Retro-commissioning for Compressed Air Systems: A Case Study for Customer Commitment-Based Assessment Incentives

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ABSTRACT

This paper discusses the successes of a recent pilot program that offered an increased study incentive towards a retrocommissioning-style study in return for the customer's commitment to implement quick-payback measures that are identified during the study. The pilot program focused on compressed air systems, but the model would be equally applicable to other industrial systems such as steam, chilled water and process ventilation. The study requirements were modeled after a retrocommissioning approach and focused on uncovering low and no-cost measures. The pilot program succeeded in enrolling seven different manufacturing facilities that, combined, represented more than 5,475 connected compressor horsepower. Five of the seven companies completed the pilot program and captured more than 2.3 Million annual kWh at an incentive cost of less than $0.03/kWh for the first year's savings.

Background

As efficiency programs mature implementers are forced to rely more on complex custom measures to achieve savings goals. Growing beyond commodity-type measures such as lighting towards more complex custom measures can create strain on program cost-effectiveness. One way to counteract this strain is through incentives for studies or assessments which can provide excellent cost effective savings. Typically the incentive required for a study is much smaller than the incentive required to influence measure implementation.

There are two types of studies and it is important to understand the difference. One type of study looks to better understand a known opportunity. For example a customer may have been told that it would be a good idea to recover heat from an industrial process, but the customer needs a study to determine more accurate savings estimates before making the decision to proceed. The second type of study is designed to uncover new opportunities that the customer would otherwise be unaware of. For example a customer may know that there commonly energy savings opportunities within compressed air, but is unaware of specific opportunities in his system.

Providing an incentive to study a known opportunity can be cost effective only if the customer ultimately installs the measure. This is a gamble at best for the program. When the customer does not install the measure the study incentive provides zero return for the program. It is tempting to address this shortcoming by requiring project implementation as a prerequisite to receiving some or all of the study-incentive. But if one takes a moment to consider the impact of such a requirement, it becomes clear that the only users of a study-incentive with this requirement would be those who are confident they are going to implement the measure regardless of the study results, or those who are fully willing to pay for the study if the measure

is not implemented. In both cases the incentive dollars provided for the study have zero impact. The result is zero attribution at worst, and reduced cost-effectiveness at best.

A program can avoid these risks by funding studies that uncover unknown measures and, before the study takes place, having the customer commit to implementing identified any measures that provide an agreed upon level of economic return. By using this structure the program can greatly increase chances that an installed measure will result from every study and maintain strong attribution for the realized savings. The attribution is strong because even though the customer has committed to implementing certain types of measures, the measures are not identified at the time of the commitment; implementation is still fully dependant on the study to uncover the measures.

The only remaining program risk with this model is the risk that a funded study won't uncover any measures that provide the agreed upon economic return. This risk can also be mitigated by careful incentive design requirements that limit studies to system that are likely to return such measures.

Customer Commitment-Based Assessment-Incentives

A successful customer commitment-based incentive requires minimizing risk to the program and the customer. Without this, neither party will be eager to commit. Risks can be minimized by careful design of the incentive, the required assessment activities, and customer's commitment. Wisconsin's Focus on Energy chose compressed air as the focus system for the pilot program for the following reasons:

- There is a very mature compressed air service provider network in Wisconsin
- Compressed air is a common industrial system increasing the number of eligible sites
- Compressed air provides many low and no cost opportunities for improvement

Incentive Design

Focus on Energy's pilot incentive design offered $15 per active (non-backup) compressor nameplate horsepower towards the cost of the assessment not to exceed $25,000. The incentive amount was determined using program minimum cost-effectiveness targets. Part of the design of the pilot required all participants to repair leaks; this ensured the program could claim a minimum energy savings for each study. The program used estimated savings from leak repairs per horsepower and existing custom incentive rates to develop an incentive rate that would provide similar incentive cost-effectiveness as the existing program custom incentive rates. The $15 per horsepower incentive is almost four times larger than what the Focus on Energy program offers towards a compressed air audit that does not include a customer commitment.

In return for the larger incentive, applicants must agree in advance to implement all measures identified with a simple energy payback of 1.5 years or less or spend at least $15 per horsepower towards those measures.

Table 1 explains the requirements and features built in to the incentive to maximize the potential for savings and protect the program from risk.

Table 1. Incentive Features to Reduce Program Risk

Feature	Explanation of Risk Reduction
Leak survey and repair required	Guarantees savings can be claimed from leak repairs for every applicant regardless of other uncovered measures
Assessment provider must make the case in the application that the applicant's system is likely to have savings measures	Reduces the likelihood of paying for an assessment that doesn't find any measure
Applicant must have at least 200 active compressor horsepower	Small systems are less likely to have the complexity that lends itself well to retrocommissioning activities

Assessment Design

Retrocommissioning is a great assessment model for focusing on low and no-cost measures. The goal of a retrocommissioning assessment is to uncover measures within the customer's existing equipment as opposed to recommending new equipment upgrades. These measures often take the form of reprogramming of controls, replacing failed components or correcting improper system use.

The basic concept of a RCx assessment consists of two parts. The first is to document the original performance specification of each system component and how the components should interact under different operating conditions. The second is to take the required measurements and perform the necessary investigations to verify that each system component and the system as a whole perform in accordance to those specifications.

To apply this framework to compressed air the Wisconsin Focus on Energy program created individual performance verification worksheets for common compressed air system components. Worksheets were created for compressors, dryers, distribution piping, sequencing controls, and leak documentation. These worksheets required the assessment provider document for each system component:

- The performance specifications from the original manufacturer specification sheets
- The customer's actual requirements based on the customer's existing compressed air needs
- The actual performance each component and the system deliver as it is currently operated

After documenting the above information opportunities show themselves as discrepancies between how the component is currently operating and how it should be operating based on either original specification sheets or the customers current needs.

Additionally the program required assessment providers utilize Compressed Air Supply Efficiency (CASE) to establish complete system efficiency. The CASE number for a system is the average unit of air flow per unit of energy consumed over a one week period of data logging. The flow measurement for the CASE test is measured downstream of all supply side equipment, and kWh includes energy consumption of all supply side equipment (Babu, 2004). The goal of requiring the CASE metric was to help promote the use of standardized total system efficiency metric within the compressed air service market.

Customer Commitment

In return for the larger incentive amount the customer is required to commit to implementing all the measures identified during the study that have an energy payback of less than 1.5 years or spend at least $15 per connected horsepower towards those measures. The 1.5 year payback was chosen because anecdotally it is a common hurdle rate at which industrial customers agree to consider doing a given energy measure without additional incentive. If this is true then agreeing to implement measures with less than a 1.5 year payback should be a low-risk obligation for customers to assume.

By limiting the total expenditure to $15 per connected horsepower there is a ceiling placed on the customer's total exposure by participating.

Additionally the incentive design allowed the customer to use any remaining incentive above the cost of the assessment towards his implementation obligation. For example if an assessment on a 1000 horsepower system could be completed for $10,000, the customer could use the remaining $5,000 of incentive towards implementing the measures uncovered during the study. This further reduced financial risk for the customer and kept pressure on the study provider to keep study costs low.

Program Implementation

Rather than use traditional program outreach channels for releasing this offering to the broader market, the compressed air RCx pilot program was released only to the compressed air market providers through a roll-out meeting. Providers who wished to participate in the pilot program were required to attend this roll-out meeting where details of the offering were released. Other than required attendance at the kick off meeting, the pilot program did not restrict who could be an assessment provider. Any contractor who could perform the required assessment activities, and attended the roll-out meeting was free to participate. The roll-out meeting also put competitive pressure on market providers to act quickly because each could see his competition was in the same room.

The reason the program roll out was handled through the market providers is that it was assumed that market providers have the best knowledge of their own customer's systems and would know the best system to target for such an offering. Mass market advertising was avoided due to the limited spots available in the pilot.

Features of the pilot implementation were:

- Program limited to 10 compressed air systems at different customer sites
- Each assessment provider was allowed a maximum of 2 customers in the pilot program on a first-apply-first-serve basis to promote urgency on the part of providers hoping to apply
- Program duration was approximately one year
- Identified measures must be completed by conclusion of program to receive the incentive
- Incentives are paid to the customer after measures are implemented

Results and Lessons

The table below summarizes the results of the customer commitment-based study pilot program. The customer names have been replaced with letters for identification purposes for the remainder of this paper. The columns in the table are defined as follows:

- *System Hp* – the system horsepower represents nameplate horsepower for active, non-backup compressor capacity
- *Total Customer Cost* – the cost of the initial RCx assessment and any costs that the customer incurred implementing the identified measures
- *kW Saved* – an average kW reduction determined dividing the energy savings over the hours of system operation (not to be confused with peak kW reduction)
- *kWh Saved* – the annual estimated energy savings resulting from the implementation of measures identified during the RCx assessment
- *Incentive* – the total financial incentive paid to the customer at the conclusion of the program

Summary of Pilot Program Results

Customer	System Hp	Total Customer Cost [Assessment + Repairs]	kW Saved	kWh Saved	Incentive
A	1,000	$41,500	79	573,161	$16,125
B	800	$25,294	66	507,769	$12,000
C	500	$14,500	48	423,320	$7,500
D	500	$7,500	35	305,549	$7,500
E	-	DNF	NA	NA	NA
F	1,200	$25,000	41	553,601	$22,500
G	-	DNF	NA	NA	NA
Total	**4000**	**$113,794**	**269**	**2,363,400**	**$65,625**

Customer A is a large fabrication and assembly company and the assessment results did not contain the low and no-cost measures that the program hoped to uncover. During the post-assessment interview, the Focus on Energy representative found that the facility had large open-blowing tubes underneath a stamping machine to blow the stamped part out of the mold. It was also discovered during the exit interview that at time the entire plant remained pressurized over the weekend simply to feed a single EDM machine. An existing stand-alone compressor for this machine had failed, and the machine was simply hooked to the central compressed air system. Unfortunately there wasn't time or budget for the vendor to investigate these measures in time for the offering deadline. The savings claimed for this customer were from leak repair only.

Customer B a furniture manufacturer has 925 hp of air compressors. During the assessment it was discovered that a bypass valve on a 300hp air compressor was stuck open. The repair was authorized immediately the day of the assessment. The repair cost was $1,600 and the resulting energy reduction will save the customer approximately $32,000 per year.

Customer C, a metal parts manufacturer has five 100hp compressors. Over the years dozens of open blowing applications have been installed to facilitate the movement of small parts through the automated machining centers. These open tubes are estimated to represent more

than 500 cfm of air demand. The RCX assessment recommended that customer install nozzles on each of these tubes to reduce the free flow of air. The customer responded that they had already tried a nozzle and it "didn't work". However because payment of the incentive was dependant on customer follow-through of recommendations the customer had a greater incentive to investigate more nozzle types. The customer eventually found a nozzle that worked. 51 nozzles were installed that reduced air flow from at each open tube by 50%. The cost to purchase the nozzles was $1,245 the reduction in CFM will save the customer approximately $33,000 per year in energy costs. A program representative was included at both the initial sales meeting for the pilot program as well as the exit meeting.

Customer D, a PVC pipe manufacturer has six (6) 50 hp compressors and two (2) 100 hp compressors in 3 different buildings. All of the compressors feed into one system and piping runs between four buildings on the campus. The power and flow monitoring during the RCx assessment uncovered the fact that one of the 100 hp compressors was stuck in idle mode. The damaged idle linkage caused the compressor to run 24/7 without compressing any air. This particular discovery would not have been possible without flow metering which was a requirement of the assessment model for this pilot. The malfunctioning control was fixed by the assessment provider for $623 and saved the customer over $10,000 per year in energy costs. A program representative was included in both the initial proposal meeting as well as the exit meeting after the assessment.

Customer E, a large industrial printer, struggled to install the required metering without interrupting production. Delays in the logistics of carrying out the assessment pushed the measure beyond the program deadline and the program did not pay an incentive or claim any savings from this customer. This may have been avoided by more program involvement and regular check-in meeting with the customer and provider.

Customer F a plastic bottle manufacturer has six air compressors totaling more than 1500 hp worth of capacity. During the RCX assessment it was discovered that one compressor was not tied into the central compressor control system. It was estimated that bringing the compressor into the control scheme would save almost 250,000 kWh per year. The system owner investigated and found out that actually the compressor was tied in the control system the controls simply weren't "activated". With the flip of a switch the customer saved almost $20,000 per year in electricity costs.

Little is known about the assessment for Customer G as the vendor did not include the program in any of the customer interactions. The assessment report was submitted but the customer did not act on any of the recommendations and therefore did not receive an incentive.

At the conclusion of the pilot program the total incentives paid by Focus on Energy came to $65,625. In return the program was able to claim more than 2.3 million kWh. Dividing the kWh into the total incentive cost gives an incentive cost-effectiveness of less than $0.03/kWh.

Program Cost Effectiveness

Program Incentive Cost	$65,625
Gross Savings Achieve [kWh]	2,363,400
Cost Effectiveness [incentive $/kWh]	$0.027/kWh

Pilot Program Objectives and Outcomes

The table below looks at the overall success of the pilot program by comparing pilot objectives with the outcomes of the pilot program.

Objective	Outcome
Achieve Cost-Effective Savings	The offering succeeded in capturing more than 250kW and over 2.3 Million kWh for the Focus on Energy program for less than 75% of the cost of typical program incentive for the same savings.
Focus on low and no-cost measures to improve the efficiency of existing equipment	Initially this was difficult for providers to grasp as they are used to looking for measures to sell new equipment. However the concept was quickly adopted as providers realized this was a value-added service that the incentive enabled them to offer. No and/or low-Cost measures were identified at all participant sites.
Overcome the high-cost barrier to a comprehensive assessment	Based on the ability of service providers to sell this offering it appears the incentive level is adequate. There have been multiple inquiries as to the RCX's availability for 2011.
Focus the assessment provider's attention on the often overlooked distribution and demand side of compressed air systems	Most compressed air service providers are in the business of selling supply-side equipment and the current assessment offerings in the market place reflect this by focusing attention on the compressor room. Few of the RCX assessments provided the in-depth demand side assessment expected it is recommended changes be made to more clearly define assessment activities in future RCX offerings.

Lesson Learned

Participants were not frightened by the prospect of committing in advance to implement measures with a 1.5 year payback. The 1.5 year payback seemed to be an acceptable return for the companies approached with the RCx concept. Even the company that failed to enroll stated that the 1.5 year payback was an acceptable commitment.

Two of the seven applicants did not include a Focus on Energy representative at the initial kick-off meeting. These two applicants were the only two that did not successfully complete the compressed air RCx program before the incentive deadline. Involvement of the demand side management program staff is critical to the success of RCx. Future offerings should make it a strictly enforced requirement that a program representative must be at the initial kick-off meeting.

Not only is program representation critical at the initial kick-off meeting, but program participation is critical throughout the process. More regular program involvement, for example monthly check-in meetings would have likely avoided some of the lost measures from time constraints or customers that ultimately did not finish.

Many of the service providers involved already offered some type of compressed air system assessment. Many times the required RCx assessment activities did not align with the providers typical assessment activities. Initially providers were confident they could meet the additional requirements of the RCx assessment. In practice the RCx activities such as kW monitoring and flow measurement were harder for most providers to complete than originally thought. Future RCx offerings will use the lessons learned to develop a more complete but also more realistic set of required activities to qualify for RCx.

Compressed air equipment providers are not necessarily experts at demand-side equipment efficiency or design. During post-assessment meetings the Focus on Energy

representative was able to uncover demand-side measures not investigated during the assessment. Future RCx offerings need to create a list of common demand-side measures and require program staff work closely with assessment providers to be sure those measures are fully investigated during the assessment.

Enforcing the detailed assessment requirements was very difficult. Each customer site and assessment provider is unique and trying to enforce a universal set of assessment activities across all the system was difficult. Many times during the pilot program assessment providers could not complete specific required assessment task because the task was either physically or economically unfeasible. Only one provider successfully completed all of the equipment worksheets and ironically that assessment uncovered the smallest number of measures.

Conclusion

The customer commitment based model for providing study incentive was a success. Customers were not concerned about committing to implementation of identified measures as long as the commitment was designed to limit perceived customer risk to acceptable levels. The benefit of trying to use retrocommissioning as an assessment model is questionable. It is critical for the study to focus on low and no-cost measures which retrocommissioning does, but true retrocommissioning requires explicit detailed measurements and activities that add cost to assessment that may not be needed to achieve the savings seen in this paper.

References

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