

## **Meticulous Study Makes the Case for Cost-Effective Commercial-Building Commissioning**

by Nadine Lihach

Commercial building owners have heard the promises: commissioning is a highly cost-effective way to verify that a building is performing the way it was intended to perform. The process identifies and remedies design flaws, construction defects, malfunctioning equipment, and other problems, repaying owners with lower energy bills and other benefits. That's the promise—but most building owners have yet to be convinced to try commissioning. Many cite a lack of information on commissioning's actual cost-effectiveness. Others contend that commissioning is an unnecessary added cost, especially if they've already paid a premium for design and construction of high-performance buildings. A new Lawrence Berkeley National Laboratory (LBNL) study that meticulously compiles and standardizes commissioning data from 224 commercial buildings—by far the largest available collection of standardized information on actual building experiences—may help owners overcome this hesitancy.

This U.S. DOE-funded study concludes that commissioning is indeed cost-effective for both new and existing buildings over a range of facility types and sizes, not only in terms of energy savings but also in savings from improved equipment lifetimes, reduced maintenance, fewer contractor call-backs, and other non-energy benefits. Investigators found that commissioning existing buildings achieved median energy cost savings of 15%, with payback periods of 0.7 years. The median payback time for new buildings was 4.8 years, and when non-energy impacts were factored in, those payback periods were considerably reduced, often to zero. Looking beyond individual building savings, the study suggests that widespread commissioning of existing commercial buildings could save the nation over \$18 billion a year in energy costs alone.

### **Unprecedented Database**

Commercial building owners have been reluctant to buy into building commissioning because of lack of independent, reliable data and because many previous cost-effectiveness studies have been based on relatively small numbers or few types of buildings. The new study should go a long way toward overcoming their reservations: this ambitious effort, conducted for DOE's Building Technologies Program by LBNL with assistance from Portland Energy Conservation, Inc., and the Energy Systems Laboratory of Texas A&M University, breaks new ground in both the breadth and standardization of its commissioning data. The study includes published and unpublished data from 175 commissioning projects from the past 20 years and across 21 states. The 224 commercial buildings in the sample cover virtually all building types and represent over 30 million square feet of commissioned floor space—73% in existing buildings and 27% in new construction—providing an unprecedented picture of real-world commissioning.

## **Rigorously Standardized Methodology**

Hesitant building owners should also be reassured by the study's detailed, rigorously standardized methodology, which stresses accurate cost-benefit analysis and exhaustive characterization of building deficiencies and corrective measures. To equalize comparisons between different commissioning projects, in different areas, over a 20-year period, the study corrected all data for inflation, using 2003 dollars across the board. Investigators also normalized all energy-price variations to 2003 U.S. average energy prices for commercial buildings. Without these prudent adjustments, costs and benefits cited in the study would have varied wildly, confounding comparisons. (Note: Raw data are available for those wanting to see these variations.) Investigators were also careful to fairly represent all relevant commissioning costs that were available in the source documents, whether paid for by building owners, tenants, local utilities, or other third parties. And because building commissioning is an infinitely variable process—every project is different—investigators developed detailed, consistent characterizations of building deficiencies and corrective actions, resulting in a standardized way to evaluate apples-and-oranges approaches.

When all the data were collected and analyzed, it was evident that few commercial buildings performed as intended, and many were far off the mark— in some cases over 50% energy savings were achieved by commissioning. The projects in the study identified a staggering 3,500 different deficiencies among 85 existing building projects, and 3,305 deficiencies among 28 new construction projects. While many owners assume top-notch performance in new buildings, the numbers revealed that new buildings actually had three times more problems than existing facilities: an average of 62 deficiencies per building in new construction, compared with an average of 32 deficiencies per building in existing structures. Investigators reasoned that newer buildings tend to have more complex, innovative systems, which can lead to problems if those systems are not properly designed, implemented, and operated. Also, more money (i.e. time and effort) is typically invested in commissioning new construction, so it is not surprising that more deficiencies are found. Plainly, when it comes to new buildings, commissioning is not a superfluous exercise. Existing buildings also stand to benefit from commissioning since buildings are essentially large machines and can fall out of tune over time, and require periodic correction.

## **The Case for Cost-Effectiveness**

After investigators carefully evaluated the costs and benefits, commissioning proved to be one of the most cost-effective ways to improve energy efficiency in commercial buildings. Among existing buildings, commissioning cost a median of \$0.27/sq ft, and yielded energy cost savings ranging from 7 to 29%, with a median savings of 15%, for quick payback times of 0.7 years. New-building commissioning, costing \$1.00/sq ft (or 0.6% of total construction costs), took 4.8 years to pay back when only energy cost savings were considered. Energy savings attributed to commissioning were six times higher in existing buildings than in new construction, perhaps evidence of the fact that existing-building commissioning is more strongly driven by energy savings objectives, while commissioning of new construction is more motivated by non-energy objectives such as ensuring overall building performance meets the owner's requirements including ensuring a healthy indoor environment.

## **Non-Energy Benefits Count**

Importantly, non-energy benefits contributed significantly to commissioning's overall cost-effectiveness. These benefits include improved equipment lifetimes, reduced change-orders due to early detection of problems, prevention of premature equipment breakdown by timely correction of problems, reduced operation and maintenance costs, and improved indoor environment. When these often-overlooked benefits were taken into account, the cost-effectiveness of commissioning increased considerably, particularly among new buildings. For the cases where estimates were available, one-time non-energy benefits were \$1.24/sq ft-yr for new construction, effectively offsetting the entire cost of new-building commissioning. Non-energy benefits reported for existing buildings were lower, \$0.18/sq ft-yr, but so were costs.

In the final analysis, the study found that commissioning yielded cost-effective outcomes for existing buildings and new construction alike. The most cost-effective results were found among energy-intensive facilities such as hospitals and laboratories. Smaller buildings tend to still be cost-effective, but less so. Energy savings tended to rise with increasing comprehensiveness of commissioning. Investigators emphasize that the benefits reported in the study are conservative: commissioning projects, including those on which this study was based, hardly ever address each and every building system or fuel where savings may be found, and certainly not every commissioning recommendation is implemented. In addition, significant first-cost and ongoing non-energy benefits are usually not quantified: examples include correcting the oversizing of HVAC equipment before it is installed, and improved occupant comfort and productivity. Yet these real and valuable benefits boost commissioning's cost-effectiveness significantly.

## **Passing the Word**

The study's message on the cost-effectiveness of building commissioning is unequivocal, and it's now a matter of getting the word out to building owners, as well as architects, designers, utilities, research groups, and others who can do their part to help encourage widespread adoption of commissioning. "Commissioning is underutilized," acknowledges Evan Mills, LBNL staff scientist and lead author of the study, adding, "Many building owners are unaware that commissioning can identify and help solve serious building problems, and many who are aware of commissioning aren't confident that it's cost-effective. We hope this study reaches those owners." Word is already spreading: at California's Department of General Services (DGS), which oversees the design, construction, operation, and maintenance of many state-owned facilities, over 150 DGS and other state agency staff recently listened attentively to a presentation on the new study. California plans to boost energy efficiency in state buildings by 20% over the next 10 years, and commissioning of about 50 existing DGS buildings, in addition to new buildings, is on the agenda. Dan Burgoyne, DGS's sustainability manager, says the new study confirms they're on the right track: "The study did a good job of substantiating commissioning's many benefits, including impressive non-energy benefits. I think it helped convince some who may have been skeptical about commissioning."

There's an important postscript to the study's message: the value of commissioning can only increase over time, as commercial buildings become ever more complex, ever more problem-prone, and ever more in need of commissioning. Without commissioning to verify how well buildings are performing, even the best energy-

efficiency measures may have a difficult time fulfilling their potential.

The full report on the new study, The Cost-Effectiveness of Commercial-Buildings Commissioning: a Meta-Analysis of Energy and Non-Energy Impacts in Existing Buildings and New Construction in the United States, Lawrence Berkeley National Laboratory Report Number 56637, is available at <http://eetd.lbl.gov/emills/PUBS/Cx-Costs-Benefits.html>

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