U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

BUILDING TECHNOLOGIES PROGRAM

Commissioning Existing Hospital Buildings Aids Peak Energy Performance

Many hospitals that have never gone through a commissioning process have building systems that are performing well below optimal levels. Problems may have occurred during construction, systems may have degraded over time, or space-use requirements may have changed—all contributing to inefficiencies.

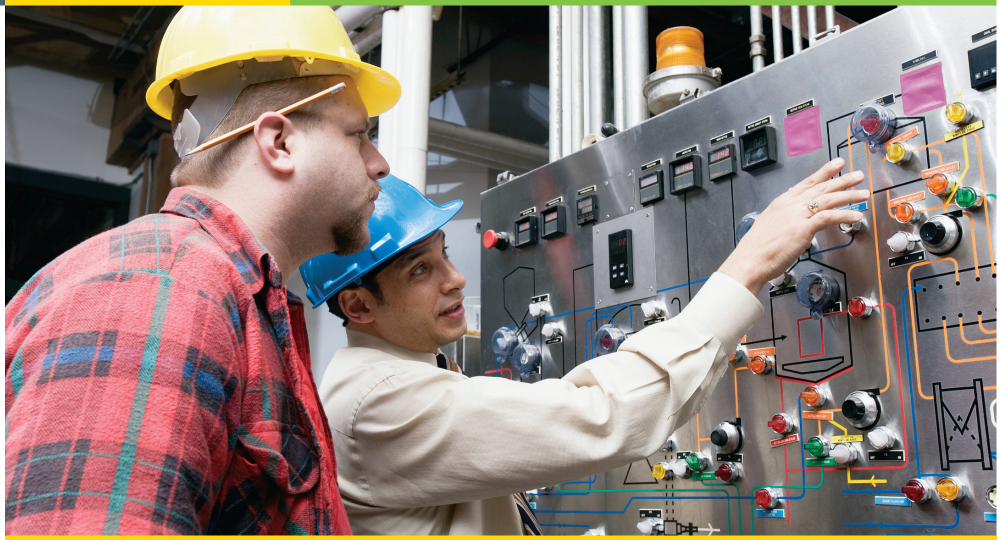


Photo courtesy of Horizon Engineering Associates, LLP

Commissioning is a systematic process of tests, analyses, and follow-ups to ensure building systems perform as designed. Commissioning generally is applied to new construction, but buildings constructed before commissioning became commonplace benefit from the application of its principles, too. Commissioning of existing construction helps building systems to operate and interact efficiently and effectively, frequently reducing the need for expensive capital improvements.

EBCx Benefits

- Improves building performance, saves energy, reduces operational costs, and extends equipment life.
- Verifies that a facility and its systems meet the current facility requirements.
- Identifies and resolves building systems operation, control, and maintenance problems.
- Improves indoor environmental quality, resolves occupant complaints, reduces associated liability, and minimizes operational risk.
- Documents system operation, improves personnel training, and increases asset value.
- Creates a plan/schedule for recommissioning and for making improvements over the life of the building.
- Assists in achieving green building certification.

Systems that perform below their potential use more energy and cost more to operate than systems that perform at acceptable levels. Too often, system problems are not noticed until a serious failure occurs. When that happens, quick fixes are frequently performed, which improve one system while inadvertently causing problems to develop in others.

Commissioning of existing buildings takes a methodical approach to achieving optimal performance in all systems of a facility. Further, the process provides tools that support continual improvement. Existing building commissioning (EBCx) may be staged when system upgrades are called for or undertaken as a separate effort. In addition to uncovering current problems, it can be an important tool in preventing problems from occurring.

This fact sheet has been developed by the U.S. Department of Energy's Hospital Energy Alliance to assist hospital facility owners, designers, and operators in using the EBCx process to improve building performance, save energy, resolve operational problems, and reduce operating costs.

Retrocommissioning, Recommissioning, and Ongoing Commissioning

Existing building commissioning is a broad term that includes more narrowly focused variations, such as retrocommissioning, recommissioning, and ongoing commissioning.[1] Retrocommissioning refers to the application of the commissioning process to an existing building that has never undergone commissioning. A building that has undergone the commissioning process, either at construction or through retrocommissioning, may be recommissioned. Generally, the commissioning process would be repeated periodically.

After a building has been commissioned—or recommissioned—it is best to practice ongoing commissioning. This involves continuing certain elements of the commissioning process to ensure system performance improvements between formal commissioning processes.

1. Boiler Retrofit vs. Replacement, HPAC Engineering, January 1, 2009. http://hpac.com/heating/boiler_retrofit_vs/.

Commercial Building Initiative

Following the EBCx Process

Generally, EBCx procedures must be executed sequentially, but certain aspects of the process should be repeated periodically to ensure ongoing building performance. The EBCx process takes place in the basic phases listed below.[2]

- *Planning*—Develop goals, determine facility requirements, and create a commissioning plan.
- *Investigation*—Conduct field inspections, collect data, analyze system performance, and identify improvement opportunities.
- *Implementation*—Make desired facility improvements and repairs and verify results.
- *Turnover*—Conduct a project hand-off meeting between the commissioning team and the operations and maintenance team. Hand off final documents, including the final report and the recommissioning schedule.
- *Persistence*—Develop and apply systems to support continual performance improvement over an extended period of time.

A Whole-Building Approach

Proper EBCx requires a whole-building evaluation. All building systems—and interactions among systems—should be tested and confirmed as adequate for current requirements. Limiting the focus to a single system (for example, HVAC) or a particular goal (such as reducing energy loss) is unlikely to result in a building that operates at peak efficiency.

The hospital building systems list that follows should be included in the EBCx plan. This list is not all-encompassing—each facility should be evaluated to determine which additional systems and equipment to include in the analysis.

- Plug loads (including equipment, computers, and vending machines).
- HVAC/Refrigeration systems (including ductwork, chillers, and boilers).
- Central plant systems (including combined heat and power and power distribution).
- Building envelope (including assembly, doors, windows, and insulation).
- Water/Plumbing systems (including sanitation, fire suppression, and distribution).
- Lighting/Electrical systems (including overhead lights and electric distribution).
- Building control systems (including energy management and automation).

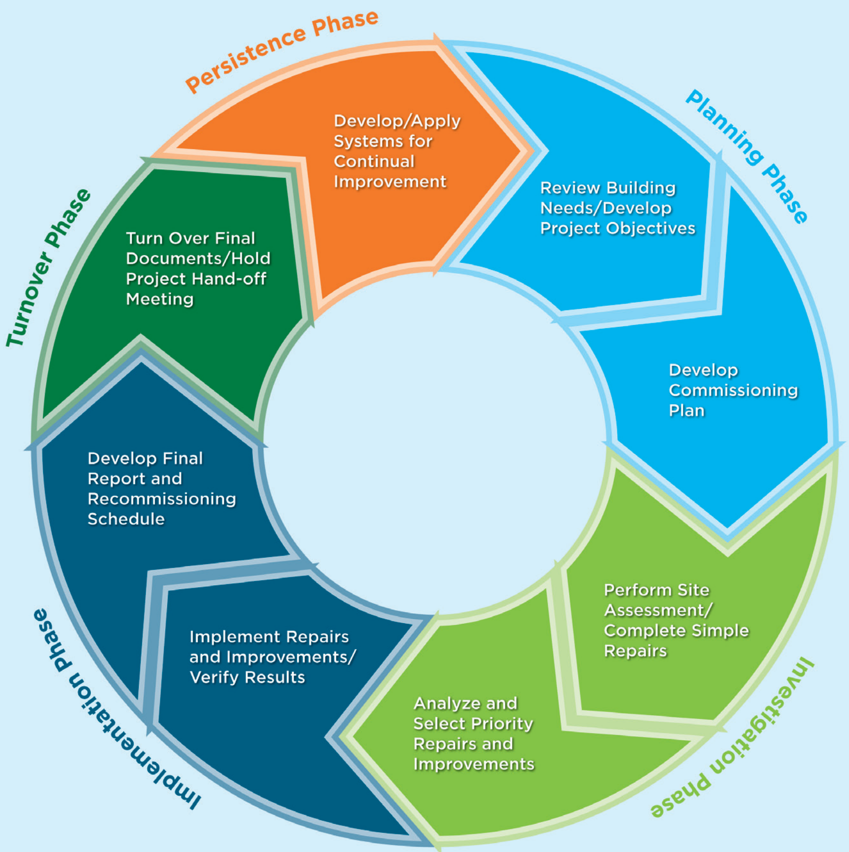
Because building systems are interdependent, energy-efficiency upgrades need to be considered together in sequence. This approach helps to ensure that building systems are correctly sized and optimally used. It also helps hospitals to avoid wasting money on redundancies, unnecessary upgrades, and temporary repairs.

Measuring Savings

EBCx offers hospitals measurable opportunities to conserve energy, save on energy and non-energy costs, and improve air quality. The amount of savings, of course, depends on the building type and location, as well as on the scope of the EBCx process. Types of savings include[3]:

- Annual *non-energy cost savings*, including those from extending equipment life.
- Annual *energy cost savings*. The HVAC system and plug loads represent key areas where major savings can be realized:

PHASES OF EBCx



This diagram illustrates the flow of the EBCx process.

Source: Modified from T. Haasl and T. Sharp, 1999. A Practical Guide for Commissioning Existing Buildings, Office of Building Technology, U.S. Department of Energy.

2. The Building Commissioning Association. https://netforum.avectra.com/eweb/StartPage.aspx?Site=BCA&WebCode=HomePage
3. Mills, E., H. Friedman, T. Powell, N. Bourassa, D. Claridge, T. Haasl, and M.A. Piette, 2004. "The Cost-Effectiveness of Commercial-Buildings Commissioning," Lawrence Berkeley National Laboratory. http://eetd.lbl.gov/EMills/PUBS/Cx-Costs-Benefits.html.

- During the EBCx process, all HVAC system components are inspected, calibrated, and set to ensure optimal energy efficiency while meeting indoor environmental quality standards. Commissioning the HVAC system can result in total annual energy savings of 5 to 15 percent.[4]
- Because plug loads account for about 9 to 10 percent[5] of a hospital's energy consumption, commissioning that leads to the use of energy-saving equipment and equipment settings (such as timers and energy-saving modes on electronic devices) results in considerable savings. Exact amounts vary widely due to system variables.

In addition to the relatively short-term payoffs EBCx provides, the process sets the stage for long-lasting results. By documenting exact specifications for the facility's building envelope, equipment, and processes, EBCx provides a baseline for future commissioning projects and guidance for preventative maintenance strategies.

For more information, see http://www1.eere.energy.gov/buildings/commissioning_rd.html, http://www1.eere.energy.gov/femp/program/om_commissioning.html, and http://www1.eere.energy.gov/femp/pdfs/ccg01_covers.pdf.

Persistence Pays Off

Persistence and ongoing commissioning efforts are very important. While undertaking such efforts may cost more than a limited approach, annual savings can exceed the initial investment. For example, the retrocommissioning of one hospital was projected to garner annual savings of just over $56,000. However, monitoring led to identification of additional savings opportunities, and the hospital's projected annual savings was increased to nearly $74,000, more than 30 percent higher than the original estimate.[6]

4. http://www.epa.gov/iaq/largebldgs/energy_cost_and_iaq/project_report7.pdf.
5. EERE Buildings Energy Data Book 2010.
6. Mills, E. and Mathew, P. 2009. Monitoring-Based Commissioning: Benchmarking Analysis of 24 UC/CSU/IOU Projects, Lawrence Berkeley National Laboratory, Berkeley, CA. http://eetd.lbl.gov/emills/pubs/pdf/MBCx-LBNL.pdf.

Case Study

St. Joseph Hospital Cardiovascular Center & Surgical Services

Bellingham, Washington

Began retrocommissioning in September 2008

St. Joseph Hospital is a 253-bed, two-campus medical center and level III trauma center in Bellingham, Washington; it is part of the PeaceHealth system. A 127,000-square-foot Cardiovascular Center & Surgical Services tower was built in 2003 and was never commissioned. The facilities team initiated retro-commissioning of the tower's mechanical system as part of the hospital's Strategic Energy Management Plan. The tower houses surgery suites, cardiac catheterization and electrophysiology labs, procedural care units, and sterile processing—all among the most energy-intensive areas of the hospital. The implementation phase began in September 2009. Cost is estimated to be about $192,000 when the effort is completed.

Key Findings

- Implementation of scheduling control, deadband control, and calibration of sensors in the six main air handler units were recognized as the greatest areas for improvement.
- No setbacks or energy-saving strategies were in use during low occupancy.
- Critical-area temperatures were set per physicians' expectations and maintained 24/7, regardless of patient load.
- The HVAC system and sensors had not been tuned since the building was initially opened.

Key Adjustments Under Way

- Increasing deadband of room air temperature setpoints in non-critical areas during low occupancy.
- Setting HVAC systems to utilize unoccupied setback for supply air cubic feet per minute (CFM) in the surgery suites.
- Sealing leaking duct work.
- Updating the controls programming for operating rooms and catheterization labs to allow for a "stand by" room temperature that is within Association of periOperative Registered Nurses (AORN) standards.
- Tuning sensors and rewriting programming code to optimize equipment operation.

Benefits

- Expected savings of $108,000 per year, with a payback period of about 1.8 years.
- Realizing approximately $800 per month in electrical fan energy savings for the first surgery suite operating in a setback configuration; seven more will follow. There are additional savings in reheat and chilled water.
- Building documentation will be up to date.
- All areas will meet clinical practice standards.
- Protocols are being put in place to sustain efficiency gains.

EBCx provides short-term payoffs and sets the stage for long-lasting results.

Case Study

Shriners Hospitals for Children®—Texas

Houston, Texas • Retrocommissioned 1997; recommissioned 2002

Texas Shiners Hospital for Children is a 40-bed, 247,775-square-foot, nonprofit acute-care facility. Opened in 1996, it is part of the Shriners Hospitals for Children's 22-hospital, nationwide healthcare system. In 1997, in an effort to reduce hospital utility costs, Texas Shriners' energy management team determined to undertake a retro-commissioning project. When the hospital initially benchmarked the facility with EPA's ENERGY STAR® Portfolio Manager—using 1996 data—it scored a below-average rating of 42 on a scale of 100. The following year, the team began investigating and implementing energy-efficient strategies, technology upgrades, and several no-cost and low-cost operations and maintenance opportunities. Portfolio Manager was used to track progress and daily energy demand and consumption. Texas Shriners improved its ENERGY STAR rating to 75 within three years. The hospital was recommissioned in 2002 and now has a rating of 92.

Key Findings

- No control of operating room temperature and humidity.
- Significant temperature fluctuation from floor to floor.
- No air balancing.
- Malfunctioning dampers.
- Many automatic temperature control devices not working.
- Significant amount of steam trap failures.
- High energy bills.
- Staff complaints of headaches.

Key Adjustments

- Upgraded the lighting and installed LED exit signs.
- Installed occupancy sensors in public areas and mechanical timers in non-public areas to turn lights off automatically.
- Installed variable frequency drives on air handling units, chilled water pumps, and domestic water pumps.
- Utilized a duct-free, split-HVAC system for weekends and after-hours use where appropriate, in place of running the central air handling unit.
- Replaced V-belts and sheaves with synchronous belts and sprockets.
- Instituted a rigorous preventative and predictive maintenance program that included energy management system and automatic temperature controls training for all maintenance technicians.

Benefits

- Realized a 24 percent reduction in energy consumption in the first two years.
- Saved approximately $2.6 million through the end of the 2009 fiscal year.
- Saved approximately $219,000 during the 2009 fiscal year.
- Improved building ENERGY STAR rating from 42 (1996) to 92 (2009).
- Received seven consecutive ENERGY STAR awards, from 2003 through 2009.

Utility	1997	2009	Difference	% Reduction
Electrical (kWh)	3,671,352	2,821,589	849,763	23.14%
Chiller—water (K-TH)	2,100.77	1,260.12	840.65	40.01%
Steam (K-LB)	10,949.45	6,770.00	4,179.45	38.16%

kWh = kilowatt-hours • K-TH = thousands of cooling ton-hours • K-LB = thousands of pounds (steam)

Hospital Energy Alliance

HEA is a forum in which healthcare leaders work together with DOE, its national laboratories, and national building organizations to accelerate market adoption of advanced energy strategies and technologies.

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

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Commercial Building Initiative

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