with, as a guide for contractors implementing the measures and as a record for the stage of implementation that the measure is currently at. The master list of findings should provide information as shown in Table 3. This has the same format as the "standardized energy conservation measure (ECM) tracking spreadsheet" used for the City's Benchmarking Policy and Energy Action Plan. Calculation methods and assumptions must also be provided.

6. **Investigation phase deliverables:**

    - Diagnostic monitoring plan [8].
    - Master list of findings Table 3.
    - List of measures to be implemented immediately.

7. **Prioritize and select operational improvements.** Selection of measures will be based on the master list of findings, eligibility under Southern California Edison (SCE) or Southern California Gas (SCG) funding requirements [10] and internal funding and staff availability.

Implementation

The implementation phase will vary depending on the nature of the measure. Implementation will be carried out by City staff when internal capabilities are sufficient or third-party providers, when not. In all cases, the project lead should be involved in the implementation phase. This section provides further details on the implementation phase steps listed in Figure 4.

1. **Develop an implementation plan.** An implementation plan defines the scope of work associated with each measure to be implemented. The scope outlined in the implementation plan must allow either staff or contractors to correctly execute each measure; it may also be used for bidding purposes. The implementation plan must follow SCE or SCG requirements for funding [10], [4] and [5]. This includes meeting eligibility, verification and calculation method requirements. Examples of RCx implementation summary reports can be found at the California Commissioning Collaborative [8].

2. **Implement selected measure.** Choosing an approach to implementing measures will depend on internal staff capabilities and staff availability to manage implementation. The three most common approaches are:

    - Turn-key implementation, where a third-party provider executes all of the implementation. This approach is favored when most of the work requires outside contractors. In this case, the City has one contract and the RCx provider manages sub-contractors.

    - Internal staff implementation with RCx provider guidance, which is favored when internal staff are highly skilled, available to execute the work and the need for contractor implementation is minimal.

    - City-led implementation, which is favored when the City has capable internal engineering staff or strong relationships with service contractors.

3. **Verify results.** Verification ensures that implemented measures are performing properly. Verification can be accomplished through EMS trending, portable data logging, functional testing, direct observation or a combination of these techniques. Post implementation data should be documented and compared to baseline data and compiled into an implementation summary report. These data provide the basis for energy savings calculations and future verification efforts to ensure desire performance is persistent.

4. **Implementation phase deliverables:**

    - Implementation plan [10].

    - Implementation summary report [8].

Project Hand-Off

The RCx project must be handed-off to the City such that it has all the necessary information and training in place to properly monitor and maintain the implemented measures. This section provides further details on the hand-off phase steps listed in Figure 4.

1. **Develop the final report.** The final report compiles and documents all RCx activities. It serves as a record document for current and future facility staff and assists in maintaining implemented measure performance. Examples of RCx final reports can be found at the California Commissioning Collaborative [8]. The final report will provide information on project objectives, scope and economics.

2. **Compile a systems manual.** The intent of the systems manual is to provide staff with the ability to understand the results of the RCx process and operate and maintain the implemented measures. The results of the RCx process may redefine aspects of the owners operating requirements. Any changes should be reflected in the systems manual. Examples of RCx systems manuals can be found at the California Commissioning Collaborative [8].

3. **Develop a re-commissioning plan.** It can be necessary to periodically re-commission facilities to maintain optimum performance. Re-commissioning can be done on a set schedule or based on performance degradation. The best time to establish the re-commissioning process is during the hand-off phase.

4. **Provide training.** Training allows staff to perform O&M and identify and resolve issues associated with RCx measures. City staff will determine the best method of training for each RCx project. Training methods may include field demonstrations, classes and videos. Examples of RCx training plans can be found at the California Commissioning Collaborative [8].

5. **Hold a close-out meeting.** The final report is presented at the close-out meeting and allows any remaining issues and next steps to be discussed.

6. **Implement persistence strategies.** Strategies should be put in place to maintain peak facility performance over time. Example strategies include:

    - Document changes to operation and controls resulting from the RCx process.
    - Provide ongoing staff training.
    - Update preventative maintenance plan to include RCx lessons learned and implemented measure maintenance requirements.
    - Track facility energy performance. This is currently being accomplished for City of Simi Valley facilities using Energy Star's Portfolio Manager and McKinstry's Enterprise Energy Management Information System (EEMIS).
    - Perform periodic re-commissioning.

7. **Hand-off phase deliverables:**

- Final report [8].
- Systems manual [8].
- Re-commissioning plan.

Integration with Other Processes

RCx may be integrated with other energy related projects such as energy audits, equipment retrofits, larger facility retrofits, energy service company (ESCO) performance contracts, on-site energy system additions and incentive programs. It is wise to understand how RCx may interact with these other project types and how to schedule them appropriately to minimize costs and maximize benefits. This section explores these interactions in more detail.

1. **Energy audits.** Energy audits are an investigatory process where energy conservation measures (ECMs) are identified. Energy audits are typically less technically sophisticated as compared to RCx. However, an energy audit's level of detail can vary considerably. In some cases the audit may identify control opportunities that require further investigation, which can be accomplished through RCx. Since audits logically progress to RCx projects, there is typically not a conflict between the two. However, the audit may identify other ECMs, such as retrofits, that may interact with RCx in a more complex way.

2. **Equipment retrofits.** Typically, equipment retrofits occur for one of three reasons: when equipment has reached its end of life, when enhanced functionality is required, or to replace inefficient equipment with the goal of achieving energy and cost savings. Retrofit recommendations may result from either energy audits or RCx projects. If both RCx projects and equipment retrofits are to be conducted they should be prioritized. Typically if RCx is to be conducted prior to the retrofit, the RCx improvements chosen should be those that will remain intact after the retrofit. RCx implementation prior to the retrofit may reduce loads; this allows smaller capacity equipment to be specified, thus reducing retrofit costs. When the retrofit is to be conducted first, the equipment should be commissioned to ensure it operates properly and, to the extent possible, integrates well with other equipment operation. RCx that follows the retrofit may be needed to ensure optimized interaction with other equipment. Ultimately, if the retrofit is a component of an RCx project it is likely to be more effectively prioritized and best integrated with the rest of the facility equipment.

3. **Facility retrofits.** Facility retrofits may consist of renovations that affect a large fraction of the facility or facility equipment. Much of the same logic described for prioritizing equipment retrofits and RCx projects can be applied to facility retrofits.

4. **Energy service company (ESCO) performance contracts.** ESCO performance contracts are energy projects financed by a third party where the City pays for the project through energy cost savings. It is best to conduct RCx prior to the ESCO project so that systems are operating as efficiently as possible. This will help the City reap energy cost savings in advance of ESCO involvement and allow the performance contracting process to focus on deeper retrofits. RCx can also help identify the equipment that would be best served by retrofits, while maintaining the implemented RCx improvements. ESCOs typically tend towards large capital projects and the RCx process can be a good method of vetting the value of ESCO project recommendations. This may be specified as part of the RCx scope.

RCx reports should be shared with ESCO providers prior to engaging in a contract. This will ensure that baseline energy use and the impact of RCx on the ESCO project are understood.

5. **On-site energy system additions.** An on-site energy system produces electricity, heat or cooling at the facility site and offsets purchases from conventional utilities (SCE or SCG for the City of Simi Valley). RCx projects should be properly prioritized with on-site energy system installations. In general, anything that reduces energy usage prior to installation will allow the on-site energy system to be sized in the most cost effective way. Only the RCx improvements that will remain intact after the installation should be considered. For instance, if a combined heat and power installation will take boilers off-line, those boilers should not be a focus of RCx.

   Furthermore, on-site energy systems installations should be properly coordinated with retrofits. For instance, systems should not be located in an area where future construction may be slated and careful attention should be made in sizing the system when a facility may be downsized in the future and not require the system's generation capacity.

7. **Incentive programs and funding.** Incentive programs from utilities, such as SCE or SCG for the City of Simi Valley, typically have separate and distinct funds for retrofit and RCx projects. SCE provides Express and Customized Solution incentives for energy efficiency; RCx incentives fall under the Commercial Retro-commissioning (RCx) Program. It is important to understand and follow the incentive funding requirements for RCx projects [10], [4] and [5]. It is also necessary to be able to differentiate energy savings that may come from a retrofit vs. an RCx project, since RCx projects are funded by measured energy savings. Retrofits should be deferred until after the RCx verification period is complete.

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RETRO-COMMISSIONING TEAM

Retro-Commissioning Team Members and Their Responsibilities

When a RCx project is identified, City staff from the Public Works Department will assemble an RCx project team and the RCx team leader. The staff members on the team will depend on complexity of the project and budget. The RCx plan, roles and responsibilities, scope, process and schedule are outlined in the kick-off meeting, which should include all team members. A description of team member roles and responsibilities is described below.

1. **RCx lead.** The RCx lead is the RCx project manager. The RCx lead can be a member of the City staff or a third-party contractor depending of project complexity and staff capability and availability. The RCx lead is responsible for planning, scheduling and coordinating the RCx process. The RCx lead helps to identify RCx measures, may be involved in implementation and verifies that documentation, training and measures are performed.

2. **City staff.** If a City staff member is not the RCx lead, there will be a need for staff support. Staff support consists of clearly defining project expectations, establishing City requirements and providing existing documentation.

3. **Building manager and supporting staff.** The building manager and O&M staff are key players in the RCx process. They typically have highly valuable institutional knowledge that can be leveraged. These staff should be involved in the goal setting process and as much of the RCx process as possible to enhance understanding of building systems and controls and the ability to test and maintain RCx improvements.

4. **Contractors and manufacturer's representatives.** Equipment, maintenance and controls contractors are often involved in the RCx process. They may assist with equipment that is still under a service contract or warranty, but may need a separate contract to assist with RCx of equipment no longer under service contract or warranty. Only the responsible party should manipulate equipment under warranty to avoid voiding the warranty. Testing and balancing contractors may be brought in to rebalance the system prior to RCx. If a controls contractor has the primary knowledge of sequences and programming, they may be required to improve controls.

5. **Design professionals.** Design professionals are usually involved in RCx when a retrofit is being designed or when issues related to the original design need clarification.

6. **System specialists.** When specialized systems such as waste water treatment plants, data centers, fume hoods, etc. are involved in the RCx process, a specialist may be hired to perform inspection and diagnostics, review documentation or train operators.

Selecting a Retro-Commissioning Lead

Selecting the team leader is one of the most important decisions in the RCx process. This individual can be a City staff member or a third-party provider. The lead should be chosen at the outset of the RCx process based on the complexity of the project and their capabilities and availability. An RCx lead with experience in managing the appropriate technical, analytical and administrative project requirements should be chosen. Having staff members assist a third-party RCx lead is an effective way of training and developing internal resources for future projects. RCx lead qualifications are outlined below.

1. **Technical knowledge.** The RCx lead should have a technical knowledge of design, construction and building operations. It is not necessary to have technical knowledge in all areas, but the RCx lead should have a strong background in the design and operation of HVAC and control systems. Technical specialists may be needed to support certain technical aspects of the project.

2. **Relevant experience.** The lead should have recent hands-on and troubleshooting experience in RCx and utility incentive funding requirements. For RCx projects of average complexity, the RCx lead should have experience with at least two similar projects. For RCx projects of high complexity, the RCx lead should have experience with at least four similar projects.

3. **Communication and organizational skills.** The RCx must have excellent leadership skills, verbal and written communication skills, organizational skills, be able to resolve conflicts and be objective.

4. **Availability.** The RCx lead must have the availability to fully focus on the project and effectively lead the team. When utilizing a City staff member as the RCx lead, it is critical to ensure that they have the availability to achieve a successful project.

Involving a Third-Party Provider

Evaluating the need to hire a third-party RCx provider as opposed to using City staff resources is one of the first project decisions. Some criteria in making this decision and descriptions of various third-party RCx approaches are outlined below.

1. **Evaluating the need to hire a third-party provider.** A third-party provider may be beneficial depending on the scope of RCx work, staff availability and the complexity of managerial and technical requirements.

2. **Advantages to hiring a third-party provider.** Some of the advantages to hiring a third-party provider include:

    - The City may not have the staff experience, availability or technical resources.

    - Third-party providers may have broader experience, leading to more efficient project delivery.

- Possession of analytical skills to determine root causes and suggest the most cost effective solutions.
- No bias to protect the operational status quo.
- Possession of the tools necessary to perform the testing.
- Proven procedures and protocols.

3. **Third-party provider approaches.** The four main approaches to utilizing a third-party RCx provider are:

    - **Turn-key.** A third-party is hired to manage the entire RCx project and is solely responsible for the outcome. This works well when staff experience, availability and technical resources are low.
    - **Third-party team lead.** A third-party is hired to lead the process with staff assistance. This works well when staff has RCx experience or expertise in HVAC and control systems. This is an active partnership that can reduce costs.
    - **Training.** A third-party is hired to work closely and train staff so that subsequent projects can be carried out internally. This works well when there are multiple buildings that need RCx and there is well-trained and available staff.
    - **Consulting.** A third-party is hired to work closely and train staff so that subsequent projects can be carried out internally with assistance of third-party on advanced tasks. This works well when a division of labor structure is needed based on technical capabilities and staff availability.

4. **Selecting a third-party provider.** Selection should be based on the complexity of the project, relevant experience and value to the City. The City issues a request for proposals (RFP), including qualifications, for the desired services.

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