

Commissioning for Building Performance: An Essential Element in LEED™

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RETROCOMSM
Energy Strategies

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Outline

- Defining terms
- Why Commission Buildings?
- What does LEED-NC/CS/CI require?
- Examples of issues corrected through the commissioning process
- What does LEED-EB require?
- Examples of benefits of existing building Cx



RetroCom Energy – our background

- Founded 2006
- Commissioning Agents, Energy Engineers, LEED Consultants
- CxA for
 - 2 certified LEED-NC projects
 - 1 certified LEED-CI project
 - 8 certified LEED-EB projects
 - 13 LEED-NC projects in progress
 - 1 LEED-CI project in progress
 - 9 LEED-EB projects in progress
- RetroCommissioned 21 add'l buildings, not LEED projects, totaling over 12 million sq. ft.



What the #!@%*! is Commissioning?



Commissioning defined:

“The Commissioning Process is a quality-oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meets defined objectives and criteria.”

- ASHRAE Guideline 0



When and where –

- Commissioning – new construction or major renovation
- RetroCommissioning – existing building that was never properly commissioned
- ReCommissioning – previously-commissioned building
- Continuous Commissioning – ongoing monitoring and diagnostics to optimize performance



Why commission buildings?

- Few buildings perform as intended
- Performance deficiencies stem from:
 - Design flaws
 - Construction defects
 - Controls never commissioned and/or tweaked
 - Deferred maintenance
- Performance deficiencies lead to:
 - Comfort complaints
 - Premature equipment failure
 - Indoor environmental quality issues
 - Excessive energy use

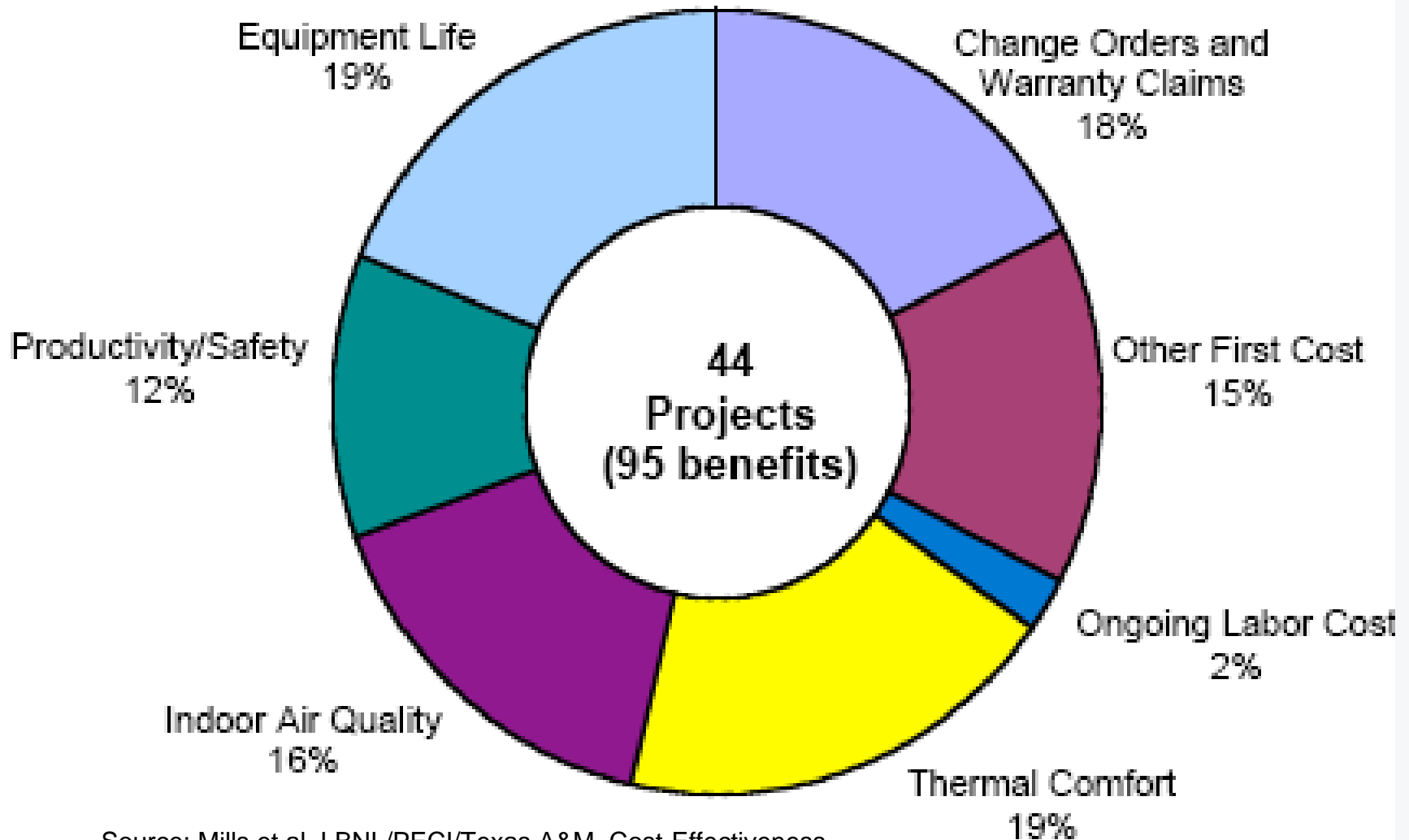


Benefits of commissioning in new construction

- Reduced energy consumption
- Reduced change orders and warranty claims
- Longer equipment life
- Improved indoor air quality
- Enhanced comfort
- Improved safety and reduced liability (may reduce insurance premiums)



Fig 35. Reported Non-Energy Impacts (New Construction)



Source: Mills et al, LBNL/PECI/Texas A&M, Cost-Effectiveness of Commercial Buildings Commissioning, 2004

Cx requirements for LEED-NC, CS, CI EA prereq 1

- Facilitate development and review documentation of Owner's Project Requirements (OPR) and Basis of Design (BOD)
- Provide specification language for incorporation of commissioning requirements into construction documents
- Develop project commissioning plan and coordinate implementation
- Provide Construction Checklists for each relevant trade to track proper installation and start-up of commissioned systems



Cx requirements for LEED-NC EA p1, cont'd

- Develop functional test procedures and oversee functional testing of systems to verify performance in compliance with design intent
- Maintain an Issues Log
- Provide a Final Commissioning Report
- Commissioning for LEED applies only to:
 - HVAC systems
 - Lighting and daylighting systems
 - Domestic hot water systems
 - Renewable energy systems



Cx reqts for Enhanced Cx, EA credit 3

- Provide Cx design review at 50% and 95% construction document phases for compliance with OPR and BOD
- Review submittals applicable to systems being commissioned
- Prepare a Systems Manual for building operators
- Coordinate, participate in, and verify completion of training of operating personnel and occupants for the commissioned systems
- Review building operation within 10 months after substantial completion to establish persistence of performance and resolve any outstanding Cx issues.



Commissioning begins when design begins

- OPR & BOD should clarify Owner's and design team's intent **before** detailed design is underway
- Provides basis for steering and prioritizing value engineering decisions
- Design team has to include commissioning requirements in construction documents
- Early review can uncover design issues that will create commissioning problems later
- Enhanced Commissioning (LEED EA-3) requires design and submittal review



Examples of issues corrected – Fundamental Cx

- Owner's design objectives regarding daylighting misinterpreted by architect (BOD)
- Owner's design objectives regarding number of occupants misinterpreted by ME (OPR/BOD)
- Improperly programmed ventilation controls that provided insufficient or excessive ventilation air
- Residential-grade thermostats unable to provide required control for commercial building
- Daylighting controls not configured or functioning properly
- AC condensing units with obstructed airflow
- Solar water heating system with improper piping configuration



Examples of issues identified with Enhanced Cx design review

- Oversized, undersized, or mismatched HVAC equipment
- Insufficient/incorrect control design specification
- Poor sensor location
- Obsolete lamp and ballast specification that would have resulted in higher energy use & lower quality of light
- Mismatched ballasts and lighting controls that would have resulted in early component failure
- Oversized DHW branch lines resulting in long waits for HW
- Test room HVAC system unable to deliver specified range of conditions
- Insufficient relief air openings for HVAC system with air-side economizers



Impact of Cx design review on equipment sizing

| <i>Equipment Description</i> | <i>Design Load Before Review</i> | <i>Design Load After Review</i> | <i>Rating Before Cx Review</i> | <i>Rating After Cx Review</i> |
|------------------------------|----------------------------------|---------------------------------|--------------------------------|-------------------------------|
| Chiller 1 | 280 tons | 248 tons | 300 tons | 260 tons |
| Chiller 2 (Absorption) | 95 tons | 96 tons | 110 tons | 110 tons |
| Ch1 Primary Pump | 60' head | 28' head | 20 HP | 7.5 HP |
| Ch2 Primary Pump | 40' head | 24' head | 5 HP | 3 HP |
| Cooling Tower Pumps | 45' head | 27' head | 25 HP | 15 HP |
| Secondary CHW Pumps | 110' head | 54' head | 40 HP | 20 HP |
| Backup Boiler | 2200 mBh | 2185 mBh | 3600 mBh | 2875 mBh |
| Primary HW Pump | 40' head | 11' head | 5 HP | 1.5 HP |
| Secondary HW Pumps | 70' head | 44' head | 10 HP | 7.5 HP |

Over \$60,000 reduction in equipment costs!

RetroCommissioning

USGBC

U.S. GREEN BUILDING COUNCIL
NORTHERN CALIFORNIA CHAPTER

www.usgbc-ncc.org



Benefits of RetroCommissioning

- Reduced energy consumption and costs
- Improved comfort
- Reduced wear on equipment (reduced cycling, fewer run hours, lower loads)
- Reduced tenant/occupant complaints
- Prioritize deferred maintenance work based on cost/benefit
- Can help achieve Energy Star or LEED certifications



Common RetroCommissioning Findings

- Broken/stuck/disconnected dampers/valves
- Lack of or sub-optimal reset strategies
- Setpoints never commissioned
- Unnecessary operation; insufficient schedule or lockout controls
- Throttled valves or balance dampers; oversized equipment without part-load control
- Simultaneous heating & cooling
- Sub-optimal staging of equipment
- Sub-optimal or disabled economizer control



Relevance of Cx to LEED-EB

- EA prerequisite 1 – document control sequence of operations; develop Systems Narrative; conduct Level I Energy Audit
- EA prerequisite 2 & credit 1 – optimize energy performance
- EA credit 2.1, 2.2, 2.3 – Cx investigation and analysis, implementation, and ongoing Cx plan
- IEQ prerequisite 1 – minimum indoor air quality



What LEED-EB EA Credit 2.1 requires

- Prepare Commissioning Plan
- Document Building Operating Plan
- Evaluate and document breakdown of energy consumption by end use
- Test and evaluate building systems for deficiencies in operation, maintenance, or control
- Identify low-cost/no-cost measures to improve operations and reduce energy use; analyze benefits
- Identify capital improvements that will cost-effectively improve energy efficiency



Case study 1: High-rise office building

- Annual savings identified:
1,362,365 kWh, 200 peak kW,
447 therms natural gas
- Measure description: VFDs on
throttled pumps, VFD on
chiller, resheaved supply fans,
lighting controls, makeup air
schedule optimization
- LEED-EB Gold
- Increased Energy Star score
from 92 to 96 , <2 yr payback



Case study 2: Corporate HQ

- Annual savings identified:
298,000 kWh, 9,400
therms,
< 1 year simple payback
- Measure description:
Control
optimization, relocate
sensors, repair dampers,
add boiler controls
- LEED-EB Platinum



Case study 3: Low-rise office complex

- Annual savings identified: 285,000 kWh, 47 peak kW and 15,000 therms of natural gas, with payback of 1.5 years
- Measure description: optimize existing controls system, upgrading and controlling lighting, and replacing oversized equipment to match actual use.
- LEED-EB Gold



Case study 4: High-rise office building

- Annual savings identified: 454,000 kWh, 28 peak kW, 3,200 therms, 2.5 year simple payback after incentive
- Measure description: Pump VFDs, garage exhaust fan control, cooling tower optimization, static pressure optimization, economizer repair, lighting control repair/tune
- LEED-EB Gold



Conclusion

- No flashy technology or silver bullets, just methodical process of ensuring buildings achieve their performance objectives
- Commissioning of control systems is key element in achieving intended performance
- LEED requirement or not, Commissioning of new and existing buildings provides tangible benefits to building owners and occupants



Thank You!



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