White Paper

Retrocommissioning – Enjoy the Sausage

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Utility-sponsored energy efficiency programs have been in existence since the late 1970s, and over the course of the following 30-plus years, the vast majority of impacts have been achieved by one-off energy efficiency projects. These one-off projects may include the replacement or retrofit of thousands of lighting fixtures or the replacement of a chiller with a more efficient model.

Retrocommissioning, or RCx, on the other hand, has been around for about a decade. The concept has legs with DSM managers, regulators, and customers alike. However, RCx uptake and widespread implementation are anemic. E Source recently published a paper, which included impacts of the "top performers" in the country (Merson, Fife & Costlow 2013). The average impact for these 10 programs was only 4.75 GWh, annually. These programs are delivered in the nation's most populous states and urban areas, so clearly a lot is left on the table and in the pantry.

There are many probable reasons for the low participation and impact, but this paper focuses on one broad reason: confusion between a service-centric program like RCx and an object-centric program – the conventional energy efficiency program. Understanding the differences, and more importantly, addressing them and communicating them to customers is critical to "best in class" RCx.

This paper compares and contrasts RCx against conventional commercial and industrial energy retrofit programs and provides proven recommendations to increase uptake and program impacts.

Customers Buy RCx for One Reason

The first major difference between RCx and object-oriented (widget) programs is the customer's motivation to participate. Customers participate in RCx programs to:

- Save energy and money with a high return on investment.

This also flows into demonstrable benefits for energy performance (ENERGY STAR®), sustainability, improved cash flow and profitability, and typically improves comfort, related productivity, and reduced maintenance costs.

Customers may participate in object-oriented programs for one or more of a wide range of reasons:

- Equipment is nearing the end of its useful life.
- Equipment failed.
- Better performance, lighting, control, and/or reduce maintenance are desired.

- The customer's contractor gets a spiff, and benefits from improved marketing and greater margin for more costly efficient equipment.
- Facility expansion or other new construction.
- Added redundancy / capacity.

For the conventional object-oriented program, energy savings – the impact on the customer's cash flow, is not known or verified in almost any case. Once the equipment is installed and the incentive is received, the program has satisfied the participant in most cases. The customer has a tangible asset in the form of equipment and an incentive check to deposit to the bank account.

Retrocommissioning program participants don't receive an equipment upgrade and get very little in terms of tangible assets, and for most programs, no incentive check to deposit to the bank account.

Therefore, it is critical to demonstrate savings – the "asset" – to satisfy customers in a clear, concise, and indisputable way.

RCx is a Process, Not a Widget

Aside from possibly new construction programs, no other program category is as comprehensive as RCx. All RCx programs include some form of the following steps:

- Screening and qualification of customer facilities.
- Facility investigation and analysis.
- Implementation.
- Measurement and verification.

Some successful programs include other steps that are critical and other programs have bureaucratic, delaying, and unnecessary red tape. These include development of detailed implementation documents, functional (active) testing of measures, and customer training. Some programs require a planning phase, and assigning/selecting an RCx team.

In summary, not only is RCx like new construction in terms of comprehensiveness, it is similar to new construction in terms of the process, number of phases and timeline. The entire process from facility qualification through implemented measures takes a year or more in nearly all cases[1].

Conversely, customers may install an efficient piece of equipment with no added time. Whatever the reason for the project, it was likely to happen in some form, regardless of the program. Consider the reasons for retrofits noted above. The gratification of "energy efficiency" and the incentive check is, by comparison, instant. "I am installing a new chiller. What's my rebate?", is a common paraphrase for these participants.

[1] Not including RCx express or "tune-up" programs developed for small facilities and their common, simple equipment and systems.

Customers Can See Widgets but They Cannot See RCx

To most customers RCx is really an unknown; not only before it happens but even after it has been implemented. This is because the vast majority of customers cannot see or recognize control valves and dampers, fan and pump speeds, or water temperatures function in unison to substantially save energy and reduce energy cost.

Conversely, customers can see boilers making hot water; chillers making chilled water; new light fixtures light the space; and a new control system with boxes sporting LED displays and web browser interfaces.

To further complicate matters for RCx, the measures themselves can be very difficult to understand and comprehend. It takes an engineer several years of building energy modeling, analysis, and system response, particularly for energy consumption due to changes in control sequences to become an effective, successful RCx provider.

Typical is OK for Widgets, but not for RCx

Virtually all savings generated under DSM program portfolios (widgets) result from programs and measures that are at least vaguely understood. For example, trade allies including contractors, architect and engineering firms, distributors and equipment representatives understand that a 90% efficient boiler uses less energy than an 80% efficient boiler; and that a condensing unit for a split system air conditioner with a SEER of 18 uses less energy than a unit with a SEER of 14, all else equal. Some commercial customers may understand some of these concepts as well, but clearly the average person does not understand these concepts or there would be no need for ENERGY STAR®.

Most of the savings produced by DSM portfolios come from programs with prescriptive measures and as such, savings are calculated for the typical application. A minority of savings are generated by custom measures for which energy savings are determined for the specific application. In either case, the energy-saving concepts hold and the trade allies understand them.

Retrocommissioning, on the other hand, is not at all widely mastered by the “trade ally” community. While the market for RCx is enormous, measures are often ill-defined or unimaginable. It requires years of energy efficiency technical and program expertise, classroom, on-the-job, in-the-field training, backed with energy analysis, metering and monitoring to gain the knowledge to identify, develop, analyze and guide cost estimating for RCx measures and projects.

These qualified people and firms are in very short supply, as noted in numerous RCx program evaluation studies (Peters, Scholl & Wylie 2009), (Gunn, et al. 2013), (Merson, Fife & Costlow 2013). As noted by one utility DSM portfolio manager, the utility has the responsibility to train and educate qualified RCx providers to effectively participate in the program while achieving high levels of customer satisfaction in the process. It is not the utility’s responsibility to train

"trade allies" in the art and science of RCx. This is what many product and portfolio managers need to understand.

Widgets Offer Discrete Alternatives; RCx *Is* or *Is Not*

Modern commercial facilities require heating, cooling, ventilation, lighting, insulation, and windows. Customers can select from a nearly infinite variety of not only make, model and efficiency, but equipment and system types to boot. Trade allies can effectively promote efficient alternatives for these necessities. When buildings get built or systems/equipment needs replacement, trade allies are well suited to make informed decisions, on price including incentives for sure, and to a lesser extent, energy savings estimations, depending on the technology and application. These elements are required and therefore, alternatives are almost always considered. If program/portfolio marketing is doing its job at least these alternatives are considered.

This is not the case for commissioning and RCx. Commissioning, recommissioning, functional testing, and yes, RCx are all optional. Buildings can needlessly waste energy and provide an endless flow of problems for decades without ever being properly addressed and without building owners knowing it doesn't have to be that way. Retrocommissioning happens or it doesn't. It is not required like heating, cooling, lighting, and ventilation systems.

Moreover, energy, labor, and maintenance costs wasted by poorly performing systems can offset "savings" from choosing efficient alternatives during new construction or retrofit, many, many times over.

Successful RCx Program Elements

Having addressed fundamental differences between RCx and conventional incentive-based programs, DSM managers should consider the following recommendations for RCx program development.

Simple Messaging

"Keep Messaging Simple" is one of the five E Source tips for boosting RCx participation (Merson, Fife & Costlow 2013). This consists of simplified program rules and staying out of the technical mumbo jumbo when talking with customers about programs. Beyond these, the following key points are recommended.

Describe what RCx does and describe in high level terms each step of the process along with a typical and realistic timeline. Minimize perceived risk by placing boundaries on the customer commitment to make it easy for decision makers to say yes. What are these boundaries?

- Study cost reimbursement criteria - usually a commitment to implement all measures with a pre-defined simple payback period.
- Set a timeline for project milestones and completions. This is more for the program but customers understand there are limits and they want to know this.
- An implementation cost cap. Customers want to know not only the "return on investment"; they need to know the maximum they are required to invest.

Set Expectations

Since customers will not "see" what happens as a result of RCx and since they are doing RCx for one reason – to save energy/money – it is rather important to quantify the reason. Having a savings estimate is critical for customer/participant and administrator alike because neither wants to spend undue time and money on a study that will produce 25 cents savings on the dollar of study cost.

The typical realistic timeline should be explained in the promotional messaging as described above. Now, what is the timeline for the specific phase at hand whether that phase is the study, implementation documents, final cost estimating from contractors, and so on? Customers must be informed of the major milestones, what they consist of, and an approximate timeframe for completing them, step by step as the project rolls through the entire process – all phases. Milestone timelines should be in relation to customer approval to move forward with the various phases of RCx – study, implementation documents, implementation, and so on.

Setting expectations is also critical for service providers – the firms doing the investigative studies. This should be done in the screening and benchmarking process for each facility with the key metric being a comparison to peer buildings with similar systems in the same climate. Benchmarking facilities using energy intensity by fuel type and keeping them separate is all

important, as is ensuring the energy consumption data are representative of the conditioned floor space – not more, not less. This is tricky with multiple meters serving one building or one meter serving multiple buildings. Heating and cooling system types and fuel sources must also be factored into the estimate, as well as factors that will not be affected by RCx, such as a major lighting retrofit or an HVAC system conversion. These are capital improvements, not RCx measures, and thus won't be available for capture in the RCx project.

The service provider is then tasked with identifying the energy waste and developing RCx measures to reduce or eliminate the waste, or, they must explain why the savings cannot be cost-effectively achieved as projected with RCx. Service providers need to explain their findings in this context.

Control the Message and Expectations

Regular and consistent communication is critical during the major phases of the RCx process. While the customer won't care or understand why the installed variable air volume boxes cannot accommodate a reverse acting control sequence, they do want to know if the projected waste reduction / energy savings can be achieved with RCx or RCx-like measures.

From there the advice is straight forward but rarely executed – weekly status updates regarding the phase at hand. If there are delays, why, and who is responsible? It could be customer staff assigned to assist with the project. Over communicate status; control the message openly and fairly.

Include the controls contractor in the cost estimating for the study. It is crucial to have their involvement and buy-in during the study so there are minimal or no unpleasant surprises during the implementation phase. The study may identify and appropriately quantify savings, but if some quirk of the control system requires unanticipated extra cost that the controls contractor is best suited to identify, the expectations are blown and the customer is dissatisfied at minimum.

Control the Process

Expectations are set in the screening and benchmarking processes, they are controlled as the investigation, energy analysis and cost estimating are completed and included in the RCx report, but many programs lack the critical "miracle in the middle" – the necessary steps between study completion and final sign-off on implementation/testing. Consistent with Michaels' findings, Gunn notes that the implementation phase presents the greatest challenge as service providers are not engaged during this critical phase (Gunn, et al 2013). The result is delays in implementation, under-exploited opportunities, and missed savings for the program. Tso promotes similar recommendations for follow-up services after the studies are completed (Tso 2010).

The RCx report is a decision-making document with accurate (±10%) energy savings and implementation cost estimates. At this stage, the RCx project is similar to a new construction

project in terms of the steps required and delivery period. It is no more an implementation guide than is an artist's rendering of a new building. Architects do not "hand off" their programming report, which outlines the essential concepts of a building, to the contractors and turn them loose with excavators, concrete, and so on.

Like plans and specifications for new buildings, implementation documents for RCx include detailed specifications for implementing the measures to achieve the estimated savings. Implementation documents do not describe how to implement measures but what the functional requirements are – specifically, the control sequences that must be implemented. The program has to support this critical step or the equivalent of a missing wall or chiller wired to run in reverse will be built and no one will know it, until the energy bills don't indicate the projected success.

The final step in implementation is verification that measures were implemented as designed. This again is where many programs miss the boat – meaning, if the verification is passively conducted after the contractor closed the project and invoiced the customer, the ship has left the peer. The verification needs to be done with the controls contractor on site and this should be built into his pricing as noted in the RCx report.

Manage the Team

Retrocommissioning for energy savings in a utility program is substantially different than commissioning for new construction, LEED®, or water/air systems balancing. Unfortunately, these are the skill sets and expectations brought to the program by unwitting trade allies. Skillsets required of effective RCx service providers include expertise in systems control and, in particular, how they use energy. Energy analysis, control sequence literacy, and preferably, control sequence writing expertise, plus familiarity with program needs and requirements are also necessary skillsets.

Program evaluations have noted that service providers lamented of "insufficient compensation relative to the time planning projects, redundant paperwork requirements, delays in receiving approval to proceed…" among other things (Gunn, et al. 2013). Peters reported almost the same findings two time zones away (Peters, Scholl & Wylie 2009). Many of these issues are telltale signs of unfamiliarity with energy analyses and with program needs. Another comment by the same source included detrimental delays due to "back and forth" in the review process between service provider and program implementer.

Tso recommends reducing service-provider burdens by outsourcing detailed energy analyses to utility staff or their consultants (Tso 2010). Gunn states low-risk, high-reward measures are not given enough analysis attention and savings are left on the table (for the utility) (Gunn, et al. 2013). Peters states service providers are not providing consistent, adequate, explanatory data to support energy calculations. Calculation templates are recommended (Peters, Scholl & Wylie 2009).

Here's the problem with these recommendations. At least half the savings to be captured by RCx are from measures that a "state of the art" simulator like DOE-2 will not calculate because the system is a unique combination of design elements developed over the last 100 years. If DOE-2 isn't sufficient, a template won't be either. Additionally, regardless of how many buildings an experienced facility / energy efficiency / program expert has seen in two or three decades of facility investigation, trouble shooting and RCx, many measures are fundamentally unique energy-wise, and unimaginable – like fingerprints.

Calculation templates, if deployed perfectly (they won't be), may cover half the savings. Service providers must be able to customize savings calculations to match the fingerprints of their specific scenario. There is no way around it. If it is outsourced, there will be disgruntled providers as they will have already sold the customer, at least verbally, setting unrealistic expectations that will lead to trouble.

Service providers should be considered partners with the program and not "trade allies" in the traditional sense. They should work hand in glove with the implementation contractor.

Demonstrate Success

The only thing tangible to the customer as a result of an RCx project is the savings demonstrated by comparing energy bills before and after RCx implementation. Demonstrating savings in excess of 10% of the customer's total expenditure should not require complex weather normalization although normalization may be needed if building occupancy changes substantially.

The low-risk route to this destination is to manage and control the process rather than turning it over to the fellow behind the tree.

Parting Thoughts

Retrocommissioning is systematic sausage making. Customers won't want to know the ugly details but they should enjoy the end result and not have to get messy in the process.

The primary takeaways of this paper include:

1. Retrocommissioning is an extensive process with one main purpose: energy savings.
2. Projects need to be properly screened, examined, designed, implemented and tested, with handoff and management from step to step.
3. Service providers have to be experts in system control and energy use, controls sequencing, energy analysis and the objectives of the utility program. They need to be properly vetted and performance monitored.
4. The only thing the customer gets is savings – show it off.

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