Know-How and the Incessant Energy Diet

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ABSTRACT

Because of its relatively low implementation costs and substantial energy savings potential, Retrocommissioning (RCx) has been demonstrated to represent a large share of the most cost-effective energy efficiency projects for commercial and industrial end users. Nearly all RCx programs deliver projects to customers with a combined simple payback of one to two years.

However, depth and breadth of projects, defined as implementation of all pre-defined cost effective measures in a facility, is poor. One barrier is the net lack of expertise on the supply side for these services. Others include the typical barriers of lack of customer time and expertise, and their risk aversion toward the nebulous RCx process and unquantifiable savings estimates at the time of deciding whether to participate in these programs.

This paper discusses these barriers in addition to barriers added by status quo programs and describes how to mitigate them with alternative RCx program processes as demonstrated by Alliant Energy. Independent evaluation, research, and commentary in this paper document the existence and impact of these barriers and the results from the alternative approach.

Introduction

In recent years retrocommissioning (RCx) has been documented in extensive studies to offer great savings potential, wide applicability, and very high return on investment; yet these favorable attributes have not resulted in commensurate energy efficiency program activity and associated impacts.

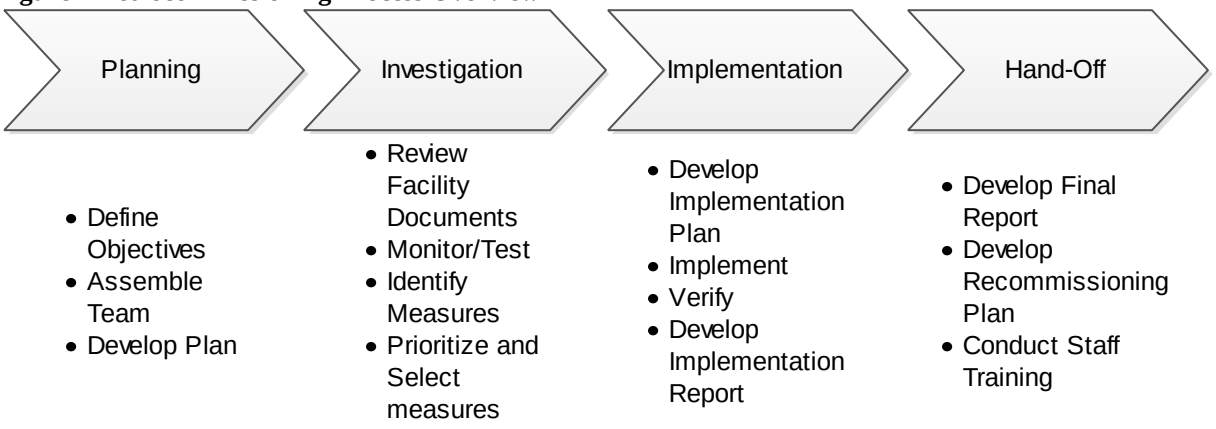
One group of reasons for low uptake of RCx projects is that programs do not adequately address barriers to participation and rather, programs often add and exacerbate barriers for customer participation. This paper offers alternative program processes to avoid program-induced barriers and provides methods to mitigate typical project barriers for targeted end users.

Retrocommissioning Process

The typical process for RCx is shown in Figure 1 (PECI 2007). In most cases, the planning phase includes a preliminary assessment of the facility, development of an RCx plan, some form of report or memo and approval by the program technical and/or administrative staff. It also typically includes benchmarking using a resource such as EPA's Portfolio Manager. Some programs have also front-loaded the process with an application phase in which facilities are screened at even a higher level than benchmarking to include facility type, existence of a facility-wide digital control system, and square footage[1]. The objective of the planning phase for program purposes is to ensure the facility and RCx provider are a good fit for the participant and facility.

[1]http://www.centerpointenergy.com/staticfiles/CNP/Common/SiteAssets/doc/03%20RCx%20meeting%20presentation%202013.pdf

Figure 1 Retrocommissioning Process Overview



The investigation phase is generally where most of the value is developed and provided by the program to the program participant. As indicated in Figure 1, this includes a detailed investigation of the facility, data logging of key operating parameters, occupant and building operator interviews, detailed energy analysis and cost estimates, and typically an investment-grade report of the findings.

The third phase includes implementation of recommended or program-required measures identified and developed in the investigation phase. Implementation is typically conducted by a combination of participant personnel and contractors. Larger enterprises are more prone to implement measures themselves. The final step in this phase is the verification that measures were implemented as intended and developed in the investigation phase.

The hand-off phase includes a final report of the findings and activities, typically some training, and in some cases, a systems or operations manual is delivered to the customer. Note also that some programs essentially separate the verification of measures into the fourth phase rather than the third phase as shown. This is important and will be discussed below. Verification may be completed by the service provider (RCx agent) in charge of the investigation or by the program administrator.

It must be noted that planning and investigation phases may be completed by energy efficiency consultants, engineering firms or by consulting divisions of energy service companies or controls contractors.

Retrocommissioning Barriers

Having documented the status quo RCx program process, it is worthwhile to observe the pertinent barriers to implementing energy efficiency projects for purposes of examining how the process interacts with these barriers. Granade et al. provide an excellent synopsis of energy efficiency attributes and barriers to participation. Energy efficiency project attributes include:

- Requires capital
- Fragmented potential (with thousands of facilities in typical service territories)
- Low mind share / low priority
- Difficult to measure impacts

The paper goes on to explain common barriers to implementing energy efficiency and the ones that RCx programs should mitigate, including:

- Risk and uncertainty
- Lack of information/awareness (expertise)
- Capital constraints
- Product (or service) availability

- Improper installation or deployment of measures

Granade et al. note that one key barrier is missing from the list and that is a lack of end user time to identify and develop measures and projects, implement them, or manage service providers and/or contractors to do the work on their behalf. This is a major barrier in many cases.

RCx Program Design – Meet the Barriers

Table 1 includes key barriers to energy efficiency and retrocommissioning specifically, and the program elements that address those issues for the better (plus) or worse (minus). Status quo program design mitigates some barriers but exacerbates others and even creates additional barriers.

Table 1 Program Elements to Address Risk

Barrier	Program Element	Plus or Minus	Comment
Risk	Study Funding	+	Mitigates chance of paying for worthless study
	Verification	+	Ensures measures were implemented as intended to achieve savings
	Need for Participant Commitment to Unknown Implementation Cost	-	Participants unsure of measure mix or capital requirements for implementation before signing on
Expertise	Qualified Service Providers	+	Identifies and provides list of qualified RCx providers to participants
	Challenged Service Providers	-	Service providers unfamiliar with energy efficiency programs result in substantial challenges for implementers
Capital	Study Funding	+	Mitigates up to roughly half the cost of RCx process in many cases
Service Provider Availability	Qualified Service Providers	+	Program vetts and consolidates service providers for participants
Poor Installation	Implementation	-	Service providers (investigation/study) are out of the loop between study completion and implementation verification
	Verification	+	Ensures measures are implemented as intended
	Verification	-	Verification done "after the fact" with no leverage on implementation contractor
	Verification	-	At component or system level, not at utility meter level
Time Requirement	Multiple Approval Steps	-	Big negative for customer and service provider experience and budget

Risk

As noted in Table 1, RCx programs reduce some risks (pluses), but in other cases they offer substandard risk mitigation and for some elements even add uncertainty and risk (minuses) to customers. While end users may understand the basic premise of RCx as a building “tune up”, virtually all end users, and in particular decision makers, often imagine the process and potential benefits as a vague, nebulous mystery. The typical RCx program asks owners to sign off or make commitments on an invisible, unquantifiable, unknown outcome. Examples of uncertainty in the eyes of customers include:

- Committing to implement required projects with a certain simple payback, or face a reimbursement charge. Potential participants in these instances are faced with uncertain capital outlays that must be made within a specified period of time. In some instances, customers may also need to reimburse programs if measures are undone in the subsequent five years (Peters, Scholl & Wylie 2009). Some programs do limit required participant commitments.
- Having to agree to adjust and accept temperature setpoints that may be unacceptable to occupants (Peters, Scholl & Wylie 2009).
- Paying tens or hundreds of thousands of dollars for RCx implementation with uncertainty in the outcome (Peters, Scholl & Wylie 2009).

Investigation and Reporting

Facility investigation, data collection, analysis and reporting all require the experience and skill sets of seasoned process and impact evaluation professionals, program implementers and other energy service professionals. While many approved RCx service providers are highly skilled in systems troubleshooting, commissioning, and retrocommissioning, many providers are primarily architectural and engineering firms, controls contractors, and mechanical contractors. They are not energy efficiency experts nor are they familiar with the needs of programs, utilities or third party implementers[2]. Because energy efficiency and participating in energy efficiency programs are not part of many service providers' core services, this creates problems for both providers and program administrators.

One evaluation states, "These [concerns] included insufficient compensation relative to the time planning projects, redundant paperwork requirements" (Gunn, et al 2013). This indicates providers are not accustomed to the pricing of these services and the required documentation that many providers take in stride. In another case, "Some measures are low-risk and high-reward in terms of savings, and there is a temptation by RSPs [RCx service providers] to apply less rigorous calculations to quantify savings, since the RSPs are certain the customers will implement those measure" (Gunn, et al 2013). This indicates an under appreciation of the needs for the program that is paying for the service. Another evaluation states, "Most or all of the providers' estimated savings may be achievable by those projects, but the providers' documentation did not support their estimates. Documentation deficiencies included missing information (such as the calculations themselves) or missing data on which the calculations were based (such as facility descriptions, occupancy and energy-consumption assumptions, measurements, and equipment descriptions and usage). Other problems with providers' calculations included invalid assumptions, questionable calculation methodologies, the use of inappropriate weather data, and savings estimates so great they are not credible" (Peters, Scholl & Wylie 2009).

Some programs have developed standardized calculations for service providers to use, but since measures are highly customized and unique in nature, these calculations frequently do not adequately represent the measure. Indeed, even industry-norm simulators such as DOE-2 cannot properly represent RCx measure impacts. Even so, service providers find these calculation tools to be burdensome: "In the eyes of the service providers, the amount of work required of them by the program's quality control reviews exceeded the compensation paid to them by the program. This was the cause of the decline in the number of service providers willing to do program work" (Peters, Scholl & Wylie 2009).

[2] E.g., program approval processes, oversight, documentation, and reporting and energy analysis requirements

Implementation

RCx opportunities, in general, are poorly understood by the trades that need to deliver their implementation and by the end user – which is why the opportunities exist in the first place. The common non-RCx energy efficiency project includes installation of incrementally more efficient equipment that is performance tested in the laboratory using sanctioned methods developed and maintained by trade organizations like the Air Conditioning, Heating and Refrigeration Institute or the National Electrical Manufactures Association. Specifying equipment for these projects with standardized metrics is straight forward. Specifying how to implement RCx measures is, by comparison, very complex and unique to the application. The upshot is the intent and concepts of the RCx agent's measures can go substantially unfulfilled unless there is sufficient guidance between study delivery and implementation of the measures as typically performed by controls contractors.

The purpose of an RCx study is to identify and document measures, investigate and conceptually develop them and to accurately estimate implementation cost and energy and demand impacts so participants can confidently make informed decisions. The RCx study is rarely sufficient for communicating scope of work for implementation. This is not its function. Whether the study is completed by an independent consulting firm or the consulting division of a controls company or energy service company, it is vital to document precisely the controls sequences to properly implement the measures.

It is this gap between delivering the RCx final report to participants and implementation where much of the potential savings are squandered. Program logic modelers call this gap the "miracle in the middle"[3]. This is due to participants essentially handing the investigation results to the implementation contractor without the build-out of these details (control sequences) for the precise implementation of developed measures. These problems are corroborated by one RCx program evaluation: "The implementation phase of the Program continues to be the primary source of challenges. This phase is generally participant-led and the timely completion of projects is largely dependent on the customer keeping the project moving. RSPs expressed a concern that while they are not involved in this phase, they are still held responsible, via the RSP review process, for the timely [and accurate] completion of projects" (Gunn, et al 2013).

Verification

Verification assures participants that RCx measures have been implemented as intended by the RCx agent and that the savings will be realized. Most program processes include some type of verification of measures after implementation, but details of the verification process are scarce to non-existent in program literature.

Verification after the fact is common and better than no verification at all, but when it reveals non-compliance with the intent of the RCx agent's measures, it typically creates tension among the stakeholders for the project, particularly if the RCx agent is independent from the project implementer. Without detailed design, implementation, and or control sequences which are beyond the scope of the RCx investigative study, the documented intent is left open to too much interpretation. Moreover, once the project implementation contractor has left the scene and moved on to other projects, it is difficult to require them to remedy issues with "non-compliant" work unless there are perceptible comfort issues, and this is not normally the case.

Another limitation of verification is that it examines how a building is performing at one point in time, yet performance may vary depending upon changing conditions. Therefore, retrocommissioning projects should always address year-round facility management, systems control, and operations and maintenance. For example, economizing (using cool outdoor air for free cooling) may not be required in

[3] Marjorie McCrae, Research Into Action

very cold or very hot weather. If verification is completed under these conditions, the sequence cannot be positively verified. There are ways to test this, however, as discussed below.

Also, verifying the measures at the component and system level only provides participants with a vague, nebulous, savings verification mystery because it isn't something they can see on their monthly utility bills. A much more compelling case is "showing them the money" using the differences in their energy bills before and after implementation. However, only one in 10 program processes that we researched mention any sort of utility bill monitoring after implementation. The one mention was part of a university implemented program.

Retrocommissioning programs often boast savings in the double digits, which makes for noticeable differences between pre and post implementation energy bill comparisons. Even for projects that do not quite save 10%, the savings from these projects should be clearly visible when comparing pre to post implementation energy consumption. The International Performance Measurement and Verification Protocol (IPMVP) uses a minimum of 10% savings as the threshold for using the "whole facility" approach (billing comparison). Since this method is quite easy and inexpensive to deploy, it is a good idea to use it as an indicator of savings well down into the single digits of percent energy savings.

Timing

Possibly the greatest barrier that RCx programs throw up for end users is excessive time commitment, including multiple stops and starts, and multiple approvals to proceed with implementation. In nearly every case, the need for participant approval prior to proceeding with the project causes delays because decision makers in these organizations do not have energy cost and efficiency near the top of their priority list.

One RCx program evaluation reported, "These [concerns] included insufficient compensation relative to the time planning projects, redundant paperwork requirements, and delays in receiving approvals to proceed from one program phase to another" (Gunn et al 2013). Another evaluation states, "Other program issues included: project delays arising from shortcomings in the building screening process; project delays arising from customers' perception of risk from signing the program's [owner program agreement]" (Peters, Scholl & Wylie 2009). The resulting delays harm programs and in many cases kill projects.

These findings corroborate with Michaels Energy experience as a service provider in similar programs. Michaels Energy has participated in a program with such a process, including a Phase 1 "Triage" Report, a Phase 2 Walk-Through Report, and a Phase 3 Investment Grade Study. Phases 1 and 2 were completed by technical support engineers with the program implementation team, while Phase 3 was bid out to technical service providers for the program. The customer in one particular case assumed that the analysis was over at the completion of Phase 2 and presumed the Phase 3 study awarded to Michaels Energy was for actual implementation of the measures.

A Case Study RCx Program – Crush the Barriers

Alliant Energy is delivering an RCx program that substantially mitigates the under-treatment of market barriers by status-quo programs. These barriers are listed as minuses in Table 1 and are better addressed by the program as summarized in

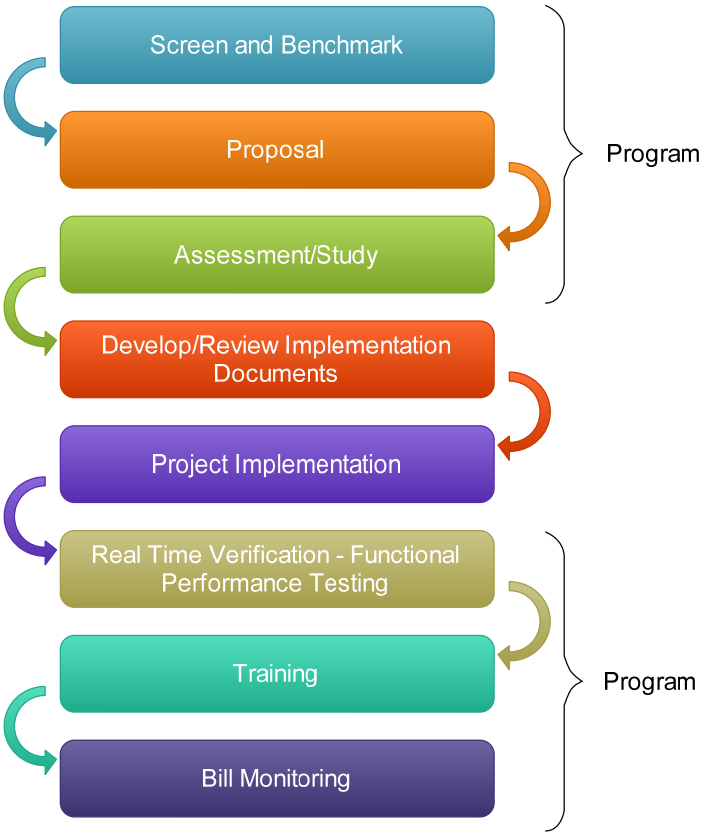
Table 2. Because RCx is a nebulous, vague mystery to most end users, the program is designed with the end in mind – using the most unequivocal proof of results possible: utility meter comparisons of pre and post implementation energy consumption. The unequivocal results speak clearly to prospective participants.

Table 2 RCx Program Mitigation Strategy

Barrier	Program Element	RCx Program Barrier	Alliant Energy Program Response
Risk	Commitment	Participants unsure of measure mix or capital requirements for implementation before signing on	Study proposals include estimated savings, capital limit, return on investment, and 50/50 split reimbursement of study cost
Poor Installation	Implementation	Service providers (investigation/study) are out of the loop between study completion and implementation verification	Service provider collaborates with project implementation contractor and many times writes control sequences for project
	Verification	Verification done "after the fact" with no leverage on implementation contractor	Implementation contractor knows at the close of the study that measures will be validated in the field before their work is closed out
	Verification	At component or system level, not at utility meter level	Utility bills are monitored in the interim and again after a full 12 months of post implementation of measures
Time Requirement	Multiple Approval Steps	Big negative for customer and service provider experience and budget	Benchmarking and screening for commercial buildings rarely requires a site visit and prelim assessment reporting is not necessary

Figure 2 depicts a roadmap of Alliant Energy's RCx program. Portions of the process funded by the program are indicated to the right of those steps, or phases.

Figure 2 Alliant Energy RCx Process



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Mitigating End User Risk

Under the Alliant Energy program, the first agreement that prospective RCx participants sign is a proposal/contract to perform an investment grade study of their facility. The proposal includes projected electric and natural gas savings, when applicable, as well as dollar savings, a maximum capital commitment for project implementation, and an agreement to implement all measures that fit into a package of measures with a two year or shorter simple payback period. The contract includes an agreement to pay the study provider in full at the completion of the study, at which time Alliant Energy reimburses the customer for the first 50% of the study cost. The remaining 50% of the study cost is reimbursed once the agreed-to 2-year package of measures has been implemented and verified with real-time testing prior to implementation project close out.

This process greatly mitigates the risk of spending money on a worthless study. The entire process is covered in the proposal and the fact that the program will be there 12 months after implementation instills confidence in customers that the program and process will deliver.

As of October 2013, the program signed contracts (studies in progress or completed) with 18 customers and 30 buildings. Nine proposals representing nine buildings have been dropped from consideration, while an additional 10 proposals are pending approval. Thus the success rate on proposal execution is 67%.

Mitigating Implementation Phase Risk

Four key elements help reduce risk during the implementation phase. First, energy analyses are completed using key operating data logged over a period of at least two weeks. Implementation design concepts and control sequences are shared with controls contractors to develop accurate pricing. Since the controls contractor will get the work for project, they have vested interest in getting the cost estimate right to avoid unpleasant surprises and finger pointing once pricing for implementation is finalized. Lack of unpleasant surprises results in smooth project implementation and minimal complaints that hinder program success.

The second risk mitigation for implementation is information transfer to project implementation contractors. In most cases, the RCx service provider also develops control sequences, and in some cases simple drawings and specifications. The same service provider / implementer team that collaborated for study completion also works on the implementation of measures. This collaboration results in a satisfied customer for the utility, implementation contractor, and RCx service provider.

The third risk mitigation element of the program involves real-time verification, testing and corrective action before the project is closed out by the implementation contractor. Again, the implementation contractor knows ahead of time that this “functional performance testing” will be occurring near the end of the project and therefore has time and fees built into the project. Functional performance testing includes a battery of tests on affected equipment for all reasonable inputs to determine and verify that the control response is correct. As alluded to above, for one example, this allows the verification of appropriate economizer response when outdoor conditions don’t call for it. A test input is supplied to the control system and the response is observed and verified or corrected. This type of test is performed on all measures leaving the customer with a very high probability of full project impacts.

Lastly, proof of savings is demonstrated by comparing energy consumption at the utility meter before and after implementation. This has worked well for all commercial buildings to date. Industrial customers that address one process at a time see smaller percentages of savings relative to their full bill. Other strategies from IPMVP are deployed to verify these savings but even with a few percentage points of savings projection, the savings are evident on the bills.

Customer Time Requirements

As mentioned, multiple RCx assessment and approval phases result in starts and stops and hang-ups that can cause frustration among customers, RCx service providers, and implementation contractors, and in many cases, may also result in loss of interest, the dropping of projects, or dropping out of programs (Peters, Scholl & Wylie 2009).

The Alliant Energy screening and approval process avoids this by only requiring four key elements: 1) utility billing data, 2) a brief conversation with facility operators and/or managers, 3) study proposal development, and 4) Alliant Energy approval to fund the study per the terms and conditions of the program. Behind the scenes, information from the customer interview, and in some cases a facility walk-through, are used to benchmark the facility against peers to determine savings potential in kWh, therms, and dollars. This translates to an implementation cost commitment by the customer (two year payback). Customers are of course free to spend more on implementation as they choose. In most cases, this provides all the information that finance departments need for approval. One industrial customer commented that "finance loved it" (the process and proposal). That particular project went on to save 1.3 million kWh and 330,000 therms on HVAC units alone. This was evident on their utility bills as well.

Analysis and Results

Costs and Savings

The Alliant Energy RCx program provides incentives to the customer for services only. There are no incentives for implementing measures other than the requirement that the resultant package of measures with a 2 year payback must be implemented before the second 50% of the study is reimbursed. Note that research of other RCx programs indicates this is the most aggressive implementation requirement in the country. Most other programs require only specific measures with simple paybacks of less than 1.0 to 1.5 years. The Alliant Energy program requires all reasonably cost effective measures[4] that can fit into a package of measures with a combined two year simple payback to be implemented by the customer.

Figure 3 illustrates cost effectiveness from both the program and customer perspectives. It includes data from early projects only – those that have been implemented and verified with functional performance testing (FPT) to capture all costs and savings for this analysis.

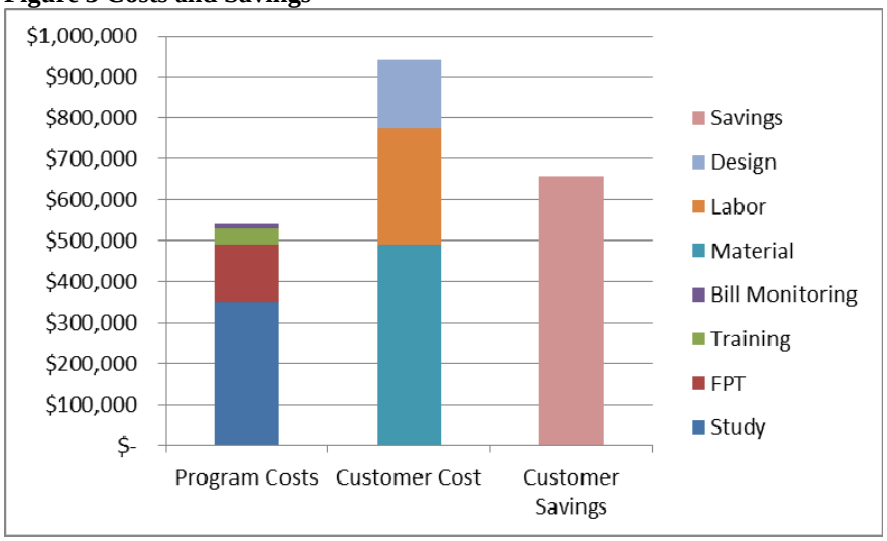
Program services covered for the customer include the study, functional performance testing (FPT) / verification of measures, training, and bill monitoring. Customer costs include implementation design assistance, labor, and materials. Services funded by the program are 83 cents for every dollar of customer savings. The customer pays $1.44 per dollar of energy saved, or a simple payback of 1.44 years.

As demonstrated in Figure 3, material costs and design assistance account for 70% of the customers' implementation costs. These elements deliver two distinct benefits. First, the material cost is indicative of spending extra for some measures to help ensure savings persist over the long term. An example of this is modifying a system and removing a pump rather than merely shutting it down. If the pump is removed, it will never use energy again.

Second, detailed RCx analyses and reports are for informational purposes and sound decision making only. They are not suitable for detailed implementation instructions for contractors. Design services convert chosen measures into detailed implementation direction for contractors and this ensures measures are implemented correctly and it also holds them accountable to complete the job as intended.

[4] Individual measures with a maximum of 5 year simple payback.

Figure 3 Costs and Savings

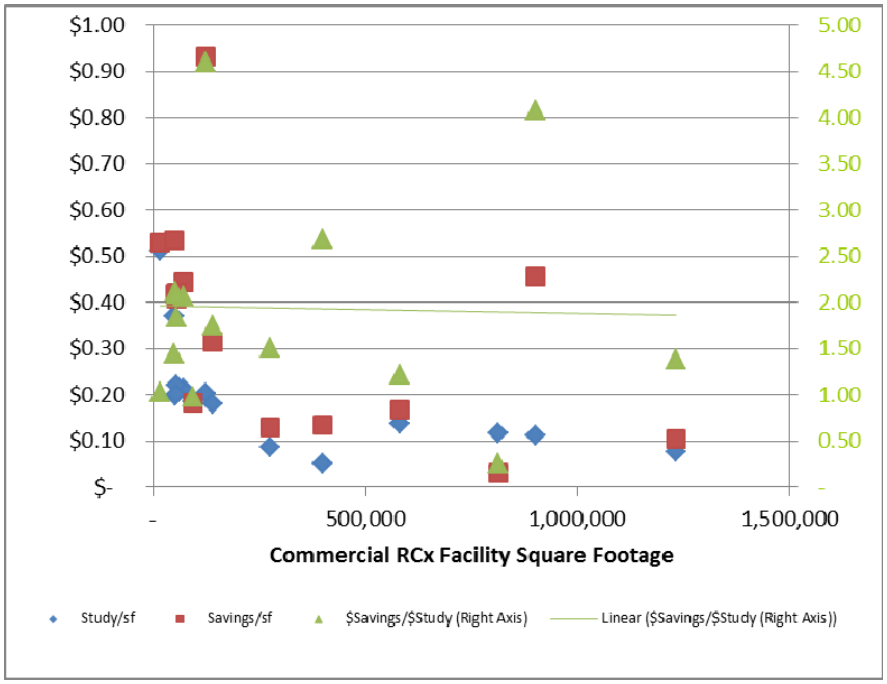


Facility Size

The official minimum facility size for the Alliant Energy program is 20,000 square feet, although an exception was made for one participant's facility which was only 15,000 square feet. Unlike other programs, which use a minimum facility size of 50,000 to 400,000 square feet, the Alliant Energy program uses projected savings and study cost; i.e., cost effectiveness as the primary metric for qualifying facilities for the program.

Figure 4 uses Alliant Energy project data from completed studies to demonstrate that small buildings can be cost effective for RCx. This sample of projects shows that RCx is slightly more cost effective for smaller buildings than large buildings as measured by ratio of savings to study cost (right scale).

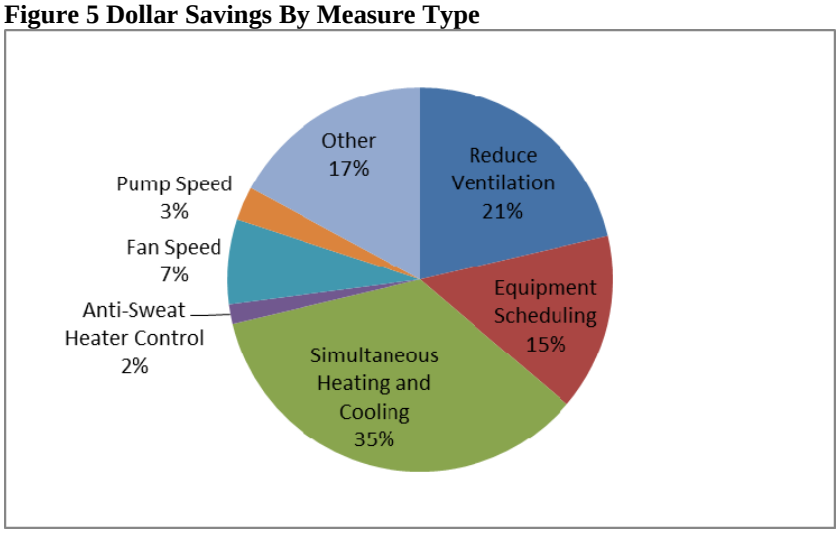
Figure 4 Building Size and Cost Effectiveness



Measures

Savings by RCx measure type from the Alliant Energy program are shown in Figure 5, which demonstrates that the greatest opportunity for savings is simultaneous heating and cooling reduction or elimination. This is a complex systemic interactive measure that affects both cooling energy and heating energy consumption and therefore, savings opportunities are substantial.

Figure 5 Dollar Savings By Measure Type



The Bottom Line

As described in the Alliant Energy RCx process above, savings for commercial buildings are estimated twice: once at the time of the study contract with the customer and again at the completion of the report. Measure implementation is verified during functional performance testing. Savings are proven on the customers' energy bills. The proposal estimates and the proven results to our knowledge are unique to the Alliant Energy program compared to all other programs in the United States.

Realization rates representing the proven results as a percentage of estimated savings are shown in Table 3. Billed savings for these projects include about 10 million kWh and 0.5 million therms.

Table 3 Estimated Savings versus Billed Savings

	kWh	Therm
Study to Actual	113%	94%
Proposal To Actual	125%	237%

The results demonstrate that savings estimates provided in study contracts for customers are very conservative. Actual billed savings exceed these predictions by 25% for electricity and 137% for natural gas. Study results using in-depth investigation, data logging, and detailed energy analyses are much closer with savings exceeding predictions by 13% for electricity and 6% low for actual natural gas savings.

Conclusions

Timothy Simonds, with Connecticut Light and Power, states, "If you do retro-commissioning the right way, it shouldn't just be a quick tune-up. You really need to spend time on the engineering side to

make sure you properly analyze the data to implement the right controls measures and then making sure they are delivering the savings" (Davis 2013).

This is precisely what the Alliant Energy program provides for its customers and the results are indisputable because customers can compare their bills before and after the program has run its course. Key elements for delivering deep savings include extensive engineering expertise for any and all types of measures and required assistance from study completion through testing and training.

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