

# How Recommissioning Saves Energy in Buildings

by Brandi McManus and Brandy Moore

## Executive summary

Changes to a building that occur over time often make building performance less efficient. This results in lower employee productivity, a higher energy bill, and increased building maintenance costs. Companies that “recommission” or fine tune their buildings are experiencing positive impacts to their bottom lines. This paper reviews how recommissioning can result in energy savings of 5 to 15% with a typical payback of less than 2 years.

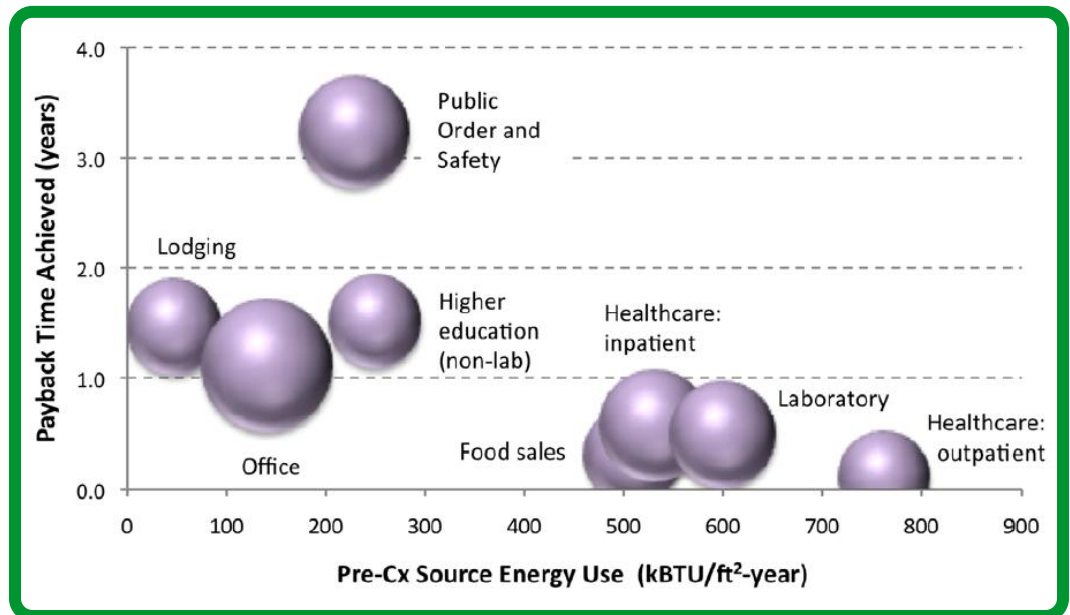
## Introduction

In today’s business environment, buildings change on an ongoing basis. Employees are added or moved. New departments are formed and old ones dissolved. Over time, entire sections or floors may be repurposed—from storage to office space, from office space to assembly space. In buildings where space is leased to businesses, tenants come and go on a regular basis and this further contributes to the changing building environment. All of these changes involve minor or major construction and the removal and addition of partitions, phones, power lines, data lines, and other infrastructure that support a business.

While these changes are occurring, time marches on and building technology evolves and improves. Facility, Energy, and Sustainability Managers are expected to stay current with new technologies in order to fully leverage their existing building management systems. They also face the challenge of a decline in existing equipment performance. Components break or fall out of calibration, and general wear and tear often leads to a rapid decline in the building’s performance. Changes in building use and occupancy can contribute to indoor air-quality problems, uncomfortable environments, and higher overall energy costs.

For these reasons, building owners often deploy a technique called “recommissioning” to fine tune their buildings. Through recommissioning, it is possible, with minimal expense, to bring a building back to its best possible operation level. In fact, research reveals that recommissioning results in improved comfort and energy savings of 5 to 15% with a typical payback of less than 2 years (see **Figure 1**).<sup>1</sup>

**Figure 1**  
 Recommissioning payback times vary among building types. Most achieve payback within 2 years (Courtesy of Lawrence Berkeley National Laboratory)



In simple terms, standard commissioning ensures that a new building operates as the owner intended and that building staff are prepared to operate and maintain its systems and equipment. For information regarding how to commission the data center portion of a building, see the Schneider Electric white papers, “Data Center Projects: Commissioning” and “Ten Errors to Avoid When Commissioning a Data Center”.

Retrocommissioning is a process that seeks to improve how an existing building’s equipment and systems function together, often resulting in changes to the original system design. It often resolves problems that occurred during design or construction, or address problems

<sup>1</sup> Evan Mills Ph. D., “Building Commissioning - A Golden Opportunity for Reducing Energy Costs and Greenhouse Gas Emissions”, Lawrence Berkeley National Laboratory, 2009

that have developed throughout the building's life due to changes in the use or occupancy of the facility. Retrocommissioning improves a building's operations and maintenance (O&M) procedures to enhance overall building performance.

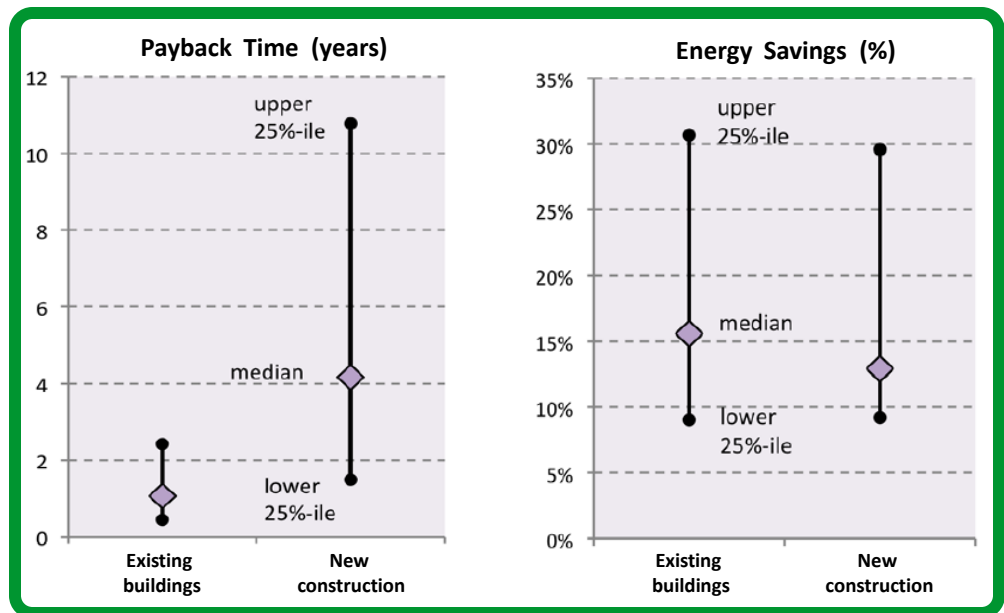
Recommissioning occurs when a building that has already been commissioned undergoes another commissioning process. The decision to recommission may be triggered by a change in building use or ownership, the onset of operational problems, or some other need.<sup>2</sup> Whether it's conducted once a decade or annually, re- and retrocommissioning can result in significant benefits, some of which show up on the bottom line.

A fourth type of commissioning is monitoring-based commissioning (MBCx), which provides ongoing performance diagnostics and fault detection. Manual remote monitoring services or advanced analytics engines process building data to continuously diagnose facility performance and identify equipment and system faults, sequence of operations improvements, and system and energy usage trends.

## “Fine tuning” benefits

The basic question every building owner faces is simple: do the benefits of recommissioning outweigh the costs? In other words, will recommissioning pay for itself? The answer depends on each individual situation, and only a professional assessment can provide the answer for a specific building. But in many cases, recommissioning reduces energy cost and returns the investment very quickly (see **Figure 2**).

**Figure 2**  
Commissioning and recommissioning payback times and energy savings of both existing and new construction buildings (Courtesy of Lawrence Berkeley National Laboratory)



A recent Lawrence Berkeley National Laboratory study analyzed results from 643 buildings across 26 states, representing 99 million square feet of commissioned floor area (76% in existing buildings and 24% in new construction). These projects collectively represent \$43 million of commissioning investment. The new construction category represents \$2.2 billion of total construction costs. For existing buildings, median commissioning costs were \$0.30 / ft<sup>2</sup>, with a median whole-building energy savings of 16%, and payback time of 1.1 years. For new construction, median commissioning costs were \$1.16 / ft<sup>2</sup> (0.4% of total construction costs), yielding a median payback time of 4.2 years, excluding quantified non-energy impacts.

<sup>2</sup> T. Haasl and K. Heinemeier, "California Commissioning Guide: New Buildings" and "California Commissioning Guide: Existing Buildings". *California Commissioning Collaborative*. 2006

According to the study results, buildings with comprehensive commissioning attained nearly twice the overall median level of savings and five times the savings of the least-thorough projects. Significant non-energy benefits such as improved indoor air quality were also achieved. The study went on to conclude that non-residential building recommissioning in the US could result in an annual energy-saving potential of \$30 billion (and 340 Mt of CO<sub>2</sub>) by the year 2030.<sup>3</sup>

## Tenant satisfaction and productivity

Employee productivity is an important building performance metric for two reasons. First, employee salaries are usually the largest operational expense in a building. Therefore, any increase in productivity has a visible and dramatic impact on company (and building) value.

Second, many studies have linked air quality and temperature to employee productivity. For example, according to a report entitled, Control of Temperature for Health and Productivity in Offices, there is a 2% drop in productivity for each degree above 78°F<sup>4</sup>. A similar reduction in productivity occurs when the temperature drops below 72°F. Thus, temperatures between 72°F and 78°F are considered the comfort zone.

For building owners, this represents a huge opportunity. William Pape, the cofounder of VeriFone, reported that 18 months after VeriFone employees began working in a building retrofitted to cut indoor pollutants and improve indoor environmental quality, absenteeism rates were down 40% and productivity was up by more than 5%. Pape notes that healthy workplaces have “done more to boost productivity than all the bandwidth in the world.”<sup>5</sup>

Gary Jay Saulson, the Senior VP and Director of Corporate Real Estate for PNC Realty Services, describes the benefits of the LEED Silver PNC Firstside Center building in Pittsburgh as follows, “People want to work here, even to the point of seeking employment just to work in our building. Absenteeism has decreased, productivity has increased, recruitment is better, and turnover less.” After moving into the new Firstside facility, two business units experienced respective reductions in voluntary employee terminations of 83% and 57%. When compared with a control group that experienced an 11% reduction, the outstanding improvement is evident.<sup>6</sup>

## Direct cost savings

The most direct and quantifiable benefit of recommissioning can be seen in reduced energy costs. One study of 44 recommissioned buildings found attractive return-on-investment (ROI) based on energy savings alone. In this study, the project costs were moderate—ranging from \$10,000 to \$80,000—yet the returns were dramatic, delivering total energy savings of 5 to 15% of the total energy bill.<sup>7</sup>

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<sup>3</sup> Evan Mills Ph. D. “Building Commissioning - A Golden Opportunity for Reducing Energy Costs and Greenhouse Gas Emissions”, Lawrence Berkeley National Laboratory, 2011  
<http://evanmills.lbl.gov/pubs/pdf/cx-enef-mills.pdf>

<sup>4</sup> O. Seppanen, W.J. Fisk., & D. Faulkner, “Control of Temperature for Health and Productivity in Offices.” *Espoo, Finland: Helsinki University of Technology: Institute of Heating Ventilating and Air Conditioning & Berkeley, CA: The Lawrence Berkeley National Laboratory: Environmental Energy Technologies Division*, June 2004

<sup>5</sup> W. Pape, “Healthy, Wealthy, and Wise.” Inc., No. 2, pp. 25 – 26, 1998

<sup>6</sup> Green Building Alliance, “Shades of Green: 2002 Report of the Pittsburgh Green Building Alliance”. Pittsburgh, PA, 2002

<sup>7</sup> Energy Innovators Initiative, “Recommissioning – The Optimization of a Building Systems’ Operation”, Canada: Office of Energy Efficiency of Natural Resources, 2005.

Additional data from across the industry seems to support the notion that a building optimized for energy efficiency produces benefit on a number of financial fronts. According to McGraw Hill Construction<sup>8</sup>, benefits from higher efficiency buildings include the following:

- Operating costs decrease 13.6% for new construction and 8.5% for existing building projects
- Building value increases 10.9% for new construction and 6.8% existing building projects
- Return on investment improves 9.9% for new construction and 19.2% existing building projects
- Occupancy increases 6.4% for new construction and 2.5% existing building projects
- Rent increases 6.1% for new construction and 1% existing building projects

**Table 1**  
 Summary of benefits of high performing buildings (Source: The US Green Building Council, "The Business Case for Green Building")

Benefits Commercial Building Owners	Benefits Commercial Building Tenants
Increased rental rates	Lower operating costs
Higher tenant occupancy	Healthier, cleaner indoor environmental quality
Improved cost effectiveness	Immediate and measureable results
Competitive differentiation	PR and community benefits
Simplified risk management	Contribution to bottom line

The benefits for high performing buildings are shared by owners, and tenant / occupants (see **Table 1**). A guide published by Portland Energy Conservation, Inc. and the Oak Ridge National Laboratory cites the following additional benefits of recommissioning<sup>9</sup>:

- Identification of system operating, control, and maintenance problems
- Assistance in long-term planning and major maintenance budgeting
- Reduction of energy waste and validation that energy-consuming equipment operates efficiently
- Reduction of maintenance costs; reduction in premature equipment failure
- Documentation improvements which expedites troubleshooting, and reduces maintenance cost
- Training improvements which provide operating staff with increased skill levels; and improved effectiveness in serving customers or tenants
- Reduction in operational risk of the building

## Penalty for inaction

The link between building recommissioning and energy savings is an important one. Those buildings that are lacking in the area of energy efficiency find themselves at a profitability disadvantage for the following reasons:

- They are more expensive to condition, operate, and maintain.

<sup>8</sup> McGraw Hill Construction, "Green Outlook 2011: Green Trends Driving Growth", 2010

<sup>9</sup> T. Hassl, & T. Sharp, "A Practical Guide for Commissioning Existing Buildings". Portland, OR: Portland Energy Conservation, Inc. & Oak Ridge Tennessee: Oak Ridge National Laboratory, 1999

- They run the risk of high vacancy rates. For example, according to a RICS research study, in buildings surveyed, all buildings occupancy rates averaged 78.6% while those buildings that achieved LEED certification averaged a 99% occupancy rate<sup>10</sup>.
- They face quick asset value depreciation.
- They offer give tenants more negotiation power over lower rental rates. For example, the same RICS research study found that rent \$ per square foot averaged \$25.92 for LEED certified buildings as opposed to an average of \$18 for other buildings<sup>11</sup>.

## Process steps

Any buildings that have undergone changes, or whose systems have not been examined for many months or years, are obvious candidates for recommissioning. However, the best candidates for recommissioning may be those buildings that have a computerized building energy management system (BEMS) in place; the investment in technology has already been made, but is often underutilized. Surveys find that staff often lacks training, that equipment does not function properly, or that building owners do not leverage system capabilities.

The recommissioning process is an opportunity to leverage these systems, understand and document their capabilities, and create truly optimized buildings. In addition, recommissioning is an opportunity to train the staff how to use the powerful tools that are available to diagnose and troubleshoot HVAC and other systems. This allows building owners to gain long-term value from their BEMS investment.

Newer buildings built to current or recent energy and ventilation codes are also viable candidates. The tight tolerances in their mechanical design which are laid out as part of the design specification can result in higher energy use if not properly monitored and maintained.

The benefits of recommissioning are clear. What about the process? How does a business reach the goals of recommissioning with minimal disruption and cost? The following five-step process is recommended:

1. Site assessment
2. Testing and definition of scope
3. Prioritization of improvements
4. Implementation of agreed improvements
5. Verification of results

Following these steps ensures that goals are defined, the easiest changes are made first for rapid ROI, and the bigger changes are properly prioritized and measured (see **Figure 3**).

### Site assessment

While many books and documents describe the process of recommissioning, it is best to begin with an assessment of the site with an Energy Management System (EMS) or Building Management System (BMS) provider. They will identify simple and inexpensive items that may increase the operation of the building and have short paybacks.

Some items that an EMS / BMS provider will review include the following:

- Overall building energy use and demand, and areas of highest energy use and demand

<sup>10</sup> Fuerst and McAllister, RICS Research, "What is the effect of eco-labelling on office occupancy rates in the USA?", 2010

<sup>11</sup> Ibid.

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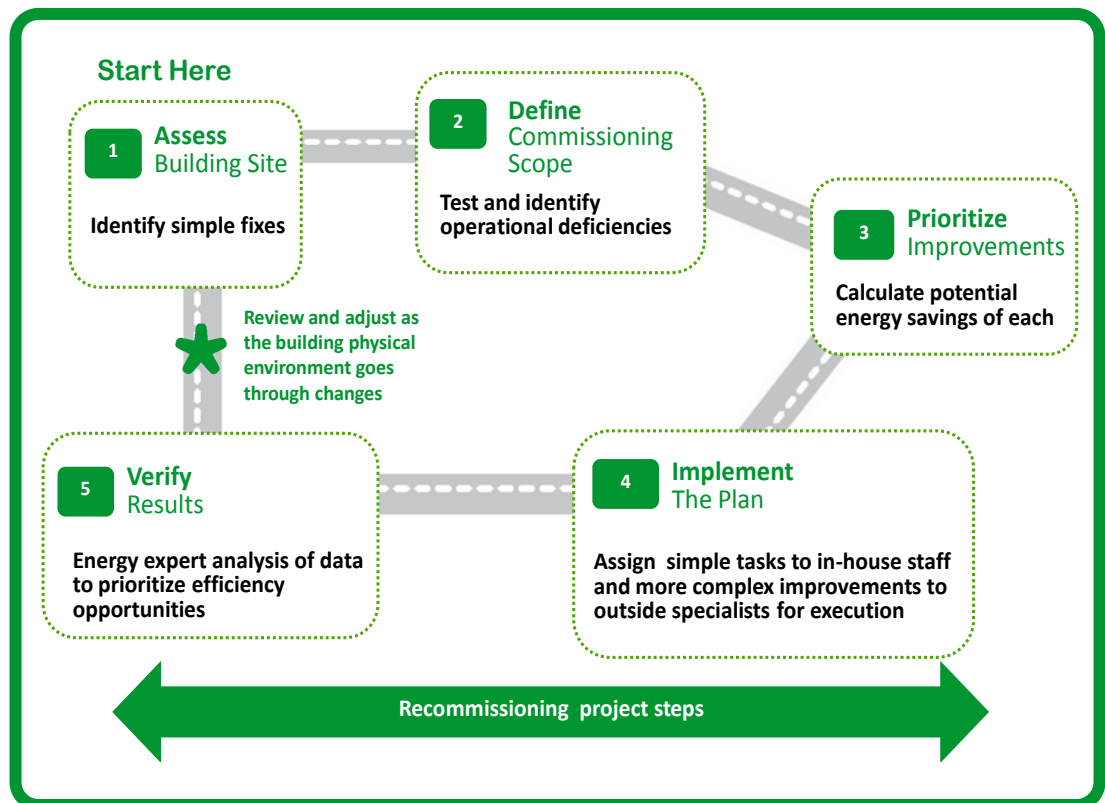
- Current design and operational intent and actual control sequences for each piece of equipment included in the project
- Equipment nameplate information and equipment condition issues (broken dampers, dirty coils, sensor calibration, etc.)
- Management system scheduling parameters (i.e., set-point, time-of-day, holiday, lighting)
- Major control and operational problems
- Location of comfort problems / trouble spots in the building
- Current operations and maintenance practices

### Testing and definition of scope

An output of the assessment should be the identification of simple measures to take, such as: functional testing of equipment, trend-logging temperature sensors to identify problems, and portable data-logging for short term diagnostics like investigating a reset schedule or graphing outside air temperature against hot water supply temperature. Other work accomplished at this stage should include the following:

- Identify simple repairs with associated costs
- Identify testing and data-logging that may be needed
- Identify lists of longer term deficiencies and repair costs
- Explore the option of new cloud-based, monitoring-based commissioning to manage and maximize building data on an ongoing basis

**Figure 3**  
The recommissioning process can be executed by internal staff and / or by outside specialists.



## Prioritization

After establishing the list of potential improvements for the building, it is important to prioritize. The value of any improvement will depend on the specific circumstances of a building and the goals of the owner. Consider not only the cost of each improvement, but also the potential energy savings. Some improvements may cost more, but will deliver larger energy savings and comfort enhancement.

Many recommissioning improvements are straightforward and the facility manager can have confidence that the improvements will be quick and measurable. However, some improvements, such as advanced energy conservation measures and equipment replacements, may need an energy analysis to investigate.

## Implementation

The implementation of recommissioning measures may be completed by in-house staff, the BMS provider, or third-party contractors. For example, simple schedule changes and set-point adjustments may be implemented by in-house staff, but more complex programming changes can be contracted to the BMS provider through an annual service contract or a project purchase order. Other building improvements, such as lighting changes, mechanical system upgrades, or electrical system measures may need other third-party contractors. No matter which implementation approach is selected, it is vital to have a comprehensive approach to the building and to work with a trusted partner.

Below are some examples of typical recommissioning activities:

- Replace, calibrate, or relocate space temperature sensors
- Reset original or create energy-focused time schedules
- Verify all previously implemented energy efficiency control strategies such as optimum start, resets, and load control
- Verify space temperature set-points, as well as plant and system set-points
- Verify operation of lockouts and overrides
- Replace or repair non-functioning dampers
- Add actuator and dampers where needed
- Add programming to allow automatic startup of chillers and boilers
- Add points to EMS to allow energy- and demand-tracking on the entire building as well as specific equipment
- Add trending capabilities for diagnostics and troubleshooting
- Investigate sizing of pumps for relocating
- Test and verify operation of valves
- Install pressure and temperature gauges on chillers, boilers, and pumps for maintenance and troubleshooting
- Extend training of facility staff
- Review and update energy management system documentation

*“In all cases, it is important to balance the cost of measurement with the benefit of the information”.*

## Verify results

The options for result measurement range from simple calculation to whole-facility measurement and monitoring. In all cases, it is important to balance the cost of measurement with the benefit of the information. For example, advanced metering and monitoring increases



cost but also adds benefits such as verified results and operational data to identify further measures. Selecting the appropriate method of calculating energy, operational, and maintenance cost reduction depends on the long-term goal of the building and energy management programs.

Also, it is important to remember that while some results of recommissioning are easy to measure—such as lighting changes—others are not. Recommissioning may involve many operational changes which, while generating significant energy, operational, and maintenance savings, may be difficult to measure and verify. Establish measurement methods at the beginning of the project with the selected BMS or EMS partner.

## Conclusion

Over time, changes in building occupancy and use can significantly impact energy costs, as well as employee comfort and productivity. By undertaking a modest recommissioning project, building owners can upgrade facility performance dramatically to achieve reduced energy costs, improved comfort, and increased employee productivity. For many facilities, the savings can be as high as 15% of the total energy bill.

An energy or building management partner can help facility owners assess the current performance of their buildings, correct simple problems, and develop a plan for enhancing performance and measuring the results. Properly executed, a recommissioning project will cut costs, improve operational efficiency, and reduce the organization's carbon footprint.



### About the authors

**Brandi McManus** is the Senior Vice President of Content and Communities at Schneider Electric. She earned her Bachelor of Science degree from University of Oklahoma in Environmental Engineering and her Masters in Business Administration from Southern Methodist University. She has published multiple white papers on the topic of energy efficiency for buildings. Ms. McManus also focuses on the development of new, interactive content and the distribution of business and energy efficiency best practices to organizations, customers, and partners worldwide.

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