Costs and Benefits of Commissioning LEED-NC™ Buildings

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Synopsis

More and more owners and developers are considering LEED® certification for their projects. The impetus behind this is not only competition, but also the potential for added value with a more environmentally responsible and energy-efficient project. To make this commitment, owners and developers want information on whether it is cost effective to pursue LEED-NC certification and what the additional costs and benefits are.

A requirement of LEED, commissioning is often new to many owners. Commissioning, along with energy modeling and LEED documentation fees represent the bulk of the increased soft costs for buildings pursuing LEED-NC. This paper presents real world results of eleven buildings pursuing LEED-NC, including perceived and achieved benefits and costs incurred. A formal study commissioned by the Colorado Governor's Office of Energy Management and Conservation was conducted and information was gathered through detailed design team and owner interviews. The study included large and small buildings as well as owners with varying levels of experience with incorporating commissioning into the design and construction process.

The study provides a wealth of information to help guide owners in setting commissioning budgets for LEED-NC projects as well as understanding the benefits and potential pitfalls related to commissioning and commissioning of LEED projects. It presents scope of commissioning services and associated costs and well as owner's feedback on the LEED and commissioning processes.

Is LEED cost-effective? This question comes up time and time again as building owners and design teams who want to build the best building possible are considering the option of pursuing LEED-NC certification. This paper presents the results to address this question with a focus on commissioning.

About the Author

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served as senior project manager for a national energy services company, managing the design and construction of large-scale, facility improvement projects in the commercial and industrial sectors. Peter is Advisor to the Colorado Governor's Office of Energy Management and Conservation, providing services in energy management and high performance building design and assisted in the management of the research project on which this paper is based. Peter has held the role of general contractor, engineer, field technician and planner and is an accomplished author and speaker on building energy efficiency. He serves as board member and committee chair/member for professional and community organizations including the USGBC, AEE and ASHRAE. Peter holds Bachelor's and Master's degrees in civil engineering from the University of Maryland and the University of Colorado.

Background

This paper summarizes the results of a research project conducted in 2006 by ***Rebuild Colorado***, a program of the **Governor's Office of Energy Management and Conservation,** to examine the costs and benefits of eleven LEED-NC version 2.1 certified projects in Colorado. Also included is an expanded discussion of the cost and benefits of the commissioning of these projects.

This effort included the convening of an advisory committee, a survey of owners of LEED-NC certified buildings in Colorado, and publication of a white paper entitled *The Costs and Benefits of LEED-NC in Colorado*. The process was structured to gather hard (construction related) costs and benefits in a manner as consistent as possible, while still capturing the occupant impressions and other soft (non-construction related) costs and benefits.

Research has shown that high performance, energy-efficient buildings provide a variety of benefits including improved learning, occupant health and satisfaction, and lower energy and water costs. There are a growing number of studies addressing the cost and benefits of building green and commissioning green buildings in various parts of the nation; Colorado has historically lacked such a resource. This research project begins to address these issues as well as explore strategies to help project teams create more cost-effective, high performance green buildings.

Thankfully, LEED-NC requires commissioning. After all, commissioning, like LEED, is focused on sustainability. Commissioning is intended to not only deliver building systems that work, but also to set the stage for ongoing, sustained operational success of these systems. Commissioning is one of the most cost-effective means of reducing operating costs and improving energy-efficiency and occupant comfort in commercial buildings.

Objectives

Is LEED-NC cost effective in Colorado? What does it cost to build a high-performance green building? What is the cost-premium for a LEED-NC certified building? How much should I budget for a LEED-NC building and commissioning of a LEED-NC building?

These questions come up time and time again as building owners and design teams who want to build the best building possible are considering the option of pursuing LEED-NC certification and high performance green building. This project attempted to address these questions as well as begin to address the following:

- Of the four LEED-NC certification levels available, do certain levels cost more than others to obtain?
- What are the factors that make some LEED-NC projects cost less than others?
- Why do some projects cost so much more, and how could costs be better managed in the future?

This research is only one step in an ongoing endeavor that has the potential to more effectively use funding for design and construction of buildings, to help produce better buildings at every stage of a building's life, and to change perception and encourage innovation in design, construction and operation of buildings.

Cost Basis

Builders often claim that building green or to the LEED criteria is too expensive and that they can't afford to incorporate high-peformance or green features into construction. What is often left out of the discussion is the basis for this claim. For example, costs more compared to what? Compared to a similar building down the street; compared to the last building that was built; compared to the original budget, which may or may not have been based on the current goals of the project or market conditions; or compared to a code or juristictionally compliant building? Design and construction are complex, as are the factors and forces that influence cost. By evaluating multiple buildings under this report we are able to share differing experiences and approaches taken by teams in construction of LEED buildings.

This study attempted to quantify the costs and benefits associated with achieving LEED-NC certification with the baseline or preexisting standard being if the building were not constructed to LEED-NC. Some project teams incorporate certain requirements of LEED, such as commissioning or energy modeling, as business as usual and do not consider them additional costs. Therefore, the relative cost premiums in this study are exaggerated for such project teams. To take it a step further, if a project team or owner considers their building design and construction standard and equal to LEED, then in reality there would be no premium.

Summary of Findings

Table 1 summarizes the survey findings. The survey was limited in scope, but the sampling is significant enough to support the key conclusions.

Table 1: LEED-NC Costs and Benefits

LEED-NC v2.1 Project	LEED-NC Certification Level	Building Size [SF]	Year Completed	Construction Cost [$/SF]	LEED Cost Premium [$/SF]	NPV Energy Cost Savings [$/SF]	Net LEED Savings [$/SF]
Aspen Skiing Company Snowmass Golf Clubhouse	Silver	10,000	2005	$370	($20.00)	no data	
CH2M Hill North Building	Certified	112,600	2003	$156	($1.90)	$4.30	$2.40
CH2M Hill South Building	Certified	112,600	2002	$156	($1.90)	$4.30	$2.40
CH2M Hill West Building	Certified	164,500	2003	$156	($1.90)	$4.30	$2.40
City of Boulder N. Boulder Rec. Center	Silver	62,000	2002	$188	($8.70)	$10.40	$1.70
City of Fort Collins Vehicle Storage	Certified	15,250	2005	$129	($8.20)	$6.70	($1.50)
Colorado College Tutt Science Center	Certified	54,123	2004	$200	($9.20)	no data	
Colorado Dept of Labor & Employment Addition	Certified	40,000	2004	$100	($3.30)	$2.30	($1.00)
Pikes Peak Regional Development Center	Silver	111,758	2005	$112	($0.90)	$5.10	$4.20
Poudre School District Fossil Ridge HS	Silver	288,685	2004	$122	($1.00)	$4.00	$3.00
University of Denver Law Building	Gold	210,000	2003	$230	($0.70)	$3.50	$2.80

NPV calculation assumes 6% discount rate over 20 years.

Based on the discussions with the design teams and the data collected for these LEED-NC v2.1 certified projects in Colorado, we found the following:

Overall

- The cost premium for LEED-NC version 2.1 certification ranged from 1% to 6% of construction costs, for nine of eleven projects providing sufficient data (excluding Pikes Peak Regional Development Center and University of Denver Law School).
- While LEED cost premiums were shown for all projects, two of the projects (Fossil Ridge High School and Department of Labor and Employment Addition) noted that they were able to achieve LEED certification and complete the projects on schedule and under the original budget (hard cost increases were attributed to life-cycle decision making and design and construction standards, not LEED). Additionally, the Department of Labor and Employment Addition set their budget before LEED certification became a project priority.

Soft Costs and Benefits

- Soft costs, including LEED registration and certification, LEED documentation, energy modeling and commissioning, average roughly 0.8% of the construction costs, or approximately $1 per square foot.
- Documentation costs for LEED certification submittals were difficult to quantify as the basis for the fee reporting was inconsistent with a reported range from less than $3,000 to a maximum of almost $60,000. Almost all of the project teams recommend reducing the documentation requirements. They recognize the importance of accountability provided by the LEED submittal review process; however, they view the documentation costs as a burden.
- Energy modeling averaged roughly $10,000 across nine projects reporting data, with eight projects reporting cost at or below $10,000 and one project reporting cost of nearly $35,000. Smaller projects exhibited higher costs per square foot than larger projects. All of the teams

designed and built their projects to at least 20% better than the requirements of ASHRAE 90.1-2001 *Energy Standard for Buildings Except Low-Rise Residential Buildings* (LEED requires only that the building meet the requirements of ASHRAE 90.1 or local code). The net present value of the energy savings associated with the project energy efficiency measures offset all of the LEED soft and hard costs in seven of the nine projects reporting energy savings data (counting the three CH2M Hill projects as one project).

- Commissioning is a significant soft cost at an average of $0.55 per square foot, counting only one of the three CH2M Hill buildings, and accounts for roughly 60% of total soft costs. Commissioning ranged from $0.19 to $1.50 per square foot based on ten projects reporting data. The majority of the teams found it to be valuable, and commissioning costs were reportedly recovered soon in two projects (Snowmass Golf Clubhouse and Pikes Peak Regional Development Center). Although not quantified in this study, previous studies have reported a median payback period of less than five years for commissioning related activities.

Hard Costs and Benefits

The information provided by the project teams related to hard costs and cost savings of specific LEED-related decisions is too limited to provide budgeting guidance per LEED credit/point or overall.

Commissioning Findings

The costs for commissioning these projects are given in Figure A. All projects except the City of Fort Collins Vehicle Storage Building incorporated enhanced commissioning. The projects did not break out fundamental and enhanced commissioning costs, with the exception of North Boulder Recreation Center and Pikes Peak Building Department.

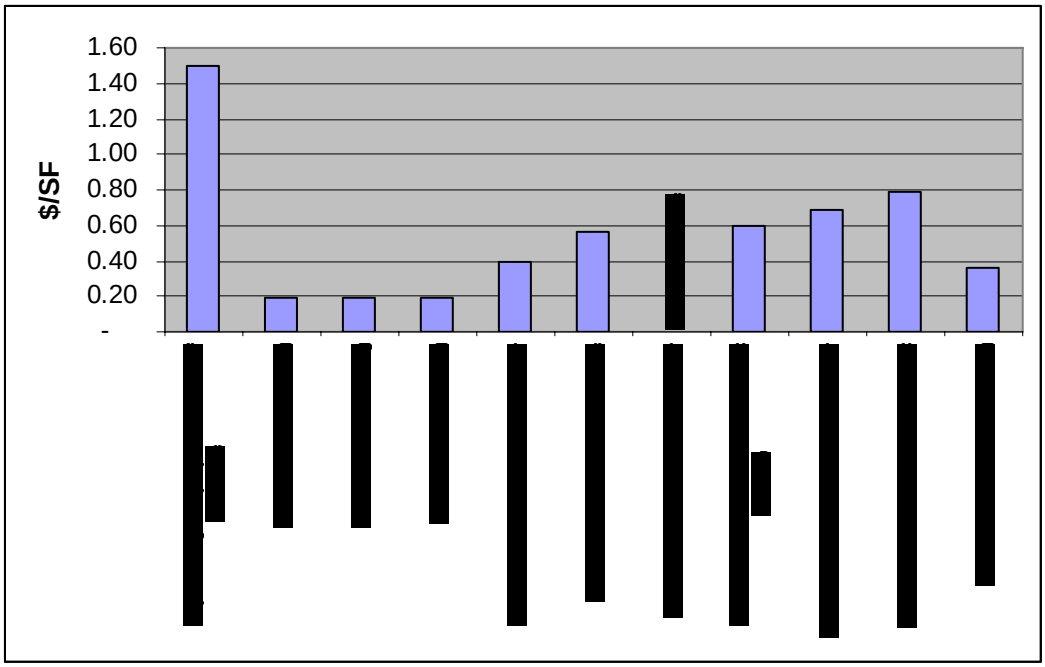

Figure A: Commissioning Costs

The average commissioning cost is $0.55 per square foot. For all projects, the costs ranged from $.19 to $1.50 per square foot. For projects over 100,000 square feet, the commissioning costs make up the majority of the project's LEED related soft costs (considering commissioning, energy modeling, LEED documentation and LEED certifications fees).

All project teams with the exception of two were strong advocates of the commissioning process. The City of Fort Collins – Vehicle Storage Building and Colorado College Tutt Science Center, found the commissioning process to be too documentation intensive.

Poudre School District (Fossil Ridge High School), the State of Colorado (Colorado Department of Labor and Employment Addition) and Aspen Skiing Company (Snowmass Golf Clubhouse) require commissioning on all their projects because they have found the benefits justify the costs, and have incorporated building commissioning into their design standards. So the decision to commission is not based on whether or not LEED certification is pursued.

Commissioning costs were recovered almost immediately at the Aspen Skiing Company Snowmass Golf Clubhouse and the Pikes Peak Regional Development Center through identification of cost saving opportunities.

The following sections provide specific owner and design team feedback, including anecdotal evidence regarding the commissioning costs and benefits for each project.

Aspen Skiing Company – Snowmass Golf Clubhouse

Fundamental and enhanced commissioning added $15,000 for this facility. The high commissioning cost relative to the building size at the Snowmass Clubhouse is a result of a relatively remote site and a small project. Snowmass sees commissioning as an added cost; however, they would have commissioned the project even if LEED certification was not sought and they commission all of their projects, mostly because they have had great experiences with it. Commissioning began in the design phase of this project. During the design development phase, the commissioning agent noticed that one of the four geothermal heat pumps planned for the building could be eliminated without compromising the design. The mechanical engineer agreed, resulting in a $10,000 savings. They see LEED as critical because of the third party stamp of approval, not because it drives their green design. It is a certification process, not a design tool. They recognize the value of the third party certification for credibility, but can not certify all buildings due to the cost of LEED. In the owner's opinion it is really unfair to say LEED costs more because LEED requires commissioning. In reality you have to commission buildings and one of the most important things LEED is doing is requiring commissioning. There was no impact on the project timeline due to pursuing LEED certification. While they don't have hard data, they feel commission provides a sub-10 year payback.

CH2M HILL – North, South and West Buildings

LEED Commissioning costs for these three projects were as follows and include fundamental and enhanced commissioning: North Building = $21,350, South Building = $21,350, West Building = $31,170 for a total of $73,870. This was the lowest cost per square foot of all the buildings studied. The low cost of commissioning is attributed to the repetitive nature of these buildings and the fact that commissioning was provided by the owner (CH2M Hill). Interviews with the design team were not conducted for these buildings.

City of Boulder – North Boulder Recreation Center

Commissioning costs were $24,300 for fundamental commissioning and included $7,400 for enhanced commissioning. Since building occupancy began, there have been no unforeseen maintenance issues and predicated energy savings are reportedly being achieved. The City of Boulder performs cost/benefit analysis as standard practice, and would have likely incorporated most of the project energy systems (with the exception of the solar pool heating) had they not attempted LEED certification.

The city's experience was very positive with commissioning and they recommend it for other projects. The city's project manger now budgets for LEED in every project and feels that LEED helps the City get the best building possible through LEED's third party certification. Going for LEED impacted the schedule mostly attributed to the additional testing required by the commissioning process, but the City found commissioning resulted in more organized equipment and systems documentation, as well as provided baseline data useful for ongoing operations and maintenance. Enhanced commissioning was a big success on this project and is automatically included in the program plan for future projects.

For future projects, the City has plugged in roughly 2% for LEED costs and recognizes that for smaller projects the percentage would likely be more. The 2% would cover commissioning as well.

City of Fort Collins – Vehicle Storage Building

Commissioning cost $8,500. Enhanced commissioning was not pursued on this project. LEED certification was a goal from the onset of the project. They feel major design integrations such as climate responsive building orientation and day lighting would not have been incorporated if LEED certification was not attempted, and the City is committed via a City Council Resolution to attempt LEED certification on all future City building projects. Building occupancy began in May 2005 and the City is happy with the results. The City reported that the commissioning process is too documentation- and time-intensive (especially related to basis of design, owner's requirements, and commissioning plan documentation) and has questionable benefit. The LEED submission process was viewed as pretty streamlined related to commissioning. The City feels more benefit would be achieved if commissioning focused less on the paperwork and more on the systems with this project.

Colorado College – Tutt Science Center

Colorado College paid roughly $300,000 for commissioning and LEED-related documentation though costs were not broken out enough to identify the cost only associated with commissioning. Prior to undertaking this project, Colorado College conducted and included their maintenance staff in detailed design and specification reviews and performed extensive testing and balancing of building systems. They are very life-cycle conscious and currently have a good integrated design and life-cycle approach to projects. Commissioning failed to identify and resolve all control problems, the University's expectations around commissioning have not been met, and the success of third party commissioning is questionable on this facility. Subsequent problems with controls and electrical system issues existed. They cannot justify commissioning and LEED costs though they are pursuing LEED on another new, larger campus building project, because of the University's commitment to sustainability and professor's embracing the third party verification benefit of LEED. The commissioning process appeared to have failed in a number of areas. One example is that the electric meter was not properly commissioned and previously collected data is erroneous. The problems have been corrected and energy data available should be available in the future. In spite of these commissioning issues, occupant satisfaction is reportedly very high, from an architectural and comfort perspective.

Colorado Department of Labor & Employment Addition

Commissioning for this building totaled $24,000 and was a good experience on the mechanical side, with lighting and water systems having some problems. The commissioning agent was brought on earlier in the design process (a testament to LEED) and the owner felt this shift greatly benefited the project. The commissioning agent also reportedly gave the owner a stronger voice and helped implement the owner's agenda. Occupant satisfaction was high with

people noting the building 'smelled good' and provided views for workers. The Office of the State Architect notes that many of the costs attributed to LEED are not truly LEED costs because items such as commissioning, high performance glazing and high efficiency boilers would have been included in the project had LEED not been pursued. Commissioning is considered a standard on all state projects now, and the state is moving to a continuous commissioning plan. Note that the engineer of record on this project did not have LEED experience prior to the project. During the design and commissioning process they came back several times and said LEED was causing them to do additional design work, however, requests for additional design fees were not granted.

Pikes Peak Regional Development Center (PPRDC)

Fundamental commissioning was $70,000, and enhanced commissioning cost $7,000 for a total of $77,000. PPRDC established a goal of LEED certification at the start of the design process in the year 2000, incorporated LEED into the design documents and the project came in under budget. Pikes Peak Building Department (Pikes Peak Regional Development Center) is a strong proponent of building commissioning.

The building systems are relatively complex at the PPRDC and include thermal storage. The facility manager and owner's representative reported the systems ran considerably more efficiently in the first two years of operation than anticipated because of the commissioning process. One of the main problems identified through commissioning was in the atrium. The atrium has mechanical units with low and high returns. When the units are in heating mode they utilize the low returns. When in cooling mode, they use the high returns. During commissioning, the commissioning agent discovered the control sequence was backwards and worked with the team to correct the problem. The design team recognized that a traditional test and balance effort would not have uncovered this problem. Commissioning was brought in during design phase and the design team found it to be an interactive process. The team found the commissioning agent to be very supportive and avoided finger pointing. The process was a team effort.

Poudre School District – Fossil Ridge High School

Fundamental and enhanced commissioning cost $226,477, including the monitoring and verification plan. Commissioning started with Zach Elementary School in the late 1990's and is now part of all Poudre School District projects, including large remodels, and was part of the original budget. The school district has found that commissioning costs are warranted and frees up their maintenance personnel. The district feels that, as school districts get leaner and maintenance staff get reduced, third party commissioning is a benefit as it frees up maintenance staff to perform their core mission, provides better documentation and a better level of accountability, and allows maintenance to work along side the commissioning agent feeling comfortable knowing they are well represented.

University of Denver – Law School

A formal interview with the design team was not conducted for this building. The facilities manager reported a commissioning cost of $75,000. The facility opened in August, 2003 and was the first LEED-NC law school in the country. The University of Denver is applying lessons learned from the Ricketson Law Building to other new campus buildings as it expands its commitment to sustainable construction.

Additional Costs, Benefits, and Findings

Below is a list of some of the remaining finding of the research.

- Life-cycle cost analysis (LCCA) is a valuable tool in creating a high-performance building. LCCA is employed on all projects for Poudre School District, Colorado College and the City of Boulder, and their designs are some of the most aggressive in terms of energy-efficiency.
- A few of the projects noted improvement in indoor air quality from the use of low-VOC materials. Colorado College has incorporated the low-VOC specifications into their design guidelines.
- A majority of the projects also enhanced the daylight levels and views in their facilities through the use of more and high performance glazing, interior glazing, light shelves and shading.
- All projects noted greater occupant satisfaction and the public relations value of having a LEED certified building. This benefits the commissioning industry as well.
- We were unable to draw any general conclusions as to the costs and benefits relative to individual LEED certification levels.
- Most of the project teams would and are pursuing LEED on future projects. Project teams generally anticipate LEED-related costs will be lower on future projects, due to experience garnered from completing the certification process.

Areas for Future Research

The work under this study has brought to light additional questions and potential areas for future study related to commissioning of LEED-NC projects.

The energy savings reported by the project teams are, in a majority of the cases, based on savings predicted by design team computer simulation, and, therefore, the findings related to cost-effectiveness rely heavily on the accuracy of these predictions. A re-analysis report will be valuable in confirming that these predicted energy savings were realized, and also will provide some measure of indication as to the effectiveness of the commissioning process in delivery savings. Many of the benefits quantified in other related studies as well as reported anecdotally under this study and elsewhere, such as operational and maintenance savings from commissioning, as well as reduced water consumption and related waste water fees, reduced tipping fees, increased productivity and decreased vacancy rates, were not quantifiable within the

scope of this research project. Future research to quantify benefits in these areas will serve to strengthen the findings of this report.

The projects under this study required independent, third party commissioning regardless of building size. The current version of LEED (LEED-NC 2.2) alters this requirement to only require third party commissioning on projects larger than 50,000 square feet. For projects less than 50,000 square feet, commissioning is required, but the commissioning agent can be a qualified member of the design or construction teams. This change to the commissioning requirements was intended to help minimize the cost impact of commissioning on smaller projects. Future study could quantify the cost and benefit impacts of this rating system change.

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