



## 6. How Existing Buildings Figure In the Climate Change Scenario

**B**uildings represent a golden opportunity for cutting greenhouse gas emissions. “Energy efficiency options for new and existing buildings could considerably reduce CO<sub>2</sub> emissions *with net economic benefit*,” according to the IPCC Fourth Assessment Report. “By 2030, about 30% of the projected GHG emissions in the building sector can be avoided *with net economic benefit*” (emphasis added).

The IPCC report further remarks that it is “*often more cost-effective* to invest in end-use energy efficiency improvement than in increasing energy supply to satisfy demand for energy services”—in other words, making buildings more energy-efficient would reduce the need to build more coal-fired power plants. [WGIII/SPM, p. 13; emphasis added]

In the U.S., this opportunity has been squandered for the most part. Despite the well-meaning efforts of the U.S. Green Building Council, the Green Building Initiative (GBI), Energy Star, the National Association of Home Builders, and others, only a small percentage of new commercial buildings, and an even smaller percentage of new homes, get any kind of green treatment. Meanwhile, millions more “conventional” buildings and homes are being added to the nation’s building inventory.

The situation is even more distressing when it comes to existing buildings, which represent about 98% of the square footage in place in any one year. The USGBC’s LEED for Existing Buildings: O&M just hasn’t caught on with building owners; nor has the GBI’s existing buildings module.

Perhaps the fault lies in our infatuation with the new. After all, it’s a lot more exciting to talk about, say, the super-LEED Platinum-plus Bank of America building

in Manhattan—a magnificent project, to be sure—than it is to extol the virtues of a small office building rehab job in Flatbush that produced 38% energy savings. We in the “green” media are as guilty as anyone of falling under the spell of the new.

The fact remains, however, that to have any impact on cutting emissions, the U.S. design and construction industry is going to have to address two agendas in tandem: first, to make new buildings and major reconstructions as energy efficient as possible; and, second, to upgrade much of the nation’s existing stock of buildings and homes.

Both efforts have to be done on the basis of cost effectiveness. It may be, for example, that making many low-cost improvements to millions of existing buildings and homes may be more effective than trying to achieve zero or near-zero emissions in a relatively few new buildings and homes.

Further, this effort will require AEC professionals to recognize (perhaps to their chagrin) that most buildings in the U.S., even the newest, rarely function at their optimal or designed efficiency. And because most commercial buildings (and homes) are built to last 50 or even 100 years, their inefficiencies—and preventable GHG emissions—could endure for a century.

According to Tudi Haasl, associate director of commercial services at Portland Energy Conservation Inc. (PECI), the six biggest energy wasters in buildings are:

1. Equipment running more than needed
2. Cooling or heating air more than needed
3. Cooling or heating water more than needed
4. Heating and cooling at the same time
5. Moving too much air
6. Moving too much water<sup>1</sup>

1. “Real Reasons for Optimizing Building Performance,” Tudi Haasl, National Conference on Building Commissioning, Newport Beach, Calif., 21 April 2008.

Project Description	Cost	Rebate	Annual savings	Payback	FO
Installed dimmers in alcoves and stairwells	\$83,034	\$21,108	\$46,853	1.4 years	73%
Retrofitted variable-frequency drives on main supply fan	\$73,000	\$29,400	\$12,000	3.6 years	28%
Installed automated drip irrigation system	\$3,610	\$0	\$9,001	0.4 years	249%
Reduced run-time on parking garage fans to 10 minutes in a.m./p.m. rush hours without sacrificing air quality	\$200	\$0	\$98,000	Immediate	48,204%
Installed waterless urinals	\$35,374	\$5,396	\$6,338	4.7 years	21%

Source: “Building Optimization: The Value Proposition,” George Denise, National Conference on Building Commissioning, Newport Beach, Calif., 21 April 2008.

Cushman & Wakefield achieved relatively short payback periods and high returns on investment from well-known technologies for client Adobe Systems. Nineteen lighting projects alone produced \$729,185 in annual energy savings on a \$445,248 investment. With a \$205,437 utility rebate, the lighting projects produced an FO of 304%. Commissioning has helped reduce operating costs at Adobe Systems’ headquarters site by \$1.2 million.



- Mistakes abound even in the newest buildings:
- Fans in air-handling units running backwards
  - Temperature sensors placed in direct sunlight, making their readings inaccurate and unreliable
  - Vibration isolation components in the shipping position instead of in the operating position
  - Missing gauges
  - Setpoints not inputted<sup>2</sup>

One of the most cost-effective ways to overcome “discrepancies” like these is through the process of building commissioning.<sup>3</sup> At Adobe Systems in San Jose, Calif., building manager Cushman & Wakefield retrocommissioned two towers and trimmed operating costs \$1.2 million a year on a \$1.4 million investment (mostly on energy-related systems) and received \$389,000 in rebates (mostly from the local utility).

The simple payback period of the project was nine-and-a-half months, with a 121% ROI. Electricity use was cut 37%, and GHG emissions were directly cut by 17%; another 19% in GHG reductions came from the purchase of renewable energy credits (Table 6.1).<sup>4</sup>

#### How commissioning benefits buildings

Only about 1% of buildings are commissioned, according to the U.S. Department of Energy, probably because most building owners are wary of the up-front

cost of commissioning and the cost of fixing the problems that have been identified in the process.

To put solid numbers on the costs and benefits of commissioning, Evan Mills, PhD, and colleagues at Lawrence Berkeley National Laboratory (LBNL), Portland Energy Conservation Inc. (PECI), and Texas A&M University (Energy Systems Laboratory) reviewed published and unpublished data on 224 buildings in 21 states, representing 30.4 million sf of commissioned space—73% in existing buildings, 27% in new ones.<sup>5</sup> Total commissioning costs for these buildings were \$17 million (2003\$), an average \$0.55/sf. Among their findings:

- An average 11 deficiencies were found in existing buildings, 28 in new buildings. HVAC systems represented the bulk of the problems.
- For existing buildings, median commissioning costs were \$0.27/sf; energy savings came to a median 15% (18% average); payback times were less than nine months (0.7 years).
- For new buildings, commissioning costs were \$1.00/sf (0.6% of total construction costs), yielding a median payback of 4.8 years.
- Reduced change orders and other non-energy benefits accounted for \$0.18/sf savings in existing buildings and \$1.24/sf for new construction—for new buildings,

2. Gretchen Coleman, *Engineering Economics, National Conference on Building Commissioning*, 22 April 2008.

3. For an excellent review of the forms of commissioning, see “Casting call for Cx,” Ronald Wilkinson, *Consulting-Specifying Engineer*, September 2008, pp. 44-50. At: [www.csemag.com/article/CA6596632.html](http://www.csemag.com/article/CA6596632.html)

4. “Building Optimization: The Value Proposition,” George Denise, *National Conference on Building Commissioning*, Newport Beach, Calif., 21 April 2008.

5. Mills, E., N. Bourassa, M.A. Piette, H. Friedman, T. Haasl, T. Powell, and D. Claridge. “The Cost-Effectiveness of Commissioning New and Existing Commercial Buildings: Lessons from 224 Buildings,” *Proceedings of the 2006 National Conference on Building Commissioning*, Lawrence Berkeley National Laboratory Report No. 56637. At: <http://eetd.lbl.gov/emills/EMillspubs.html>

## Commissioning helps Marriott cut emissions by 68,000 tons in its U.S. hotels

Five years ago, at the National Conference on Building Commissioning, Marriott International’s E.J. Hlts put the participants to the test: How many “deficiencies” in energy use and guest comfort could they find in the very building where the conference was being held, Marriott’s Rancho Las Palmas Hotel in Palm Springs, Calif.?

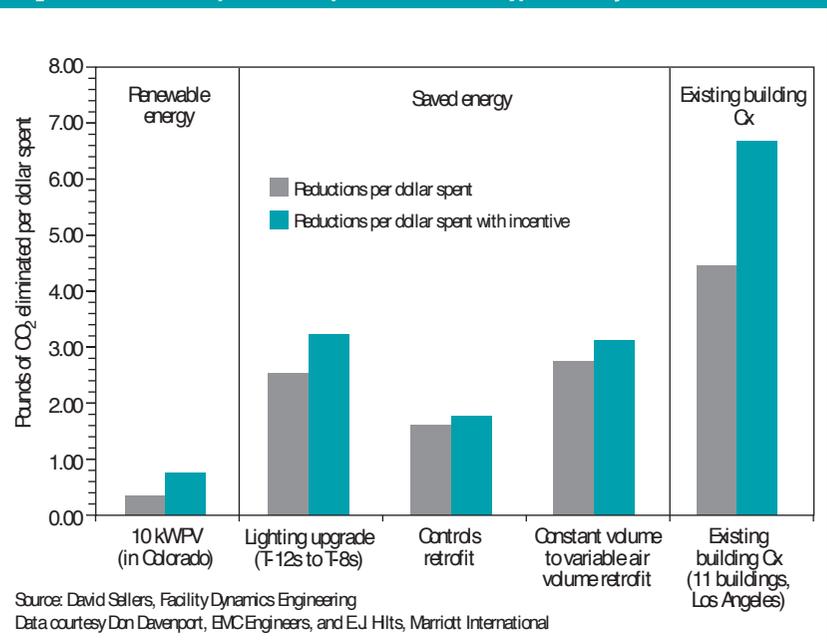
The answer: 27. Hlts, regional director of energy for the hotel management firm’s properties in the western U.S., invested \$100,000 in the most cost-effective ones and wound up with \$150,000 in savings and incentives from the California Public Utility Commission’s Statewide Building Tune-up Program.

Hlts has also recommissioned the San Diego Marriott Hotel & Marina, two 25-story towers built in 1984 and 1987 with a total 1,362 rooms, at a cost of \$195,304. The project resulted in 8.4% energy savings and energy cost savings of \$272,500 a year, for a simple payback of nine months.

Retrocommissioning project at the Newport Beach Hotel & Spa led to 11 interventions that are saving \$56,000 a year in energy costs, with less than a one-year payback.

Marriott’s retrocommissioning program is saving the hotel management firm more than \$4.5 million a year and cutting emissions in the hotels it operates by 68,000 tons annually.

Chart 6.1  
CO<sub>2</sub> Emissions Saved per Dollar Spent for Different Types of Projects



Analysis of various strategies used to reduce emissions in existing buildings shows building commissioning to produce the most cost-effective results, followed by lighting upgrades and retrofitting to variable air volume HVAC. Installing PVs proved the least cost-effective in terms of emissions reductions per dollar spent.



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6. "Think Small: The Key to Unlocking the Existing Buildings Market," Tim Kensok and Jim Crowder, AirAdvice Inc., National Conference on Building Commissioning, Newport Beach, Calif., 23 April 2008.

7. A study of existing buildings >25,000 sf by Portland Energy Conservation Inc. found that unit costs ranged from \$0.32/sf to \$0.47/sf based on average building size and depending on market sector. "Final Report: California Commissioning Market Characterization Study," PECL, November 2000. At: <http://resources.cacx.org/library/boldings/018.pdf>

8. Additional resources on commissioning:

- Building Commissioning Association, [www.bcxa.org](http://www.bcxa.org)
- California Commissioning Collaborative, "California Commissioning Guide: New Buildings" and "California Commissioning Guide: Existing Buildings," <http://www.cacx.org>
- Northwest Energy Efficiency Alliance, [www.betterbricks.com](http://www.betterbricks.com)
- PECL Commissioning Library, <http://peci.org/CxTechnical/resources.html>
- "A Retrocommissioning Guide for Building Owners," <http://peci.org/Library/EPAguide.pdf>

enough to cover the entire cost of commissioning, the researchers note.

The authors conclude that "commissioning is one of the most cost-effective means of improving energy efficiency in commercial buildings." While not a panacea, they admit, it is "one of the most cost-effective and far-reaching means of improving the energy efficiency of buildings."

**Obstacles to Building Commissioning**

Why aren't more building owners taking advantage of commissioning? One reason is inertia. Many building owners just accept higher energy costs as a fact of life—and either absorb them or pass them on to their tenants. The fact that only 45 public-sector companies of BOMA's 16,500 members have taken up the 7-Point Challenge is a sign that building owners would rather live with the problem than address it.

Building size is another limiting factor. According to the USDOE's Energy Information Administration, 98% of commercial buildings in the U.S. are less than 100,000 sf in size. They comprise about two-thirds of total floor area and consume about 60% of the energy used by buildings in the U.S. Since the "fixed costs" (mostly labor) of hiring a commissioning resource provider are roughly the same regardless of building size, the cost of retrocommissioning smaller buildings—estimated at \$.40-.60/sf—is greater than for large buildings (\$.27/sf for the median 151,000-sf building in the LBNL study).<sup>6,7</sup>

Another obstacle has to do with insulation. Adding insulation to a building is one of the most cost-effective

**Table 6.2**  
**Typical Deficiencies Found in Commissioning School Buildings**

Excessive play or gap in dampers
Malfunctioning power exhausts
Inoperative dampers and actuators
Malfunctioning economizer controls
Incorrect programmed sequence of operations
Oversized fans
Unapproved field modifications
Direct-wired exhaust fans always on
Dirty filters and coils
Improper setpoints
Water leakage on electrical equipment
Improper CO <sub>2</sub> -based purge operation
Improper flue exhaust
Malfunctioning exhaust fans

Source: "Evolution of Commissioning within a School District: Provider and Owner/Operator's Perspectives," Vivek Mittal, Enovity Inc., and Mike Hammond, Folsom Cordova (Calif.) Unified School District, National Conference on Building Commissioning, 23 April 2008.

Commissioning of 10 campuses (more than 500,000 sf) of the Folsom Cordova Unified School District in the Sacramento, Calif., metro area identified more than 700 systems deficiencies: 26% were associated with energy systems, 37% with comfort and IAQ, 32% with C&M, and 6% with safety.

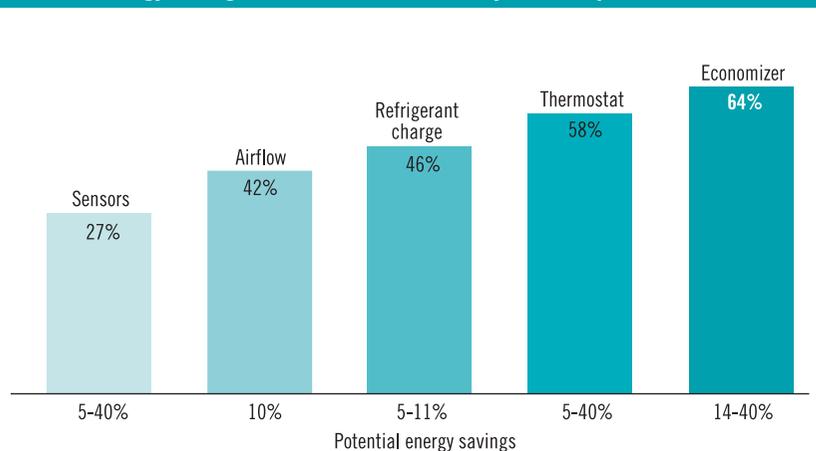
ways to cut energy and reduce GHG emissions, but it can be physically impossible to do in many existing commercial, retail, hospitality, multifamily, and healthcare buildings, unless they are undergoing a major renovation. However, tens of millions of existing homes could benefit from insulation improvements.

Many building owners are also apparently unaware of the rebates available to them from utility companies for making energy-saving building improvements. These can be substantial, and experienced commissioning agents report that they often make the difference in whether a property owner goes ahead with a recommissioning project.

The final hurdle has to do with what those in the commissioning field call "persistence." Many owners, even enlightened ones who have commissioned their buildings, fall into the trap of thinking that it's a one-time event. In fact, building systems, particularly HVAC systems, are forever falling "out of tune," even in new buildings. This raises the question of the need for more and better training of facilities personnel to get them to carry out the commissioning on a day-to-day basis, as well as the need for periodic (some even advocate "continuous") recommissioning.

One last thought about commissioning, from PECL's Tudi Haasl. "There's a myth that recommissioning is a cheap and easy way to get your building running happily," she says. "In reality, it's a mix of some really complex things with other easier things. But owners like it because the paybacks for some parts can be so quick, and when you bundle it all together, recommissioning gives you quick payback for the whole building."<sup>8</sup> **BD+C**

**Chart 6.2**  
**Potential Energy Savings from Commercial HVAC System Components**



Source: "Review of Recent Commercial Roof Top Unit Field Studies in the Pacific Northwest and California," A. Cowan, National Buildings Institute, October 2004. Cited in AirAdvice State of Building Performance Report 2007.

HVAC systems are a frequent source of discrepancies found in the commissioning process. Replacing or adjusting malfunctioning HVAC components can lead to significant energy savings and GHG emissions reductions.