

Effects of Project Screening Criteria on RCx Energy Savings

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Synopsis

Which screening criteria are the most effective in identifying buildings for recommissioning? When investigating recommissioning efforts on large populations of buildings, candidates must be carefully screened and judiciously selected to ensure favorable project economics. The cost-effectiveness of these commissioning efforts is tied directly to the building's potential to achieve energy savings without major equipment retrofits. Frequently, selecting the appropriate candidate is the first and most difficult hurdle in administering a cost effective project.

The results of recommissioning projects implemented through utility programs offer building owners and others a unique learning opportunity. In order to determine which projects will offer worthwhile energy savings opportunities, criteria such as energy use intensities, building size, equipment type, facility type, and controls capabilities are used. Which criteria should customers and utilities use when screening building stock for attractive candidates? The answer can be found by looking at the criteria that have proven to be the most effective in accurately predicting past RCx project performance. For this paper, savings results from about 100 projects implemented through three large utility RCx programs were evaluated to identify the key project variables and how they correlated to actual energy savings achieved.

About the Authors

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Overview of RCx Programs

The key to implementing any cost-effective recommissioning (RCx) effort is to first identify appropriate candidate buildings. We analyzed the results from three large-scale recommissioning programs to determine what project selection criteria have demonstrated parallels to realizing significant levels of energy savings. Our findings show that using demand benchmarking combined with engineering assessment techniques is a proven method to select recommissioning projects that can achieve high levels of energy and demand savings.

Results are drawn from 89 projects completed through Xcel Energy’s past Recommissioning Program (2002 – 2005), CenterPoint Energy’s current Commercial and Industrial Retro-Commissioning Program (2004 - present), and Rocky Mountain Power’s ongoing Recommissioning Program (2006 – present). Energy savings from these projects account for almost 15 MW of peak demand and 40 GWh of annual electric usage, as shown in Table 1.

Table 1: Summary of Project Data

Program	Number of Projects	Peak kW Saved	Annual kWh Saved
Xcel Energy	61	8,720	28,338,400
Rocky Mountain Power	13	1,400	7,323,474
CenterPoint Energy	15	4,598	5,054,885
Totals:	89	14,718	40,716,759

Program Requirements

The three programs vary in design and administration strategies, but all are focused on offsetting peak electric demand and reducing overall electrical consumption. Savings are realized through systematic evaluation of building systems and implementation of low-cost and no-cost measures targeted to improve system operation, and in many cases, occupant comfort. Natural gas and other fuel savings were also realized, but amounts were not quantified.

The base criteria that were defined by the utility sponsors for buildings to qualify for participation in the three programs include building size, peak demand, location, customer funding commitment, and electric rate classification. The minimum requirements for participants in each of the three programs are outlined in Table 2 below. The three chief criteria used by all of the programs are building size, energy use, and owner commitment to implementation. Other criteria are considered in these programs, but were not used to determine eligibility.

Table 2: Minimum Criteria for RCx Program Participation

Program	Minimum Square Feet	Minimum Peak Demand (kW)	Implementation Funding Commitment	Other Criteria
Xcel Energy	175,000	300	\$10,000	Location
Rocky Mountain Power	N/A	300	\$10,000	Rate schedule
CenterPoint Energy	300,000	1,000	\$10,000	

These criteria were set up to ensure these utility sponsored programs are cost effective, as defined by each states' individual regulatory oversight body. Typically, utility programs must prove they are cost-effective if program costs are to be reimbursed by rate-payer funds. These state requirements limit a utility's tolerance to project risk.

Project Size and Energy Use

All of these programs have specified a minimum project size, in either building square feet or in energy demand, or both. By focusing on only the largest buildings, utilities maximize the probability of a cost effective recommissioning project. Recommissioning projects from these programs resulted¹ in an overall reduction in energy use by 3 to 19 percent (average reduction of 7%) and peak demand reduction of 4 to 16 percent (average reduction of 10%), as seen in Figure 1. The number of projects comprising each building category is shown Table 3.

Figure 1: Average Percent Energy and Demand Savings

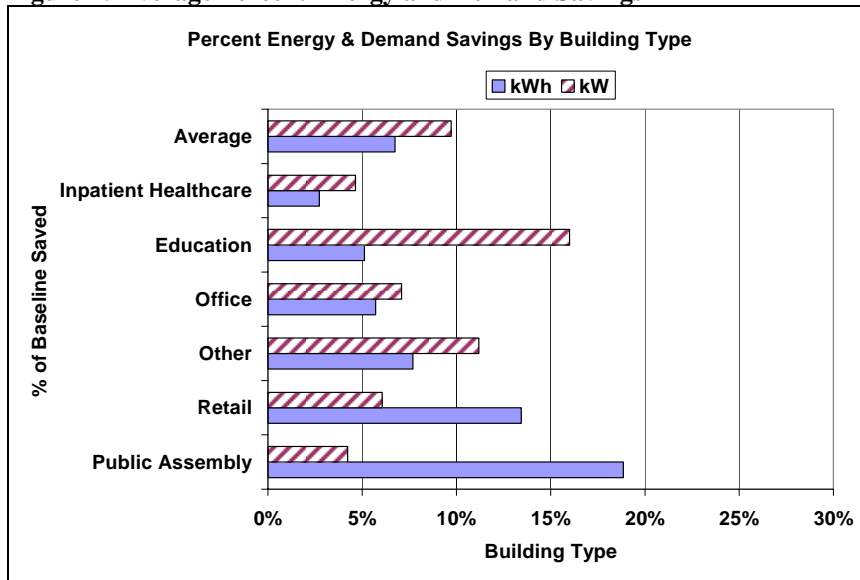


Table 3: Average Savings results and

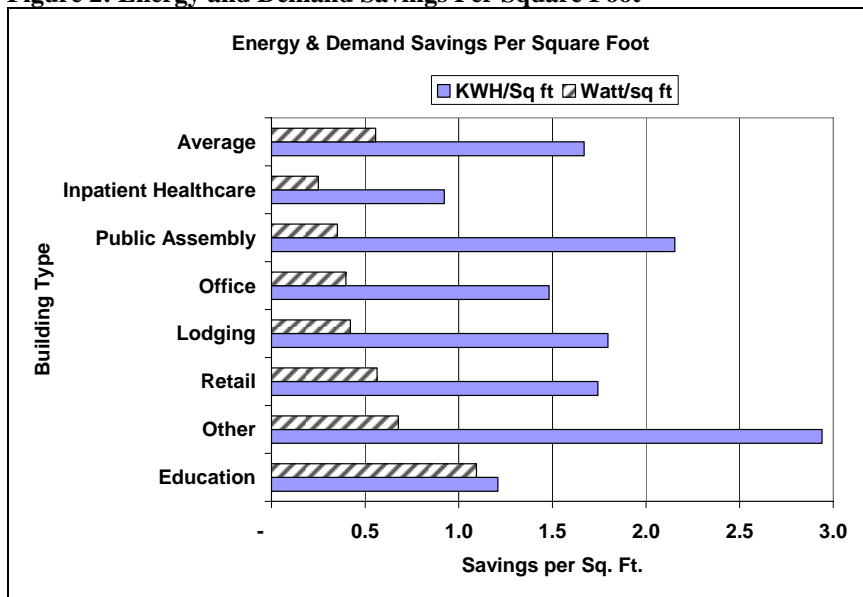
Building Type	Average kWh Saved	Average kW Saved	Number of Projects
Office	5.7%	7.1%	45
Other	7.7%	11.2%	16
Education	5.1%	16.0%	14
Inpatient Healthcare	2.7%	4.6%	6
Public Assembly	18.9%	4.2%	4
Retail	13.4%	6.1%	4
Average	6.7%	9.7%	89

¹ Results are based on preliminary results from the RCx investigation phase.

Since the base costs to implement a RCx study are somewhat fixed, focusing on larger buildings with energy management systems is the most direct way to assure cost effectiveness. Utility programs set minimum savings targets for each project. For example, a typical recommissioning study costing \$30,000, minimum energy savings levels would be determined to meet the cost-effectiveness criteria. If one facility only required 3% energy savings and another required a 12% reduction to be cost effective, the first candidate would be more attractive financially.

To look at the project size issue another way, savings per square foot for the projects were calculated and compared for different types of buildings, as shown in Figure 2. The energy savings per square foot ranged from 0.9 to 2.9, with an average of 1.7 kWh per square foot saved. The demand savings ranged from 0.2 to 1.1, with an average of 0.6 watts per square foot saved. Using the low-end of these results can help to gauge the level of expenditures that is appropriate for a given facility.

Figure 2: Energy and Demand Savings Per Square Foot



Customer Funding Commitment

Regardless of the level of energy savings opportunities available and identified, project success is predicated upon an owner's commitment to fully implement the measures identified. For utility programs this is particularly a concern as owner's are receiving engineering services paid for through the program, and may not have funding needed for implementation. All of these utility programs require a signed commitment by the owner to send up to \$10,000 implementing measures. This is not as much of a concern for building owners who are paying for the recommissioning study themselves and have some access to funding.

Other Considerations

Although criteria for program admittance are intended to ensure applicant buildings are cost-effective candidates for recommissioning, these criteria alone (the project size and customer commitment) do not guarantee a successful project. Other desirable features for candidate buildings identified by these programs are advanced control systems and motivated staff. All three of these programs require the submission of a detailed questionnaire (6 to 12 pages), which includes both general facility data and detailed engineering information.

Questions on the application attempt to ascertain basic facility and staffing information, as well as details regarding equipment types and configurations, control strategies, and operational issues. These questions require detailed knowledge of the facility operations, which must be answered by the building engineer. Most of this information is only valuable to a knowledgeable engineer that has a deep understanding of the nuances in operating building systems.

In only one of these programs was the engineering information used extensively to select program participants. In the other two programs, participants were accepted based only on eligibility criteria.

Project Escape Hatch

Once a project has been accepted into one of these utility programs, additional screening is performed by the recommissioning service provider. Since it is difficult to ascertain operational improvements from the application screening process, a preliminary assessment of the recommissioning opportunities is required after the engineering team has spent some time at the site. This allows the project to be canceled prior to conducting a full investigation if sufficient opportunities are not present to ensure a cost effective project. Several projects have been canceled in these programs based on preliminary findings.

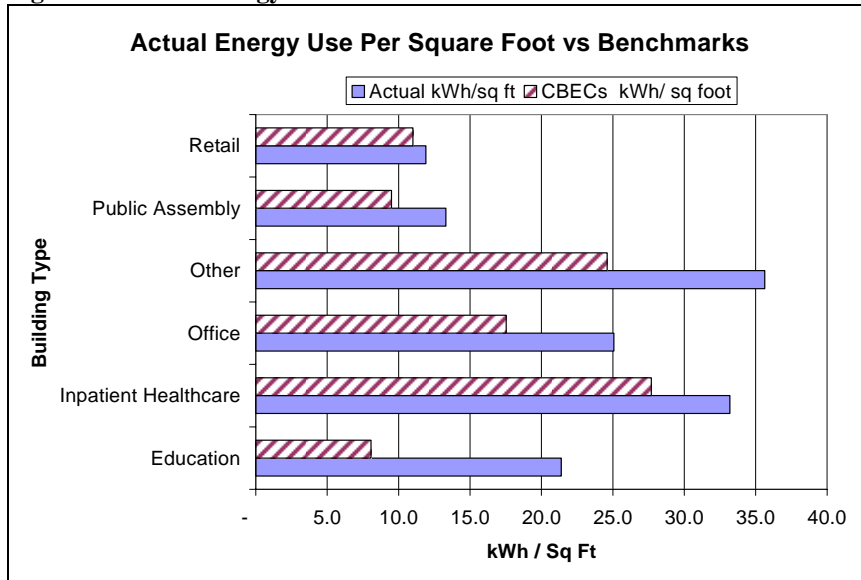
Analysis of Program Results

Energy Benchmarks

The most popular way to evaluate buildings that are candidates for recommissioning is utilizing energy benchmarks - energy use per square foot. The baseline energy benchmarks most commonly used by electric utility programs are peak demand (kW) and energy (kWh) per square foot. These values are then typically compared to average energy data, such as CBECS². We compared CBECS's electrical consumption data based on climate zone and building type to the actual energy (kWh) benchmarks from the projects, as shown in Figure 3.

² Energy Information Administration, 2003 Commercial Buildings Energy Consumption. The Commercial Buildings Energy Consumption Survey (CBECS) is a national sample survey that collects information on the stock of U.S. commercial buildings, their energy-related building characteristics, and their energy consumption and expenditures.

Figure 3: Actual Energy Use vs. EIA Benchmarks

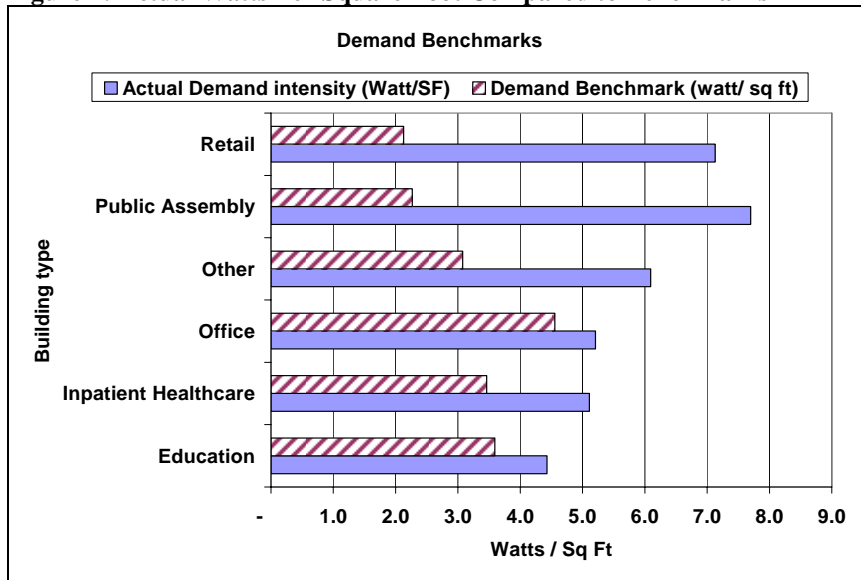


Demand based benchmarks are also popular, although CBECS does not publish this information directly. Demand benchmarks can be deduced from the CBECS consumption information by assuming average annual operating hours. To calculate average demand benchmarks, we used the average operating hours by facility type assumed in Xcel Energy’s Custom Efficiency Program, which are shown in Table 4. The actual baseline demand per square foot for our projects compared to the CBECS data is shown in Figure 4.

Table 4: Average Operating Hours by Building Type

Building Type	Annual Operating Hours	Building Type	Annual Operating Hours
Food Sales	2246	Retail	3735
Food Service	5167	Office	5167
Health care	5167	Public Assembly	3850
Inpatient Healthcare	2900	Public Order & Safety	4190
Outpatient Healthcare	8000	Warehouse & Storage	5167
Lodging	8000	Other	5632

Figure 4: Actual Watts Per Square Foot Compared to Benchmarks



Reviewing the benchmark data quickly shows that the average energy benchmarks for the program participants are higher in both energy and demand than the published CBECS data. The theory behind using benchmarks is that each of the participant buildings should be able to reduce their energy and demand usage to about the same level as the “average” benchmarks. Savings predicted using this method, however, dramatically overestimate energy and demand savings in almost every building type, as shown in Figure 5 and Figure 6. In fact, using the benchmarks to predict energy savings would have over-predicted energy savings for these projects by 430%, while the demand benchmarks over-predicted by 154%.

Figure 5: Energy Savings Predicted by Benchmarks Compared To Actual Savings

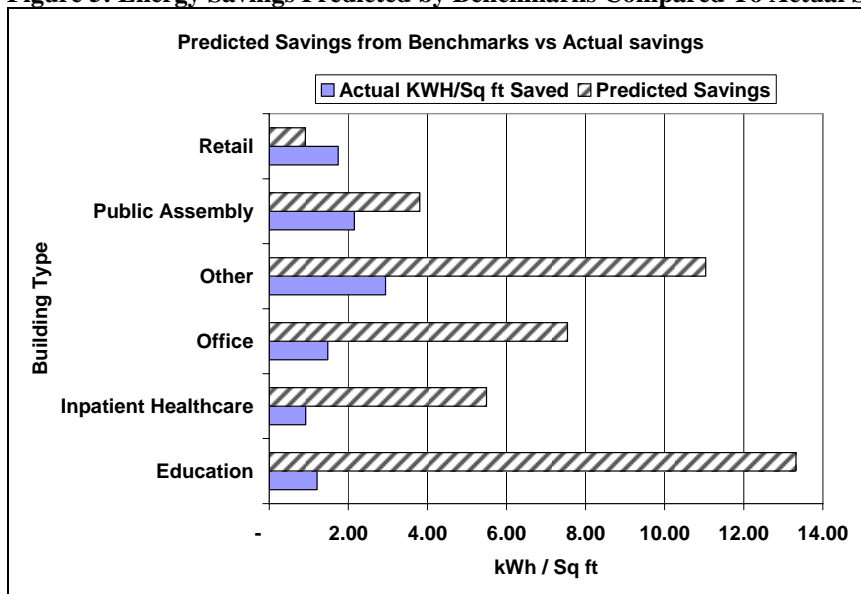
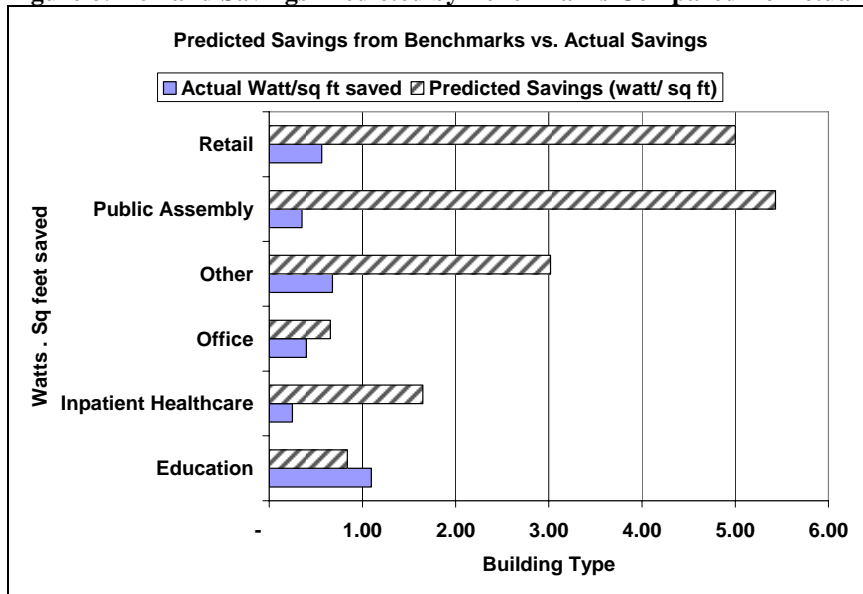


Figure 6: Demand Savings Predicted by Benchmarks Compared To Actual Savings



Looking more closely at the baseline energy use and energy savings results from each of the 89 projects. It is clear that although benchmark data does not accurately predict energy savings, it can be successfully used as a gauge. Demand benchmarks are more substantially reliable than energy benchmarks in predicting levels of savings. The percent of predicted energy and demand savings actually achieved are shown in Figure 7 and Figure 8. On average, 27% of the energy savings predicted by the benchmarking method were achieved, where as 73% of predicted demand savings were achieved.

Figure 7: Percent of Energy Savings Predicted by Benchmarks Achieved

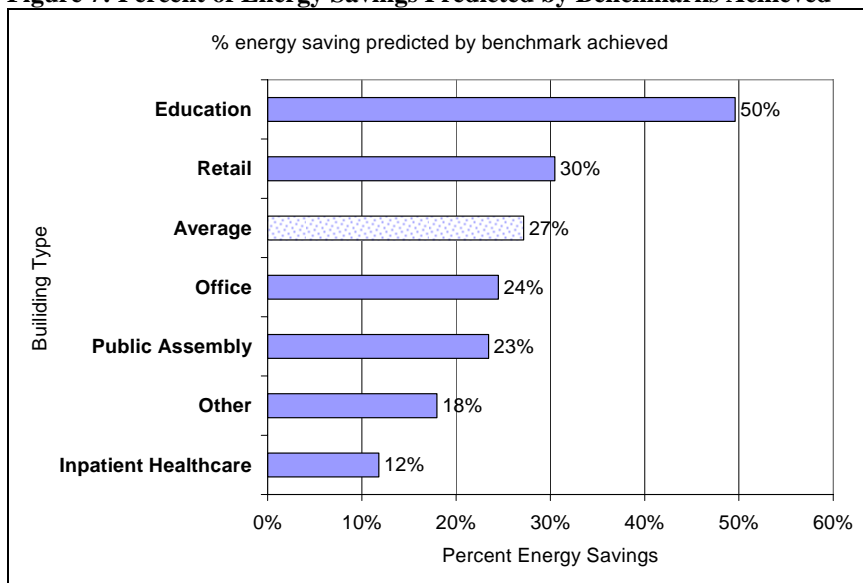
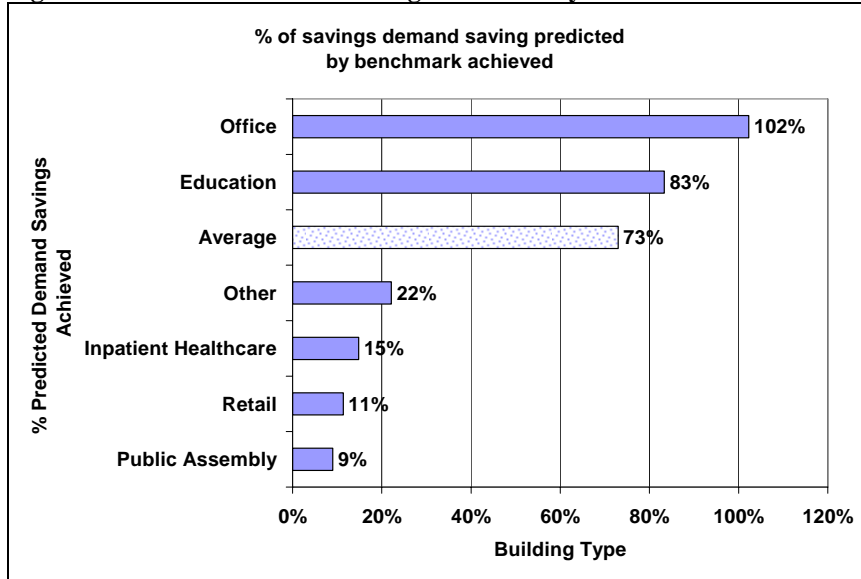


Figure 8: Percent of Demand Savings Predicted by Benchmarks Achieved



These results support the use of demand benchmarks as an indicator of operational improvements opportunities, and to a lesser degree, energy benchmarks. Understandably, some of the savings opportunities indicated by the benchmarks are based on equipment efficiencies and not operational issues addressable through recommissioning.

Engineering Assessment Approach

Although a part of the application process for all three programs involves screening engineering data from the site, we find this to be an under utilized approach that, when used with demand benchmarks, provides greater accuracy in selecting facilities for recommissioning. One of the primary challenges in using this approach is having the expertise necessary to translate the information provided on a facility into an assessment of the recommission-ability of a building. Unfortunately, this is not a simple method, but is the preferred approach when choosing between buildings with similar benchmarks.

To simplify the process, we have devised a scoring methodology for recommissioning projects based on the detailed facility data provided through the facility questionnaire required with the program application. Points are assigned for each category of information, based on the potential for operational improvements. Projects are then scored based on a percentage of the total available points, with higher scores indicating more potential for RCx opportunities. The key features evaluated, our scoring methodology, along with our rationale, are outlined in Table 5.

Table 5: Overview of Engineering Assessment Approach

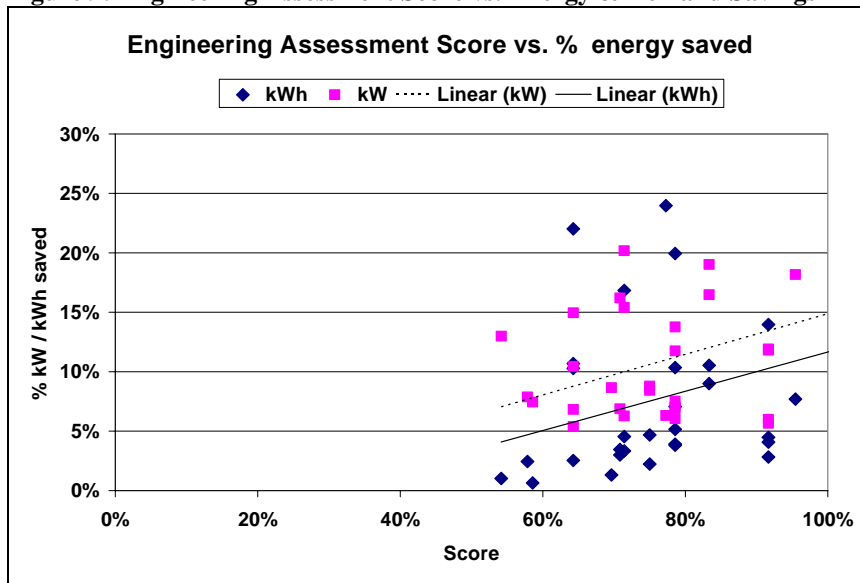
#	Item	Points	Rational	Scoring Basis
1	Minimum outdoor air fraction	0 to 2	Ascertain potential for outside air levels to be reduced to ASHRAE 62-2004.	0 = 0% minimum outdoor air (OA); 1 = Low levels of OA; 2 = Very high levels of OA

#	Item	Points	Rational	Scoring Basis
2	Economizer types	0 to 3	Potential for economizer tune-ups are likely.	0 = No economizer; 1 = Has water economizer; 2 = Has air side economizer; 3 = Has water & air economizers
3	Heat recovery	0 to 1	Potential for heat recovery tune-up.	0 = No heat recovery 1 = Heat recovery is installed
4	Evaporative cooling present	0 to 2	Systems are often decommissioned or underutilized.	0 = No evaporative cooling 1 = One evaporative cooling unit 2 = Two or more evaporative cooling units
5	Problem areas identified by applicant	0 to 2	Nature of problems identified indicates opportunities and customer's level of knowledge about building.	0 = No problems identified; 1 = Minor comfort based problems 2 = Equipment control problems
6	Cooling type (DX, IDEC, Chiller)	0 to 3	Helps identify level of effort needed to identify problems. Bigger single systems offer more potential for same level of effort.	0 = Packaged DX units only 1 = Custom AHUs 2 = IDEC or chilled water system 3 = IDEC & chilled water system
7	Staging strategy for cooling equipment	0 to 1	Proper staging of central plant equipment critical to energy efficiency.	0 = Automated based on actual loads 1 = Manual based on estimated loads or outdoor air temperatures
8	Air-side distribution system type	1 to 2	Variable flow systems tend to offer more potential for optimization.	1 = Constant volume; 2 = Variable volume
9	AHU setback strategies	0 to 2	Optimized supply air temperatures and pressures can result in significant savings for VAV units.	0 = temperature and static pressure reset used 1 = temperature or static pressure reset used 2 = no resets used
10	Type of reheat system	0 to 2	Reheat is often a source of energy waste.	0 = No reheat; 1 = Hydronic reheat; 2 = Electric reheat
11	Use of automated scheduling	0 to 2	Excessive equipment run-times offer energy savings opportunity.	0 = Optimum start program in use; 1 = Building is scheduled to match occupancy; 2 = No automated scheduling
12	Equipment general condition	0 to 2	Condition of equipment must be sufficient for low cost opportunities, else capital improvements may be needed.	0 = Poor 1 = Good 2 = Excellent
13	Local controls staff available?	0 to 3	Not necessary to have onsite; however constant controls supervision needed.	0 = No onsite controls personnel; 1 = Onsite personnel with some controls capabilities; 2 = Local controls subcontractor or offsite expert; 3 = Local staff with controls expertise
14	Controls sufficient?	0 to 3	Level of effort increases when data loggers are required.	0 = Local controllers; 1 = All pneumatic; 2 = Pneumatic actuators/DDC control; 3 = All DDC

#	Item	Points	Rational	Scoring Basis
15	Level of control	0 to 3	Better control capabilities equate to more savings potential.	0 = No control; 1 = Central plant; 2 = Central plant & AHUs; 3 = All equipment
16	On district chilled water or steam loop?	0 to 1	Helps determine whether study can reach savings at central plant.	0 = On district system 1 = Building level systems
	Total Points Available:	34		

We tested this point system to a sample of the 89 projects. The engineering assessment score was a strong predictor of both demand and energy savings in these projects. The results are shown graphically in Figure 9.

Figure 9: Engineering Assessment Score vs. Energy & Demand Savings



Additional Resources for Project Screening

In addition to the key screening criteria already discussed (project size, funding, energy and demand benchmarks, and engineering assessments) other tools are available to help pinpoint the best candidates for recommissioning.

The electric focus of the three utility programs discussed somewhat skewed the focus of the evaluation process. A building owner would more typically be interested in overall energy use and cost savings potential of all fuels including natural gas. In those cases, it would be appropriate to look at total energy benchmarks in BTU / square foot.

One of the best all-energy benchmarking tools available is free through Energy Star Portfolio Manager. This service, run by the EPA, compares actual energy use to the expected performance

based on building composites. Criteria are more detailed than the breakdowns available CBECS. This ranking requires at least a one year history of all energy used at a facility.

Another potential screening tool is to compare a building's load profile to those of similar buildings within the same climate region. If a building's energy use profile based on 15 minute utility data is available, it can be compared to average daily and annual load shapes such as Itron eShapes³. Load shape analysis can sometimes demonstrate abnormalities in equipment operations. For laboratory buildings, Labs for the 21st Century (Labs21) offers tools and guidance on efficiency for laboratory buildings.

Conclusions

The key to implementing any cost-effective recommissioning effort is to first identify the most suitable buildings. The results from three large-scale recommissioning programs demonstrate that demand benchmarking combined with engineering assessment techniques can help select recommissioning projects that can achieve high levels of energy and demand savings. Focusing on larger buildings with advanced energy management systems is the most direct way to assure cost effectiveness, although no project will succeed if an owner is not committed to fully implementing the measures identified.

Demand benchmarks and, to a lesser degree, energy benchmarks are a solid indicator of operational improvements opportunities. These benchmarks over predict the level of savings since some of the savings opportunities indicated by the benchmarks are based on equipment efficiency and not operational issues addressable through recommissioning.

We also demonstrated a scoring methodology for recommissioning projects based on the detailed facility data such as equipment types, system configurations, control system capabilities, control strategies in use, and knowledge of customer staff. Projects were scored based on a percentage of the total available points, with higher scores indicating more potential for RCx opportunities. The engineering assessment score was a strong predictor of both demand and energy savings in these projects. This method requires engineering expertise, but is the preferred approach when choosing between buildings with similar benchmarks. Other tools that may be helpful include Energy Star Portfolio Manager, load shapes, and Labs 21.

Since selection criteria are not infallible, conducting a preliminary on-site engineering assessment allows the project to be canceled prior to conducting a full investigation if sufficient cost savings opportunities are not present.

³Residential and commercial energy usage profiles by geographic regions are available through http://www.itron.com/pages/products_detail.asp?id=itr_000491.xml.