Savings Persist with Monitoring-Based Commissioning

The Problem

Commissioning is a process that ensures that building systems are functionally tested and capable of being operated as efficiently as the designers intended. However, after commissioning, a building's performance may degrade over time. Retrocommissioning programs, which commission buildings that have not been commissioned previously, can tune a building to its optimal performance, but the savings achieved through retrocommissioning also degrade over time. It is desirable that the high initial savings be consistently maintained.

The Solution

Monitoring-based commissioning (MBCx) is a program approach that combines permanent building-energy-system monitoring with standard retrocommissioning practices to provide substantial, persistent energy savings. It's based on the ability of permanent monitoring systems to increase the effectiveness of retrocommissioning by providing a means to verify and ensure the persistence of savings achieved through operational improvements. Additionally, permanent monitoring systems can identify previously unrecognizable and unquantifiable savings opportunities—such as equipment cycling; excessive simultaneous heating and cooling; or the unintended nighttime operation of air handlers, chillers, boilers, or lighting equipment—that would not be apparent from monthly utility readings. A pilot program has demonstrated MBCx's ability to reduce total energy consumption in commercial buildings by a median value of 10 percent in a portfolio with minimal project screening. The median simple payback was 2.4 years in a campus environment where building-level metering—sometimes including Btu meters for chilled water, hot water, or steam—was provided by the project.

Features and Benefits

The MBCx approach is intended as an open forum for participants to choose their own systems and share their experiences and feedback—rather than being prescriptive for the type of monitoring system that should be used. However, the approach encourages whole-building monitoring because it provides links to the most common performance-benchmark information, such as utility bills. Additionally, more frequent sampling rates are encouraged because they can often provide the best diagnostic capability. This, of course, depends on a particular facility's ability to manage and archive data.

To establish the potential of MBCx, program developers used PIER and other research results to design and conduct a pilot program on 25 California university campuses. Facilities included more than 40 buildings, many with energy-intensive lab spaces, as well as nine plant systems. The researchers found that MBCx provides several key benefits, including reductions in overall energy consumption and peak-period demand as well as opportunities for benchmarking and identification of additional savings opportunities (**Figure 1**).

Reduced energy use. MBCx reduced total annual energy use by a median value of 10 percent in the portfolio of buildings participating in the pilot program (see **Table 1**). The median value payback period was 2.4 years. This is comparable to the typical commissioning projects studied in a meta-analysis of West Coast commercial buildings.

Reduced peak-period electricity use. Researchers found that MBCx reduced peak-period electricity use by a median value of 5 percent. Peak-period electricity has both higher value and a deeper environmental impact. This reduction was achieved, in part, by MBCx's ability to catch problems with control systems that are normally hard to detect. Variable air-volume systems, for example, presented one of the most common opportunities for correcting control problems: Control corrections in these systems reduced fan power and peak-power draw. Finding and correcting problems with HVAC reheating systems also resulted in substantial peak-power reduction.

Figure 1: Pilot program shows MBCx savings

Monitoring-based commissioning (MBCx) reduced building-energy consumption by identifying and correcting faulty system operation on California campuses.

Courtesy: The University of California.

Table 1: Median annual energy reductions

The monitoring-based commissioning pilot program produced a median reduction of 10 percent of total annual energy use.

Energy source	Portfolio median savings (%)
Electricity	9
Fuel	9
Hot water/steam	12
Chilled water	17
Total source energy	**10**
Total site energy	**11**

Benchmarking. MBCx provides the ability to trend and benchmark building-performance data continuously. By serving as a baseline for comparison with subsequent data sets, this information can be used to alert operators when performance starts to degrade and help them determine what actions to take. This information can also help future MBCx programs identify and quantify the most effective savings opportunities. More generally, the data can also be used by energy managers and designers as they plan new systems and buildings.

Identification of future retrofit projects. The pilot project demonstrated that MBCx has value beyond retrocommissioning. Specifically, MBCx was found to be effective in guiding decisions about retrofit projects, either by identifying cost-effective retrofit opportunities or by showing that some retrofit solutions were not needed. For example, MBCx found that discomfort calls and extreme temperature differences in one building were caused by faulty thermostat calibration and inoperative air-damper actuator or reheat valves, and not by an undersized chiller. This led to a shift in retrofit priorities away from a new chiller and to new digital zone controls.

Applications

MBCx can be used in commercial and institutional buildings or laboratory-intensive buildings that have energy information or energy-management and -control systems that are capable of trending building energy use. Health care facilities might also be able to benefit.

California Codes and Standards

The MBCx approach is not currently covered by California's Title 24 energy-efficiency standards. However, the results of this project may lead to future revisions of the state energy code that include enhanced monitoring as a prescriptive technology or as a candidate for compliance credit.

What's Next

The program team intends to continue its efforts with an additional project data set, working in concert with the California investor-owned utilities (IOUs)—Pacific Gas and Electric, Southern California Edison, Southern California Gas, and San Diego Gas & Electric. Researchers hope to continue to benchmark building-performance data to identify best practices and the most effective predictive parameters for identifying future MBCx projects. They also plan to learn more about applications with additional building types and about benefits of whole-building versus sub-system metering. The work will be conducted in partnership with the University of California (UC) and California State University (CSU) systems. A similar partnership with the California Community College system will enable the approach to be tried in several community college buildings.

Collaborators

The organizations involved in this project include the UC/CSU/IOU Energy Efficiency Partnership, the California Institute for Energy Efficiency, Lawrence Berkeley National Laboratory, Portland Energy Conservation Inc., and Newcomb Anderson McCormick.

For More Information

For more information on this project, please contact the California Energy Commission researcher listed below.

More PIER Technical Briefs can be found at http://www.energy.ca.gov/research/techbriefs.html.

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About PIER

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