# Making the Leap: Data and Lessons Learned from Scaling Up Retrocommissioning Programs

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## ABSTRACT

Retrocommissioning, or commissioning of existing buildings, has become a central strategy in California for reducing energy use and improving building performance. At the state level, this is demonstrated by recent legislation such as Executive Order S-20-04 that led to a mandate to retrocommission all state owned and operated buildings greater than 50,000 square feet. In addition, to meet the state's 2006-2008 energy efficiency goals, California's investor-owned utilities have supported retrocommissioning incentive programs at unprecedented levels.

Currently, Portland Energy Conservation, Inc. (PECI) is implementing retrocommissioning programs for Pacific Gas & Electric Company, Southern California Edison, San Diego Gas & Electric, and Sacramento Municipal Utility District which cumulatively will retrocommission nearly 60 million square feet of commercial building space in the state, which will total approximately 200 buildings. Together, the programs are projected to reduce annual energy use by 65 million kilowatt-hours (kWh) and 600,000 therms, and reduce peak demand by as much as 9,100 kilowatts by the end of 2008.

These programs will produce the largest number of retrocommissioning projects implemented under a common framework. Program results of this scale will help answer industry questions about the viability of retrocommissioning as a reliable and high quality energy-efficiency resource. This paper will describe the challenges of implementing retrocommissioning on a broad scale and operating in a relatively immature market. It will also share the available results, including statistics about participant buildings, typical measures identified and systems affected through retrocommissioning, and average savings and costs associated with measures. Then, through a summary of key lessons learned, the paper will explore implications for the design of future retrocommissioning programs.

## Background

Retrocommissioning (RCx) is a process for improving an existing building's operations. The process focuses on the operation of mechanical equipment and controls, and optimizes how the equipment functions as a system. The retrocommissioning process typically begins with a whole-building investigation to identify opportunities for energy savings and to calculate the anticipated savings and paybacks from those measures. Building owners achieve energy savings through the implementation of those identified measures.

In the 2004-2005 program cycle, a number of California investor-owned utilities identified RCx as an opportunity to achieve low-cost energy savings through operational measures. The combined claimed annual savings for the 2004-2005 San Diego RCx Program, the 2004-2005 Building Tune-Up Program, and the 2004-2005 Monitoring-Based Commissioning Program were 42.6 million kWh from retrocommissioning 36.3 million square feet (Itron 2007; Tso et al. 2007).

In 2006-2008, ten investor-owned utility programs[1] are offering incentives for RCx and RCx-type projects with cumulative goals of more that 126 million kWh over the three year period. This represents a 250% increase over the goals of the 2004-2005 cycle, requiring very rapid scale-up of both program delivery and retrocommissioning provider firm capacities.

PECI currently administers the RCx programs in the San Diego Gas & Electric, Southern California Edison, and Pacific Gas & Electric territories. These programs represent the largest sample of RCx projects implemented under a common framework and are the basis for this paper. The RCx Program for Sacramento Municipal Utility District, also administered by PECI, is excluded as it did not start until late 2007 and there are no reported results to-date.

## Scaling Up for the 2006-2008 Programs

At the 2006 ACEEE Summer Study on Energy Efficiency in Buildings, PECI and Architectural Energy Corporation presented a paper discussing the lessons learned during the 2004-2005 San Diego RCx Program pilot (Moore et al. 2006), and made the following recommendations:

- Customer recruitment must occur through diverse marketing channels and be adaptable for various decision-makers.
- The program process must be streamlined upfront to move – not stall – the investigation.
- The program must understand the financial decision-making process by organization, and allow for multiple phases of implementation.
- The program must provide support to see each project through implementation.
- Standardized program protocols should be provided, to streamline project tracking, reporting and program review of deliverables
- Persistence activities will not occur without specific requirements and funding from the program.

The following sections describe how each of these recommendations was integrated into the 2006-2008 PECI RCx programs.

**Customer recruitment must occur through diverse marketing channels and be adaptable for various decision-makers.** The 2006-2008 California programs used a variety of approaches in recruiting building owners. Two significant changes from the earlier pilot program were the addition of full-time Field Energy Analysts (FEAs) to work with owners from recruitment through to project completion, and secondly contracting with RealWinWin to support recruitment activities. Additional leads were expected to be supplied by utility account managers and RCx providers.

A number of marketing tools were incorporated into the programs: a comprehensive website, brochure, factsheet, case studies, white paper, conference booths, and a half-day RCx

[1] The ten programs are: SCE Retrocommissioning Program, San Diego Retrocommissioning Program, and the following PG&E programs: Airflow/Fume Hood Control Systems Re-Commissioning, Data Center Cooling Controls Program, Hospitality Energy Efficiency Program, Hospital Pilot Program, Macy's Comprehensive Energy Management Program, Monitoring-Based Persistence Commissioning, Retrocommissioning Services & Incentives Program, and PG&E's Core Retrocommissioning Program.

workshop hosted by the utility. These tools were typically used once contacts had been established as opposed to the tools actually directing new leads to contact the program.

Utility account managers are a valuable resource for generating new leads, and the programs experienced varied levels of success in this area. Challenges included:

- Educating account managers on a program process that is more complex than existing retrofit programs. This problem is exacerbated in cases where there are multiple RCx programs being offered through a utility.
- Utility bonus structures and the utility's level of internal promotion of the program can impact the priority placed on supporting RCx.

RealWinWin's strategy was to enroll a relatively small number of commercial real estate portfolio owners/managers, each having a high number of buildings. While there is huge potential square footage in this area, the programs' experience has been that this is a very difficult market to break into due to the complexity of the ownership/management structures, very strict legal oversight, and a reluctance to jump into a new initiative on a wholesale basis. Despite the challenges, the programs have created significant momentum in this area and are expected to see RCx activities expanded through entire portfolios in future rounds.

The incidence of leads being brought to the programs through RCx providers was generally lower than expected, although the San Diego RCx Program had more success in this area than PECI's other California programs.

The programs' FEAs used a variety of means to recruit owners: cold-calling from business directories/lists, attending local business group meetings (including BOMA chapters), and networking through established leads. Results have been positive, although there have been major challenges due to a generally low level of awareness of the RCx process among property owners.

**The program process must be streamlined upfront to move – not stall – the investigation.** For this round of programs the scoping phase was replaced with a building screening. The screening focused on obtaining energy/equipment usage information for each building and assessing the enthusiasm and perceived commitment of financial decision-makers. The screening process has successfully reduced cycle times; whether the elimination of the scoping phase will increase the incidence of projects with low savings will be assessed once more projects have been completed.

**The program must understand the financial decision-making process by organization, and allow for multiple phases of implementation.** One of the fundamental changes for the current round of programs was the replacement of a Memorandum of Understanding (MOU) with a legally binding Owner Program Agreement (OPA), to be signed by building owners *before* commencement of investigation. This requires that owners will implement any measure that has a payback of one year or less, or else repay the program's investigation costs.

This commitment was a significant challenge to overcome in the early phase of the programs, for two major reasons: First, the level of commitment required meant that the agreement often had to be passed to a corporate executive who was unfamiliar with the process, and second, the terms and conditions frequently needed to be renegotiated due to the involvement of company attorneys.

The OPA was a major cause of the slow start in recruitment for the current programs, but the challenges appear to have been largely overcome due to program experience in dealing with any customer concerns and growing confidence in the marketplace that RCx is a credible energy efficiency strategy. It is accepted that gaining an OPA signature will always take longer than the more loosely-defined MOU, but this has a lower impact than completing a costly investigation and then finding that the owner will not complete implementation of measures. Results to date demonstrate that owners are choosing to implement the majority of the measures identified through investigation, as evidence of the success of the OPA.

**The program must provide support to see each project through implementation.** In the 2006-2008 programs, PECI has placed FEAs on the ground in each program to support the building owner from initial recruitment through to project end. This has successfully relieved the building owner of the burden of coordinating a complex process and ensures program involvement at each decision-making point. Given the complex nature of the process, keeping a large number of projects on schedule is a significant challenge, requiring much more effort than originally expected.

**Standardized program protocols should be provided, to streamline project tracking, reporting and program review of deliverables.** PECI and Architectural Energy Corporation (AEC) developed a comprehensive program toolkit for the 2004-2005 San Diego RCx program to provide guidelines and templates for provider deliverables and to standardize the quality of deliverables across RCx providers. In scaling up the RCx program model, it has been crucial to maximize throughput while at the same time maintaining a very high quality of work and accurate energy savings estimates.

To achieve these conflicting goals, PECI and AEC have further developed the toolkit with more detailed descriptions of requirements and easy-to-use templates for providers. In addition to enhanced provider resources, PECI and AEC worked with the utilities to place a higher level of scrutiny on the providers' baseline data, assumptions, and savings calculations, in response to higher EM&V concerns.

While the comprehensiveness of the program documentation is considered to have taken RCx to a higher level of rigor and clarity, there have been two key challenges in this area:

- Due to the complex nature of RCx measures and relative immaturity of the industry, there were no standardized calculations available for program use; therefore providers use their own spreadsheet calculation tools. This inevitably increases the complexity and inconsistency of deliverables and the program's review process, at a time when demands of EM&V are raising utilities' expectations for project documentation. This has resulted in lengthy reviews of deliverables, sometimes taking months, as data and calculations are reworked.
- While the programs created comprehensive guidelines and templates, and conducted orientations for providers, there was no formal training given under the program, nor are there industry training programs that are specifically designed with utility-run programs in mind. Given that this is a quickly growing industry, this has compounded the issues discussed in the bullet above.

While there have been no simple solutions to these challenges, the programs have continuously refined their processes to be more proactive with providers in aligning their deliverables to utility expectations. In addition, once providers have been through the review process for the first time their subsequent submissions pass through review more quickly. Standard calculation spreadsheets have recently been published for some RCx measures by the California Commissioning Collaborative (CCC), but these are not yet widely used.

**Persistence activities will not occur without specific requirements and funding from the program.** The large scale of the current programs and the increasing pressures on the cost-effectiveness of programs led to the exclusion of performance tracking systems to monitor persistence (with the exception of the SDG&E program where it is being applied on a sampling of projects). In the absence of installed performance monitoring, the program is focused on helping providers develop clear documentation and training to aid building owners in understanding the measures implemented and how to maintain those measures over time. In addition, all participant buildings are benchmarked using the EPA's ENERGY STAR® Portfolio Manager, with the account being transferred to the building owner at project end.

## Program Findings

RCx has been shown to offer improvements with quick paybacks and consistent energy savings. Common measures and building types are often discussed, as are theories about the ability of the RCx provider market to keep pace with the growth in the sector. As RCx programs have grown in scale over the past several years, PECI now has the opportunity to use an ever-expanding data set to reexamine some common perceptions about RCx and add to the body of knowledge about this process.[2]

### An Increased Level of Scrutiny on Reviews has Impacted Savings Estimates

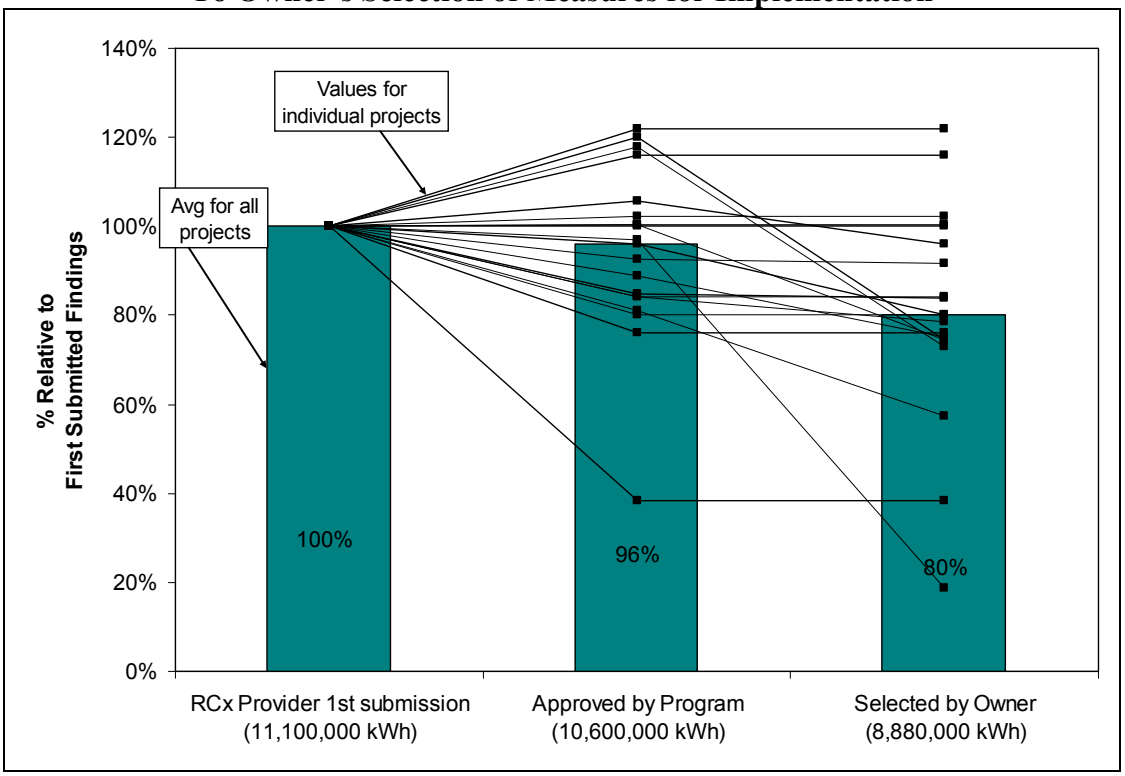
As mentioned above, the rigor of utility EM&V has led to lengthy reviews of the project deliverables. The values in Fig.1 below relate to 21 projects with combined savings potential of 11.1 million kWh at first submission of investigation findings. Providers' first submissions are normalized to 100%, and overall these savings drop to 96% by the time measures are approved. This drops further to 80% based on the measures that are actually selected by owners for implementation. The potential causes for the 4% reduction in savings due to the program approval process are:

- Measures may be rejected as ineligible under the program guidelines, or are no longer considered energy-saving measures once calculations or trend data are corrected through the review process.
- Measure savings may be adjusted when calculations or assumptions are updated based on additional baseline data collection.

[2] Savings data presented here is mostly based on providers' calculations following investigation, not based on implemented measures. Costs used to calculate payback include owner's estimated implementation costs but not investigation or other program costs.

Although the net impact of the deliverable approval process on identified savings has been relatively small (a 4% reduction), variation for individual projects has ranged from a 22% increase to a 62% reduction. The general trend is downwards, although seven projects show an increase in savings due to the approval process. As RCx providers become more familiar with the scope of utility programs and the data and calculations requirements, the gap between submitted and approved energy savings is expected to diminish or disappear.

**Figure 1. Variation in kWh Savings, from First Submission of Findings To Owner's Selection of Measures for Implementation**




Source: Portland Energy Conservation, Inc. (2008)

Increasing Owner's Upfront Commitment Improves Follow-Through with Implementation

Following investigation approval, owners then selected measures with a total forecasted savings of 8.8 million kWh (84% of the 10.6 million kWh approved by the program). While owners are obligated to implement measures that pay back in one year or less, the remaining measures are not required, although incentives are available from the RCx programs for measures with a payback of between one and four years, paid on a per-kWh basis. Many factors go into this decision for the owner, including budget limitations and future plans for system upgrades and retrofits. Some measures may also be mutually exclusive, with one selected measure precluding the need for another.

As discussed earlier, the current round of programs included a legally-binding OPA to address the risk of owners not implementing measures once investigation was complete. Program experience has shown that although the level of commitment required initially represented a challenge in getting owners to sign up, it is a key component of program success. Owners selected 83% of the approved measures (111 out of 134) which represent 84% of the available

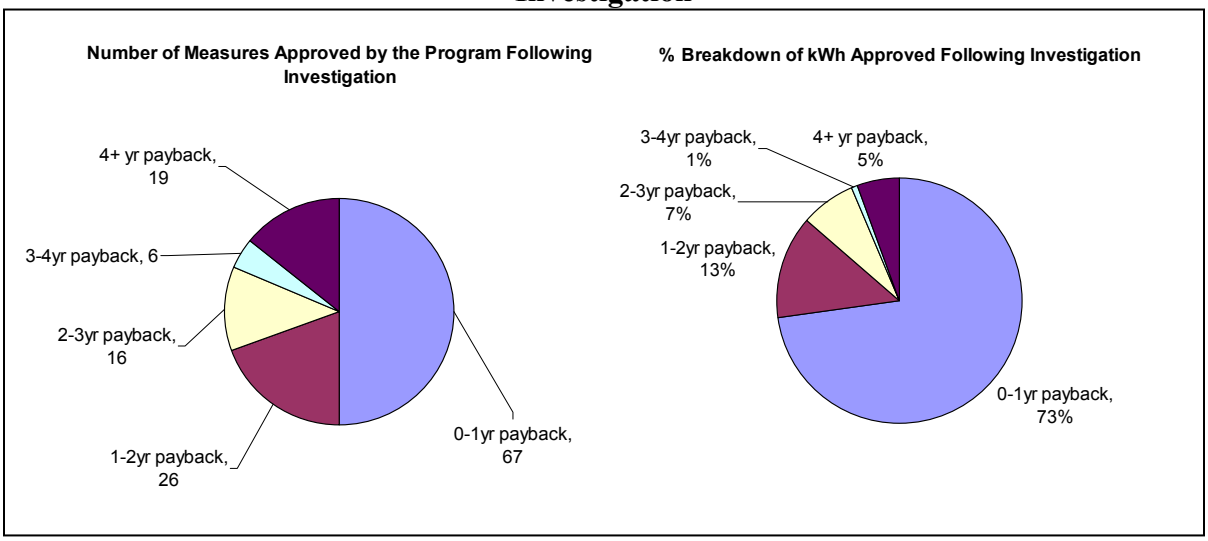
kWh savings (this is illustrated in Fig.1). Results are not yet available to measure the successful implementation of measures, but it is expected to be significantly higher than if the contracts were not in place.

**Measures Identified through RCx Really do Pay Back in Less than Two Years**

The RCx process focuses on optimizing building operations instead of installing equipment, resulting in low costs and payback relative to measures in retrofit programs. PECI's program marketing focuses on the assertion that RCx measures generally pay back in less than two years. The 2006-2008 program results to-date confirm this perception: 69% of the measures identified through investigation pay back in less than two years, accounting for 86% of the total kWh savings. Of the measures selected by building owners for implementation, 76% have a simple payback of less than two years, accounting for 84% of the forecast kWh savings. Fig.2 illustrates this.

Program guidelines do not offer incentives for measures with a simple payback of over four years, but in some cases it has been beneficial to report them. Owners see this as an added value and sometimes implement these findings even though they are not eligible for incentives. Most of the high-payback measures that are selected have low energy savings but address maintenance or occupant comfort issues.

**Figure 2. Breakdown of Simple Payback for Measures Uncovered during RCx Investigation**



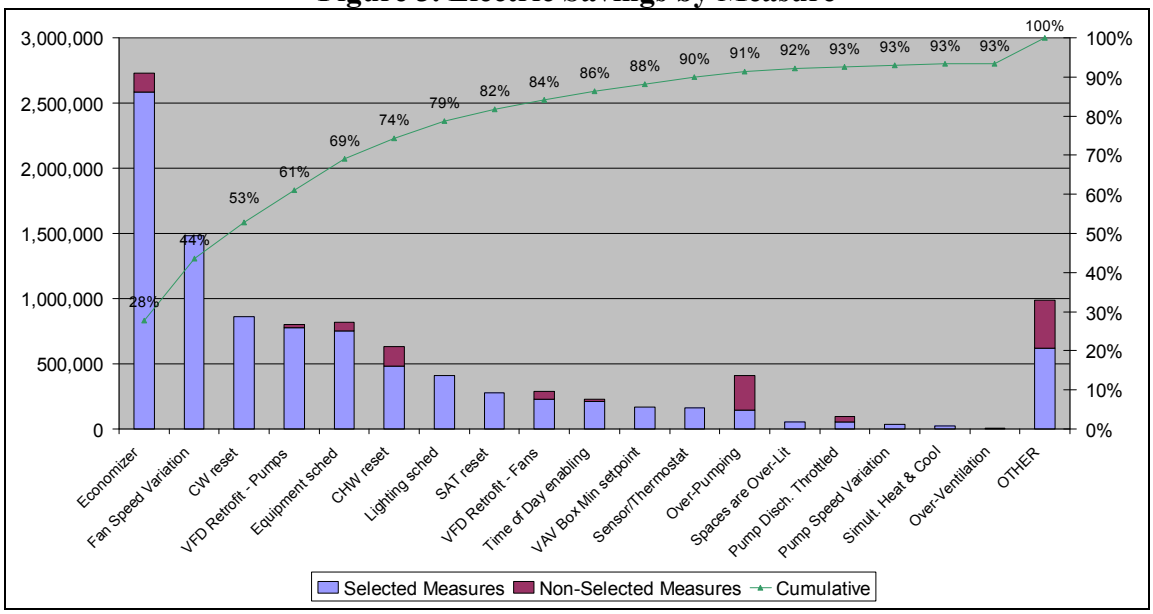

Source: Portland Energy Conservation, Inc. (2008)

## Five Measures Represent the Majority of RCx Savings

As shown in Fig. 3 below, the five measures presenting the greatest kWh savings in the programs are economizer optimizations, fan speed variation adjustments, condenser water resets, variable frequency drive retrofits for pumps, and equipment scheduling. These top five measures account for nearly 70% of the forecast kWh saving for the programs.

However, looking at only the total kWh savings for particular measure types does not tell the full story. For some measures, such as economizer optimizations, the number of air handling units (AHUs) can rapidly multiply the kWh savings found in one measure – almost half of the economizer savings shown in the chart below are from one project. As further data is collected the picture will become clearer, although the general impression is that these top five measures will continue to generate the majority of savings.

**Figure 3. Electric Savings by Measure**

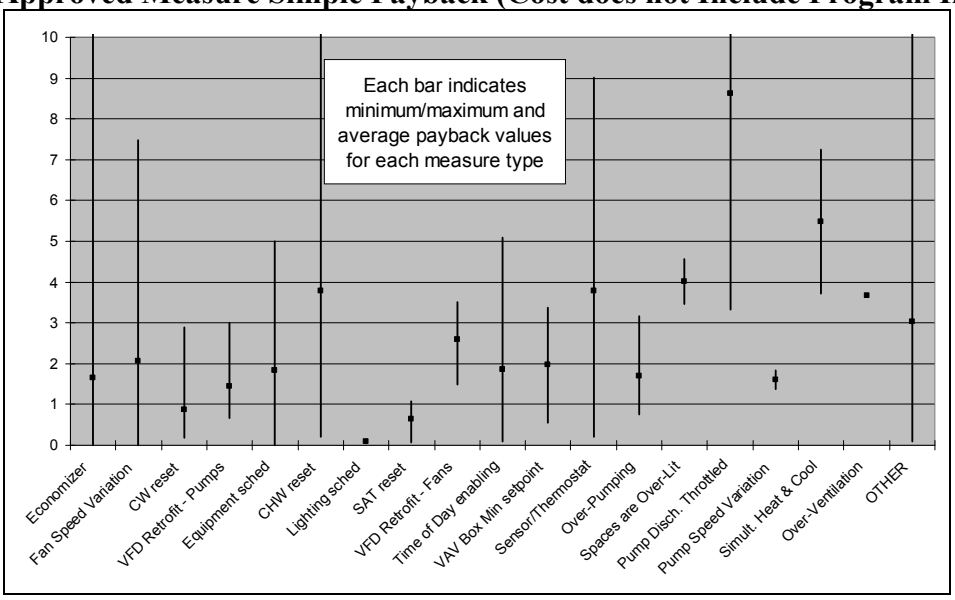



Source: Portland Energy Conservation, Inc. (2008)

## Cost-Effectiveness Varies by Measure Type

Fig. 4 below shows the variability of simple payback for a variety of measure types. Sensor/thermostat installation or calibration, fan speed variation adjustments, and economizer measures have seen the greatest variation in payback. Simple classification of measures for this type of analysis can be misleading, e.g., an economizer measure can be a simple reprogramming exercise for an in-house engineer or a repair of dampers for ten AHUs by an outside contractor. However, it is expected that the program data can be used to assess cost-effectiveness for owners and for future programs.

**Figure 4. Approved Measure Simple Payback (Cost does not Include Program Incentives)**




Source: Portland Energy Conservation, Inc. (2008)

## Results Confirm that 5-15% Savings Claim for RCx is Reasonable

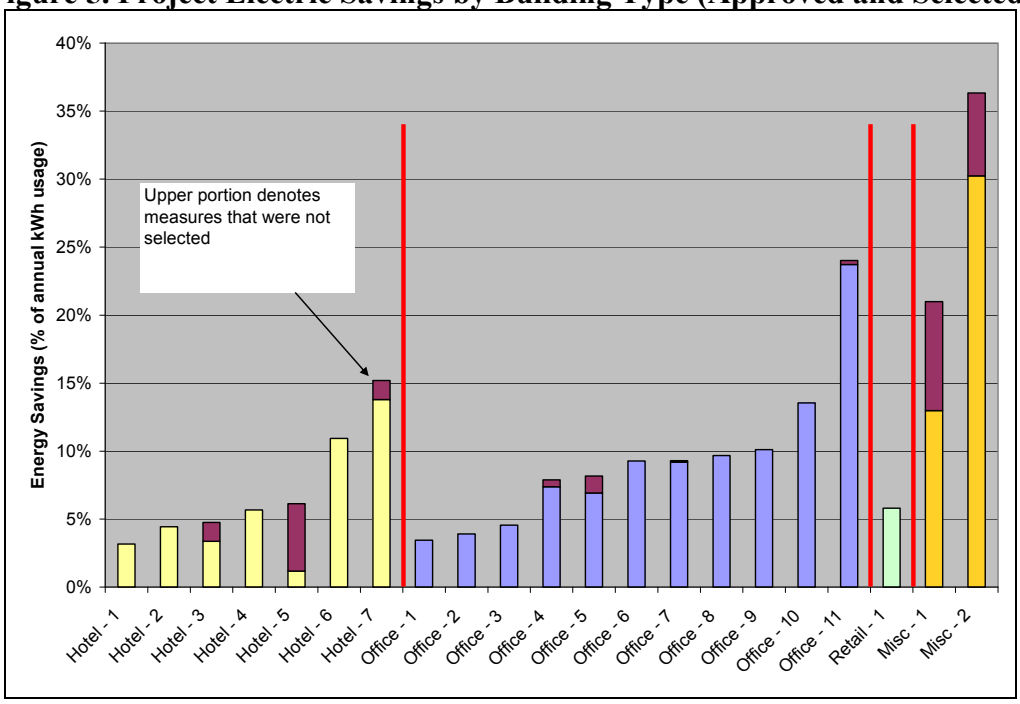
Building projects enrolled in the 2006-2008 programs use between 2 million and 27 million kWh of electricity annually. Previous studies have found savings in the range of 5-15% (Mills et al. 2004; Jump & Flanagan 2004), though PECI experience indicates that savings of over 20% are achievable. The current programs' goals are based on a general assumption of 8.5% savings in energy (kWh) and an average electric EUI of 15 kWh/sq ft/yr. Results from the current programs to date confirm that a 5-15% savings claim is reasonable, with estimated savings ranging from 3% to 36% of annual kWh. The combined savings *potential* for all projects is 7.8%, and the measures *selected* by owners for implementation represent an overall program saving of 6.9%. Reasons for owners not selecting measures vary and include budget limitations, operational limitations, and retrofit plans.

The 2006-2008 programs used screening criteria to determine if a building was appropriate for the program's design. In particular, the screeners looked at conditioned floor areas, electric EUI, HVAC system type and age, control system type, operations and maintenance practices, future plans, and facility staff enthusiasm. As projects move through investigation, the programs are learning where improvements can be made in the screening process to filter out projects which would be less cost-effective. Building type and EUI are considered two key variables in evaluating a building's suitability.

## Energy Savings Vary by Sector and EUI

Buildings in different market sectors deliver varying levels of savings through retrocommissioning. Savings also vary based on the pre-RCx EUI of the building. The two predominant building types in the RCx programs are hospitality (hotels and resorts) and large office buildings. Buildings from retail, medical, laboratory, and educational sectors are also represented. Fig. 5 displays the percent electricity savings for projects to date, by sector.

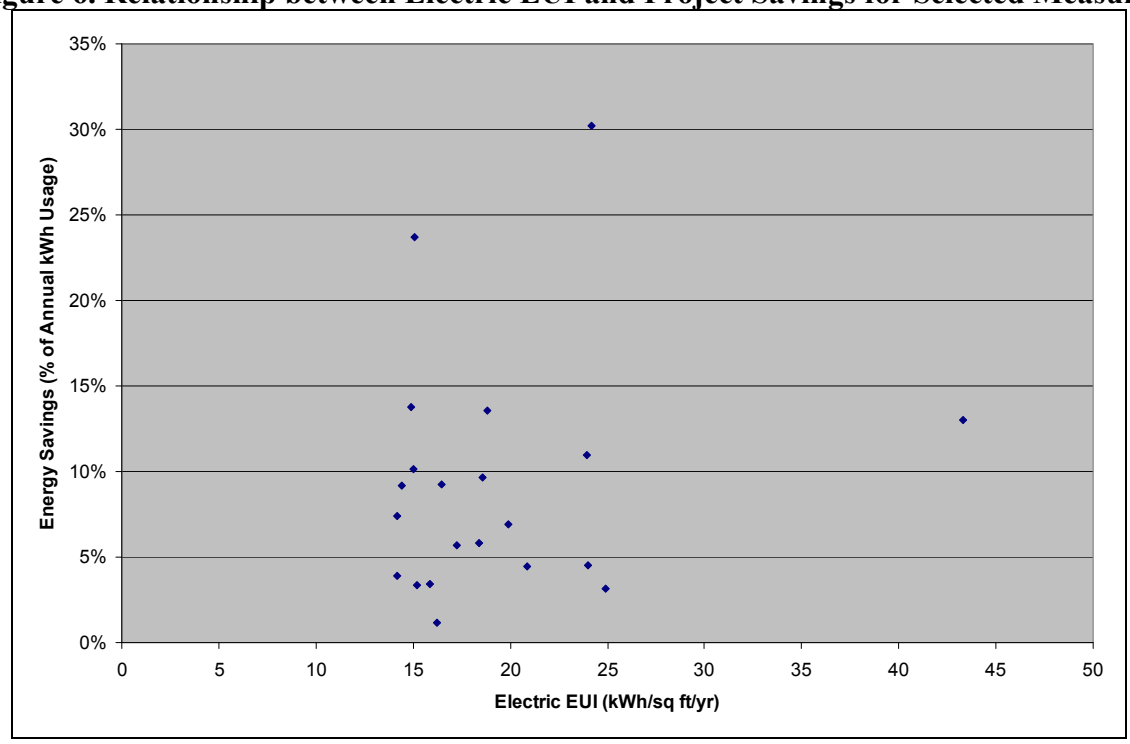
**Figure 5. Project Electric Savings by Building Type (Approved and Selected)**




Source: Portland Energy Conservation, Inc. (2008)

Thus far, hotels are seen to result in lower savings potential than office buildings as a percent of pre-RCx kWh, with average savings of 7.2% for approved measures. This is considered the result of there being a significant portion of the building's heating and cooling that is controlled by the guestroom occupants, not by the building operators. Guestroom areas are essentially 'off-limits' to typical RCx measures related to equipment scheduling. Office buildings have achieved higher savings, ranging from 3% to 24%, while other miscellaneous building types have much higher savings. These additional projects include laboratories and other energy-intensive buildings in which small adjustments can result in large savings. It should be noted that, while the programs have targets in terms of percent savings, project budgets are based on square feet and so a building with a high EUI can be cost-effective even if savings are below the target percentage (this is especially true of hospitals and data centers).

**Figure 6. Relationship between Electric EUI and Project Savings for Selected Measures**




Source: Portland Energy Conservation, Inc. (2008)

Fig. 6 above shows some correlation between electric EUI and % kWh savings opportunities. At the program level this can offer evidence that buildings with a higher EUI could justify a higher level of investment, but the data available to date does not suggest that EUI alone is a reliable measure of an individual project's potential.

## The RCx Provider Market has Sufficient Capacity but Faces Other Challenges

With a 200% increase in kWh to be saved through the 2006-2008 RCx programs relative to the previous years' programs, many in the industry questioned whether there would be enough RCx providers available to investigate the targeted buildings. In a market characterization study prepared in 2000 for PG&E, PECI estimated that a single full time RCx provider could retrocommission 300,000 square feet in one year, and that 165 fully experienced providers would be needed to reach a 2% penetration rate (PECI 2000).

Evidence from the current round of programs suggests that providers are able to retrocommission more than was previously thought. In a new study, PECI estimates that a full-time provider can commission an average of four projects in a year, with 64 providers needed to reach a market penetration rate of 5% (PECI & Summit Building Engineering 2008). There are currently 27 individual providers working to retrocommission over 48 million square feet of buildings, and each of these projects has a one-year timeline.

While plenty of individual providers are qualified under the programs (over 130), there are a number of other limiting factors:

- Challenges dealing with varying levels of provider skills. Due to the strict nature of the QA-QC process (which can vary between utilities) and the need for very reliable savings calculations, extensive time has been spent in training providers on program requirements for deliverables. While this should increase the skill level in the next round of programs, it has resulted in extended time schedules and increased time commitments from providers, reducing their ability to take on additional projects.
- Provider availability may be further reduced because most provider firms work on non-retrocommissioning projects as well, and RCx projects may not be the highest priority.
- In addition, the three-year program cycle results in projects moving along similar timelines, creating periodic peaks in demand that may coincide for multiple programs.

## Conclusions

The experience gained from scaling up RCx programs in California provides valuable insight into ongoing program challenges and opportunities for further improvement in the next round of large-scale RCx programs. These important lessons have been learned from the program experience as presented in the data above:

- Obtaining a legally-binding financial commitment from building owners prior to investigation is crucial for successful follow-through to implementation. There still remains potential for owners to implement a higher proportion of the measures discovered through investigation, but an 83% selection rate is considered a good result.
- Provider training and standardization of calculations are key to reducing approval time of provider deliverables and maximizing project throughput.
- When scaling up RCx programs, it is still possible to achieve the 5-15% energy savings shown for earlier RCx studies.
- Savings potential varies significantly by building end-use. Marketing strategies and messages should reflect this variability.
- Low level of understanding of the RCx process was initially a barrier for the current programs, but marketing through a variety of channels has seen significant momentum grow in this area.
- Five measure types account for the majority of program savings. This information should help shape future program design and provider training.
- Results to date confirm the claims relating to RCx measure payback, with 86% of the forecast savings coming from measures with a payback of two years or less.

As the programs move forward to completion, PECI will continue to evaluate these data trends and others to feed back into the industry insights and lessons to continuously improve the cost-effectiveness and savings realization rates of large-scale retrocommissioning programs. With RCx programs growing in scale both in the California markets and nationally, the lessons-learned from California's large-scale RCx programs are critical pieces for informing ongoing program development.

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