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Retro-commissioning Best Practice Study

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Acknowledgements

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Executive Summary

This paper describes the results from a collaborative effort to identify retro-commissioning (RCx) program features that qualify as best practices. Adoption of these practices could help the Massachusetts Program Administrators (PAs) achieve higher levels of participation and savings through retro-commissioning. The program elements identified in this study as best practices include:

- Pre- screen potential project sites to ensure a good likelihood of significant RCx savings and to identify specific focus areas for the RCx study. Facilities that do not pass the pre-screening will not be eligible for RCx incentives.
- For applicants that pass the aggressive screening, provide incentives to cover the full RCx study cost, conditioned on a customer commitment to install all measures under a specified payback period or up to cost cap, at their own expense.
- Create a consistent statewide set of tools, templates, and protocols and provide training to help prequalified RCx providers deliver consistent and cost-effective services.
- Continuing support to the customer throughout the implementation phase of the project, including measurement and verification, hands-on operator training, and ongoing support.

Additional recommendations for potential program enhancements include:

- Evaluate integration of Monitoring Based Commissioning (MBCx) with the program elements above to retain continuity in the market, reduce savings uncertainty, and ensure measure persistence.¹
- Provide incentives for account managers to pursue RCx projects.

We note that additional research is required into the cost effectiveness of implementing the best practices and their potential for success and support within the MA market. Because there is an existing MBCx program being delivered, the PAs should manage the process and timeline for program changes to limit market disruptions.

We also note that the best RCx programs are a “market niche” offering for larger buildings (most programs have a minimum size threshold of 50 – 100,000 square feet), with relatively engaged, savvy, and motivated managers and building operators on staff and owners who are motivated to achieve operational savings.

Another key finding of the research was the long timeframe for RCx project development. Projects typically have a 2-3 year development cycle from intake to verified measure installation and owner training. While immediately eliminating the first cost barrier could be seen as a quick fix to garner increased enrollment, our research shows that incentives need to be coupled with many other factors in order for measures to move past implementation and persist in the long term. These other factors include rigorous screening, use of qualified providers, and standardized tools.

¹ MA currently offers a market-based MBCx program, but the program structure is significantly different from the practices outlined above.

Retro-commissioning Definitions

Retro-commissioning (RCx) is the process of applying a rigorous testing, verification, and upgrade protocol to an existing building control system to identify and correct operational inefficiencies. RCx can be coupled with a monitoring system which uses metering and software to provide energy performance feedback directly to building operators and/or PAs. RCx that is facilitated by such a monitoring system is called monitoring based commissioning (MBCx).

Introduction

The Massachusetts Energy Efficiency Advisory Council Consultant Team (Consultant Team) proposed to complete a study of best practices in RCx program design and delivery in collaboration with the MA Program Administrators (PAs). RCx best practice was selected as a study area because RCx has historically been a challenging market with many barriers and short measure lives. The Consultant Team and the PAs wanted to ensure that the Massachusetts programs are optimized to address market barriers while generating reliable savings and meeting cost effectiveness requirements.

Process

The study concept was introduced at the C&I Management Committee (CIMC) in the fall of 2013. A research group was formed consisting of representatives from the Consultant Team, Northeast Utilities, National Grid, a PA Consultant, and periodic participation by Liberty Utilities and the Cape Light Compact.² The group developed a set of criteria that would be used to identify best practices (see Appendix A), established a solid understanding of the MA MBCx program, and identified programs in other areas with effective elements that were potential best practices. The Consultant Team interviewed the program managers from four leading RCx programs; a fifth program of interest was not responsive to interview requests. Program information was also collected from a literature review. The programs that were investigated are summarized in Appendix B and the program elements that were ranked are in Appendix C and D.

The Consultant Team documented 44 effective RCx program practices from the research (Appendix D). Each program component was scored against the best practice criteria using the following scale:

- 1 = best practice criteria satisfied
- 0 = don't know or not applicable
- -1 = does not satisfy the best practice criteria

The results were compiled and reviewed both in terms of the total scores and the top five elements scored by the five core members of the research group. The results had a single cluster around the need for tools and information to improve the consistency and cost effectiveness of engineering analysis. Other than that, the results were inconclusive.

² Team members include: Jennifer Chiodo and Cliff McDonald (Consultant Team); Adam Jennings (NU), Amit Kulkarni (NG), Doug Baston (PA Consultant), Matt Zenni (LU), Nicole Price Voudren (CLC)

Due to the inconclusive results, the group evaluated the scoring process and identified several issues.

- Without the in-depth discussion that occurred when reviewing the results, members did not have enough information about the interactions and effectiveness of program elements to accurately rank them.
- The elements were disparate and some were repetitive.
- The scoring system was not applied consistently by the group and did not provide enough gradation in scoring elements against the criteria.
- The criteria were not always clear.

To address these issues, the group agreed that elements should be combined with the associated program characteristics necessary for them to be effective. The list was streamlined from 44 to 13 effective program components. The scoring system was changed to a 1-5 system with 5 indicating “fully satisfies criteria” and 1 indicating “does not satisfy.” The best practice criteria were refined so that each criterion (such as adoption or persistence) could be scored independently.

The second round of scoring was completed and compiled. The results had much greater consistency in scoring by the research group. The top three elements were scored in the top 5 of all core group members.

Findings

Based on the research and rankings, the group identified the following programs and elements that should be investigated for applicability in the Massachusetts existing building market. The program elements below are the top five rated elements. See Appendix C for a full list of elements and their scores. Because there is an existing program being delivered, the process and timeline for program changes will need to be managed by the PAs to limit market disruptions. The five top ranked program elements are:

Overall Rank	Element Description
1	RCx provider gives on-going support through implementation and operation including: - Commissioning for measures implemented as a result of the RCx study - M&V - Building operator training
2	Savings estimates developed by RCx providers using a consistent statewide set of approved tools; reviewed by program administrator and validated through M&V provided by RCx provider
3	Control costs of RCx study with an in-house budgeting tool and a joint scoping exercise with the customer, PA, RCx provider and controls contractor
4	Aggressive screening of potential participants to reduce risk, combined with up front incentives covering study cost
5	Energy Management Information System (EMIS)/interval meters directly funded by PA. Ongoing support to assure savings and measure persistence

Potential Integration into RCx Program Design

The following narrative synthesizes the top five ranked elements into a potential program design based on best practice. There are several steps that are required before final decisions can be made regarding program changes. These are discussed within the program element narratives below and in the *Next Steps* section following the program narrative.

Project Pre-qualification Screening

In order to ensure value for ratepayers and customers investing in RCx and MBCx it is critical to carefully screen participants. RCx can generate significant savings for qualified participants, but in best practice it is only applied to larger buildings or facilities with larger loads. *RCx is not a good solution for small buildings.* While careful pre-qualification (PQ) does limit participation, it is a best practice to ensure the success and cost-effectiveness of RCx and MBCx projects, especially when coupled with higher levels of up front incentives.

Implementing a rigorous PQ process would be a significant change from the current program in MA which is currently open to all customers. It would be possible to leave the existing program in place while rolling out a new, more focused RCx program that includes a rigorous PQ protocol including consideration of the following factors.

- Minimum building size thresholds (e.g. 50-100,000 square feet³)
- Minimum load thresholds (PG&E uses 1MWh or 50k therms, ComEd requires a peak demand of at least 500 kW)
- Customer commitment and capacity
 - RCx projects typically take two to three years to implement with the studies completed in year 1, funding for measures and measure implementation in years 2 and/or 3 and verification shortly thereafter. This requires customers to be engaged for a significant period of time. Building operators need to be capable of and committed to more efficient operations introduced through RCx to support achievement and persistence of savings.
 - All programs reviewed combine an incentive payment of 100% of the cost of the RCx study with a requirement that the customer agree to implement all measures up to a certain threshold. BC Hydro, CenterPoint, and PG&E all require that the customer implement all measures under a certain payback (2 years for BC Hydro, 1.5 for Centerpoint, and 1 for PG&E) to a maximum customer investment in the RCx measures of \$0.25 per square foot.
- Other indicators of RCx potential, including changes in building occupancy or use, building performance issues, occupant complaints, or high energy use intensity.
- Building type: Data centers⁴, commercial offices, hospitals, bio-tech, larger schools and universities are all good potential candidates for RCx.
- Presence of a digital HVAC control system, known as a building automation system (BAS) (desirable, but not a pre-requisite).

³ 50,000 sq ft is used as a threshold by PG&E, Centerpoint Energy uses 100,000 sq ft.

⁴ PG&E was the only PA interviewed that identified specific building types that indicated good RCx potential. PG&E included data centers in their list of buildings with good RCx potential.

For further development of this element in Massachusetts, a review of customer size by PA would be necessary to estimate the impact of PQ thresholds on market potential for RCx participation rates and savings. With rigorous screening coupled with other effective program practices, PAs are seeing RCx savings between 2% and 10% of total building load.⁵ This information could be used to support market potential and cost effectiveness analysis by the PAs. PAs could begin to test the use of project PQ protocols and processes in the near term to inform more formal program development.

Provider Qualification

RCx and MBCx providers have a range of experience, expertise and skill. In order to ensure consistent results for participants and reliable savings estimates, the PAs interviewed use an RFP/RFQ process to pre-qualify the providers and in multiple cases, the PAs contract directly with providers to improve management and cost controls. Massachusetts has a strong record of pursuing market based solutions in the larger customer market which would be more consistent with supporting a customer/provider contract structure using prequalified and trained providers. The tradeoff is that the PA/provider contract model can provide for more consistent management of service delivery and cost.

The provider prequalification process is typically initiated by the PAs issuing periodic requests for proposals for RCx providers and selecting a limited number of qualified providers to deliver RCx services under the program. The selected providers are fully trained on the program requirements. Procedures for assigning providers to projects typically takes into account equitable distribution of projects among providers, provider specialization (such as data centers or hospitals) and location. This model is very similar to the protocol the Massachusetts PAs have used for some time to prequalify TA service providers.

PAs implement quality assurance processes to ensure the providers are delivering services in accordance with program requirements. PG&E indicated that it often takes a couple of years to get providers fully up to speed on the program and its tools, and they invest the time to help the providers get there.

RCx provider pre-qualification can be implemented easily by releasing an RFP asking for qualified RCx firms.

RCx Tools

In addition to provider pre-qualification, a consistent set of tools used to streamline the RCx process and calculate savings for common RCx measures will help ensure that savings are estimated consistently and accurately, and that the engineering costs of creating the estimates are not excessive. Tools and guidelines may include protocols on how to define the baseline, savings analysis tools, and report templates. RCx providers can be trained on how to use the tools as part of the qualification process. This set of tools will allow the lower the cost of the RCx study and thus ensure the cost effectiveness of 100% funding for RCx studies.

For further development, the PAs could contact the Portland Energy Conservation Initiative (PECI), which operates the California Commissioning Collaborative (CCC) and developed the analysis tools and templates used by some of the PAs interviewed. PECI could provide information on the cost of tool development and revision for applicability in

⁵ Centerpoint has reported an average of a 15% reduction in energy use and a 10% reduction in peak demand, although these results have not been evaluated.

the MA market as well as provider RFPs, screening and training support. The PAs could investigate the potential to build of the CCC work with PECl which is likely to be more cost effective than starting from scratch.

Enrollment and Incentives

Once a project is pre-qualified the customer is enrolled. All of the PAs interviewed provide a customer incentive that covers 100% of the RCx study cost, coupled to a requirement that the customer commit to install all measures with a specified payback (ranging from 1-2 years) and a total spending cap of \$0.25/square foot for the facility. This approach limits the customer risk and eliminates the first cost barrier of the study. If the customer does not implement the measures, they are responsible for the study cost. One PA that supports the RCx contract between the customer and the provider has established milestones at which the PA reimburses the customer as the project progresses. Cost effectiveness will be a key concern as the PAs look at the potential for implementing the practices outlined in this narrative; this analysis is discussed in the *Next Steps* section below.

Scoping Walk-through

One significant issue with RCx projects is that the scope is often too broad. This results in very expensive engineering studies which can be overwhelming for the customers resulting in paralysis. An innovative practice used by one PA to address this issue is a collaborative project scoping exercise. Project scoping is undertaken by a team, including:

- PA Engineer
- PA assigned RCx provider engineer
- Customer building operator
- Customer controls contractor

The team performs a joint walk through of the facility to identify the best candidates to be addressed in the RCx study. Based on the scoping study, the RCx provider documents the potential areas to be addressed in the RCx study in an ASHRAE Level 1 Audit. This serves as a final qualifying step for the customer/project and helps ensure that project expectations and budgets are in line with the potential scope of the savings. Based on this scoping meeting, the RCx provider and PA establish the project scope of work and budget.

PG&E implements this approach by contracting directly with the RCx provider. If the walk-through indicates that the facility is not a good candidate for RCx, or if the project does not progress after the walk-through, the provider does not have to be compensated for a full RCx study. Providers should be compensated for performed tasks required by the program; the incentive design should take this into account. PG&E, for example has developed a project budgeting tool which they use to establish the RCx budget for the scoping walk-through as well as any follow up by the RCx provider based on the walk-through. This tool ensures that RCx providers are compensated in a fair and consistent manner. PG&E developed their in house tool based on years of experience working with RCx studies and providers. Again, the PG&E contracting model allows for strong quality and cost controls.

For further development, the PAs can develop a walk-through approach to develop focused scopes of work which are likely to advance to implementation on custom RCx projects.

Project Implementation & Follow-up

In all programs reviewed, the RCx process includes about one year for the development of the RCx report. Once the report is developed, the provider and PA meet with the customer to review the opportunities, identify any measures that qualify for custom incentives, and agree on the scope and timeframe for project implementation. The PAs interviewed fully fund the engagement of the RCx provider through project implementation and operations. PG&E funds an M&V plan as part of the RCx study and the delivery of project M&V by the RCx provider after implementation. PG&E claims savings based on the provider's M&V report. The other PAs claim savings based on savings in the RCx study.

The programs typically support the engagement of the RCx provider with the customer to provide training and ongoing support and feedback to the building operators and ensure measure implementation and operation through year five of the project. Longer-term RCx provider engagement offers several benefits:

- Provides a resource to increase and maintain the knowledge and skill levels of building operators
- Ensures and documents measure persistence
- Establishes a feedback loop to increase provider understanding of the benefits and draw-backs of various control improvements over time, resulting in more accurate savings estimates and better projects.

While there was consistent funding for ongoing RCx provider engagement across the PAs surveyed, the hours supported and specific expectations of activities were not investigated in this study. For further development, additional research is required to understand the costs and benefits of this level of RCx provider engagement.

MBCx Program Integration

Two of the PAs interviewed (BC Hydro and PG&E) offered a monitoring based commissioning program. The BC Hydro program includes the installation of whole building interval data meters for electric and gas coupled with energy management and information system (EMIS) software to provide customers and the PA with analysis of energy use, trends, and savings. The PA has specific requirements for system performance, data aggregation, and data analytics. They contract directly with EMIS providers who install building level gas and electric metering equipment and provide software and support for the customers. The EMIS was intended to support savings estimates by providing baseline data before measure installation and data for use in the measurement and verification of savings after implementation. It has been found to be effective for developing the baseline but less so for M&V.. They have found that for simpler buildings, such as commercial offices, the EMIS is a good tool to validate savings. For more complex buildings like hospitals and laboratories, whole building meters have been less useful in predicting or verifying savings; more robust metering and EMIS would likely be required to support MBCx.

In California, there is a statewide MBCx program administered by the State through the PAs in partnership with the University of California (UC) System. This program has been in place for many years and is not available to customers outside of the UC system. This study did not investigate California's UC MBCx in depth.

The MA program currently is designed around market based MBCx in which the MBCx and RCx providers are contracted directly by the customer to install metering and analyze savings opportunities. The customer then implements measures and incentives are provided based on proven savings.

Before implementation in MA, further investigation would be needed as to whether a basic level of EMIS could be cost effectively implemented to improve the understanding of baseline performance, measure analysis, and performance monitoring. The investigation would give a better idea of the costs and benefits of EMIS and would help the PAs understand when and how to integrate it into a modified program design.

Next Steps

There are several steps necessary to support the enhancement or redesign of the MA MBCx program. These steps are more overarching than the *Further Development* steps documented above and will typically be supported by that development work.

- Cost/benefit analysis – additional research is necessary to understand the costs and benefits of a revised program approach using Massachusetts screening criteria. All of the PAs interviewed indicate that their programs are cost effective using their local avoided cost tests and meet the program screening requirements of the commissions that oversee them.
- Stakeholder engagement – once a straw proposal is developed, it will be important to review the concept with a broad sample of RCx Providers, EMIS providers, and potential participants in a systematic way to ensure that revisions to the program design address the market barriers and characteristics unique to Massachusetts.
- Tool development - consistent tools, criteria, and training are necessary to increase the consistency and cost effectiveness of RCx studies.⁶
- Incentive structures - address PA incentive structures that may reduce the account manager incentives to promote RCx projects. Because RCx measures have a short life and a long development time, current internal PA incentive structures discourage account managers from promoting RCx. However, eliminating the customer first cost barrier may be seen as a significant benefit that would make promotion of RCx easier for account managers.

Conclusion

RCx presents a significant and cost effective mechanism to measurably increase the efficiency of building operations for medium and large customers that have the right combination of size, engaged building management staff, and motivated owners. In order to best serve the market, it is important to address first cost barriers and implement rigorous quality control protocols to ensure projects and providers are consistent with customer and utility expectations.

While a valuable part of the overall portfolio, RCx is not a near-term savings opportunity. Projects typically have a two to three year development cycle from inception to verified installation. This means that program changes made in 2014 will not yield substantial results until 2016.

⁶ Tool development is discussed under Further Development in the section above. It is replicated here because its unique ranking as a high priority best practice by all parties in the first round of assessment warrants additional emphasis.

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Appendix A: Best Practice Criteria

The research group agreed to establish a list of criteria that would be used to identify best practices. The following are the final criteria used to identify best practices. A weight was applied to the scores (shown in parenthesis).

The following are the criteria used for the final ranking:

- Supports increased measure adoption (1.0)
- Supports high levels of participation by qualified customers (1.0)
- Generates deep savings (1.0)
- Supports persistence of savings at customer site (1.0)
- Addresses barriers: Owner lack of confidence in savings; limited owner capacity, AND/OR difficulty in identifying projects that are good candidates for RCx (0.9)
- Addresses first cost barriers associated with engineering study (0.9)
- Increases customer awareness of benefits (0.9)
- Helps ensure that engineering effort is sufficient and not disproportionate (0.9)
- Shows reasonable promise to reduce the need for incentive dollars over time (0.9)
- Accurately quantified and reported program results (0.8)

The original criteria included:

- Address barriers to increase measure adoption and persistence (1)
- High levels of participation (1)
- Generate deep savings (1)
- Address a variety of identified market barriers in addition to first cost (0.9)
- Customer Awareness of Benefits (0.9)
- Engineering effort sufficient and not disproportionate (0.9)
- Shows reasonable promise to reduce the need for incentive dollars over time (0.9)
- Accurately quantified and reported program results Evaluated program results (0.8)
- Evaluated program results (0.8)



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Appendix B: RCx Program Summaries

The programs reviewed included:

- MassSaves MBCx
- Centerpoint Energy RCx
- PG&E RCx
- BC Hydro MBCx
- California Commissioning Collaborative

The following highlights elements of the programs that were of interest as potential best practice program components.

Massachusetts MBCx

The Massachusetts MBCx program is vendor driven. Early on there was involvement by Account Managers, but the uptake, savings and persistence has been low, making it less desirable than traditional equipment driven efficiency projects. The program design includes incentives for proven energy savings after the RCx study is completed, monitoring equipment installed, baselines established and measures installed and tracked. The PAs perform pre and post installation inspections. Incentives are provided after the savings have begun to accrue and are documented. Incentives are \$0.075/kWh and \$0.75/therm. Measure lives are five years.

This program design has the advantage of being market driven. However, it may not offer enough incentive money to overcome the risk aversion and first cost barriers that most C&I customers face when considering RCx and MBCx. Vendors who had originally pushed for the program are looking to develop a revised cost structure due to insufficient revenue generated with the current approach.

The MA PAs also offer more traditional RCx project support on a custom basis to large customers in which the PAs support study costs up front with the requirement that measures be implemented. This approach is used on a very limited basis for large customers – typically those with MOUs.

Centerpoint Energy RCx (Houston)

Centerpoint redesigned their RCx program in 2014 in order to expand customer eligibility and streamline program processes. Customers must be at least 100,000 sq ft in order to qualify for the RCx program, and Centerpoint further screens facilities, looking for building with high existing EUIs. The program pays for the full cost of the RCx study, on the condition that the customer agrees to implement all measures with a 1.5 year payback, up to a maximum of \$0.03/sf (although almost all projects have paid more than this).

Most marketing for the program is done through the RCx firms, which are pre-qualified using an RFQ process. When an RCx provider brings a customer into the program, the first step is to produce a pre-assessment report. This report is

completed as part of the application screening process, and uses utility data and programs such as Retroficiency to benchmark the facility against comparable peers and to identify end uses with particular savings potential. If the facility shows promise for cost-effective savings, the project moves to the Investigation Phase, and the pre-assessment report is used to help focus the scope of the RCx study.

Once the detailed RCx report has been produced, it is the owner's responsibility to implement the identified measures – the RCx agent does not provide much support through this phase. If the owner fails to do implement, he is required to pay back the cost of the RCx study. When the measures have been implemented, the Rx agent returns to the site for a verification visit. During this visit, the agent verifies that the measures have been installed correctly and updates savings calculations to reflect the actual site conditions. The report will also include a concise document stating what changes were made and the reason those changes were made. This document will be posted on site for the reference of the facility operators.

Between 2004 and 2012, Centerpoint completed a total of 64 projects, and has 28 more in the pipeline for 2013. These projects have seen an average of 15% of energy use, and have seen a 10% decline in peak demand. This equates to an annual energy cost savings of \$0.128/sf for implementation costs of \$0.08/sf – less than a one year payback.

PG&E RCx

PG&E recently redesigned their RCx program to address several issues including customer risk aversion and engineering costs that were sometimes too high to be supported by potential savings. Their new program design includes several effective elements.

The program is delivered by PG&E and a team of prequalified commissioning providers directly contracted to PG&E. Projects are pre-screened using the following criteria: 50,000 sq.ft., or annual consumption greater than either 1,000,000 kWh or 50,000 therms. The program is marketed directly to customers meeting those criteria by account managers who help customers complete and submit the application form. The project is then further screened through a telephone call to the customer by PA engineering staff to verify that the project is a strong candidate (additional criteria include high energy use intensity, recent change of use, comfort problems, and customer capacity and commitment to undertake the work is investigated). The project is assigned to an RCx provider.

A joint scoping site visit is held including the RCx provider, a PG&E Engineer, the controls contractor and a customer representative. An ASHRAE Level 1 Audit is conducted and the project scope is determined. PG&E then further screens the project by inputting data to a spreadsheet based tool which qualifies the building. A budget is developed by PG&E based on their experience with past projects and the RCx provider is authorized to proceed with the study and implementation scope under the approved budget.

The RCx provider works directly with the customer to develop an RCx study based on the approved work scope in the first year of the project. The customer is responsible for implementation of projects up to a \$25,000 investment or a one year payback, whichever is lower. The RCx provider supports the customer in project implementation and provides operator training, commissioning and measurement and verification of measure performance (funded by PG&E). The provider reports the M&V results to PG&E and those results are used as the actual savings claim for the project.

PG&E's program includes the following additional elements:

- RFP for RCx providers – program only engages with qualified providers
- Standardized tools and provider training for analyses, reports and M&V.
- Feedback loop in which providers get feedback on measure performance to support continuous improvement.

BC Hydro

The BC Hydro (BCH) program incorporates MBCx and RCx. BCH contracts with Energy Management Information System (EMIS) vendors who install whole building electric and gas interval meters and EMIS software prior to project inception. BCH uses size and load based screening criteria for customers and has achieved 60% market penetration of its target market with this program.

BCH prequalifies RCx providers who contract directly with the customer. The BCH incentives have covered 100% of the study cost until recently. Because of the high level of market penetration, BCH determined that the program and market have reached maturity and the program is now requiring a customer cost share on the engineering study. BCH pays out incentives to the customer to cover study costs as specific project milestones are reached so that the customer outlay is not excessive at any point in the process. BCH indicated that their interest is to mitigate customer risk with the program design.

The RCx provider undertakes the study in year one and uses the EMIS to develop baseline data. The providers use tools developed by PECEI for analysis and reporting. Customers are responsible for implementing projects within 18 months of receiving the reports.

Customers can choose to have ongoing engagement with either the EMIS vendor or the RCx provider for three years after project implementation. The RCx providers are responsible for a moderate level of implementation support, measure verification and customer training all of which is included under the project incentive.

The original intent of the EMIS element was to use the data for project and program M&V. BCH is just beginning to undertake this type of data assessment. The program has been in place since the mid-2000's.

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Appendix C: Synthesized Program Elements

Rank	Element Description	Score
1	RCx provider gives on-going support through implementation and operation including: commissioning for measures M&V Building operator training	137.2
2	Savings estimates developed by RCx providers using approved tools; reviewed by program administrator and validated through M&V provided by RCx provider	137.1
3	Control costs of RCx study with an in-house budgeting tool and a joint scoping exercise with the customer	132.95
4	Aggressive screening of potential participants to reduce risk, combined with up front incentives covering study cost	128.2
5	EMIS/interval meters directly funded by PA. Ongoing EMIS support is given. Provides assurance of savings and measure persistence	126.8
6	Engineering analysis tools to standardize savings calculations	122.75
7	Incentive covers the full study cost, but must be repaid if customer doesn't implement measures under a specified payback	119.9
8	Providers are required to check-in on projects 2-6 years after implementation to ensure measures are still operating and provide building operator training.	119.2
9	Outward facing web based tools for customers and providers (ex. templates, best practice guidelines, case studies)	113.9
10	RCx providers are prequalified by RFP process and provided training on the program.	102.45
11	Program marketed by key account managers	101.4
12	Use utility bill regression analysis to create savings estimates	95.9
13	Hold regular public meetings and webinars as outreach for program	91.9

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Appendix D: All Program Elements

Rank	Element Description	Key benefits
1	Web based tools for providers and customers - report templates, best practice guidelines, EBCx energy calc tools (BOA and CBOA, fans, pumps) library of relevant reports, linked in site for hot topics. Case study library. EBCx M&V guide.	Increase market knowledge; tools reduce cost, increase trust in engineering estimates, reduce review time, increase owner confidence.
2	Program Delivery: Standardized analysis tools: BOA - standard measures CBOA - custom measures http://www.cacx.org/resources/rcxtools/spreadsheet_tools.html (Don't expect immediate results - people have to learn the tools and you have to test them and work out the kinks - PG&E is seeing increased use of the more recently introduced CBOA) Need to provide training)	Reduce engineering cost, improve consistency of savings analysis. PGE reports overall their costs have come down since the roll out of the redesigned program - they built cost controls into the entire process.
3	EMIS directly funded by PA RCx study is contracted by customer and paid 100% (historically) by PA based on completion milestones - (now that 60% of market served transitioning to cost share for study) customer implements measures with 2 yr payback up to \$0.25/sq ft)	Eliminates customer first cost barriers. Very high rate of adoption of 2 year payback bundle. Customers don't know the value of studies until they see them. EMIS doesn't save energy so customers are hesitant to invest, but it proves savings which gives customer, provider and PA confidence
4	Program delivery: RCx provider supports customer during implementation (PA pays) - provider knows what should be done and how; can review bids; does limited commissioning on completed installations; undertakes M&V in accordance with plan; reports verified savings to PA which PA uses for claim; provides training and follow up to operators.	Increases persistence and accuracy of savings claim
5	List of 38 standard RCx measures and Excel based calculator for providers	Increases consistency of services and savings estimates
6	Standardized tools developed by PECl	Reduce cost, increase consistency

7	Centralized organization disseminating information and supporting PAs, owners and market actors in promoting and implementing cost effective Cx programs.	Market transformation - over time CA market actors are increasing RCx. PG&E operates 4 separate RCX programs
8	Customer has ~ 18 months to implement 2 year bundle. RCx consultant goes back for 4 quarterly coaching visits - PA paid.	Customer paid implementation is where savings come from. RCx visits increase implementation and persistence as well as providing feedback to providers about what actually works
9	Additional customer support - customers choose either EMIS support or RCx provider support. To finish out the 5 year measure life	Persistence and repeat participation at end of project term
10	Incentive design: pay 100% engineering costs and require owner to pay for all measures with 1 year payback or less up to \$0.25/sq ft. - if customer fails to implement, must reimburse study cost.	Minimizes customer risk, overcomes first cost barrier, increases likelihood of measure installation due to pre-agreed customer commitment
11	Two parallel components to delivery: 1. Traditional RCx study using prequalified providers (about one year) 2. Prequalified vendors install interval meters on electric and gas at site.	Providing energy monitoring (real time with trending and analysis) helps customer see benefits of RCx work.
12	Pre-qualified provider and a PA developed list of measures. Provider training.	Increase efficiency and consistency of project development
13	Campus customers - enroll buildings in phases - program provides EMIS for all buildings from initial enrollment. Undertake RCx and support buildings for 10 years.	one time enrollment - simplifies comprehensive participation for large customers
14	PA puts out tenders with specific requirements for EMIS systems. PA selected and holds contracts of EMIS vendors. Vendors deliver operable systems. (Ideal scenario is that vendors would roll up the savings from their sites and report to PA).	PA risk mitigation, customer risk mitigation
15	Program delivery: pre-qualified RCx providers through an RFP process contracted directly through PA - providers prepare a comprehensive study including low/no cost and longer payback measures. Providers document an M&V Plan as part of the study.	Reduces PA and customer risk, improves quality, cost effectiveness (over time) and savings
16	Follow-up - at year 6 after start of project, check in with customer to identify additional opportunities or support required- RCx coaching - use the PECE findings work book. Providers know they cannot walk away and need to deliver the	Fills the pipeline and keeps customer focused on operations

	savings.	
17	RCx agents visit the site after implementation, to ensure all measures have been implemented to spec. Produce a report verifying correct installation, clearly stating changes and reasons for change (to post on-site for facility staff reference) and calculating updated savings	Verifies savings have indeed been captured, provides education for facility staff on the changes and how they work.
18	Education: 2 public meetings/year (~40 attendees), 5 webinars/year 90-130 attendees	Increase market knowledge
19	Incentive design includes: \$400/kW & \$5/dekatherm + 75% cost of engineering study up to \$25k + implementation bonus of \$0.03/kWh and/or \$3/Dth for measures implemented within 9 months	Customer risk barriers are reduced; bonus encourages adoption which provides savings
20	Find a way to create whole building savings using pre post utility bills - since Cx focuses on optimizing operations it is difficult and costly to account for each individual measure	Increase cost effectiveness - reduce program cost burden, increase savings reliability
21	MBCx - 3rd party statewide program available for State UC System only. (not addressed in detail) 12 year measure life.	Longer life for MBCx measures help to offset the investment and supported by the higher level of engagement by the UC staff.
22	Intake process includes screening for size and ability to take on the level of work at the facility (by owner). Also requires customer to commit to pay for measures up to 2 year payback with a cap of \$0.25 or \$0.30 per sq ft that are identified.	Reduce PA risk by ensuring the projects are well qualified and owner is committed to the study and implementation
23	Rigorous project qualification process - 1. customer application - thresholds: 50k sq ft, 1GWh or 50k therms, building performance issues - complaints, high EUI, change in occupancy, repurpose - different use, DDC improves candidate, but not mandatory. 2. PA engineering review - phone screen by PA staff to verify candidate 3. Field visit - PA engineer, RCx provider, controls provider, customer - joint on site scoping (ASHRAE lvi 1) and verify committed customer willing to make time investment 4. PA spreadsheet scoring tool (benchmark and other data) to verify candidate 5. PA assigns engineering study budget	Reduces PA and customer risk by ensuring project is a good candidate, focusing the engineering on a pre-agreed area with identified potential; Increases likelihood of successful implementation by having agreed upon area of focus Cost control through PA budgeting process (this was developed over time)
24	Program Delivery: Engineering cost management approach: - In house budgeting tool - based on benchmark hours and costs against program data - know how long it takes to set up loggers, do trend analysis and analyze via spreadsheets - Curb costs with joint scoping exercise	Controlling study costs reduces PA risk by ensuring consistent, reasonable, known project costs and predictable cost/benefit
25	Customer holds RCx provider contract and gets reimbursed at	Reduced PA contracting

	the end of each phase.	
26	Two paths - customer engages providers for the following with no direct funding: MBCx - customer contracts with vendor into service contract with 2 yr maintenance contract RCx - assumes study and implementation completed in yr 1 and provider undertakes M&V and tracking for two years	
27	EMIS vendors are prequalified based on capability to provide utility specified data	Ensure data quality and develop emv capabilities based on monitoring.
28	EMV based on whole building EMIS simulation models works some of the time. Not for complex buildings like hospitals, labs, etc.	Savings verification via whole building measurement increases PA and customer confidence where it works. (Not fully implemented yet by BCH)
29	Key account managers market programs. PA offered to pilot the program and had very high response rate in '07	
30	Measure lives depend on measure type: Repair: fix economizer, dampers, linkages: 3 yr Reset: chilled water, etc.: 5yr Record: VFDs on fans & pumps: 8yr Capital measures - custom program	Improves lifetime savings and program cost effectiveness
31	Savings estimates are those developed by RCx providers.	Engineering based estimates typically improve with the feedback loop
32	Vendor independently develops: facility benchmark, facility description of HVAC, EMS, and Ltg systems; Provides ASHRAE Level 1 Audit, Develops cost and savings estimates - then submits to PA for prequalification	
33	Use Retroficiency with interval metering data to pre-qualify participants. Participants have to implement measures with <1.5 year payback for a max of \$0.03/sf or repay RCx cost.	Ensures customer is a good candidate for RCx and will implement the measures that are found
34	Pays RCx agents on a standardized per square foot fee	Provides a fair and predictable price for the RCx study and ensures cost-effectiveness
35	PA performs pre and post installation inspections (pre-inspection occurs after the application is received; post inspection occurs after installation)	
36	100,000 sf and DDC trending, benchmark building	Reduces PA risk as these buildings are strong candidates for RCx

37	Commercial Buildings over 100,000 sf. If buildings under 100,000 sf want to participate, they will work with them, for example by aggregating multiple facilities	Increases pool of potential participants
38	Incentives paid only after savings are verified: \$07.5/kWh and \$0.75/therm capped at first yr cost of study and implementation	
39	Savings estimates are developed by RCx Providers and reviewed by program administrator. Bin calculations are preferred.	Reduces risk and savings uncertainty
40	Because of the deregulated market in Houston, CenterPoint can't market directly to customers. Outreach through trade shows, discussion panels, and presentations to interest groups. Maintain ties with property management and RCx agents.	Leverages RCx agents to market for the program. More than 90% of projects are brought in by RCx agents
41	Large commercial: 50k sq ft & up + BAS	Increases likelihood that there will be low cost RCx measures
42	5 year measure life for RCx savings	
43	Use a 10 year across the board measure life	Increases likelihood of cost-effectiveness, but may not stand up to evaluation
44	Program run by 3rd party program administrator. RCx agents need to pre-qualify by filling out an RFQ and doing an in-person interview	Reduces PA and customer risk, improves quality, cost effectiveness (over time) and savings