



California Commissioning Collaborative

Roadmap for Achieving the Commissioning Goals of California's Green Building Executive Order

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on behalf of the Green Building Action Team Commissioning and
Retrocommissioning Work Group**

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Executive Summary

The State of California has taken a leading role in promoting sustainable building practices. In December 2004, Governor Arnold Schwarzenegger signed Executive Order S-20-04 – a progressive public policy that mandates reduced energy and resource consumption statewide. The Executive Order established the state's priority for energy and resource-efficient, high performance buildings to be achieved through sustainable building practices and energy efficiency and conservation. The Executive Order names building commissioning as one strategy for meeting these goals.

Building commissioning emerged in the United States in the early 1990s as a process that ensures a building meets an owner's operational needs. The process typically saves an average of 5 – 15% of annual energy costs. Over time the growth of the commissioning industry has been supported by the efforts of forward-thinking building owners and managers, researchers, commissioning providers, California utilities, the California Energy Commission, and the California Commissioning Collaborative. California's Green Building Executive Order influences growth and change in the commissioning industry by requiring commissioning in new and existing state buildings.

The Commissioning and Retrocommissioning Work Group was formed to address the commissioning goals of the Green Building Executive Order. The group identified a number of desired outcomes, which are represented by these three key areas of focus:

- Maturity of commissioning methodology and practice
- Availability of qualified commissioning providers
- Recognition of the value of commissioning and retrocommissioning

The following report highlights progress in these areas and presents recommendations for next steps that will help move the industry further towards achieving the commissioning goals of the Green Building Executive Order.

Achievements and Progress

Significant progress has been made through research, outreach, commissioning programs, and projects conducted by California government agencies, utilities, the California Commissioning Collaborative, and other industry players. Knowledge gained through research and early program designs, development of tools, resources and sample documents, along with a variety of training opportunities and outreach efforts have created a web of interrelated activities that have fueled growth in California's commissioning industry. Table ES - 1 summarizes these accomplishments.

Table ES - 1: Accomplishments in California's Commissioning Industry, 2000 – Present

	CCC	Cx and RCx Programs	Utilities	Researchers	Cx Providers	Government Agencies
Public Policy						
The Governor's Executive Order S-20-04 – 2004						●
Acceptance Testing Requirements in California Building Code – 2000 - Present	●					●
Technical Research						
Lawrence Berkeley National Lab Cost-Benefit Study – 2004				●		
Public Interest Energy Research Program – Ongoing				●		●
PG&E California Market Characterization Study – 2000			●			
Tools and Guides						
Guidelines for Verification of Savings – 2007	●					
Retrocommissioning Toolkit – 2006-2007	●					
California Commissioning Guides for New and Existing Buildings – 2006	●					
Performance Monitoring Specifications – 2006			●	●		●
In-House Commissioning Toolkit for Small Buildings – 2006						●
Commissioning Provider List – 2005	●					
Commissioning Test Protocol Library – 2003				●		●
California Department of General Services Commissioning Process Guide – 2003						●
Cx/RCx Database Protocol – 2003	●					
Energy Design Resources/Cx Assistant – 2003			●	●		
Training						
Training Opportunities - Ongoing		●	●		●	
Forum for Training Owners – 2005	●					
FEMP Training and Case Studies – 2005	●					
Certification Program Evaluation – 2005	●					
Training Strategy Report – 2005	●					
Commissioning and Retrocommissioning Programs						
Commissioning and Retrocommissioning Programs – Ongoing		●	●		●	
New Building Commissioning Programs – Ongoing		●	●			
Support for Utility Commissioning Programs – 2005	●					
DGS In-House Retrocommissioning Program – 2005						●

	CCC	Cx and RCx Programs	Utilities	Researchers	Cx Providers	Government Agencies
Monitoring Based Commissioning Program – 2004		●	●	●	●	●
Marketing/Outreach						
Industry Networking and Idea-Sharing: CCC Meetings – Ongoing	●					
Access to Commissioning Information and News – Ongoing	●					
Resources for Building Owners – Ongoing	●					
Market Research – 2006-2007	●					
RCx Program Brochure for Owners – 2006	●					
Discussions with Real Estate and Owners – 2006	●					
Market Research Roadmap – 2006	●					

Recommendations

Moving the industry forward will require a unified vision and integrated efforts on behalf of all the participants in the market to address significant challenges in the commissioning marketplace:

- There is no single standard methodology and approach to the practice, and a lack of uniformity in project scopes, documentation, and methods for ensuring persistence of benefits achieved.
- The launch of large-scale retrocommissioning programs has placed huge demands on the limited number of available commissioning providers to meet program goals.
- A gap in understanding and communication between the commissioning industry and building owners hinders the marketing of commissioning services.

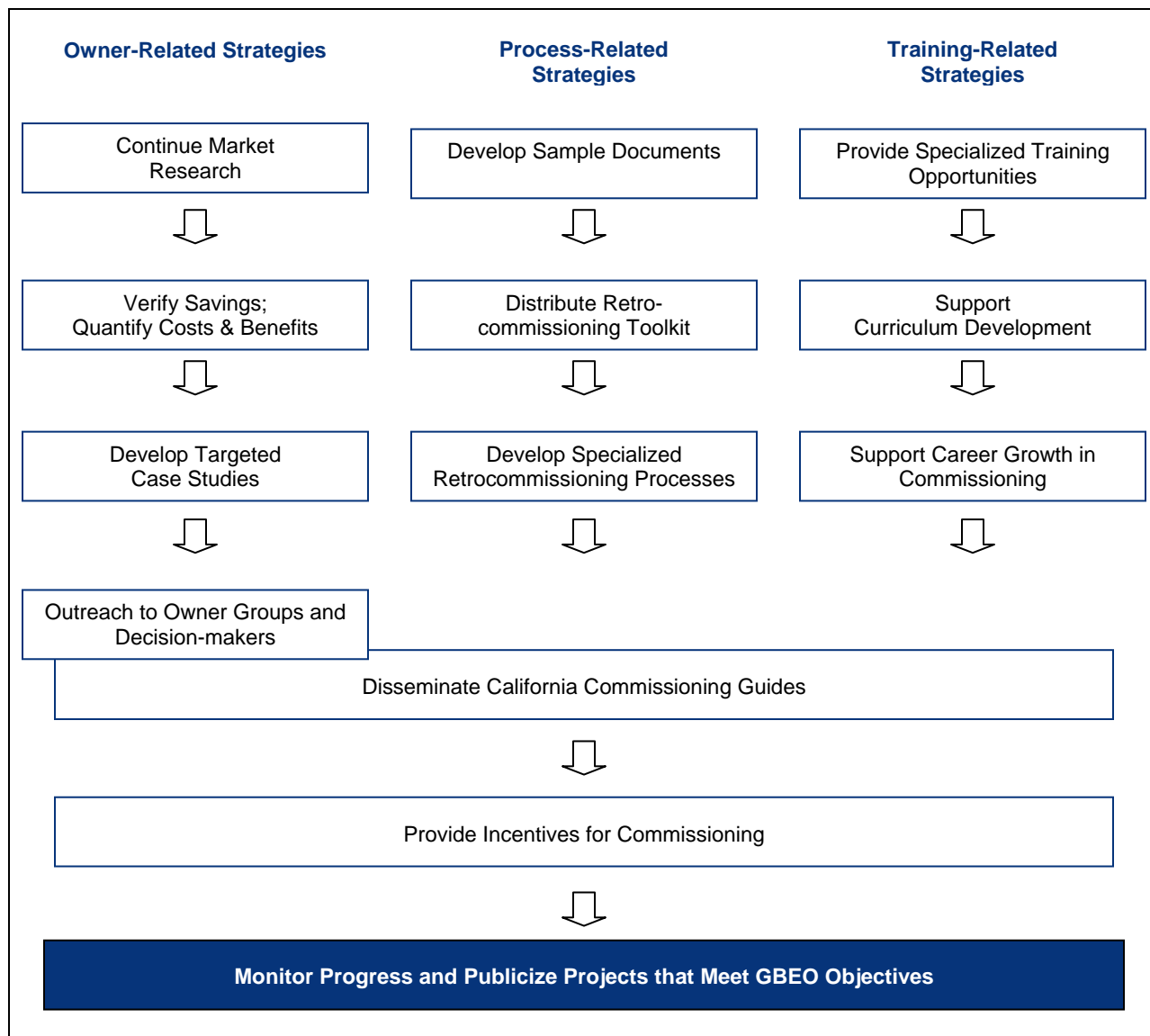
Providing effective tools and resources to commissioning providers will help bring a level of standardization and consistency to the practice. Another key area for continued focus is training and education to increase the number and skill of commissioning providers in the market. Finally, market research and analysis is a critical component to ensuring that the value of commissioning is understood by building owners. Additional data is needed to support efforts to reach out to building owners with meaningful messages.

A strategic approach to ensuring continued progress toward the Green Building Executive Order goals is described in

Figure ES - 1 below. This roadmap shows the recommended activities, broken down into three areas: owner-related strategies, process-related strategies, and training-related strategies.

The final recommendation in the Roadmap is to monitor progress and publicize projects that meet GBEO objectives. Without an effective plan to promote new tools and resources, opportunities for professional development, and successful projects implemented in state buildings, the private sector will not “follow the lead” as intended by the Green Building Executive Order. This ultimate outreach effort must make the progress made in the public sector relevant to the business needs of private building owners and decision-makers. This is the key to making commissioning and retrocommissioning standard practice.

Figure ES - 1: Recommendations Roadmap



Indicators of Success

In order to determine successes and make sound decisions on future actions, a plan to evaluate and monitor activities in the commissioning industry is essential. It is recommended that these key metrics be measured, evaluated, and monitored over time:

1. **Market Penetration Rates** will reveal increases in adoption of commissioning over time.
2. **Availability of Training and Education** will signify the need for more and better trained professionals in the commissioning workforce.
3. **Widespread Use of Standardized Tools and Resources** will indicate acceptance of common practices and methodology.
4. **Requests for Information and Participation in Industry Events** will point to increased awareness of commissioning.

Conclusions

Commissioning is a key requirement in the Green Building Executive Order. It leads to significant energy savings and other benefits that improve building operations, maintenance, and occupant comfort resulting in more efficient and healthier indoor environments.

The Commissioning and Retrocommissioning Work Group has developed well-defined objectives to address the commissioning-related mandates of the Green Building Executive Order, and this roadmap provides a strategy and recommended activities to move the industry toward meeting those objectives. Successful results will depend on integrated effort from all participants in the commissioning industry to overcome market barriers and guide the growth of the industry to the point that commissioning is standard practice. Achieving these objectives will ensure that California buildings are not only designed to be green, but are built, operated and maintained with these ideals.

1. Introduction

The State of California has taken a leading role in promoting sustainable building practices that will help create healthier and more productive indoor environments. In December 2004, Governor Arnold Schwarzenegger signed Executive Order S-20-04 (Green Building Executive Order, or GBEO), a progressive public policy that mandates reduced energy and resource consumption statewide. The Executive Order established the state's agenda for energy and resource-efficient, high performance buildings to be achieved through sustainable building practices, energy efficiency, and conservation.

The Green Building Executive Order establishes targets for reducing energy use in state-owned buildings and encourages the private commercial sector to set similar goals. The intent of the GBEO is to lead by example, using the authority of the executive branch to mandate energy and resource improvements in state-owned and leased buildings and to improve codes, regulations and incentives to increase energy efficiency of all new buildings statewide. Successes in the public sector will encourage private sector investments in energy-conserving and energy-efficient practices. The anticipated result will contribute to the transformation of the commissioning market – from one largely bolstered by public sector influence to one that operates independently based upon free market forces.

The Green Building Executive Order directs compliance with the Green Building Action Plan, which details measures the state will take to meet these goals, including specific commissioning-related mandates:

- New state buildings shall achieve a Silver rating or higher from the Leadership in Energy and Environmental Design for New Construction (LEED™-NC) system (LEED is a green building rating system to recognize sustainable buildings using defined criteria, and the new construction rating system includes commissioning as a prerequisite).
- Existing state buildings over 50,000 square feet shall achieve a LEED for Existing Buildings (LEED™-EB) Silver rating (includes retrocommissioning as a prerequisite).
- All existing state buildings over 50,000 square feet shall be retrocommissioned within five years, and recommissioned every five years thereafter.
- Reduce grid-based energy purchases for state-owned buildings by 20 percent (from a 2003 baseline) by 2015.

Building commissioning is a key strategy for improving and preserving the energy and environmental performance of new and existing buildings. It is a cost-effective process resulting in energy reduction, cost savings, and optimized operations of new and existing buildings. Commissioning a new building (Cx) ensures that it will operate in accordance with the owner's intent and will provide a comfortable and healthy environment with equipment and systems that are well designed, selected, installed, and operated. Existing building commissioning, or retrocommissioning (RCx), improves the performance of existing buildings, reduces energy used initially, and sets the building up for more efficient operations into the future. In the United States, the commissioning practice gained recognition in the late 1980s in response to a need for quality assurance and building system integration and as a method for achieving and preserving energy conservation and reduction efforts.

The Green Building Action Plan explicitly names building commissioning as a strategy for meeting the GBEO's energy efficiency goals in section 2.2 – CEC Building Benchmarking and Commissioning (see Figure 1 below), and in other related sections of the Plan.

Figure 1: Excerpt from Green Building Action Plan

2.2. CEC – Building Benchmarking and Commissioning

2.2.1. A combination of benchmarking the energy efficiency of all buildings, and conducting commissioning activities that ensure that buildings and their energy systems are operated at their optimal designed efficiency, can contribute towards the overall goal of 20% by 2015.

2.2.2. The CEC, in consultation with other governmental agencies, public and private utilities, and representatives of the business community, shall propose by July 2005 a simple building efficiency benchmarking system for all commercial buildings in the State. This should be California-specific, coordinated with the US EPA Energy Star benchmarking system, and should clarify which buildings are energy efficient.

2.2.3. The CEC shall develop guidelines and standards for commissioning activities to achieve operational and maintenance efficiency savings in commercial and public buildings.

2.2.4. The CEC shall prepare and submit to the Governor's office by July 2005 a plan, timetable and recommendations to accomplish benchmarking of all commercial and public buildings in California, including benchmarking at the time of sale, as well as a system by which benchmarking ratings can be disclosed to tenants, buyers, and lenders to advise them in making decisions.

In 2005, the Commissioning & Retrocommissioning Work Group (CWG) was convened to address the commissioning goals of the Governor's Executive Order. The Work Group identified key outcomes to be accomplished:

- **Recognized Importance.** Building owners and managers recognize the importance and value of commissioning and retrocommissioning.
- **Common Practices.** A commonly accepted methodology and practice is established to yield highly cost-effective results.
- **Operator Training.** Training building operators to participate in retrocommissioning and persistence activities becomes standard practice.
- **Qualified Providers.** Sufficient trained labor force (commissioning providers and building operators) exists to meet demand.
- **Business as Usual.** Retrocommissioning becomes a routine practice for owners, managers, and operators.

The purpose of this report is to describe progress made towards these desired outcomes and provide recommendations for future growth and development of the commissioning industry. To ensure the actions of the CWG and other market players continue to move the industry forward, indicators of success are also described.

2. Historical Perspective on Commissioning in California

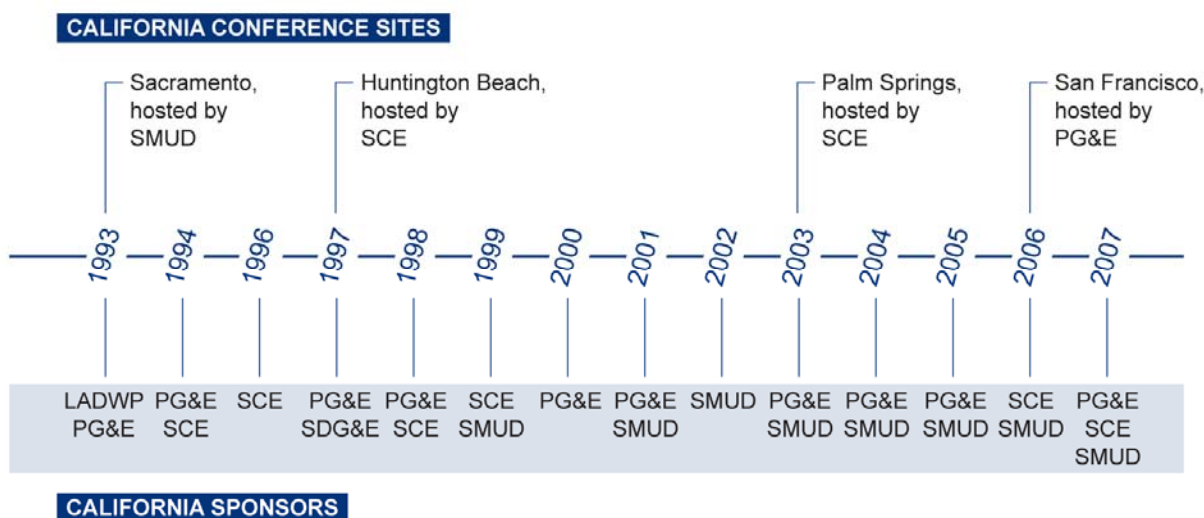
In recent years, building systems have become more complex and error-prone. At the same time, the building construction industry has become more cost-competitive, resulting in less effective quality control measures, systems that are not working as expected, and building operators who do not have the training or tools to operate their buildings effectively. The performance of these buildings is often less than optimal on the day it is turned over, and continues to degrade over time. Realizing this, professionals in the building design and engineering industries began to look increasingly at quality control processes, and adopted the commissioning process to address this problem.

In the early 1990s, utilities began to evaluate the performance of the buildings enrolled in their energy efficiency programs. Studies and evaluations of these programs indicated the predicted savings from utility-rebated measures were often much less than expected (Piette et al.,1994), and that commissioning and improved operations and maintenance (O&M) were needed to ensure delivery and persistence of energy savings (Piette et al.,1994). These findings sparked the development of new commissioning research, programs, and training, which fueled the growth of the commissioning industry.

2.1. Growth of the Industry

In 1993, California utilities supported the first National Conference on Building Commissioning (NCBC) to provide a forum for industry stakeholders to share information and gain a better understanding of the commissioning process and its potential benefits. The NCBC has become the industry's major annual event where stakeholders come together to exchange information and receive training. Of the past fourteen conferences, four have been held in California and hosted by California utilities. Notably, every NCBC has been sponsored by at least one California utility. Figure 2 illustrates the involvement of California utilities since the first conference in 1993.

Figure 2: California Utility Support for the National Conference on Building Commissioning



In 1994, Southern California Edison (SCE) funded the first multi-building commissioning study in the U.S. Similar to the goals of the NCBC, its intent was to better understand the potential benefits of commissioning in commercial buildings. This study not only validated the energy savings potential of commissioning for both new and exiting buildings but also set up a framework of commissioning tools and procedures, versions of which are still used in the market today. Once the need for commissioning

was established and commissioning methodology began to develop, a number of documents were published, helping to describe the commissioning process (see Figure 3).

Figure 3: Early Influential Commissioning Documents

- American Society for Heating, Refrigeration, and Air-Conditioning Engineers, 1989. *ASHRAE Guideline 1-1989: Commissioning of HVAC Systems*.
- Bonneville Power Authority, 1992. *Building Commissioning Guidelines*.
- Sheet-Metal and Air-Conditioning Contractors National Association, 1993, *HVAC Systems Commissioning Guide*.
- U.S. General Services Administration, 1995. *Building Commissioning Guide*.
- American Society of Heating, Refrigerating and Air Conditioning Engineers, 1996. *Guideline 1-1996: The HVAC Commissioning Process*.
- U.S. Department of Energy, Federal Energy Management Program, 1997. *Model Commissioning Plan and Guide Specifications*
- U.S. Department of Energy, Rebuild America. 1998. *Building Commissioning: The Key to Quality Assurance*.
- Oak Ridge National Laboratory, 1999. *A Practical Guide for Commissioning Existing Buildings*.

Additional research was conducted to support the growing practice of commissioning. The California Energy Commission's Public Interest Energy Research (PIER) Program made significant contributions to the commissioning field with energy research, development and demonstration (RD&D) projects. Some notable commissioning-related PIER-funded programs include:

- **The High-Performance Commercial Buildings Systems (HPCBS) Program – 2003.** The primary goals of the HPCBS Program were to develop and deploy energy saving technologies, strategies, and techniques; to improve processes for designing, commissioning, and operating commercial buildings; and to improve the health, comfort and productivity of occupants.
- **Energy Efficient and Affordable Small Commercial and Residential Buildings Research Program – 2004.** The primary goal of this program was to develop and demonstrate science and technology solutions that achieve a high impact on energy efficiency in California's existing and future building and housing stock. Projects within the program focused on automated commissioning and diagnostics, advanced load management and control, alternative cooling technologies and strategies, and alternative construction techniques and technology.
- **Integrated Energy Systems: Productivity & Building Science Program – 2004.** This program focused on advancing energy efficiency through systems development, integrated design, and assembly and operation of building systems.

With increased recognition of the potential for commissioning to obtain and ensure energy savings, it became clear that training and education was needed to realize this potential. Initial training efforts focused on technical aspects of the commissioning practice to increase the knowledge and qualifications of commissioning providers. Over the years, training and education expanded to include events and courses for building owners and their staff.

Beginning in the mid-1990s, commissioning programs were developed. The Los Angeles Department of Water and Power (LADWP) developed a commissioning program for their rebated energy retrofits in 1994– California's first utility-sponsored commissioning program. In that same year, Sacramento Municipal Utilities District (SMUD) offered a program that provided incentives for developing a

commissioning plan. As the commissioning industry matured and more substantive information on commissioning benefits became available, utilities began to recognize that significant energy could be saved by commissioning existing building equipment. In 1999, SMUD's Retrocommissioning Program was launched. This program became one of the models for the future utility-sponsored commissioning and retrocommissioning programs along with other publicly-funded programs to serve state buildings such as community colleges and universities. These programs made retrocommissioning accessible to both private and public sector buildings. Figure 4 presents a timeline of significant milestones that have made an impact on the commissioning industry in California.

Figure 4: Commissioning Industry Milestones



In 1998, less than 5 percent of all commercial new construction and less than 0.03 percent of existing buildings were commissioned each year, nationwide (DOE, 1998b). In 2000, the Pacific Gas & Electric Company (PG&E) funded research to characterize California's commissioning market. The *California Commissioning Market Characterization Study* estimated the demand for commissioning services, and identified four areas in need of significant attention:

- Industry-wide education on what commissioning and retrocommissioning entails and the resulting energy and non-energy benefits
- Better tools for data analysis and diagnostics for both owners and providers
- Code development addressing performance verification
- Methods for ensuring quality infrastructure (commissioning service delivery)

The PG&E study did not estimate the actual penetration rate of commissioning in California buildings, although it did define what they felt could be a reasonable market *potential* of commissioning in California. The assumed potential, shown in Table 1, is considerable – energy costs could be reduced by more than \$11 million each year in California buildings.

Table 1: Commissioning Market Potential in California

Estimated in *California Commissioning Market Characterization Study* (PECI, 2000)

	New Buildings	Existing Buildings
Total Square Feet [<i>buildings over 25,000 square feet</i>]	61.4 million / year	2,470 million
Assumed Potential Penetration Rate ¹	30%	2%
Annual Commissioned Square Feet	18.4 million	49.4 million
Annual Cost	\$20.7 million	\$12.8 million
Annual Energy Savings	147 million kBtu	690 million kBtu
Annual Energy Cost Reduction (not cumulative)	\$2.08 million	\$9.5 million
Number of Providers Needed	182	165
Square Feet per Provider	101,000/year	300,000/year

2.2. Moving Forward

Stakeholders in California recognized the potential for commissioning to improve the performance of buildings across the state, achieving environmental benefits and utility efficiencies. They also recognized, however, that the industry needed support to achieve its potential. In October of 2000, the California Commissioning Collaborative (CCC) was formed as an ad-hoc group interested in promoting commissioning in California. By 2002, the group had established a broad agenda to support the growing commissioning industry in the state and gained support from the major public and investor-owned utilities, the U.S. Department of Energy (DOE), and the California Department of General Services (DGS).

The CCC incorporated as a 501(c)3 non-profit organization in 2004 and receives funding from key stakeholders. With participation from government agencies, municipal and investor-owned utilities,

¹ These rates were considered by the author to be “reasonable points of reference for a program or market that is transforming—not beginning and not fully developed.”

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building services organizations, building owners and others, the CCC supports research, outreach, and other projects intended to grow the market for commissioning in California. The CCC has taken an important role in supporting and executing portions of the Green Building Action Plan, and has worked closely with the CWG to align efforts with other state agencies. The Collaborative's ambitious work plan (see Table 2) includes many of the programs and activities indicated as key markers of progress to achieving the goals of the GBEO.

Early adopters of the commissioning process established a strong foundation of knowledge and practical experience, and have had broad influence on the industry. Through research, innovative program designs, and development of commissioning processes, commissioning has been shown to be a cost-effective method for saving energy and improving the quality of building operations and occupancy. Although recent years have shown a significant increase in momentum behind the commissioning industry, more work is needed for it to become a standard practice.

The Governor's Executive Order has influenced the growth of the commissioning industry as well. Compliance with the Executive Order will require significant progress toward achieving the CWG's desired outcomes and continued growth of the industry. It is imperative that all market players work together in deliberate and thoughtful ways to preserve the integrity of the process on a much greater scale, increasing the reach and influence of the practice.

Table 2: California Commissioning Collaborative Work Plan

	2001	2002	2003	2004	2005	2006	2007	Future
Acceptance Testing Standards and Training	●	●	●	●	●	●	●	●
Case Studies		●	●	●	●	●	●	●
CCC Website Development		●	●	●	●	●	●	●
Development of Online Library			●	●	●	●	●	●
Evaluation of Certification Programs					●			
Recommendations for Provider Qualifications					●	●		
Support for Utility Programs					●	●		
Training Strategies Report					●	●		
Commissioning and Retrocommissioning Guidelines					●	●		
Commissioning Workgroup Roadmap						●		
Developed Matrix of Retrocommissioning Programs						●		
Market Research						●	●	
Retrocommissioning Toolkit						●	●	
Verification of Savings							●	
Analysis of Educational Opportunities							●	
Outreach to Owner Groups							●	
Support for Decision Makers								●
Toolkit for Commissioning Providers								●
Quantify Benefits								●
Controls Training for Retrocommissioning Providers								●
Publicize Career Opportunities								●
Program Design								●
Demonstration Projects								●
Support for Community Colleges								●
Mentorship Program								●
Scholarship Program								●

3. Achievements and Progress

Stakeholders in California's commissioning industry have supported the commissioning-related strategies of the Green Building Action Plan with research and tool development, programs, outreach and other projects. This progress can be summarized into major goals that capture the overall objectives of the CWG:

- Maturity of commissioning methodology and practice
- Availability of qualified commissioning providers
- Recognition of the value of commissioning and retrocommissioning

This chapter will describe these goals and what has been achieved within the industry – by government agencies and research institutions, municipal and investor-owned utilities, and by the CCC and CWG – to reach them. Specific examples of progress are described at the end of the chapter, with icons to indicate the CWG goal or goals they address. Many of the activities are part of the CCC Work Plan presented in Table 2, which illustrates the work the CCC has undertaken since its formation and its planned activities for the future.

3.1. Maturity of Commissioning Methodology and Practice

The development of an increasingly unified definition of commissioning, and standardized processes for commissioning has been a significant accomplishment in recent years. Standardized methodology and practices for commissioning distinguishes the process from simple or “start up” procedures for new construction or equipment “tune-ups” for existing buildings. Having a well-defined process helps to ensure that systems are checked out methodically, issues are tracked to resolution, findings and interventions are documented, building staff is trained to operate the systems, and, perhaps most importantly, customers know what they are getting when they pay someone to commission their buildings.

Activities that have helped to define and standardize commissioning processes include:

- Development of standards and guidelines
- Publicly available tools and sample documents
- Training opportunities for commissioning providers
- Emergence of statewide consistency in commissioning and retrocommissioning program requirements

These advancements provide common understanding and expectations across the industry and reliable resources and tools that can be applied consistently to a wide range of projects.

3.2. Availability of Qualified Commissioning Providers

Industry stakeholders have recognized that the availability of well-qualified individuals to provide commissioning services is fundamental to meeting the demand for commissioning services. In addition to there being a sufficient number of providers working in the field, education and training need to be readily available so that the qualifications and skills of providers can match the demands of the industry.

In 2004 the CCC developed a training strategy report, with funding from the US Department of Energy's Federal Energy Management Program. The report identified the commissioning industry's training needs and audiences, as well as gaps where these needs were not being met (CCC, 2004). The California Energy

Commission, California utilities, community colleges, commissioning trade associations, as well the CCC have all assisted in providing educational opportunities in an effort to expand the skills of those involved in commissioning projects. Table 3 lists the available training topics – both basic and advanced – that were detailed in the report.

Table 3: Available Commissioning and Retrocommissioning Training Topics

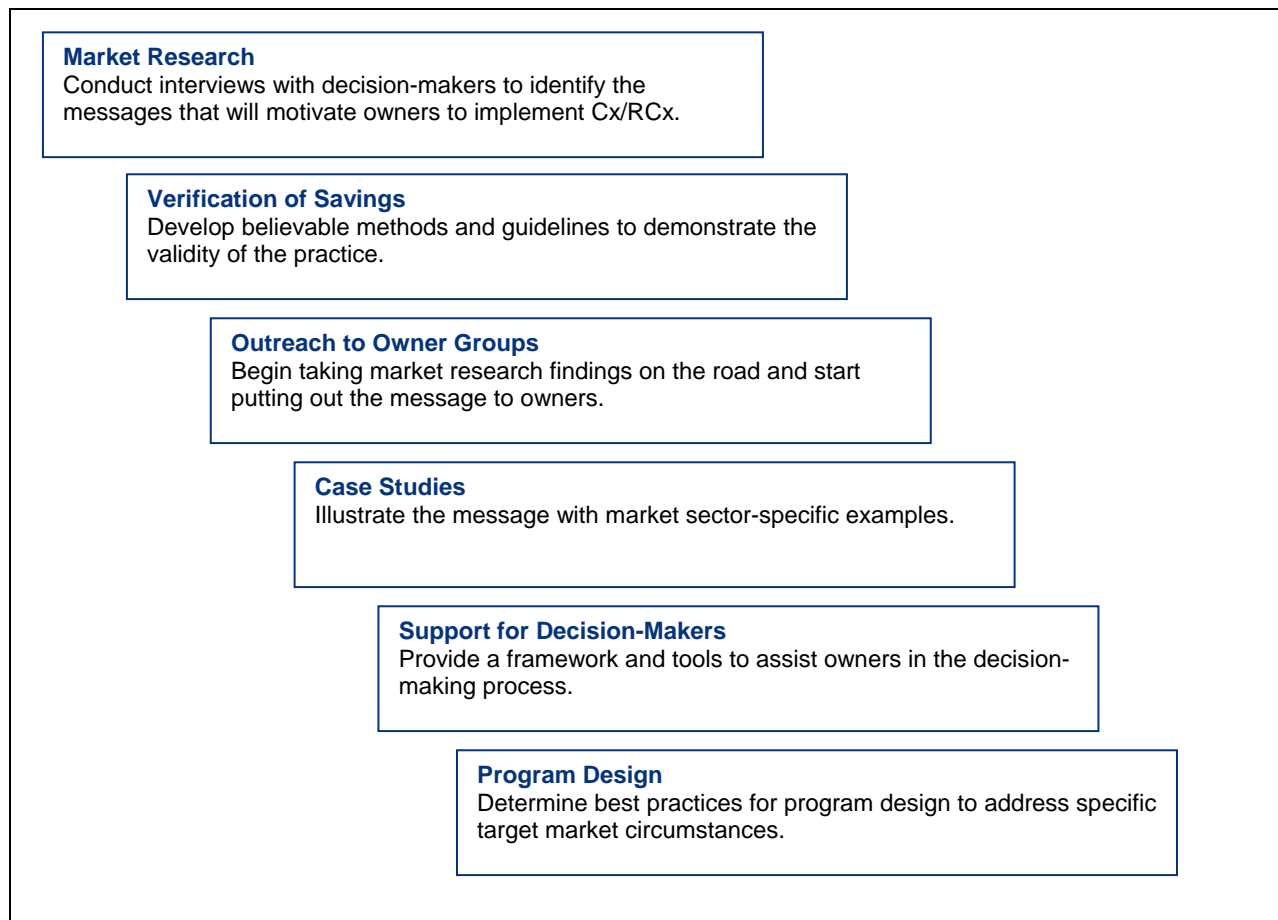
Basic Topics	Advanced Topics
Overview of RCx	System-level commissioning techniques
Top 10 RCx issues	RCx tools and techniques
Writing Cx specifications	Diagnostics testing using data-loggers, BAS, manual tests
Diagnostics testing overview and techniques	Controls integration
Developing functional tests	Specifying control & monitoring points
Developing Cx-grade sequences of operation	Managing Cx team relationships
Tools for managing the Cx process	
Roles of Cx team members	
Cx Resources	

3.3. Recognition of the Importance and Value of Commissioning and Retrocommissioning

The Governor’s Executive Order includes requirements for state-owned and leased buildings, with the goal of demonstrating the value of sustainable building techniques to the public at large. In recent years, the commissioning industry in California has made great progress in increasing building owners’ awareness of commissioning and retrocommissioning. The CCC has provided opportunities – both online and at regular in-person meetings – for owners, commissioning providers, and others to network and share information. The CCC’s Advisory Council includes a number of owner representatives who bring their perspectives to the planning and execution of CCC projects. The sheer number and size of commissioning programs and initiatives in California have raised the visibility of the practice, leading to increasing building owner awareness.

A critical element to continued progress in this area is gaining a better understanding of the needs, concerns, and decision-making processes of building owners. In 2006, the CCC initiated a market research program – the first in a series of related projects the CCC plans to undertake. These projects are geared towards understanding what building decision-makers value, how commissioning can appeal to these values, and how to communicate to decision-makers in their own language. Figure 5 illustrates how these projects are planned to build on one another, resulting in significant increases in owners’ recognition of the value of commissioning and retrocommissioning.

Figure 5: CCC Market Research and Related Projects



3.4. Examples of Progress

The most significant advances in California's commissioning industry over the past five years are summarized below. Table 4 describes the work and accomplishments of CCC programs and activities. Much of this work was completed in alignment with the CWG and other government agencies, such as the California Energy Commissioning (CEC) and DGS. Table 5 identifies state-wide advances in the industry at large. In each table, items are noted with icons that identify the CWG goal, or goals it supports. These impressive lists of accomplishments illustrate broad interest and success in supporting the commissioning industry with the development of guidelines, tools and resources, commissioning programs, research, reports, and public policy.

Table 4: California Commissioning Collaborative, 2000 – Present

CCC/CWG Accomplishments

M - Methodology and Practice **Q** - Qualified Providers **V** - Value Recognition

<p>M Q V</p>	<p>Access to Commissioning Information and News – Ongoing Access to information about commissioning processes, recent research, and other resources is important for the industry to remain vital. The CCC provides a number of resources targeted to building owners, commissioning providers, and other stakeholders in the industry, and these resources are often cited as some of the most visible and useful tools provided by the CCC.</p> <ul style="list-style-type: none"> • The CCC website offers tools, sample documents, case studies, and other relevant resources and links, including an extensive online library of research, articles, brochures, and white papers. • Quarterly newsletters report on industry news, events, and training opportunities.
<p>M Q V</p>	<p>Industry Networking and Idea-Sharing: CCC Meetings – Ongoing Approximately five times a year, the CCC holds Advisory Council meetings, which are open to the public. These meetings present technical information, updates on industry events and research, and provide a forum for industry stakeholders to share information and engage in problem solving around key issues.</p>
<p>V</p>	<p>Resources for Building Owners – Ongoing The CCC website hosts a number of articles and resources to assist building owners in selecting a commissioning provider. This information describes important issues to consider when selecting a provider and includes a list of recommended provider qualifications. The site also offers a listing of commissioning providers with information about their experience and services.</p>
<p>M V</p>	<p>Guidelines for Verification of Savings – 2007 It is crucial to demonstrate that the savings promised in a commissioning program are actually realized – so building owners know that they got what they paid for, and so policy-makers know that public dollars are responsibly invested. Techniques have been developed for other energy reducing measures, but the unique attributes of commissioning programs require unique verification methods. The CCC has initiated a project which will develop guidelines to ensure consistency and accountability as savings are verified.</p>
<p>V</p>	<p>Developed RCx Program Brochure for Owners – 2006 The growing number of retrocommissioning programs in California can be overwhelming to building owners. The CCC developed a simple brochure to describe the basic requirements and contact information for current programs. The brochure will be distributed in hardcopies, and periodically updated on the CCC website.</p>

CCC/CWG Accomplishments

M - Methodology and Practice **Q** - Qualified Providers **V** - Value Recognition

<p>M Q</p>	<p>Retrocommissioning Toolkit – 2006-2007 To provide a framework for retrocommissioning projects, as well as to facilitate providing the projects more cost effectively, the CCC has started a project to develop a toolkit of applications to aid retrocommissioning providers in their projects. The Retrocommissioning Toolkit will include templates that allow commissioning providers to streamline their process and reduce report writing time while increasing information transfer to the owner’s team. It will also provide spreadsheets that automate the process of calculating metrics and graphing building performance data and energy savings calculation spreadsheets for a number of typical calculations.</p>
<p>V</p>	<p>Market Research – 2006-2007 The first part of the Market Research Roadmap was started in 2006, with a goal of determining the marketing messages that will best speak to decision-makers. Interim results include:</p> <ul style="list-style-type: none"> • Selected large office buildings and hospitals as the research focus • Assembled a diverse 11-member Project Advisory Committee • Developed interview guide and list of interviewees; began scheduling interviews with decision makers
<p>V</p>	<p>Discussions with Real Estate and Owners – 2006 While the CCC well represents utility and government stakeholders, it was recognized that the interests of the real estate and owner communities were misunderstood and underrepresented. Information gathered from interviews with CCC Advisory Council members provided insights that were considered during program planning activities.</p>
<p>M V</p>	<p>California Commissioning Guides for New and Existing Buildings – 2006 In response to a specific mandate in the governor’s Executive Order, the CEC funded the development of two guidelines for commissioning: one for new buildings, and one for existing buildings. The guides define idealized commissioning processes, as well as describe how the process is customized for specific project types. The CCC developed and published the Guides and distributes them in hardcopy and electronic formats at industry events and conferences, through utility commissioning program marketing efforts, and through the CCC website. (CCC, 2006a; CCC, 2006b)</p>
<p>M</p>	<p>Support for Utility Commissioning Programs – 2005 The CCC commissioned a survey of commissioning program managers and other stakeholders to identify lessons learned in commissioning and retrocommissioning programs. The findings were published in a report that included key recommendations for program design elements to ensure cost effectiveness and persistence, program outreach strategies, and future research recommendations. (CCC, 2005b)</p>
<p>Q V</p>	<p>FEMP Training and Case Studies – 2005 A grant from DOE/FEMP provided funding to support commissioning training in California and to develop new marketing case studies that reinforce the business case for building commissioning.</p>

CCC/CWG Accomplishments

M - Methodology and Practice **Q** - Qualified Providers **V** - Value Recognition

V	<p>Conducted Forum for Training Owners – 2005 A Forum for Owners, held in San Diego, was intended to educate owners on the benefits of commissioning. While it achieved critical success, it was not well attended. From this experience, the CCC cultivated important information about this audience and determined that other, more appropriate venues should be utilized in owner outreach efforts.</p>
Q	<p>Training Strategy Report – 2005 The CCC conducted a survey of commissioning providers, owners, and contractors to investigate the industry's training needs. The report identified training that is already available and types of training that are highest priority. The findings of the investigation indicated that the highest priority gaps in available trainings are introductory orientations for practitioners new to the field, hands-on technical training programs for practitioners (especially in the area of controls), and training for public sector facilities managers and staff. (CCC, 2005a)</p>
Q	<p>Certification Program Evaluation – 2005 The CCC evaluated available certification programs and published a comparison chart on its website as a resource for both commissioning providers and building owners. The relative rigor of the different certifications is evident in this table, as is the balance of experience, knowledge, and coursework required.</p>
M V	<p>Cx/RCx Database Protocol – 2003 The CCC developed a protocol for collecting consistent case study data on commissioning or retrocommissioning projects, and a web-based interface to allow individuals to enter project results into the database. In 2007, a larger project funded by the National Center for Energy Management and Building Technologies (NCEMBT) will leverage the work to build an international database of commissioning data.</p>
M Q V	<p>Acceptance Testing Requirements in Building Code – 2000 - Present The CCC participated in discussions about how and whether to include commissioning requirements in California's building code, Title 24. While it was decided not to include full requirements for commissioning, provisions were included to require testing of the functionality and performance of key systems prior to occupancy. CCC has provided training related to these requirements, and is currently involved in revision of the requirements for the 2008 version of Title 24.</p>

Beyond the activities of the CCC, other advances in California's commissioning industry have fueled the growth of the market, and have contributed to achieving the goals of the GBEO. The summary of achievements below indicates the level of commitment shown by government agencies and policy makers, research institutions, and California utilities.

Table 5: California Commissioning Industry Advances since 1994

California Commissioning Industry Advances

M - Methodology and Practice **Q** - Qualified Providers **V** - Value Recognition

Q	<p>Training Opportunities – Ongoing Numerous commissioning-related training opportunities have been developed and offered by California utilities and many other entities. The training formats range from one-day workshops to classes that meet on a regular schedule over a period of time. These offerings cover a range of audiences, including those brand-new to commissioning as well as practitioners seeking more in-depth, technical training opportunities. Some training topics that have been offered are listed in Table 3.</p>
M Q	<p>Public Interest Energy Research Program – Ongoing The CEC PIER Program continues to fund commissioning-related research projects that are designed bring innovative, yet practical, tools and training to the commissioning market.</p>
M Q V	<p>New Building Commissioning Programs – Ongoing Commissioning has been included in new building design programs such as:</p> <ul style="list-style-type: none"> • California utilities' Savings by Design Program is a statewide program available to commercial, industrial, and agricultural customers, which encourages energy-efficient building design and construction through design assistance, owner incentives, and design team incentives. • California High Performance Schools (CHPS) Program facilitates the design of school environments that are energy efficient, healthy, comfortable, well lit, and contain the amenities needed for quality education.
M Q V	<p>Retrocommissioning Programs – Ongoing From the first commissioning program offered by the Los Angeles Department of Water and Power to the more than 20 programs offered in 2006, incentive programs are available to the public and private sector in all major utility districts in California.</p> <p>In the 2006-2008 program cycle, large-scale retrocommissioning programs were funded and have adopted similar structures in a move toward statewide consistency in program design. A number of innovative tools have been developed for these programs to support more consistent processes and reporting.</p>
M	<p>Performance Monitoring Specifications – 2006 Monitoring of building performance is an important part of commissioning. The <i>Specifications Guide for Performance Monitoring Systems</i> was developed by the CEC PIER Program to describe, in specifications language, the elements that a system should have for measuring the performance of building systems. (Gillespie, et al., 2006)</p>

California Commissioning Industry Advances

M - Methodology and Practice **Q** - Qualified Providers **V** - Value Recognition

<p>M Q</p>	<p>In-House Commissioning Toolkit for Small Buildings– 2006 The California DGS developed a <i>Commissioning Toolkit for Small Buildings</i>. This was a collaborative effort by DGS's Real Estate Services Division and Green Team, Architectural Energy Corp., and the PIER Program and includes instructions, tools, templates, and specifications for smaller, less complex building projects. It was developed for internal use in state buildings, but is publicly available at www.green.ca.gov.(DGS, 2006)</p>
<p>M V</p>	<p>DGS In-House Retrocommissioning Program – 2005 The California DGS initiated a program of in-house retrocommissioning efforts, by developing an RFP for providers, benchmarking buildings, and developing a plan for implementing retrocommissioning.</p>
<p>V</p>	<p>LBNL Commissioning Cost-Benefit Study – 2004 A ground-breaking study of the costs and benefits of commissioning was conducted by Lawrence Berkeley National Laboratory (Mills, et al., 2005) in 2004. This study analyzed data from a number of sources nationwide and found median energy cost savings for existing and new buildings of \$0.27 and \$0.5 per square foot, respectively, with simple payback times of 0.7 and 4.8 years, respectively.</p>
<p>M V</p>	<p>Monitoring-Based Commissioning Program – 2004 The University of California and the California State University systems, along with the California investor-owned utilities developed a unique retrocommissioning program that emphasized the installation of monitoring equipment to benchmark buildings, assist in the retrocommissioning investigation, and ensure persistence of program savings. The Monitoring Based Commissioning (MBCx) Program provided training for facility personnel (curriculum development was funded by the CEC through the PIER program), and offered a generic scope of work that defined the process for potential providers.</p>
<p>M Q V</p>	<p>Energy Design Resources – 2003 The Energy Design Resources website offers free resources and energy design tools for nonresidential new construction. It is funded by California utility customers and administered by the major California utilities (under the auspices of the California Public Utilities Commission). Current resources include commissioning-specific guidelines, software, training, and online tools. One resource that has made a particular impact on the industry is the Cx Assistant tool, developed in 2003. This tool assists commissioning project teams in evaluating costs, determining appropriate scope, and provides sample specifications by project type. The tool assists users in evaluating project scope and costs and provides a number of sample documents with specific inputs from projects.</p>
<p>M Q</p>	<p>California Department of General Services Commissioning Process Guide – 2003 This guide was developed by DGS - Division of the State Architect to describe the commissioning process in relation to procurement of education facilities. Its audience includes school districts, programmers, design professionals, contractors, operations and maintenance personnel, and commissioning providers. (DGS, 2003)</p>

California Commissioning Industry Advances

M - Methodology and Practice **Q** - Qualified Providers **V** - Value Recognition

<p>M Q</p>	<p>Commissioning Test Protocol Library and Functional Testing Guide– 2003, 2006 The Commissioning Test Protocol Library was published in 2003 by PG&E. This is a sophisticated database application that allows users to query a database of publicly available test protocols to identify tests to use for their own applications.</p> <p>During the same time, PIER funded a complimentary project that produced the Functional Testing Guide (FT Guide). The FT Guide was published online in 2006 with 95 publicly available pre-functional checklists, functional test procedures, and test guidance documents. This website is a comprehensive resource that includes many of the test protocols in the CTPL along with other publicly available test and expanded guidance for using the tests.</p>
<p>M Q V</p>	<p>California Commissioning Market Characterization Study – 2000 In 2000, PG&E funded this research to estimate the demand for commissioning services in California. The study identified opportunities for growth in the industry (education, tool development, codes and standards, etc.) that would encourage and support increased penetration rate of commissioning. (PECI, 2000)</p>

4. Recommendations

The commissioning industry has evolved from the early research projects and initial guidelines to the large retrocommissioning programs in place today. Moving the industry forward will require a coherent vision and integrated efforts on behalf of all the participants in the market, in the face of significant challenges that remain to be addressed. There are still varying definitions of commissioning in use, and specialized approaches to commissioning that are not well defined or communicated to owners. Commitments to conduct a large amount of commissioning in major programs across the state will stretch the existing workforce. Many owners, while they may implement commissioning because they can receive sizable incentives, fail to recognize the value of investing their own money in the process.

The CCC and others must use their experience and influence to address these and other issues in order to fully realize the commissioning goals of the GBEO. The following recommended activities will help the industry move forward towards the goals of having a more mature methodology and practice, a sufficient qualified workforce, and a universal understanding of the value of commissioning.

4.1. Maturity of Cx Methodology and Practice

There are a number of known areas where tools and resources are not available or are not accessible to the commissioning teams who need them. Templates for data collection and analysis, energy calculation spreadsheets, and metrics and charting software are examples of tools that would help bring uniformity and a consistent level of detail and accuracy to commissioning projects and can help support persistence strategies that ensure the benefits of commissioning are long-lasting.. It is recommended that these gaps be identified and prioritized, and that specific tools be developed and disseminated. The CCC's Retrocommissioning Toolkit includes development of tools that will fill some of those needs. Entities such as the DGS, the PIER Program, and others can also play a role in developing these resources.

Widespread adoption of these tools is essential for achieving consistency in methodology and practice, and effective distribution strategies are needed to ensure that commissioning providers have access to them. Utility programs and industry resources such as the CCC website can be utilized to promote and disseminate the tools.

4.2. Availability of Qualified Commissioning Providers

With the large scale and number of commissioning programs and projects taking place in California, the capacity of available providers is spread thin. A number of activities are necessary to ensure that there are sufficient qualified individuals and firms to meet the demand for commissioning services:

- Promote career paths in the building services and commissioning fields.
- Support the development of commissioning curriculum.
- Provide technical training to commissioning providers and building operators

Promoting career paths and supporting commissioning curriculum development will attract high school and college students as well as junior-level engineers, technicians, and professionals in related fields to work in the commissioning industry. Advanced training for providers who are already well-qualified will be able to further specialize in the practice. These efforts would increase the breadth and depth of the available workforce.

4.3. Recognition of the Importance and Value of Commissioning and Retrocommissioning

Although awareness of commissioning has increased over the years, still only a tiny fraction of all buildings undergo commissioning and retrocommissioning. Research is the key to understanding the market for commissioning:

- Who would benefit most from commissioning?
- Who are the decision-makers?
- How can decision-makers be influenced?

In 2006, the CCC initiated an extensive market research program that focuses on understanding these factors and how commissioning can be communicated effectively to building owners and decision-makers. This project will be completed in 2007. The next step will be to present well-focused and actionable information in ways that decision-makers understand and can relate to their business needs. Outreach to owners should always include the California Commissioning Guides to encourage common understanding and expectations for commissioning and retrocommissioning projects. This resource can be supplemented by additional marketing materials that help communicate the value of commissioning to building owners.

4.4. Recommendations Roadmap

Achieving the goals of the Green Building Executive Order will involve the entire commissioning industry. Specific recommendations that address the CWG goals are described in detail in Table 6 below, with icons to indicate the CWG goal or goals they address. These activities are highly interconnected and can build upon one another to create substantial impact in the market.

Table 6: Recommended Activities to Meet the Goals of the Green Building Executive Order

Recommendations

M - Methodology and Practice **Q** - Qualified Providers **V** - Value Recognition

V	<p>Continue Market Research</p> <p>Continuing with market research efforts will be crucial to ensuring that actionable intelligence is gathered, and that intelligence is translated into messages that resonate with building owners and decision-makers.</p> <p>Valuable insight can be gained from building owners who have completed projects under the utility-sponsored programs. It is recommended that feedback on the experiences of program participants be collected and analyzed to identify ways to improve the commissioning/retrocommissioning process and program experience from the owner and facility manager perspective.</p>
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Recommendations

M - Methodology and Practice **Q** - Qualified Providers **V** - Value Recognition

<p>M V</p>	<p>Verify Savings and Quantify Costs and Benefits Effective marketing to building owners requires hard data on the costs and benefits of commissioning. Currently, there are no commissioning-specific guidelines for verification of savings, and little data exists to quantify the energy and non-energy benefits of commissioning. The CCC is currently funding a research program to develop guidelines for verification of savings in retrocommissioning programs. Utility programs should look to these guidelines to enhance their marketing efforts to decision-makers.</p> <p>Once these methods are established, studies to quantify the costs and benefits of retrocommissioning are needed to provide additional data to further support marketing efforts. The results of this research should be made publicly available as a resource to the entire industry.</p>
<p>M V</p>	<p>Develop Targeted Case Studies Despite the increase in the number of buildings undertaking retrocommissioning projects, there are few documented case studies of completed projects. Market-specific case studies of commissioning and retrocommissioning projects are needed for both public and private sector buildings. Once available, these case studies can be used across the industry – from marketing to building owners to training material for commissioning providers.</p> <p>Note: If sufficient case study sites are not available, or the information available is insufficient to provide a convincing case, more detailed demonstration projects should be carried out to provide case study materials.</p>
<p>V</p>	<p>Outreach to Owner Groups and Decision-Makers The CCC's market research project will provide a better understanding of the value commissioning provides to building owners. The next step will be to communicate this value to owners through training or other mechanisms that present well-focused and actionable information in ways that decision-makers understand and can relate to their business needs. This should include preparing accurate and relevant information, packaging it so that it communicates the value well, and presenting it at conferences, chapter meetings, in trade journals, and other venues.</p>
<p>M Q</p>	<p>Develop Sample Documents Sample documents are helpful in standardizing project scopes and implementation (requests for proposals, scope of work, functional test forms, design review checklists, various reports, etc.). Ongoing efforts should be made to expand the number and types of forms that are available. For example, forms that are tailored to specific sectors or commissioning scopes would support providers and owners who undertake specialized projects. Customizable forms would add flexibility for individual users, while maintaining consistency in required elements.</p>
<p>M</p>	<p>Develop Tools for Data Mining, Performance Monitoring, and Fault Detection and Diagnostics Commissioning providers and building operators need cost-effective tools to verify energy savings and perform ongoing monitoring to detect changes that may result in increased energy use. Development of tools that automate the analysis of building data will help determine the impact and persistence of commissioning benefits and can improve the cost effectiveness of diagnosing problems and monitoring performance over time.</p>

Recommendations

M - Methodology and Practice **Q** - Qualified Providers **V** - Value Recognition

<p>M Q</p>	<p>Distribute Retrocommissioning Toolkit The CCC's Retrocommissioning Toolkit will be completed in 2007. These tools should be made available through a number of venues (CCC website, utility program materials, commissioning training courses, etc.) to ensure that they are widely available to commissioning providers who need them.</p>
<p>M</p>	<p>Develop Specialized Retrocommissioning Processes Existing guidelines, templates and sample documents provide the basic foundation for consistency in the commissioning practice. The next challenge is to establish standardized processes for special types of commissioning projects (small buildings with simple systems, specific market sectors such as healthcare and data center, and projects lead by in-house staff). This will further encourage consistency in approach and to provide new areas for growth in the industry. Utility-sponsored commissioning and retrocommissioning programs are in a position to help lead the development of these specialized processes.</p>
<p>Q</p>	<p>Provide Specialized Training Opportunities The CCC and other stakeholders should work together to develop and offer training to meet industry needs:</p> <ul style="list-style-type: none"> • Introductory orientations for new practitioners and hands-on technical training for experienced practitioners. • In-depth training on design, commissioning, and operation of controls systems. • Training that integrates with the requirements and standards of LEED, Title 24 and other future codes and standards will allow commissioning providers to offer added value and enhanced services to their clients. • Building operator training to address how facility staff can be involved in commissioning and retrocommissioning projects and their key role in tracking building performance over time to improve persistence. <p>Ongoing monitoring will be required to identify new and emerging needs for training and education that address the changing commissioning marketplace.</p>
<p>Q</p>	<p>Support Commissioning Curriculum Development Some community colleges and university extension programs have begun to offer commissioning courses for building operators. This helps individuals develop the qualifications needed by commissioning professionals and helps build up the workforce of qualified commissioning professionals. Support should be provided to these programs and other organizations (utilities, trade associations, etc.) in the form of technical expertise and assistance in curriculum development.</p>
<p>Q</p>	<p>Support Career Growth in Commissioning Promoting careers in commissioning is critical to establishing a sufficient workforce to meet the demands of a growing industry. The CCC is well-suited to carry out these activities in partnership with others in the industry:</p> <ul style="list-style-type: none"> • Publicizing career opportunities through public relations and marketing efforts • Providing a mentorship program that matches seasoned professionals with newer people in the field • Providing mentorship and support for new businesses in the industry • Developing apprenticeship programs and internships • Providing scholarships for industry conferences.

Recommendations

M - Methodology and Practice **Q** - Qualified Providers **V** - Value Recognition

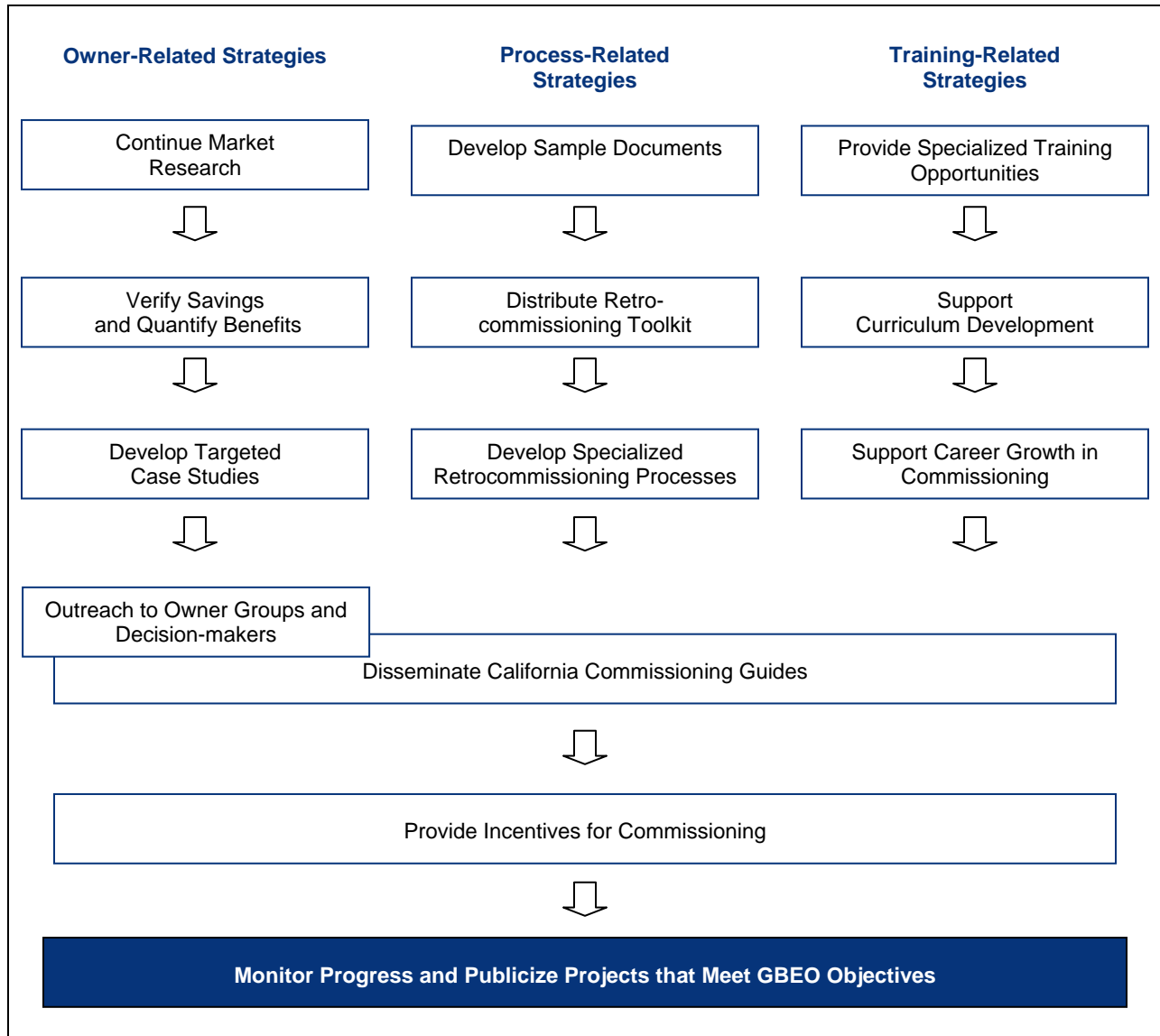
<p>M Q V</p>	<p>Disseminate the California Commissioning Guides The California Commissioning Guides are two of the most important resources on commissioning in the state. The CCC and utility programs should work together to disseminate the guides to building owners, commissioning providers, educators and others to help promote uniform expectations around the costs, benefits and process of commissioning and retrocommissioning.</p>
<p>M Q V</p>	<p>Provide Incentives for Commissioning Utility incentive programs have provided a venue for innovation in the commissioning market. Not only do these programs provide opportunities to pilot specialized processes and approaches (for example, hospital retrocommissioning, monitoring-based retrocommissioning, etc.), they are moving toward adopting standards for state-wide consistency in documentation and reporting, and they provide training opportunities for commissioning providers. While these aspects support the goals of establishing standard practices and sufficiently qualified workforce, the programs are also important in attracting owners to try commissioning. Until significant market penetration rate is achieved, utility incentive programs will be necessary to increase the use of commissioning in the private sector.</p>
<p>M Q V</p>	<p>Monitor Progress and Publicize Projects that Meet GBEO Objectives All efforts made to meet the goals of the GBEO must be monitored and evaluated to determine their impacts on the market. The successful results should be documented and promoted to demonstrate the feasibility of the sustainable practices mandated by the Green Building Executive Order. For example:</p> <ul style="list-style-type: none"> • Case studies and demonstration projects can be used to illustrate the feasibility of implementing commissioning, retrocommissioning and periodic recommissioning in new and existing buildings. • Dissemination and adoption of tools and resources to commissioning providers will demonstrate growing cohesiveness within the practice and provide building owners with high expectations for the quality of work performed in their projects. • A deliberate effort to increase commissioning curriculum at the college level, and to promote careers in the field shows that the practice of commissioning is a valid and viable option for addressing issues of sustainability in the built environment. <p>Successful “public relations” is important to the success of all stakeholders in the industry. An integrated effort on behalf of the commissioning industry would help ensure that progress toward meeting the goals of the GBEO are effectively communicated to the public.</p>

A strategic approach to ensuring continued progress toward the GBEO goals is described in Figure 6 below. This roadmap shows the recommended activities, broken down into three areas:

- **Owner-related strategies** will build on the intelligence gained from the CCC’s current market research program with additional data and guidance to more effectively address the needs of building owners as they make decisions about commissioning projects.
- **Process-related strategies** call for the development of new documentation and tools for commissioning providers. Widespread adoption of these tools will be a significant step in establishing standard practices in the industry.
- **Training-related strategies** are intended to grow the field of commissioning providers in both numbers and quality.

Dissemination of the California Commissioning Guides, providing incentives for commissioning, and monitoring progress are integrated into all three strategies as they will impact the entire market.

Figure 6: Recommendations Roadmap



Roadmap to Achieving the Commissioning Goals of California's Green Building Executive Order

The strategies to address owners, process, and training are all critical to achieving market transformation for the commissioning industry, and success with these projects will help achieve the GBEO objectives. As these efforts are made, it is imperative that results are measured and successes are announced to the public. The final recommendation in the Roadmap is to monitor progress and publicize projects that meet GBEO objectives. . Without an effective plan to promote new tools and resources, opportunities for professional development, and successful projects implemented in state buildings, the private sector will not “follow the lead” as intended by the Green Building Executive Order. This ultimate outreach effort must make the progress made in the public sector relevant to the business needs of private building owners and decision-makers. This is the key to making commissioning and retrocommissioning business as usual.

5. Indicators of Success

The activities that will continue advancement toward the commissioning goals of the Green Building Executive Order are highly interrelated and dependant on integrated efforts of the many stakeholders. To ensure the objectives of the GBEO are achieved, commissioning achieves significant market penetration, and market transformation takes place, it is important that progress be measured, evaluated, and monitored over time. Doing this requires definition of key indicators of success and development of a plan to collect and periodically update the metrics.

Four key metrics that should be monitored are:

1. Market penetration rate
2. Availability of training and education
3. Widespread use of standardized tools and resources
4. Requests for information and participation in industry events

Market Penetration Rate

The national penetration rate of commissioning in 1998 was estimated to be 5% of all new buildings and 0.03% of existing buildings per year (DOE, 1998b). PG&E's California Market Characterization Study conducted in 2000 provided a baseline for the commissioning industry in California, and assumed a possible future penetration rate of 30% of new buildings and 2% of existing buildings per year. The Market Characterization Study did not, however, estimate the actual penetration of commissioning in new or existing buildings in California or conduct a rigorous study of market potential. An update of that study is recommended, including collection of baseline penetration levels to monitor increased adoption of commissioning over time.

Availability of Training and Education

Training and education are the key factors that will ensure a sufficient commissioning workforce. Training courses directed to professionals already in the industry will help to elevate the skill level of the existing workforce, while educational institutions offering commissioning curriculum will increase the numbers of professionals entering the field. The breadth and depth of training offered and levels of attendance are indicators of the training needs present in the industry. An updated study is necessary to determine the number of providers needed and the types of individuals who are trained or can be trained, as well as identifying gaps in the current training and education available. This study should establish a baseline measurement and method of tracking the types of training offered and the number of qualified firms available.

Widespread Use of Standardized Tools and Resources

Tools and resources (such as sample documents and templates) developed by CCC, CEC, utility retrocommissioning programs, trade associations such as ASHRAE, and other organizations will create an industry-wide toolset that helps bring consistency and efficiency to the commissioning process. Measuring the usage of these tools can be a gauge of the adoption of common practices and methodology. Widespread use can be measured by monitoring the utilization of these tools (through retrocommissioning programs, website downloads, etc.) and by conducting surveys to determine acceptance.

Requests for Information and Participation in Industry Events

It can be expected that interest in commissioning and requests for information about commissioning will increase as the importance and value of commissioning is better understood. Thus, tracking building owner and provider attendance at conferences (such as the NCBC), CCC meetings, and other informational venues will give an indication of the growth of the industry. Example metrics may include:

Roadmap to Achieving the Commissioning Goals of California's Green Building Executive Order

- Number of providers and owners attending commissioning-related events and conferences
- Number of visits to the CCC website
- Number of *California Commissioning Guidelines* distributed or downloaded
- Requests for commissioning tools, and distribution of the CCC Retrocommissioning Toolkit and sample documents

The CWG has developed well-defined objectives to address the commissioning-related mandates of the GBEO, and this roadmap provides a strategy and recommended tactics that will move the industry toward meeting those objectives. The final element to this roadmap is assessment. A deliberate effort to evaluate and monitor activities in the commissioning industry will allow market players to adjust for unanticipated changes in the market and make sound decisions on future actions. Doing so will help guide the growth of the industry to meet the needs of all participants in the market.

6. Conclusions

Commissioning is a key requirement in the Green Building Executive Order. The GBEO requires new and existing state buildings to obtain LEED Silver ratings, which require commissioning for new and existing state buildings, with recommissioning every five years. It also requires a 20 percent reduction in energy use in state buildings (by 2015), and retrocommissioning is one of the key strategies for achieving that goal. While these requirements are for state-owned and leased buildings, the intent is to encourage the adoption of similar goals in the private sector by demonstrating that sustainable and energy efficient buildings are feasible and financially beneficial.

The Commissioning and Retrocommissioning Work Group has developed well-defined objectives to address the GBEO commissioning-related mandates, represented by these three key areas of focus:

- Maturity of commissioning methodology and practice
- Availability of qualified commissioning providers
- Recognition of the Importance and value of commissioning

Stakeholders in the commissioning industry have already accomplished a great deal towards these objectives through research and tool development, innovative program designs, and outreach to building owners. Continued progress will require persistent support from the industry in the near term, with an emphasis on market transformation. Table 7 illustrates the key contributors in California who will continue to move the industry forward.

Table 7: Recommendations and Key Contributors

	CCC	Cx and RCx Programs	Utilities	Researchers	Cx Providers	Government Agencies
Continue Market Research	●			●		
Verify Savings and Quantify Costs and Benefits	●					
Develop Targeted Case Studies	●					
Outreach to Owner Groups and Decision-Makers	●	●			●	
Develop Sample Documents	●			●		
Develop Tools for Data Mining, Performance Monitoring, and Fault Detection and Diagnostics	●	●	●	●		●
Distribute Retrocommissioning Toolkit	●	●	●			●
Develop Specialized Retrocommissioning Processes		●		●	●	
Provide Specialized Training Opportunities	●		●			●
Support College Curriculum Development	●					●
Support Career Growth in Commissioning	●				●	
Disseminate the California Commissioning Guides	●	●				●
Provide Incentives for Commissioning		●	●			
Monitor Progress and Publicize Results	●	●	●	●	●	●

Roadmap to Achieving the Commissioning Goals of California's Green Building Executive Order

The impact of these activities must be measured and tracked to ensure they continue to move toward the stated objectives of the Green Building Executive Order. Unanticipated events and market forces will inevitably require that strategies and tactics be adjusted to respond to the changing industry landscape. It is imperative that industry stakeholders make measurement a priority, and successful results should be promoted through effective public outreach.

The commissioning industry is still in its early stages. Currently, adoption of the practice requires methods such as mandates, incentives, education, and outreach to convince owners. However, with a continued effort to overcome market barriers, building commissioning will become a standard practice in building construction and operations. This effort will lead to an assurance for the state of California that buildings are not only designed to be green, but they are built, operated and maintained with these ideals

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Online Resources

www.theboc.info/ca

Building Operator Certification (BOC)

The BOC is a nationally recognized training and certification program for building operators, designed specifically to help them improve their ability to operate and maintain comfortable, efficient facilities.

BOC courses are offered at two skill levels and cover several topics, including electrical, HVAC and lighting systems, indoor air quality, environmental health and safety, and energy conservation. Classes are usually a combination of lecture, discussion and small group activities. BOC classes are held continuously, at locations across California.

www.cacx.org

California Commissioning Collaborative (CCC)

The CCC is a non-profit organization dedicated to supporting building commissioning in California. Their website offers case studies, sample documents, a provider list, information on selecting a provider, a searchable library of commissioning documents, a quarterly newsletter, and training and meeting announcements.

www.dsa.dgs.ca.gov

California Office of the State Architect

California's policy leader for building design and construction offers web resources such as commissioning and sustainability information, and state code and regulations.

www.energy.ca.gov/greenbuilding

California Green Building Executive Order

The website provides the latest information on the Green Building Executive Order and links to related websites.

www.chps.net

Collaborative for High Performance Schools (CHPS)

As an organization whose goal is to facilitate the design of California schools that are healthy, comfortable and energy efficient, their website offers information on high performance schools, training and event announcements, and downloadable publications.

www.energydesignresources.com

Energy Design Resources (EDR)

The website is a palette of energy design tools and resources for energy-efficient design and construction, featuring **Cx Assistant**, a web-based tool that provides project-specific building commissioning information to design teams, helps users evaluate probable costs and appropriate scope, and access sample commissioning specifications.

www.fypower.org

Flex Your Power

The website for California's state-wide energy efficiency marketing and outreach campaign contains comprehensive information on available rebates, grants, and loans, product guides, educational opportunities, and resources for new and existing buildings.

www.green.ca.gov

Green California Website

This website is the gateway for information about the Green Building Executive Order, Green Building Action Plan, Governor's Green Action Team, as well as general information on benchmarking, green building, commissioning, and retrocommissioning.

www.pge.com/003_save_energy/003c_edu_train/pec/003c1_pac_energy.shtml

Pacific Gas and Electric (PG&E)

Pacific Energy Center (PEC)

Pacific Gas and Electric Company's educational center in San Francisco features educational programs, tool lending library, and services. Their website includes energy information and class schedules.

www.energy.ca.gov/pier

Public Interest Energy Research (PIER)

PIER offers a portfolio of research, development, and demonstration projects that is administered by the CEC.

www.smud.org/education/index.html

Sacramento Municipal Utility District (SMUD)

The Sacramento Municipal Utility District website lists workshops and seminars, references, and resources.

www.sdge.com/training

San Diego Gas and Electric (SDG&E)

The website offers information on training opportunities and seminars for San Diego Gas and Electric customers, including Building Operator Certification courses.

www.sdenergy.org

San Diego Regional Energy Office

A non-profit corporation that provides information, research and analysis on energy issues for the San Diego region. Their website offers information on programs and incentives, energy technologies, news, training opportunities, events and policy updates.

www.sce.com/RebatesandSavings/EnergyCenters/CTAC/default.htm?goto=ctac

Southern California Edison (SCE)

Customer Technology Application Center (CTAC)

Southern California Edison's energy learning and demonstration center in Irwindale features six technology centers showcasing energy solutions, conference center, meeting rooms and classes. Their website lists class schedules.

www.energy.ca.gov/title24/

Title 24

Title 24 contains California's Energy Efficiency Standards for Residential and Nonresidential Buildings. The Title 24 website provides links to information on the standard and downloads for current standards and manuals.