# The Costs and Benefits of LEED-NC in Colorado

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# Executive Summary

More and more owners and developers in Colorado 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 are.

To respond to these questions, 11 of the 20 LEED-NC certified buildings in Colorado were surveyed. We found the following concerning the costs and benefits of LEED certification in Colorado:

1. The cost premium of building a LEED-NC version 2.1 certified building compared to conventional construction ranges between 1 and 6 percent.
2. Using the modeled energy savings shows that the net present value of the predicted energy savings alone outweighs the cost premium in 7 of 9 of the projects with reported data (this counts the three CH2M Hill projects as a single project).
3. Owner and design teams based decisions on life-cycle costs. Teams reported that life cycle cost analyses helped justify design decisions, such as more efficient mechanical systems.
4. The projects demonstrated that given a fixed budget that it is possible to achieve LEED certification through trade-offs and substitutions that give priority to achieving LEED credits.
5. The key strategies that impact the overall cost effectiveness of pursuing LEED-NC certification are forming a multidisciplinary internal team, setting a goal for LEED certification early and establishing priorities, including this goal in selection of the design team and contractor, budgeting for commissioning, basing decisions on life-cycle cost analyses, and using energy modeling to inform the design.

The table below summarizes the survey findings. The survey is somewhat limited in scope, but the sampling is significant enough to support the key conclusions. While LEED cost premiums are cited for all of the projects, projects such as CDLE and Fossil Ridge emphasized that their projects came in under the budgets originally established for these projects. The hard costs for these projects were not attributed to LEED because design decisions were driven by life-cycle cost analysis or their existing design and construction standards. However, note that the LEED premium cited for CDLE does include hard costs.

We found that soft costs alone are about 0.8% of the construction costs, or approximately $1/sf. Soft costs include fees for registering and certifying a project through the United States Green Building Council, documentation costs, commissioning costs and energy analysis costs. The soft costs vary depending on the size of the project, the experience level of the team, and the level of certification. The information on hard costs is too limited to provide budgeting guidance.

## LEED Costs and Benefits for Colorado Projects

| LEED Project | Certification Level / Size(sf) | Building Size (sf) | Construction Cost ($/sf) | LEED Cost Premium $/sf | Net Present Value of Energy Cost Savings $/sf | Net LEED Savings |
|---|---|---|---|---|---|---|
| CH2M Hill South | Certified | 112,600 | $156 | ($1.9) | $4.3 | $2.4 |
| CH2M Hill West | Certified | 164,500 | $156 | ($1.9) | $4.3 | $2.4 |
| CH2M Hill North | Certified | 112,600 | $156 | ($1.9) | $4.3 | $2.4 |
| Vehicle Storage | Certified | 15,250 | $129 | ($8.2) | $6.7 | ($1.5) |
| CDLE | Certified | 40,000 | $100 | ($3.3) | $2.3 | ($1.0) |
| Fossil Ridge HS | Silver | 288,685 | $122 | ($1.0) | $4.0 | $3.0 |
| N. Boulder Rec | Silver | 62,000 | $188 | ($8.7) | $10.4 | $1.7 |
| Pikes Peak Regional DC | Silver | 111,758 | $112 | ($0.9) | $5.1 | $4.2 |
| Tutt Science Cntr | Certified | 54,123 | $200 | ($9.2) | no data | |
| Snowmass Golf | Silver | 10,000 | $370 | ($20.0) | no data | |
| DU Law | Gold | 210,000 | $230 | ($0.7) | $3.5 | $2.8 |

NPV calculation assumes 6% discount rate over 20 years.

Quantifying the benefits of LEED-driven design decisions proved to be much more difficult. The cost savings associated with commissioning, water reduction, waste management tipping fee reductions, downsizing systems and equipment, reduced maintenance and repair costs, and improved productivity were not available for the projects

Nevertheless, the projects gave concrete examples of the costs and benefits of various credits. All of the teams discussed the commissioning prerequisite and credit. From the survey, we found that commissioning has an average cost of $0.6/sf. The benefits of commissioning were not quantifiable from this study, although a nationwide study shows commissioning to have a payback of 5 years. Anecdotally, the Snowmass Club House stated that the commissioning process nearly paid for itself during the design development phase. Pikes Peak Regional District found that their building ran much more

efficiently than had commissioning not been conducted. CDLE and Fossil Ridge High School employ commissioning as standard practice based on their experience with improved building performance in commissioned buildings. And on the flip side, a couple of projects questioned the value of the commissioning process.

## LEED Costs and Benefits

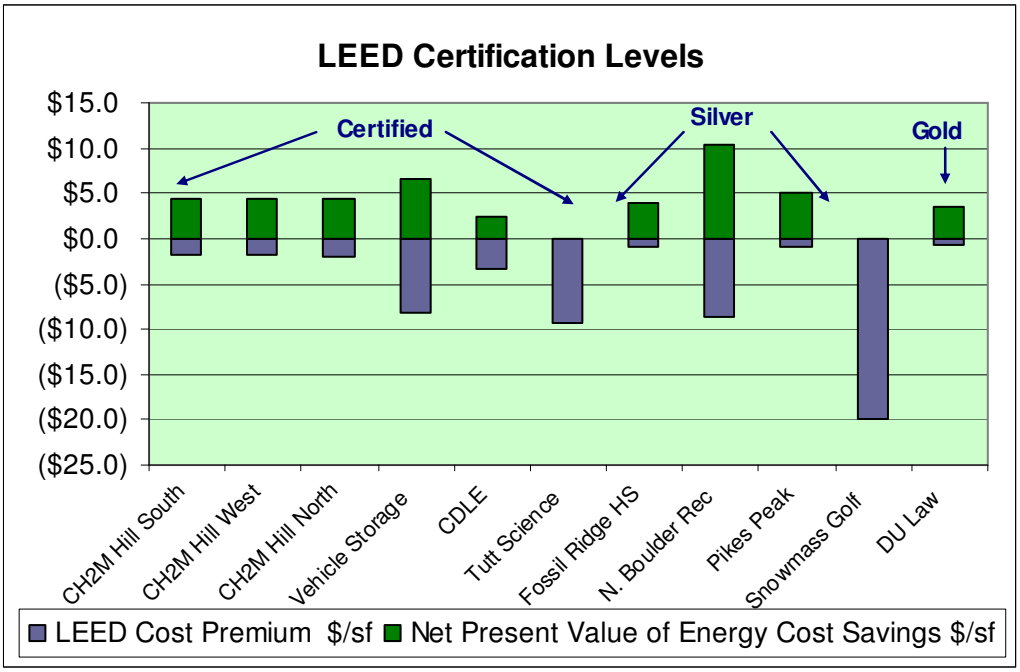
| LEED Category | Cost | Benefits | | |
|---|---|---|---|---|
| | | First Cost Savings | Operating Cost Savings | Occupant |
| Site | Bike racks | | | ✓ |
| | Stormwater management | □ | ✓Reduce waste water fees | |
| | Light colored roof | □ | ✓Reduce cooling energy costs | |
| Water | Landscaping | ✓Eliminate irrigation system | ✓Reduce water costs | ✓ |
| | Plumbing fixtures | □ | ✓Reduce water costs | |
| Energy | Commissioning | ✓Optimize systems | ✓Reduce energy costs and maintenance costs | ✓ |
| | Energy efficiency | ✓Downsize equipment and infrastructure | ✓Reduce energy costs | ✓ |
| | Renewable energy | □ | ✓Reduce energy costs | □ |
| | Measurement & Verification | □ | ✓Reduce energy costs | |
| | Green power | | | |
| Materials | Recycling | □ | ✓Reduce disposal fees | |
| | Waste management | ✓Reduce tipping fees | □ | |
| IEQ | $CO_2$ monitoring | □ | ✓Reduce energy costs if control ventilation air | ✓ |
| | Construction IAQ | | | ✓ |
| | Low emitting materials | | | ✓ |
| | System control | □ | ✓Reduce energy costs | ✓ |
| | Thermal comfort | | | ✓ |
| | Daylighting & views | □ | ✓Reduce energy costs if lights controlled in response to natural light levels | ✓ |

All of the projects noted greater occupant satisfaction and the public relations value of having a LEED certified building. A few of the projects noted improvement in indoor air quality from the use of low-VOC materials. Colorado College has even 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 glazing, high performance glazing, interior glazing, light shelves and shading.

In performing a life cycle cost analysis, the table above will assist in identifying costs and benefits of LEED credits. The table lists LEED credits that carry a cost and categorizes the potential benefits. Most of the credits will reduce operating costs and some have first cost savings. Benefits to the occupants are real, yet not easily quantified. And importantly, there are stated public relations and marketing benefits that are not included in the table.

From the cost and benefit data, we were unable to draw any general conclusions as to the costs and benefits relative to certification levels. The following chart groups the projects by certification level and there is no correlation between the costs or benefits and the certification level. Also, those projects with the lowest costs (Fossil Ridge, Pikes Peak Regional DC and DU Law) did not report hard costs. In addition, Tutt Science Center and the Snowmass Golf Clubhouse did not report their predicted energy cost savings.




Most of the project teams would and are pursuing LEED on future projects. Poudre School District will not because they cannot justify the documentation costs, although all new projects will reflect their commitment to sustainable design practices. Colorado College is certifying another project but they also find it difficult to justify the documentation costs. The

City of Fort Collins, in contrast, sees the documentation as necessary and streamlined, with the exception of that required for commissioning.

There are a number of factors and strategies to help minimize the investment in high performance and LEED-certified buildings. The United States Green Building Council has introduced an on-line certification system to streamline the certification process and reduce documentation costs. In addition, LEED-NC 2.2 includes provisions to reduce costs for commissioning and achieving energy performance points for small buildings. Projects with a commitment to LEED certification from start to finish, have the greatest success. And, as with anything, the more experience a team has with designing and building LEED-certified and / or high performance projects, the more cost effective the process will be.

We recommend that when making a decision about pursuing high performance buildings with or without LEED certification that decision-makers account for not only the hard and soft costs of the project improvements, but the hard and soft benefits as well. In most cases, the improvements in energy costs pay for themselves many times over, and enhancements in the work or learning environment provides benefits for the life of the building.

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# Introduction

The impetus behind this study is to characterize LEED costs and benefits specific to LEED-certified projects in Colorado. For this study, eleven LEED-certified projects in Colorado were interviewed. The projects interviewed for this cost study are all LEED certified under LEED-NC 2.1 and include a variety of building types (Table 2). The majority of the buildings were completed by 2003. The construction costs per square foot of building conditioned area are shown and range from $100 to $370.

**Table 2 Colorado LEED Certified Projects**

| Colorado LEED Project | Conditioned Square Footage | Certification Level | Construction Cost per Square Foot |
|---|---|---|---|
| CH2M Hill North Building | 112,600 | Certified | $156 |
| CH2M Hill South Building | 164,500 | Certified | $156 |
| CH2M Hill West Building | 112,600 | Certified | $156 |
| City of Fort Collins Vehicle Storage Building | 15,250 | | $128 |
| Colorado Department of Labor and Employment Addition | 40,000 | Certified | $100 |
| Fossil Ridge High School (Poudre School District) | 288,685 | Silver | $122 |
| North Boulder Recreation Center | 62,000 | Silver | $188 |
| Pikes Peak Regional Building Department | 111,758 | Silver | $112 |
| Russel T. Tutt Science Center (Colorado College) | 54,123 | Certified | $200 |
| Snowmass Golf Clubhouse (Aspen Skiing Company) | 10000 | Silver | $370 |
| University of Denver Law School (includes cost of parking garage) | 210,000 | Gold | $230 |

The goal of this work is to provide design teams with insight into the costs and benefits of LEED Certification for projects in Colorado. The project teams addressed soft costs associated with LEED: design, documentation, commissioning and energy analysis; as well as hard costs, such as those for low-VOC materials and system upgrades. The benefits are more difficult to quantify. Annual energy cost savings are reported based on energy simulations. A few projects realized cost savings from commissioning up front. Other benefits were discussed, but not quantified. The teams also discussed design decisions that were or were not driven by LEED considerations.

## Background

A number of comprehensive studies have been published that analyze the costs and benefits of LEED-certified projects. A report by Gregory Kats (October 2003) found the median cost premium to be less than 2% for 33 LEED-certified buildings (Table 1). He reported that buildings just meeting the certified level had little or no added cost for LEED. He also found that projects with teams with LEED experience have lower LEED cost premiums. And importantly, the cost of more sustainable materials and systems has come down as demand has increased.

**Table 1 LEED Cost Premiums**

| LEED Rating -# of projects | Cost Premium |
|---|---|
| Certified – 8 | 0.6% |
| Silver – 16 | 2.11% |
| Gold – 6 | 1.82% |
| Platinum – 1 | 6.50% |
| Average -33 | 1.84% |

Source: Greg Kats et al., October 2003.[1]

As for the benefits of a LEED project, owners point to the public relations value, reduced energy and water costs, and human and social benefits. A number of studies have attempted to quantify productivity gains from improvements in comfort, daylighting, and indoor air quality. With salaries and benefits accounting for 78% of business expenses (Carnegie Melon University, 1999), the greatest potential savings lie in improving productivity. A 1999 study by the Heschong Mahone Group, reported that daylighting improved test scores by 7-18% in Seattle and Denver.

[1] It's unclear from the source whether this data is a percent of project costs or construction costs.

# LEED Soft Costs and Benefits

LEED Certification costs include fees for registering and certifying a project through the United States Green Building Council, documentation costs, commissioning costs and energy analysis costs. Of the prerequisites included in the LEED-NC rating system, fundamental commissioning is the only prerequisite that incurs a soft cost to all projects. As for the energy analysis, all of the projects earned at least 2 points for energy efficiency and the required energy analysis is a soft cost.

Based on the range of costs reported for this study and the uncertainty surrounding the costs, estimated soft costs are a minimum of $60,000 for projects smaller than 20,000 sf. For projects over 100,000 sf, the commissioning costs dominate the soft costs. Based on the costs reported for this study and more detailed nationwide studies, $1/sf should cover registration and certification fees, documentation, commissioning and the energy analysis.

## Registration and Certification Fees

The current fees for registering and certifying a LEED-NC project are listed in Table 3. The member costs are shown because membership fees are lower than the additional costs for registering and certifying as a non-member. The LEED 2.1 projects in this study had higher registration and lower certification fees than the current USGBC fees under LEED 2.2.

**Table 3 Current Registration and Certification Fees for Members**

| Fee | Less than 50,000 sf | 50,000-500,000 sf | Over 500,000 sf |
|---|---|---|---|
| Registration | $450 | $450 | $450 |
| Certification | | | |
| Design Review | $1250 | $0.025/sf | $12,500 |
| Construction Review | $500 | $0.01/sf | $5,000 |
| TOTAL | $2,200 | $2,200-$17,950 | $17,950 |

## Documentation

LEED documentation costs are difficult to quantify because of indirect costs to the design team, contractor, and owner. The majority of teams reported documentation fees (Figure 1); however, the basis for these fees is inconsistent. The fee for Fossil Ridge High School is an estimate and that for the Colorado Department of Labor and Employment includes architectural, engineering and contractor fees. The costs reported for the three CH2M Hill Office Buildings are less than $3,000 per building, or $0.02/sf, while those for the Snowmass Clubhouse are $25,000, or $2.5/sf. There is no correlation on a cost per square basis.

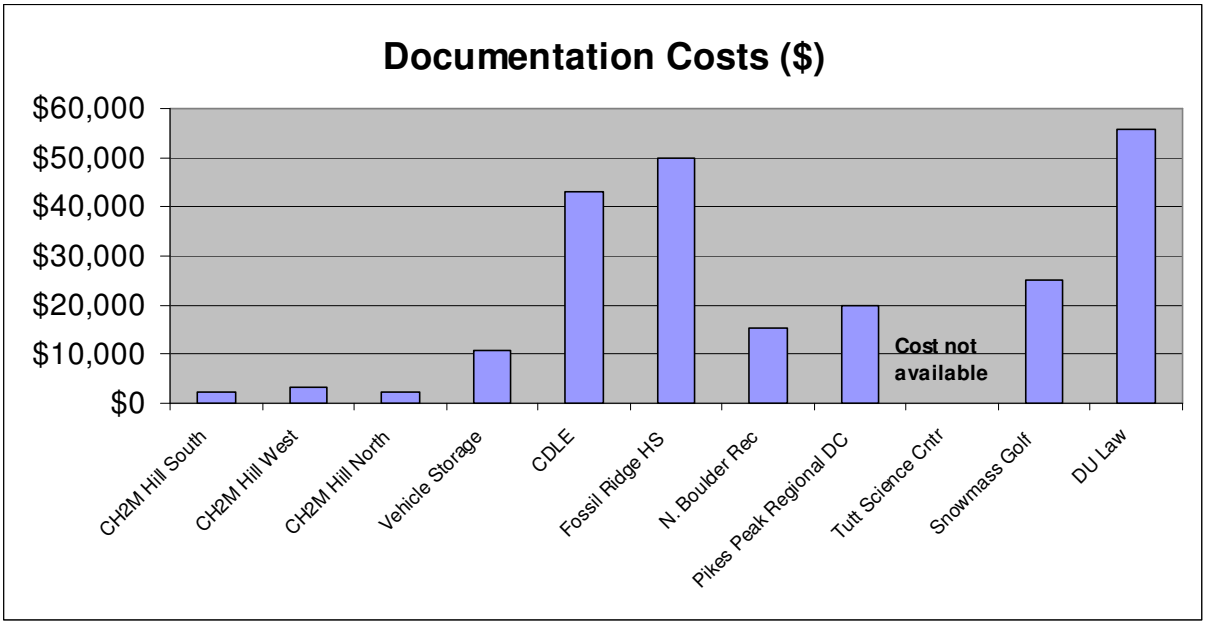


Figure 1 LEED Documentation Fees

The teams commented that the costs associated with LEED documentation are difficult to justify. Aspen Ski Company found that documentation fees on small projects can be prohibitive and is adamant about the need to rectify this. Colorado College noted that they've found that teams with more LEED experience have lower documentation costs. This is consistent with findings in other LEED studies (Kats 2003). Poudre School District (Fossil Ridge High School) estimated documentation costs at $50,000 and does not think they can justify this on future projects.

The United States Green Building Council has implemented an online application for documentation to simplify the certification process. They have also streamlined the requirements for some of the prerequisites and credits. The online system is too new to determine how it will impact documentation costs.

## Commissioning

LEED requires building commissioning for all projects seeking certification. The project teams differed widely as to the value of building commissioning. Poudre School District (Fossil Ridge High School) and the Colorado Department of Labor and Employment have incorporated building commissioning into their design standards, so these owners include commissioning regardless of whether or not they are seeking LEED certification. Pikes Peak Building Department is also a strong proponent of building commissioning and states that in more complex buildings, commissioning results in lower operating costs over the long term.

On the other hand, the City of Fort Collins (Vehicle Storage Building) and Colorado College reported that the commissioning process is too documentation intensive and has questionable benefit. Colorado College already conducts detailed design reviews and performs extensive testing of building systems. Furthermore, commissioning of the Tutt Science Center failed to identify and resolve all control problems that arose.

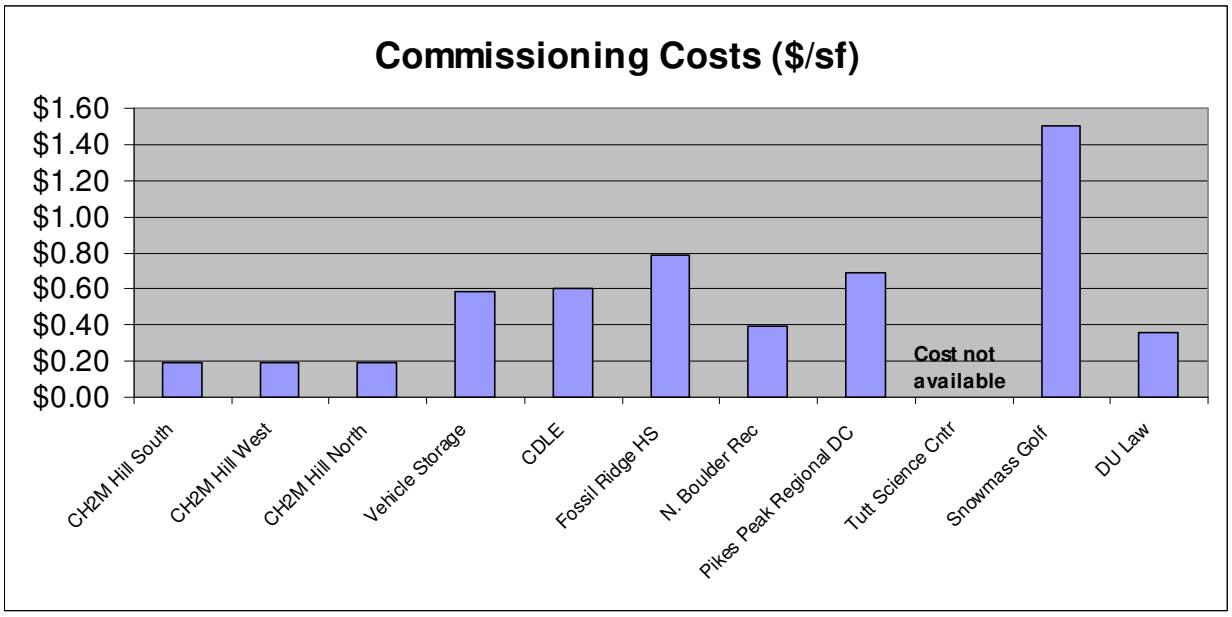


Figure 2 Building Commissioning Costs

The costs for commissioning these projects are given in Figure 2. The projects earned the point for enhanced commissioning, except for the Vehicle Storage building. The projects did not break out fundamental and enhanced commissioning costs, with the exception of North Boulder Recreation Center and Pikes Peak Building Department. Enhanced commissioning cost $7,400 on the recreation center and added 10% ($7,000) to the cost of fundamental commissioning on Pikes Peak.

Nationwide studies report commissioning costs in the $0.5/sf to $1.6/sf range with a median payback period of less than 5 years (Mills et. al. 2005). With the exception of the CH2M Hill projects, the costs for the Colorado projects are consistent with nationwide costs. The CH2M Hill buildings had fundamental and enhanced commissioning. The low costs on the CH2M Hill projects are attributed to repetitive systems in the three buildings.

The high commissioning cost at the Snowmass Clubhouse is a result of a relatively remote site and a small project. Even though the commissioning cost at Snowmass Clubhouse was $15,000, the commissioning process nearly paid for itself during design development. The commissioning agent identified a change that substantially reduced mechanical system costs without compromising the design. LEED-NC 2.2 does not require third party commissioning on projects smaller than 50,000 sf; the commissioning agent can be a qualified member of the design or construction teams. This change to the commissioning requirements is intended to help minimize the cost impact of commissioning on smaller projects.

At the Pikes Peak Building Regional Department the building systems are relatively complex. The facility manager reported that the systems ran much more efficiently in the first two years of operation than anticipated because of the commissioning process. The commissioning agent also discovered that the sequence of operation in an atrium was backwards and corrected the problem. This would have not been discovered through a typical testing and air balancing exercise.

## Energy Analysis and Annual Energy Savings

Under LEED 2.1, projects must perform an hourly energy analysis to demonstrate energy cost savings relative to ASHRAE/IESNA 90.1-1999, Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings (this has been updated to ASHRAE/IESNA 90.1-2004 under LEED-NC 2.2). Figure 3 presents the cost of the energy analysis as compared to the annual energy cost savings. These analysis costs are not consistent on a square footage basis; smaller projects have higher costs per square foot than larger projects. The annual energy cost savings are based on the results of the energy analysis. One year's savings are shown and these savings should be persistent over the life of the efficiency measures.

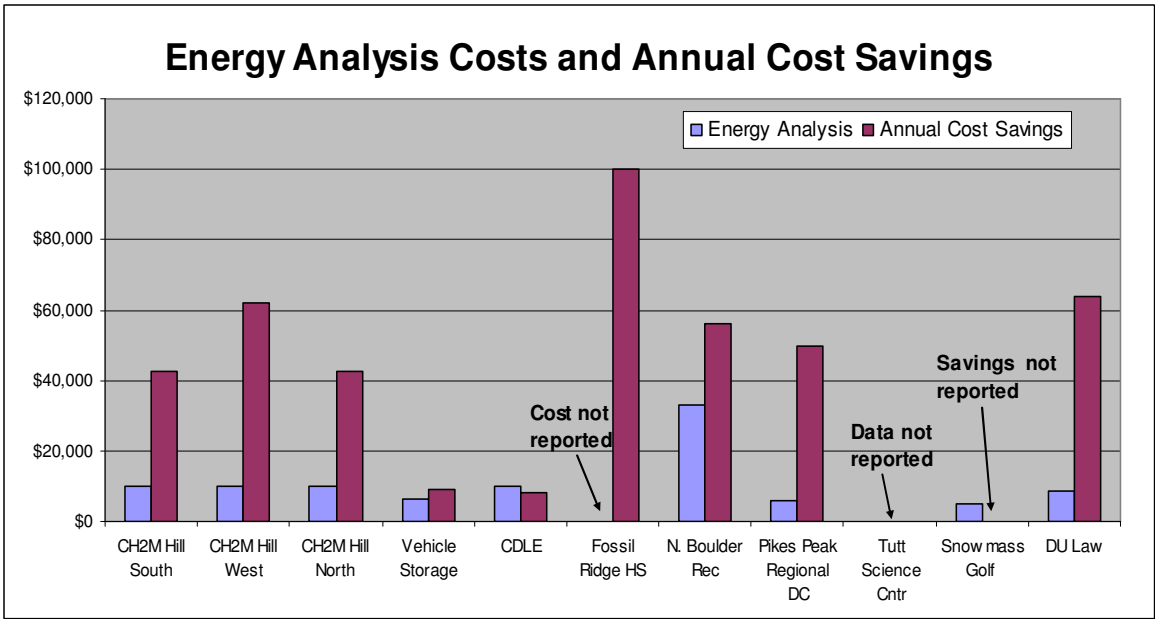


**Figure 3 Energy analysis costs and annual energy cost savings.**

The cost effectiveness of the energy analysis depends on whether the analysis is used to inform the design or just meet LEED reporting requirements. Aspen Skiing Company found that for small projects, the cost of the energy analysis is prohibitive although they recognize the value. LEED-NC 2.2 includes prescriptive compliance options that eliminate the requirement of hourly building simulations.

Poudre School District (Fossil Ridge High School) employs an integrated design process that includes energy and daylighting analysis; they would do this regardless of whether or not a project is pursuing LEED. The district is saving $100,000 per year in energy and water costs as compared to a Fort Collins High School they built in 1991 that is similar in size and number of students. These savings are achieved through an extensive daylighting design and controls, ice storage, and other high efficiency measures. The project earned all 10 points for 60% energy cost savings. Poudre School District also mentioned the first cost savings from downsizing mechanical equipment and transformers as a result of the more efficient envelope and lighting design and working with the building department using data from previous projects.

# LEED Hard Costs and Benefits

LEED certification requires that a project incorporate environmental measures to minimize the impact on the site, water use, energy use, the atmosphere, materials and resource use, and indoor environmental quality. The certification process establishes accountability, while the strategies employed by the design and construction teams are the key to creating a more sustainable project.

The costs and benefits of these strategies are more difficult to isolate than the certification costs already presented. A few of the teams provided detailed cost data, a few of the teams stated that their projects would have incorporated the strategies and incurred the costs even had they not pursued LEED certification, and a few of the teams did not have costs broken out for these strategies. A point-by-point analysis of LEED costs by Davis Langdon (2004) is available. As for the benefits, very limited quantifiable data is available. The teams commented on operations and maintenance issues, occupant satisfaction, and public awareness.

The following sections discuss the LEED strategies by LEED category: site, water, energy and atmosphere, and indoor environmental quality. For each of the categories, a table is included that lists the credits and the percentage of Colorado LEED Certified projects that complied (Architectural Energy Corporation 2006). Those credits pursued by the highest percentage of teams are likely the most cost-effective credits in Colorado, i.e. have the highest return on investment. Keep in mind that some of the credit requirements have changed in LEED-NC 2.2, simplifying some credits and making others more difficult to achieve. For example, the local materials credits now require that materials be harvested and manufactured locally to achieve both credits, whereas in LEED-NC 2.1 the first credit only required that the materials be manufactured locally.

## Site

Table 4 lists the LEED-NC 2.1 site prerequisites and credits, the percentage of projects complying with the credit and whether or not there is a cost premium associated with the credit. A number of the site credits are tied to selection of the building site and so there is no cost premium associated with complying with the credits. The heat islands credits (7.1 and 7.2) require the use of light colored surfaces. The Colorado Department of Labor and Employment reported cost premiums for substituting concrete for asphalt and for using the TPO white roof. CDLE selected the TPO roof because of its longer warranty and the cost premium cannot be identified as a LEED-related expense. The other credits, such as storm water management and

treatment, can have significant premiums; however, they also may be a requirement of the local jurisdiction and so carry no premium

**Table 4 LEED-NC 2.1 Site Prerequisites and Credits**

| LEED Credit | Credit Name | **LEED Points Possible** | *Percent of Projects Complying with this Point* | Premium (Yes/No) |
|---|---|---|---|---|
| **Sustainable Sites (14 Points Possible)** | | | | |
| *Prereq 1* | *Erosion & Sedimentation Control* | ***Required*** | | No |
| Credit 1 | Site Selection | **1** | *71%* | No |
| Credit 2 | Urban Redevelopment | **1** | *14%* | No |
| Credit 3 | Brownfield Redevelopment | **1** | *7%* | No |
| Credit 4.1 | Alternative Transportation, Public Transportation Access | **1** | *71%* | No |
| Credit 4.2 | Alternative Transportation, Bicycle Storage & Changing Rms | **1** | *93%* | Yes |
| Credit 4.3 | Alternative Transportation, Alternative Fuel Refueling Stations | **1** | *29%* | Yes |
| Credit 4.4 | Alternative Transportation, Parking Capacity | **1** | *43%* | No |
| Credit 5.1 | Reduced Site Disturbance, Protect or Restore Open Space | **1** | *7%* | No |
| Credit 5.2 | Reduced Site Disturbance, Development Footprint | **1** | *71%* | No |
| Credit 6.1 | Stormwater Management, Rate or Quantity | **1** | *21%* | Yes |
| Credit 6.2 | Stormwater Management, Treatment | **1** | *57%* | Yes |
| Credit 7.1 | Landscape & Ext Design to Reduce Heat Islands, Non-Roof | **1** | *50%* | Yes |
| Credit 7.2 | Landscape & Ext Design to Reduce Heat Islands, Roof | **1** | *43%* | Yes/No |
| Credit 8 | Light Pollution Reduction | **1** | *50%* | Yes/No |

The benefits from the site credits are significant in terms of reducing the environmental impact of development. There are potential first cost savings by minimizing parking capacity and instead relying on public transportation. While the local community is intended to benefit from new development, minimizing the influence of the development on transportation, air and light pollution, and heat islands will greatly improve its value to the community.

## Water Efficiency

The importance of water conservation in Colorado has been recognized by almost all project teams. Through water efficient landscaping and low-flow fixtures, most teams have achieved two of the water credits (Table 5).

**Table 5 LEED-NC 2.1 Water Efficiency Prerequisites and Credits**

| LEED Credit | Credit Name | **LEED Points Possible** | *Percent of Projects Complying with this Point* | Premium (Yes/No) |
|---|---|---|---|---|
| **Water Efficiency (5 Points Possible)** | | | | |
| Credit 1.1 | Water Efficient Landscaping, reduce by 50% | **1** | *79%* | Yes |
| Credit 1.2 | Water Efficient Landscaping, No Potable Use or No Irrigation | **1** | *36%* | Yes |
| Credit 2 | Innovative Wastewater Technologies | **1** | *0%* | Yes |
| Credit 3.1 | Water Use Reduction, 20% Reduction | **1** | *64%* | Yes |
| Credit 3.2 | Water Use Reduction, 30% Reduction | **1** | *29%* | Yes |

There is clearly a premium to reduce water use. CH2M Hill invested $24,000 for more water efficient fixtures in their three certified buildings. The Colorado Department of Labor and Employment spent $8,500 on upgrades to their water fixtures. The premium depends on the size of the building and the type of use. For example, the project cost to upgrade fixtures in a hospital would be much higher than in an office building because of the number of fixtures.

The benefits of reduced water consumption include reduced operating costs, the possibility of reduced infrastructure costs, and significant societal benefits from relieving demand on limited existing water resources.

## Energy and Atmosphere

There is a cost premium associated with all of the credits in the Energy and Atmosphere category (Table 6). In addition, the commissioning prerequisite incurs a cost to all LEED projects. All of the projects earned points under Energy and Atmosphere Credit 1, Optimize Energy Performance, and had to perform an energy analysis. All of the projects also earned the enhanced commissioning credit.

### Table 6 LEED-NC 2.1 Energy and Atmosphere Prerequisites and Credits

| LEED Credit | Credit Name | **LEED Points Possible** | *Percent of Projects Complying with this Point* | Premium (Yes/No) |
|---|---|---|---|---|
| **Energy & Atmosphere (17 Points Possible)** | | | | |
| *Prereq 1* | *Fundamental Building Systems Commissioning* | ***Required*** | | Yes |
| *Prereq 2* | *Minimum Energy Performance* | ***Required*** | | Yes/No |
| *Prereq 3* | *CFC Reduction in HVAC&R Equipment* | ***Required*** | | No |
| Credit 1.1 | Optimize Energy Performance, 20% New / 10% Existing | **2** | *100%* | Yes |
| Credit 1.2 | Optimize Energy Performance, 30% New / 20% Existing | **2** | *75%* | Yes |
| Credit 1.3 | Optimize Energy Performance, 40% New / 30% Existing | **2** | *29%* | Yes |
| Credit 1.4 | Optimize Energy Performance, 50% New / 40% Existing | **2** | *11%* | Yes |
| Credit 1.5 | Optimize Energy Performance, 60% New / 50% Existing | **2** | *7%* | Yes |
| Credit 2.1 | Renewable Energy, 5% | **1** | *0%* | Yes |
| Credit 2.2 | Renewable Energy, 10% | **1** | *0%* | Yes |
| Credit 2.3 | Renewable Energy, 20% | **1** | *0%* | Yes |
| Credit 3 | Additional Commissioning | **1** | *93%* | Yes |
| Credit 4 | Ozone Depletion | **1** | *36%* | Yes/No |
| Credit 5 | Measurement & Verification | **1** | *43%* | Yes |
| Credit 6 | Green Power | **1** | *57%* | Yes |

The energy analysis is assumed to be a soft cost, but there are hard costs associated with implementation of a more energy-efficient design. Few of the projects provided these costs. CH2M Hill spent $300,000 on evaporative condensers for the rooftop units serving the three buildings and $216,000 on indirect lighting fixtures. The three buildings each demonstrated 25% energy cost savings and earned 3 points under the energy optimization credit.

Under LEED-NC 2.1, energy savings from proper orientation could not be claimed. The Fort Collins Vehicle Storage Building re-oriented their building in response to the energy and daylighting analysis, and eliminated the need for a snow melt system. The project did not earn any LEED points for this effort; however, they reduced construction costs as a result of the design process. Under LEED-NC 2.2, ASHRAE 90.1-2004 does take into account the influence of orientation, although the energy savings from elimination of a snow melt system would not be included in the energy analysis.

No LEED-certified projects in Colorado have earned credit for renewable energy. North Boulder Recreation Center has a large solar hot water system but under LEED-NC 2.1 solar hot water systems did not qualify for points under the renewable energy credit. Under LEED-NC 2.2, solar hot water does qualify for points under this credit. In addition, the adoption of Federal tax credits and renewable energy incentives through utilities have significantly reduced the cost of renewables. It is anticipated that future LEED projects in Colorado will have renewables.

The ozone depletion credit required the elimination of the HCFC refrigerants on projects. This credit has been modified to minimize ozone depletion and global warming potential. Replacement refrigerants, such as R-410A, are more common today and the upcharge is minimal. This was not the case when Aspen Skiing Company was specifying the water-source heat pumps for the clubhouse. The cost premium to use a qualifying refrigerant was at least $50,000 on three heat pumps. The decision to upgrade the heat pumps was driven by this LEED credit; Aspen Skiing Company would not have made this change otherwise.

The CH2M Hill projects and Poudre School District earned the measurement and verification credit. Generally speaking, the cost premium for this credit is reasonable if there is a building automation system on the project. Neither project provided the actual costs associated with this credit. The Tutt Science Center has extensive instrumentation and attempted the measurement and verification credit. They did not earn the credit because the building is tied to the campus central plant and the plant is not monitored.

The green power credit (Credit EA 6) requires the owner to purchase power from a certified renewable energy source, such as wind or solar. The additional cost is $0.01/kWh to $0.02/kWh. The credit requirements have changed in LEED-NC 2.2 in terms of the purchase amount, but the associated costs are similar. The Colorado Department of Labor and Employment purchased the required 2-year amount equal to 50% of the regulated electricity use per year at a cost of $3,260. CH2M Hill spent

$15,000 on green power for the three buildings. The University of Denver Law School purchased $31,125 of green power. This cost appears to be high, although the baseline electricity use for the law school is higher than anticipated because of a 250,000 sf parking garage connected to the building.

## Materials and Resources

With the exception of the Snowmass Clubhouse and the Tutt Science Center, all of the projects in this study earned the construction waste management credit and the recycled content credit (Table 7). CH2M Hill gave a cost of $17,080 for construction waste management on the three buildings. The cost reported by the Colorado Department of Labor and Employments is $1,000. The costs on the two projects are consistent at $0.04/sf. These projects all realized savings from reduced tipping fees, although they were not quantified.

Poudre School District diverted 75% of the waste sheetrock by using it as a soil amendment on site. The cost to dispose of the sheetrock is double that for recycling it on site. Poudre School District is now recycling all sheetrock on their projects.

**Table 7 LEED-NC 2.1 Materials and Resources Prereq's and Credits**

| LEED Credit | Credit Name | **LEED Points Possible** | *Percent of Projects Complying with this Point* | Premium (Yes/No) |
|---|---|---|---|---|
| **Materials & Resources (13 Points Possible)** | | | | |
| *Prereq 1* | *Storage & Collection of Recyclables* | ***Required*** | | Yes |
| Credit 1.1 | Building Reuse, Maintain 75% of Existing Shell | **1** | *7%* | Yes |
| Credit 1.2 | Building Reuse, Maintain 100% of Shell | **1** | *0%* | Yes |
| Credit 1.3 | Building Reuse, Maintain 100% Shell & 50% Non-Shell | **1** | *0%* | Yes |
| Credit 2.1 | Construction Waste Management, Divert 50% | **1** | *86%* | Yes |
| Credit 2.2 | Construction Waste Management, Divert 75% | **1** | *14%* | Yes |
| Credit 3.1 | Resource Reuse, Specify 5% | **1** | *14%* | Yes |
| Credit 3.2 | Resource Reuse, Specify 10% | **1** | *7%* | Yes |
| Credit 4.1 | Recycled Content, Specify 25% | **1** | *79%* | Yes |
| Credit 4.2 | Recycled Content, Specify 50% | **1** | *71%* | Yes |
| Credit 5.1 | Local/Regional Materials, 20% Manufactured Locally | **1** | *100%* | No |
| Credit 5.2 | Local/Regional Materials, of 20% Above, 50% Harvested Locally | **1** | *100%* | No |
| Credit 6 | Rapidly Renewable Materials | **1** | *0%* | Yes |
| Credit 7 | Certified Wood | **1** | *0%* | Yes |

Boulder Community Foothills Hospital provided their spreadsheet listing material costs, recycled content and local materials. Again steel, as a high cost material on the project with a high recycled content, helped the project achieve the recycled content credit at no extra cost.

Under LEED-NC 2.1, Colorado projects all complied with the local and regional materials credits. Compliance is based on material costs. Steel structures in commercial buildings can account for the majority of the material costs and the steel is manufactured within 500 miles of the building sites. Locally harvested materials include concrete and gypsum board. These materials can be obtained at no additional charge and the Pikes Peak Regional Building Department noted lower costs for some local materials. Under LEED-NC 2.2, materials must be harvested and manufactured locally for both credits, making the credits more difficult to achieve.

## Indoor Environmental Quality

There are 15 points available under the Indoor Environmental Quality category. All of the projects picked up the points for low-emitting adhesives and sealants and low-emitting carpet (Table 8). North Boulder Recreation Center and the University of Denver Law School are the only projects that did not earn the point for low-emitting paints. All of the projects except the CH2M Hill North Building complied with the pollutant source control credit. All of the projects except the CH2M Hill projects complied with ASHRAE 55 to earn the thermal comfort point.

The facility manager at Tutt Science Center has a background in indoor air quality and recognizes the importance of specifying low-VOC materials. One of the most significant changes in the college's design guidelines attributable to LEED is the inclusion of low-emitting materials. The alternative materials have not been in use long enough to assess their maintainability and durability.

It is surprising that CH2M Hill projects did not achieve the thermal comfort point given that the requirements do not go beyond typical mechanical design practice. The thermal comfort credit went through revisions during the period when these projects were being certified. Clarifications were made that allowed teams to show that no minimum humidity control was needed. Early on, it was interpreted that all projects required humidity control which can be cost prohibitive in climates where humidification is not commonly found. The current version of the comfort standard, ASHRAE 55-2004, adopted under LEED 2.2, does not require minimum humidity control.

## Table 8 LEED-NC 2.1 Indoor Environmental Quality Prereq's and Credits

| LEED Credit | Credit Name | **LEED Points Possible** | *Percent of Projects Complying with this Point* | Premium (Yes/No) |
|---|---|---|---|---|
| **Indoor Environmental Quality (15 Points Possible)** | | | | |
| *Prereq 1* | *Minimum IAQ Performance* | ***Required*** | | |
| *Prereq 2* | *Environmental Tobacco Smoke (ETS) Control* | ***Required*** | | |
| Credit 1 | Carbon Dioxide (CO2) Monitoring | **1** | *50%* | Yes |
| Credit 2 | Increase Ventilation Effectiveness | **1** | *36%* | Yes |
| Credit 3.1 | Construction IAQ Management Plan, During Construction | **1** | *71%* | Yes |
| Credit 3.2 | Construction IAQ Management Plan, Before Occupancy | **1** | *71%* | Yes |
| Credit 4.1 | Low-Emitting Materials, Adhesives & Sealants | **1** | *100%* | Yes/No |
| Credit 4.2 | Low-Emitting Materials, Paints | **1** | *79%* | Yes/No |
| Credit 4.3 | Low-Emitting Materials, Carpet | **1** | *100%* | Yes |
| Credit 4.4 | Low-Emitting Materials, Composite Wood | **1** | *29%* | Yes |
| Credit 5 | Indoor Chemical & Pollutant Source Control | **1** | *79%* | Yes/No |
| Credit 6.1 | Controllability of Systems, Perimeter | **1** | *14%* | Yes |
| Credit 6.2 | Controllability of Systems, Non-Perimeter | **1** | *0%* | Yes |
| Credit 7.1 | Thermal Comfort, Comply with ASHRAE 55-1992 | **1** | *71%* | Yes/No |
| Credit 7.2 | Thermal Comfort, Permanent Monitoring System | **1** | *36%* | Yes |
| Credit 8.1 | Daylight & Views, Daylight 75% of Spaces | **1** | *14%* | Yes/No |
| Credit 8.2 | Daylight & Views, Views for 90% of Spaces | **1** | *57%* | Yes/No |

The following highlights some lessons from these projects:

- ✓ The Snowmass Clubhouse is the only project that complied with the perimeter controllability of systems and the daylighting of spaces credits. With smaller projects, these credits are more easily achieved because the interior areas are a smaller fraction of the total area and there are fewer pressure balancing issues with operable windows.
- ✓ The Tutt Science Center has operable windows and controls tying the windows and VAV boxes together. They did not qualify for the controllability of systems credit.
- ✓ CH2M Hill invested $280,000 in clerestory glass and sidelights in exterior walls to improve the daylighting of interior spaces. The projects did not achieve the daylighting point.
- ✓ The Colorado Department of Labor and Employment spent $3,000 on interior glass to comply with the views credit. They were awarded the

point and would have included the glass anyway to bring natural light into the core areas.

## Long-Term Performance

As part of the interview process, the teams responded to questions regarding operations and maintenance, as well as occupant satisfaction. None of the teams had problems with the operation or maintenance of a design element that was selected because of LEED. A few of the projects have annual energy cost data, although this data was not analyzed in detail to determine if the projects were realizing energy cost savings.

Pikes Peak Building Department tracked energy, water and waste water costs for 20 months. The average cost over these months was $1.12/sf/yr. The facility engineer viewed this as very efficient especially given the complexity of the building. The savings from daylighting controls have been diminished through the installation of blinds to control direct sunlight in the winter. The blinds are used year round, so the potential savings from daylighting are not being realized.

Poudre School District closely tracks energy use and reports savings of $100,000 per year ($0.35/sf) for Fossil Ridge High School over Fort Collins High School which was built 10 years earlier. The North Boulder Recreation Center compared estimated annual energy costs for 2002 with those from two of their other recreation centers. Annual energy costs are $0.59/sf to $0.79/sf lower at North Boulder Recreation Center (Southwest Energy Efficiency Project 2003).

In terms of long-term performance, occupant satisfaction is a priority, especially when considering the impact of the work environment on productivity. The projects do not have hard data from which to evaluate occupant satisfaction; however, the teams agree that there is a higher level of satisfaction with the LEED-certified buildings.

The Colorado Department of Labor and Employment has found that the addition to their existing office building has provided a number of benefits:

- ✓ Daylighting and views have improved the working conditions.
- ✓ Glass walls in the conference rooms have created a more professional atmosphere.
- ✓ Carpet tiles save money because they are easy to replace when the carpet becomes stained or damaged.

- ✓ Climate control / occupant comfort is much improved.

The owner's representative for Pikes Peak Regional Building Department noted the need to educate facility management on LEED and the sustainable features on a project. For example, there are bioswales on the site designed to have tall grasses. The areas are currently being mowed. Maintaining a LEED building requires ongoing education and buy-in from facility management.

## Summary of Costs and Benefits

One of the first questions asked by an owner or developer about LEED certification relates to the cost to build a LEED-certified building. Table 9 summarizes the soft and hard costs for each project. Table 9 also includes the net present value of the annual energy cost savings using a 6% discount rate and a 20-year life cycle. The cost savings do not include savings from downsizing equipment, lower-cost material alternatives, waste management tipping fee reductions, other reduced maintenance and repair costs, or commissioning benefits.

The rows highlighted in blue identify the projects for which complete LEED cost data is missing and so the reported premiums are low. Construction costs are used to normalize the percentage cost premium because almost all of the projects supplied this data. If the percentage was presented relative to project cost, it would be lower. The two rows shaded in yellow represent projects for which the percentage cost premium is relative to project costs, not construction costs.

The results demonstrate a wide variation in LEED costs. Fossil Ridge High School has the lowest cost per square foot because Poudre School District considers the system and material upgrades to be standard practice for their schools and the school district also realizes first cost savings from downsizing equipment and on some material alternatives. The 0.8% or $1/sf for LEED soft costs at the high school (i.e. registration, certification, commissioning and energy analysis) is consistent with the findings in the LEED cost analysis by Steven Winter Associates (2004). The net present value of the energy cost savings are four times the LEED costs. And just as important, although the LEED costs are identified, the project was completed within budget.

CH2M Hill documented a $2/sf cost associated with LEED certification of their three buildings. This also includes costs for measures that did not garner

any LEED points. CH2M Hill applied the same LEED design solutions to all three buildings which resulted in lower costs for LEED. The energy cost savings are more than twice the costs, and the benefits from other LEED-related design elements are not quantified.

### Table 9 Summary of LEED Costs

| LEED Project | LEED Soft Costs | LEED Hard Costs | Cost Premium % of Construction | NPV of Energy Cost Savings $/sf | Notes |
|---|---|---|---|---|---|
| CH2M Hill South | $0.3 | $1.6 | 1.2% | $4.3 | |
| CH2M Hill West | $0.3 | $1.6 | 1.2% | $4.3 | |
| CH2M Hill North | $0.3 | $1.6 | 1.2% | $4.3 | |
| Vehicle Storage | $1.8 | $6.4 | 6.3% | $6.7 | |
| CDLE | $1.9 | $1.3 | 3.3% | $2.3 | Hard costs are included although most measures would have been included without LEED. |
| Fossil Ridge HS | $1.0 | $0.0 | 0.8% | $4.0 | Project stayed within established budget even with LEED. There are no hard costs because LEED does not change their design practices. |
| N. Boulder Rec | $1.2 | $7.4 | 4.6% | $10.4 | Large solar hot water system accounts for large portion of LEED costs. % Cost Premium is relative to project cost. |
| Pikes Peak Regional DC | $0.9 | $0.0 | 0.8% | $5.1 | Did not have LEED hard costs broken out. |
| Tutt Science Cntr | $5.5 | $3.7 | 4.6% | no data | |
| Snowmass Golf | $4.5 | $15.5 | 5.4% | no data | The % Cost Premium is relative to project cost. |
| DU Law | $0.7 | $0.0 | 0.3% | $3.5 | LEED hard costs not broken out. This only covers soft costs. |

Colorado College views the cost premium of $9.2/sf at the Tutt Science Center as high. They have another project underway, the 73,000 sf Cornerstone Arts Center, that will be LEED certified. This is a more complex building than the science center with construction costs of $296/sf. Colorado College estimates LEED costs at $8.7/sf, or 2.9% of construction costs.

The LEED costs on the Snowmass Golf Clubhouse are 5.4% of construction costs and this translates to $20/sf. Auden Schendler of Aspen Ski Company has co-authored a paper and made presentations discussing these costs and the need to bring them down. He recognizes the value of an experienced design team and of incorporating LEED goals from the start of a project, but he also sees LEED certification as failing to accommodate smaller projects. LEED-NC 2.2 includes provisions to simplify commissioning and energy optimization for smaller projects to help address these issues.

The University of Colorado is certifying two current projects, the new law school building and the Atlas building. Their hard and soft costs for the two projects are about 1% of project capital costs. This includes $50,000-$60,000 on each project for LEED documentation, energy analysis and design assistance. The university has qualified staff to perform the commissioning. Estimated energy cost savings for the projects were not available.

The benefits of LEED are more difficult to quantify, especially on a short-term basis. The net present value of the predicted energy cost savings range from $2/sf to $10/sf. The net present value of the energy cost savings alone offset the LEED soft and hard costs on seven of the nine projects, counting the CH2M Hill projects as a single project.

The average commissioning cost is $0.6/sf, excluding the costs for the CH2M Hill projects and the Snowmass Clubhouse. Poudre School District and CDLE require commissioning on all their projects because they have found the benefits more than justify the costs. Commissioning costs were recovered almost immediately at the Snowmass Clubhouse and the Pikes Peak Regional Building DC.

A few of the projects noted improvement in indoor air quality from the use of low-VOC materials. Colorado College has even 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 glazing, high performance glazing, interior glazing, light shelves and shading.

## Project Team Observations

As part of the interview process, the teams discussed their experience with the LEED certification process. All of the teams stated that the documentation requirements are too onerous. Colorado College compared the cost of documentation and other soft costs to the loss of a classroom.

A couple teams, City of Fort Collins Vehicle Storage and Colorado College Tutt Science Center, found the commissioning process to be too documentation intensive. The other teams were strong advocates of the commissioning process.

Of the eight owners that responded to the question of whether or not they will certify future projects, five answered yes, two answered no, and one answered that they will certify projects selectively.

Colorado College and Poudre School District responded no because both owners have strong commitments to life-cycle cost analysis and providing sustainable environments for their students. The schools feel the LEED process does not add enough value on top of their current practices to justify ongoing certification costs for future facilities.

## Conclusions

The LEED projects in Colorado demonstrate similarities and differences in their approach to LEED certification. While it is instructive to isolate first costs associated with LEED certification, the benefits need to be considered in order to assess the value of LEED-related design solutions. Table 10 lists the projects, their costs and the energy cost savings. The cost benefits from energy efficiency alone offset the LEED cost premium in 7 of the 9 projects, counting the three CH2M Hill projects as one.

**Table 10 LEED Costs and Benefits for Colorado Projects**

| LEED Project | Certification Level / Size(sf) | Building Size (sf) | Construction Cost ($/sf) | LEED Cost Premium $/sf | Net Present Value of Energy Cost Savings $/sf | Net LEED Savings |
|---|---|---|---|---|---|---|
| CH2M Hill South | Certified | 112,600 | $156 | ($1.9) | $4.3 | $2.4 |
| CH2M Hill West | Certified | 164,500 | $156 | ($1.9) | $4.3 | $2.4 |
| CH2M Hill North | Certified | 112,600 | $156 | ($1.9) | $4.3 | $2.4 |
| Vehicle Storage | Certified | 15,250 | $129 | ($8.2) | $6.7 | ($1.5) |
| CDLE | Certified | 40,000 | $100 | ($3.3) | $2.3 | ($1.0) |
| Fossil Ridge HS | Silver | 288,685 | $122 | ($1.0) | $4.0 | $3.0 |
| N. Boulder Rec | Silver | 62,000 | $188 | ($8.7) | $10.4 | $1.7 |
| Pikes Peak Regional DC | Silver | 111,758 | $112 | ($0.9) | $5.1 | $4.2 |
| Tutt Science Cntr | Certified | 54,123 | $200 | ($9.2) | no data | |
| Snowmass Golf | Silver | 10,000 | $370 | ($20.0) | no data | |
| DU Law | Gold | 210,000 | $230 | ($0.7) | $3.5 | $2.8 |

NPV calculation assumes 6% discount rate over 20 years.

Based on the discussions with the design teams and the data that was collected, we found the following:

- The average cost premium for LEED certification, soft and hard costs, is 2.5% based on cost data from all of the projects except Pikes Peak Regional DC and DU Law. The range is 1% to 6% of construction costs.
- Soft costs alone are about 0.8% of the construction costs, or approximately $1/sf. Almost all of the teams view the documentation costs as a burden, recognize the importance of accountability, and strongly recommend reducing the documentation requirements. Table 11 gives budgeting estimates for the soft costs based on the costs collected for this study and identifies the potential benefits.

- While LEED cost premiums are shown, two of the projects noted that they stayed within their originally established budget that was set before LEED certification became a priority.
- Commissioning is the other significant soft cost at an average of $0.6/sf. The majority of the teams found it to be valuable, and on one project it nearly paid for itself during design development.
- All of the teams earned at least two points for energy efficiency. The net present value of the energy savings associated with the energy efficiency measures offset the LEED soft and hard costs.
- Life-cycle cost analysis is a valuable tool in creating a high-performance building. Poudre School District, Colorado College and North Boulder Recreation Center analyze the life-cycle costs of their design solutions, and their designs are some of the most aggressive in terms of energy-efficient design.
- 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 glazing, 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.
- Most of the project teams would and are pursuing LEED on future projects. LEED-related costs are anticipated to be lower on future projects.

The most challenging aspect of this study was quantifying benefits associated with LEED-related decisions. The benefits from a more energy efficient design could be estimated from the energy analysis, but other benefits, such as:

  - Reduced air pollution
  - Reduced waste water fees
  - Reduced water consumption
  - Reduced operation and maintenance fees from commissioning
  - Reduced tipping fees
  - Reduced absenteeism from improved indoor environmental quality
  - Increased productivity from improved indoor environmental quality
  - Public relations

were not quantifiable within the scope of this study. Other national studies provide more guidance on quantifying the benefits.

**Table 11 Budgeting Estimates for LEED Soft Costs**

| LEED Soft Cost | Budget Estimate | Benefits | Notes |
|---|---|---|---|
| Registration | $450 | | |
| Certification | $0.035/sf | Community Recognition; Marketing | See Table 3 for projects under 50,000 sf and over 500,000 sf |
| Commissioning | $0.6-$0.8/sf | Pays for itself within 5 years through energy savings | |
| Documentation | <$60,000 | Accountability | Cost information for documentation did not always include involvement of design team and contractor. |
| Energy Analysis | $10,000 | Annual energy cost savings offset initial investment (soft and hard costs) | Will depend on scope of work. Does not include time impact on design team. Recommend life-cycle cost analysis for all projects. |

## ACKNOWLEGEMENTS

The design teams that participated in this study were extremely helpful and provided invaluable information for owners, developers, and design teams considering LEED certification and high-performance goals for their projects. We would also like to thank the Governor's Energy Office for both their technical and financial support in conducting this survey.

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# Appendices

Synopses of Interviews

# Snowmass Golf Clubhouse

## 1. Project Overview

Auden Schendler of the Aspen Skiing Company was interviewed regarding the LEED-related costs on the Snowmass Golf Clubhouse. The Snowmass Golf Clubhouse was constructed in 2005. It consists of 10,000 sf of conditioned space. The building received LEED Silver Certification.

## 2. Project Cost Overview

Initial budget for construction and design was $3.2 million and the actual cost to build the clubhouse was $3.7 million. Approximately $200,000 was due to LEED aspects of the job.

## 3. Cost Issues

LEED was added to the design scope after the project was awarded. Documentation for LEED is biggest cost and added $20,000 to $25,000 to the cost of the project. Fundamental and enhanced commissioning added $15,000. The LEED energy analysis, which was not used for design optimization, cost $5,000. The total increase in cost was 5-6%.

The commissioning process resulted in the elimination of one heat pump and saved $10,000. These savings nearly paid for the commissioning. Aspen Skiing Company now commissions all buildings.

Expressed desire to use energy modeling on all projects, but cost may preclude using it on smaller projects.

Construction waste management doesn't necessarily add cost; training and education are necessary.

More efficient heat pumps that meet the LEED Energy and Atmosphere credit for refrigerants added $50,000-$100,000. Had they not pursued LEED for this project, they may not have upgraded the heat pumps.

## 4. Funding Sources

There were no outside funding sources.

## 5. Operation and Maintenance

There are no differences in operation and maintenance costs with the clubhouse, nor has there been any unexpected costs arising from systems or materials selected in response to LEED criteria.

### 6. Occupant Satisfaction

The clubhouse is a great building and people enjoying working in it. However, LEED had a small impact on occupant satisfaction with the exception of some added windows in the kitchen area.

### 7. Other LEED issues

The main advantage of LEED is public relations value. The main disadvantage is documentation requirements.

### 8. Would you require future projects to be LEED certified?

We will pursue LEED certification on some projects to validate our commitment to sustainable design; however, the process is to cumbersome to pursue on all projects.

# Colorado Department of Labor and Employment Addition

## 9. Project Overview

Angie Fyfe and Lance Shepherd represented the project team for the interview. The Colorado Department of Labor and Employment Addition was constructed in 2004. It is a 40,000 sf addition to their existing office building. The building was awarded LEED certification in 2005.

## 10. Project Cost Overview

CDLE provided fairly detailed costs for this study. The following table gives a breakdown of design and construction costs.

| | |
|---|---|
| Design cost $ | Garage demolition and office addition: $395,000<br>Programming: $61,000<br>LEED certification: $25,000 |
| Increase in design fees attributable to LEED process $: | $25,000 |
| Construction cost $: | $4,000,000 |

Mike Kissane of Hadji and Associates determined that the premium for LEED was $130,160, which translates into an additional 2.9% of the project costs. Of this $130,160, design fees added $77,000. Note that the engineer of record on the CDLE project did not have LEED experience prior to the CDLE addition. During the design and commissioning process they came back several times and said LEED was causing them to do additional design work. If they had been a more experienced team member they may not have had to do design work more than once. We did not authorize or pay any additional design fees.

## 11. Cost Issues

The attached spreadsheet itemizes the LEED costs. Lance Shepherd 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. In an e-mail Lance made the following clarifications:

1. The added cost of the white roofing included an extended warranty period. Could have selected compliant roof at lower cost. $5,000
2. The boiler efficiency increase is at no added cost if you look at Life Cycle costs not just first costs. $2,000
3. Same as above on the hot water heater. $1,000
4. Locking in the green power has actually saved money due to rate increases. (Angie to confirm) $3,260
5. Here at Capitol Complex our standard has been MERV 13 or better for some time due to pollution. $2,500
6. Cost of installation of entry grill. The grill is a design feature and would have been done anyway. $1,500
7. Installation of interior glazing. This was another enhanced design feature. LEED did not require all the glass. $3,000
8. Commissioning, is considered a standard. We are going to a continuous commissioning plan here. $24,000

TOTAL $42,260

## 12. Funding Sources

In March 2002, the U. S. Department of Labor distributed "Reed Act" moneys to the states. Reed Act funds are moneys that were paid, in excess, under the Federal Unemployment Tax Act (FUTA). By law, these funds can be used to pay Unemployment Insurance (UI) benefits or pay for UI administrative expenses, including the construction of new buildings. Colorado received approximately $143 million in Reed Act money. During the 2003 Colorado Legislative Session, the General Assembly appropriated $4.6 million of the Reed Act funds to be used for the 251 addition. The remainder of the Reed Act money was deposited in the UI Trust Fund, where it is used to pay UI benefits and lower UI tax rates for employers.

The $25,000 increase in design fees was funded through a grant from the Governor's Office of Energy Management and Conservation (OEMC). OEMC also provided a $5,000 grant, which was used to pay for a consultant's review of the LEED proposal prior to its submittal.

## 13. Operation and Maintenance

Electricity and gas costs were provided from 2004 through the spring of 2006. We attempted to compare the same period in fiscal year 2006 with that in 2004. There are 9 months in both years that there appears to be gas and electricity costs. For July, 2003 through March, 2004, CDLE spent $112,066. For the same period in 2006, they spent $156,337. It is difficult to quantify the energy costs for the addition

given that energy costs increased significantly in 2006 and we do not have enough information on the existing building.

Recycling is done at no cost. Existing resources are used to load and remove recyclable material, which is dropped off at a collection point three blocks away.

**14. Occupant Satisfaction**

Occupants commented on the lack of "new building" smell, due to the lack of chemicals used in construction.

15. Other LEED issues

Benefits:

- ✓ Day lighting and views have improved the working conditions.
- ✓ Glass walls in the conference rooms have created a more professional atmosphere.
- ✓ Carpet tiles save us money because they are easy to replace when the carpet becomes stained or damaged.
- ✓ Climate control / occupant comfort is much improved.

Disadvantages:

None

**16. Would you require future projects to be LEED certified?**

Yes.

# Cost and Benefits of LEED-NC in Colorado

Governor's Energy Office

**CDLE**

**HARD CONSTRUCTION COST ANALYSIS**

| Credit | | Title | Description of Measure(s) | Y | N | ? | LEED Cost | Verify | Comments |
|---|---|---|---|---|---|---|---|---|---|
| **SS Pr 1** | - | Erosion and Sedimenation Control | *curb socks and silt fencing* | | | | - | HCI | Typical project requirement ($6,000) |
| | | | *vehicle tracking pads* | | | | - | HCI | Typical project requirement ($2,000) |
| **SS 1** | 1 | Site Selection | *urban infill site* | | | | - | - | While urban sites can generate added costs, not specifically a LEED cost |
| | | | *required contaminant testing of garage* | | | | - | State | Asbestos testing by State. Typical practice when dealing with old structure. |
| | | | *required demolition of exisiting garage* | | | | - | - | A site-specific and not a direct LEED cost |
| **SS 2** | 1 | Development Density | *located near multi-story structures* | | | | - | - | No additional cost - factor of site |
| | | | *cost for off-site parking for staff and trailer* | | | | - | HCI | Typical prject requirement. ROW fees mostly ($5,000) |
| **SS 4.1** | 1 | Alternative Trans. - Public Trans. Access | *good access to bus and rail lines* | | | | - | - | No additional cost - factor of site |
| **SS 7.1** | 1 | Heat Islands, Non-Roof | *standard grey cement l.l.o. asphalt for service drive* | | | | $4,000 | HCI | Net increase from asphalt to standard grey concrete |
| **SS 7.2** | 1 | Heat Islands, Roof | *upgrade to white TPO membrane* | | | | $5,000 | HCI | Net increase over a standard black membrane |
| **SS 8** | 1 | Light Pollution Reduction | *installed 6 fixtures with cutoff* | | | | - | - | A factor of good design - low quantity, naturally shielded |
| **WE 1.1** | 0 | Landscape Water Usage, 50% Reduction | *installed landscape rock* | | | | - | - | CREDIT REJECTED - no added cost, probably less through reduced maintenance |
| **WE 1.2** | 0 | Landscape Water Usage, No Potable | *installed landscape rock* | | | | - | - | CREDIT REJECTED - no added cost, probably less through reduced maintenance |
| | | | *abandoned existing irrigation system in place* | | | | - | - | No cost to leave in place |
| **WE 3.1** | 1 | Water Use Reduction - 20% | *installed standard fixtures with exception of:* | | | | - | - | Standard fixtures used |
| | | | *16-20 low-flow faucets with sensors* | | | | $4,500 | HCI | Net increase over standard faucet |
| | | | *equal number of mixing valves likely* | | | | $4,000 | HCI | $500 per restroom |
| | | | *installation of pressure-assisted toilets versus standard* | | | | - | Hadji | Installed, but not for LEED. No relation to water savings. |
| **EA Pr 1** | - | Fundamental Commissioning | *Commissioning Authority review and inspections* | | | | n/a | State | Primarily consultant labor costs ($20,000) |
| **EA Pr 2** | - | Minimum Energy Performance | *Basic compliance with ASHRAE/IESNA 90.1-1999* | | | | $1,500 | Hadji | Negligible premium to increase envelope R-value, no premium for mechanical compliance, low-e glazing is good practice |
| **EA Pr 3** | - | CFC Reduction in HVAC Equipment | *Specification of CFC-using equipment* | | | | - | - | Requirements not unusual because HCFC is relatively standard |
| **EA 1** | 1 | Optimize Energy Performance 15% | *T-8 lamps with 2 and 3 lamps/fixture vs. 3* | | | | - | HCI | No extra labor - layout process allows for fixture flexibility |
| | | *originally submitted for 25% and 3 credits* | *88% vs. 80% efficient boiler* | | | | $2,000 | Hadji | Both baseline and efficient are sealed combustion. Est. 10% cost increase for more efficiency |
| | | | *Air-cooled DX rooftop unit* | | | | - | - | Possible savings in RTU based on lower loads, certainly over lifetime (20 tons less than base design) |
| | | | *100% Redundant Heating Water Pumps w/ VFDs* | | | | - | - | Standard equipment |
| | | | *Pumps serving RTU in VAV boxes* | | | | - | - | Standard equipment |
| | | | *90% vs. 80% efficient gas-fired water heater* | | | | $1,000 | Hadji | Similar to boiler, 15-20% cost increase for efficiency and sealed combustion model |
| | | | *5-70W outdoor lighting, metal halide* | | | | - | - | Standard equipment |
| **EA 3** | 1 | Additional Commissioning | *Commissioning Authority additional review* | | | | n/a | State | Additional contract amount. Primarily consultant labor cost ($4,000) |
| **EA 6** | 1 | Green Power | *2-year green-e certified power contract, 50%* | | | | $3,260 | State | Per contract |
| **MR Pr 1** | - | Storage/Collection of Recyclables | *provide dedicated room for collection/storage* | | | | - | - | Would only be a cost if space is at a premium (i.e. rentable) |
| **MR 2** | 1 | Construction Waste Management - 50% | *estimate to separate concrete from rebar* | | | | - | HCI | Went to same facility |
| | | | *estimate to separate cardboard* | | | | $1,000 | HCI | Small amount of extra labor |
| **MR 4** | 2 | Recycled Content | *use of recycled-content steel deck and framing* | | | | - | HCI | Standard products |
| | | | *use of recycled-content h.m. doors and frames* | | | | - | HCI | Standard products |
| **MR 5** | 2 | Regional Materials | *use of local companies for concrete, cmu, glass, etc.* | | | | - | - | Local companies can actually cost less |
| **EQ Pr 1** | - | Minimum IAQ Performance | *compliance with ASHRAE 62-1999* | | | | - | - | Standard practice and required by code |
| **EQ Pr 2** | - | ETS Control | *eliminate smoking from premises* | | | | - | - | State policy, designated area required no cost to implement |
| **EQ 1** | 1 | Carbon Dioxide Monitoring | *install 2 devices and programming time* | | | | $10,000 | Hadji | Mostly labor time |
| **EQ 2** | 1 | Ventilation Effectiveness | *compliance with ASHRAE 129-1997* | | | | - | - | Only a reformatting of the pre-requisite information, reflected in consultant labor cost below |
| **EQ 3.2** | 1 | Const. IAQ Mgt, Before Occupancy | *energy use for 21-day building flush* | | | | $500 | CDLE | Flush ran fans 3x more than they would have otherwise run |
| | | | *use of MERV-13 filters(Aerostar Micratex Minipleat)* | | | | $2,500 | HCI | Straight cost of MERV-13 filters |
| **EQ 4.1** | 1 | Low Emitting Matl's - Adhesives/Sealants | *use of low-voc firestopping and sealants* | | | | - | HCI | Standard products |
| | | | *use of low-voc carpet, base, and VCT adhesives* | | | | - | HCI | Standard products |
| **EQ 4.2** | 1 | Low Emitting Matl's - Paints/Coatings | *use of 0-voc primers, paints, and caulks* | | | | - | HCI | Standard products |
| **EQ 4.3** | 1 | Low Emitting Matl's - Carpet | *use of Interface's environmental product* | | | | - | HCI | Cost for carpet was not unusual |
| **EQ 4.4** | 1 | Low Emitting Matl's - Wood | *use of Graham formaldehyde-free doors* | | | | - | HCI | Used standard cores |
| | | | *use of Graham formaldehyde-free cabinets/counters* | | | | $4,500 | HCI | Premium for "green" product line |
| **EQ 5** | 1 | Indoor Chemical and Pollutant Source Cor | *installation of (1) permanent entry grille* | | | | $1,500 | HCI | Cost to install at staff entry |
| | | | *cost for (4) additional ducts, grilles, and larger fans* | | | | $2,500 | Hadji | Cost for each janitor closet |
| **EQ 7.1** | 1 | Thermal Comfort | *compliance with ASHRAE 55-1992* | | | | - | - | No additional material or equipment, even to maintain humidity ranges |
| **EQ 8.2** | 1 | Daylight and Views - Views 90% | *installation of skylight* | | | | - | - | More for effect than view or daylight |
| | | | *installation of perimeter windows* | | | | - | - | Glazing part of design. Not over-glazed for LEED |
| | | | *installation of interior glazing systems* | | | | $3,000 | HCI | Premium for interior glazed conference rooms over same area of drywall |
| **ID 1.1** | 1 | Green Housekeeping | *development of Environmental Purchasing Policy* | | | | $2,400 | CDLE | 30 hours of staff time to draft and implement policy |
| | | | *use of Green Seal certified products* | | | | - | - | No cost to use products once found |
| **ID 1.2** | 1 | Exemplary MR 5 | *use of local manufacturers for building products* | | | | - | - | Reformat of previous credit information |
| **ID 1.3** | 1 | Exemplary MR 4 | *high recycled content in project* | | | | - | - | Reformat of previous credit information |
| **ID 2** | 1 | LEED Accredited Professional | *certified professional on design team* | | | | - | - | No cost to submit certificate as proof |

**29** Total Credits Approved — **$53,160**

*Basic Certification Level*

**SOFT (LABOR) COST ANALYSIS**

| Party | Role | Description | Cost | |
|---|---|---|---|---|
| Hadji | MEP Engineer | Design time, lead for gathering and submitting | **$21,000** | |
| DOTA | Architect | Design time, document certain credits | **$12,000** | |
| Hyder | General Contractor | Track information, document certain credits | **$15,000** | |
| E-Cube | Commissioning Authority | Review basis of design, systems commissioning | **$24,000** | includes both fundamental and additional |
| ENSAR | LEED Consultant | Review submittal materials, provide research | **$5,000** | |
| | | | **$77,000** | |

| | |
|---|---|
| **Total Project Cost** | **$4,527,000** |
| **Premium for LEED** | **$130,160** |
| **% Premium** | 2.9% |

# CH2M Hill Buildings

## 17. Project Overview

Andrea Ramage of CH2M Hill provided the information on LEED costs for their three office buildings in the Denver Tech Center. The CH2M Hill buildings were constructed in 2001 though 2002. They consist of 112,600 sf of conditioned space in the South building, 164,500 sf in the West building, and 112,600 sf in the North building. All three buildings are LEED certified.

## 18. Project Cost Overview

CH2M Hill provided detailed costs for this study. The following table gives a breakdown of design and construction costs.

| **FIRST COSTS** | | |
|---|---|---|
| Design cost $ | $5.3 million | |
| Increase in design fees attributable to LEED process $: | See below. | |
| Construction cost $: | $60.7 million | |
| Total design + construction $: | $66 million | |
| LEED Certification cost $:<br>South Building:<br>West Building:<br>North Building: | <br>$2,252<br>$3,290<br>$2,252 | |
| LEED Registration Fees $:<br>South Building:<br>West Building:<br>North Building: | <br>$350<br>$1,645<br>$1,126 | |
| LEED Commissioning Cost $:<br>South Building:<br>West Building:<br>North Building: | <br>$21,350<br>$31,170<br>$21,350 | **Total: $73,870 for both fundamental and enhanced Cx.**<br>Fundamental or Enhanced? |
| LEED Energy Analysis Cost $: | $30,000 for all three buildings | Does this include design assistance? **Yes.** |
| Unusual first costs/funds, particularly those associated with complying with LEED | Cost $: | Notes |
| All three buildings | $24,000 | Cost premium to install water efficient fixtures |
| All three buildings | $300,000 for all three buildings. | To upgrade HVAC systems on each of three buildings with direct expansion cooling/evaporative condensers in the roof top units. |
| All three buildings | $216,000 | Install indirect lighting systems to increase energy efficiency and improve lighting conditions |
| North building only | $7,500 per year for two years. | Purchase green power to meet LEED requirement |
| All three buildings | $17,080 | Set up, enforce, and document construction |

| | | |
|---|---|---|
| | | waste recycling |
| South building only | $9,000 | Install CO2 sensors |
| All three buildings | $280,000 | Install clerestory glass and sidelights in exterior, hardwalled offices, to improve daylight in interior spaces. Inspired by LEED, but did not result in a LEED point. |
| All three buildings | $60,000 | Approximate premium paid for Herman Miller furniture as a result of it being environmentally preferable. |

**FIRST COSTS**

The premium for design and construction costs associated with LEED was $170,000 , which translates into an additional 1.2% of the project costs. Documentation, certification and registration cost were $71,000 or 0.1% of the total costs. Commissioning was $70,000 or 0.1% and the additional construction costs were $580,000 or 0.8%. These costs are for all three buildings.

The estimated saving are $147,000 per year for energy and $1,500 per year for water.

19. Cost Issues
The attached spreadsheet itemizes the LEED costs.

20. Funding Sources
Financed through loans; no grants or donations.

21. Operation and Maintenance
None.
<ADD UTILITY COSTS>

22. Occupant Satisfaction
Most people love the buildings. However, the LEED-related features are not terribly visible, so most people aren't aware of the better lighting quality, energy savings, etc. resulting from LEED. Also, the new campus buildings are so much better than the previously occupied spaces that employees are bound to view the buildings favorably.

23. Other LEED issues

Disadvantages:
None

24.Would you require future projects to be LEED certified?
Yes. The forth building is in early stages of construction and is also seeking LEED certification.

## Tutt Science Center – Colorado College

### 25. Project Overview

The Tutt Science Center at Colorado College in Colorado Springs was constructed in 2003. It consists of 54,123 sf of conditioned space. The building was LEED certified. Gary Reynolds, Director of Facilities Services, and Carl Brandenberg, Campus Architect, provided the following information on LEED certification of this building.

The Tutt Science Center was the college's first LEED certified building. They are now working on the Cornerstone Arts Center, and the experience with LEED is going much more smoothly and the projected costs are lower.

### 26. Project Cost Overview

Project costs were $16 million, of this $10.8 million was for construction. Costs for LEED commissioning, documentation and energy analysis cost $300,000. Additional costs for a recycling center, shower, bicycle racks, etc. brought LEED costs up to $500,000.

Initial bids were 50% over budget, so had to redesign project. In second round of design decided to pursue LEED. Program had been set

The Cornerstone Arts Center is 73,000 sf. The project costs are projected to be $30.6 million and construction costs are projected at $21.6 million. The LEED costs are estimated to be $635,000 and include soft and hard costs. They will commission the Cornerstone Arts Center. (The college has another 10,000 sf facility that is being built but it will not be LEED certified.)

The societal benefits can outweigh the increased costs. Any design elements that show a life-cycle cost benefit are done by the college anyway.

### 27. Cost Issues

The success of commissioning of the Tutt Science Center is questionable. They've had subsequent problems with controls and their expectations around commissioning have not been met. They cannot justify costs. The college already has an extensive process for

reviewing design documents and testing building systems; the additional cost for third party commissioning

The LEED costs do not include energy optimization efforts because this is standard practice at the school.

## 28. Funding Sources

Because Colorado College is a private school, they were able to raise the additional 5% to cover the costs of LEED. Colorado College sees LEED as a credible approach to demonstrate their sustainability. In addition, foundations such as the Kresge Foundation and Coors Foundation, require LEED certification to obtain funding.

## 29. Operation and Maintenance

The commissioning process appeared to have failed in a number of areas. One example is that the electric meter was not properly commissioned, and data that has been collected is corrupted. The problems have been corrected and they anticipate having energy data available in the near future.

## 30. Occupant Satisfaction

Overall, occupant satisfaction is very high. The architect is reknown for designing light and airy buildings and was very successful. In addition, all rooms have individual control.

Gary Reynolds has a background in indoor air quality, and one of the greatest benefits was the use of low-VOC materials. As a result, they have changed their design guidelines to require low-VOC materials. They do not have enough experience as of yet on maintainability and durability.

## 31. Other LEED issues

There is clearly a marketing value and LEED helps attract students.

Carl Brandenberg discussed the LEED process and the value of an integrated approach over just following a checklist. With the Cornerstone Center, the design approach was much more integrated and it is anticipated that the project will achieve much greater success with respect to LEED than the Tutt Science Center. Gary Reynolds

noted that with the science building, it ended up being a race to garner points and it was a very prescriptive approach.

The design incorporates operable windows with controls tying windows and VAV boxes together. They were not awarded the point for controllability

The entire building is instrumented; however, because it is located on a campus and the existing central plant is not instrumented, they were unable to achieve the measurement and verification credit.

Non-potable water is used for irrigation. This was not site-recovered water, so project was not able to achieve water efficiency point. Under LEED NC-2.2, this requirement has changed.

The project did receive the point for ozone, although it was a struggle because the back-up chillers on campus do use HCFC's.

The project tried to meet all requirements for alternate transportation and alternate fueling stations, but outlet was of wrong type so did not achieve credit.

The project submitted 32 points for Silver certification. They were denied 6 points, and the building was just certified.

## 32. Would you require future projects to be LEED certified?

The college's experience is that the cost for LEED certification is difficult to justify. The college uses a life cycle cost analysis that is very effective. If the design team has demonstrated their ability to design sustainability, LEED certification does not necessarily add to the project.

Brandenberg recognizes the benefits of LEED in terms of transforming the market, but again the costs are difficult to justify.

# Fossil Ridge High School

## 33. Project Overview

Stu Reeve, Ed Holder and Josie Plaut provided the information on Fossil Ridge High School for this survey. Fossil Ridge consists of 288,685 sf of conditioned space. The building was awarded LEED certification in 2005.

## 34. Project Cost Overview

Fossil Ridge High School had a budget of $122/sf established in 1999 for this project. The project did have some an additional design fees; however, they do not have a break out of LEED costs. Bids were submitted with LEED costs embedded into proposal.

Fundamental and enhanced commissioning cost $226,476.63. Commissioning is part of all Poudre School District projects. The school district has found that commissioning costs are warranted. Commissioning started with Zach Elementary School

Energy and daylighting analysis would have been performed regardless of whether they had pursued LEED. Poudre School District has incorporated daylighting into buildings since 1987. Energy modeling started with operations building. Energy modeling allowed them to set performance targets.

Poudre School District has a different set of priorities that drives design decisions. They make decisions that may trade off more expensive finishes for energy efficiency measures. The school district also sizes systems to reflect actual loads. They have downsized transformers, domestic hot water system, boilers, etc. The school district takes on risk. The school district has also identified appropriate design conditions for the school rather than using standard ASHRAE conditions for winter and summer.

The project cost for Fort Collins High School was $37.5 million. Fossil Ridge cost $55 million.

## 35. Cost Issues

Market was very favorable in terms of material and labor costs. Had it been delayed one year, costs would have been $5 million higher.

## 36. Funding Sources

The school district received $30,000 in design assistance from the City of Fort Collins for this project. No other outside funds were received to pursue LEED.

## 37. Operation and Maintenance

Design of Fort Collins High School was an early experience in how not to design a school. Fort Collins High School was built in 1991. The two schools are very comparable in size and students, and Fossil Ridge is saving more than $100,00 per year in energy and water costs.

On a first cost basis, school districts are spending in the $120-$130/sf range. However, energy costs are substantially less in Poudre Schools.

No unforeseen costs associated with systems and materials.

## 38. Occupant Satisfaction

Fort Collins High School has glare problems and is generally uncomfortable as compared to Fossil Ridge.

Schools are desirable as working and learning environments.

The district receives a regular demand for tours of the school.

## 39. Other LEED issues

Paperwork is definitely a drawback of LEED process. Documentation required 300-500 hours of time that is not included in budget. Contract with CSU Institute for the Built Environment was $14,000 and that included charrette work.

For the university, this was a tremendous learning experience. As for the school district, they wanted third party confirmation of their design and construction of schools. The school district did change some practices, such as the use of water-based finished on wood floors in gym. Sealing ductwork, flushing building, and recycling construction waste resulted in a cleaner building because of different level of accountability.

Subsequent buildings have benefited from prior experience. See less reluctance from contractors on recycling.

Cost of recycling versus disposal. They diverted 75% of sheetrock. The cost was about double for disposal of sheetrock over recycling. No more drywall to the landfill. School district is now recycling all sheetrock. Sheetrock is used as a soil amendment. This work is coordinating with Waste Not.

SMS: Sustainability Management System. Looking at entire footprint of school district and what the environmental impact is of these facilities. SMS is being developed to lessen environmental impact of district.

### 40. Would you require future projects to be LEED certified?

No. Estimates $50,000 cost to achieve LEED platinum. The school district cannot justify this expense for consultants and documentation.

# North Boulder Recreation Center

## 41. Project Overview

Bill Boyes of the North Boulder Recreation Center participated in the interview. North Boulder Recreation Center underwent a major renovation and went from a 34,000 sf facility to a 62,000 sf. The design process began in 2000, and the project was completed in 2003.

## 42. Project Cost Overview

If had not pursued LEED, they would not have installed solar system. The high efficiency boilers would have been installed regardless of LEED. There are other measures for which they have a cost – benefit analysis and the cost-effective measures are included on all projects.

The DOE-2 modeling helped guide them on the renovation; prior to the North Boulder Recreation Center, they had not been using energy analysis. No daylighting modeling was performed. They now use this on new projects.

The LEED costs were 4.5% on this project. Without the solar system, the LEED costs would be 2%.

**North Boulder Recreation Center LEED Costs**

LEED registration $750
LEED certification $1,500
Integrated design consultant $15,450
Energy modeling $33,000
Commissioning $24,300 ($7,400 for enhanced)
Solar hot water system $256,000
Upgrade to condensing boilers $32,000
Total cost of upgrades $461,700
**Total $536,700**
**Total as percent of project budget 4.6%**

Source: "North Boulder Recreation Center Earns A Silver," Rebuild Colorado, Colorado Governor's Office of Energy Management and Conservation.

## 43. Cost Issues

80% DD decided to pursue LEED. Bill expects LEED costs would be lower had they incorporated LEED from the start. There is always some premium with LEED because of documentation.

## 44. Funding Sources

Paid for through maintenance budget (30%), some was capital money through Parks and Recreation bond issue (60-70%). They did have to go back to city council for more money. No Xcel incentives, but are applying for rebates with new retrofits.

## 45. Operation and Maintenance

Center has seen reduced water usage. They also track energy costs and have benefited from solar hot water system and other measures. Costs are tracking predictions fairly closely. Energy costs are close to $1.6/sf. Have realized greater savings with solar with higher energy costs.

The recreation center has not had any unforeseen problems with LEED-related systems. They are currently making upgrades to make systems run more efficiently. For example, they are replacing the 32 - 400 watt HID's in the gym with 200 - 24 watt compact fluorescents. The gym was not touched during the renovation. Also, reducing power factor on motors and other strategies they are implementing.

Energy use data is difficult to evaluate, so is reluctant to provide any data. North Boulder Recreation Center is being used much more often now than anticipated. This, and other factors, make it difficult to interpret the results.

Appreciate the commissioning process and having baseline data for all systems and equipment documentation that is well organized (enhanced commissioning cost $7,400). Bill's experience was very positive with commissioning and would recommend it for other projects.

## 46. Occupant Satisfaction

Bill has had many people talk about how nice the building is – the natural light, the air, etc.

The benefit of the tours to the city and community shows a significant accomplishment of which the community can be proud. There's an economic benefit of getting the word out on the recreation center.

## 47. Other LEED issues

To achieve the views credit, they added windows to an opaque interior wall. There are now more views into spaces that were not there before. They also added windows on the east side of the gymnastic area for views. They would not have considered these changes without LEED.

They give tours to people from all over the world. This would not happen if had not achieved LEED certification.

LEED did have an impact on schedule. They would not have done the two week flush out, although they were taking care of punch list items during flush out.

They have not received any complaints. They were concerned about complaints over the construction waste recycling and other construction issues from the contractor. This was not the case. They had no problems with the contractor.

The recreation center also feels like they have set a bar that future projects will strive to exceed.

The project team had no prior experience with LEED. By bringing on Architectural Energy Corporation, the team was brought up to speed. As a first-time experience, the LEED costs are seen as low.

They evaluated City of Boulder codes and found that any projects meeting the city code would pick up 20 LEED points.

## 48. Would you require future projects to be LEED certified?

They had a very positive experience with LEED. In all new projects, Bill includes LEED Silver certification in master plan. He sees LEED as very valuable because it is so comprehensive – it addresses site, water, energy, materials, and indoor environmental quality.

They have no misgivings about any of the LEED-related decisions they made. They were excited about achieving a Silver rating, and would love to do a high-rated project.

For future projects, Bill has plugged in 2% for LEED initiatives. He recognizes that for smaller projects would have to add more. The 2% would cover commissioning as well.

# Pikes Peak Regional Development Center

## 49. Project Overview

The following people participated in the interview for Pikes Peak Regional Development Center (PPRDC):

- ✓ Bill Fischer, formerly with LKA, project architect
- ✓ Carl Chinn, formerly hired as building engineer, first 2 years, now works at LONG
- ✓ Curtis Martinel Pikes Peak Regional Building Department, assistant building official
- ✓ Leslie Gruen, manager of communications for PPRB
- ✓ Jim Cook , LKA, principal in charge, LEED AP
- ✓ Whitney Calhoun , LKA, LEED AP (but not when on project), did submittal
- ✓ Bill Harmon, Systems Engineering Corp, mechanical consultants on project

PPRDC is a 2-story, Class A office building with 111,758 sf of conditioned space. The building owners are the Pikes Peak Regional Building Department, City of Colorado Springs and El Paso County. The building was occupied in June 2004, and certified LEED Silver in 2005.

The mechanical system includes hot water radiant heat served by condensing boilers with variable flow designed at a high temperature differential to minimize piping and pumping. Cooling and ventilation are accomplished with a small chiller, ice storage and variable flow. The air distribution system is VAV with fan-powered series boxes. The supply air is delivered at 9 feet by slot diffuser to achieve ventilation effectiveness. There are DDC controls. There are three stages of cooling: atrium connects north and south buildings. Mechanical system is indirect/direct evap cooling. System communicates with north and south and serves as balancing system for building. There is a water-side economizer but no air-side economizer. Injection fans are coupled with air handlers to inject outside air so can verify minimum ventilation air is always delivered. There is energy recovery ventilation via a run-around loop in fitness area.

## 50. Project Cost Overview

PPRDC established a goal of LEED certification at the start of the design process in 2000. There was no money added to budget for LEED certification since the project had set goal. The project came in under budget. There are design costs, but if budget from beginning then no budget impact.

The project budget was $13.985 million. Six contractors bid the work. The LEED criteria were very explicit in the specifications. The accepted bid was $12.56 million (February 2003). The project is silver certified and missed gold by one point.

The total cost for commissioning was $77,000, and includes all costs the team. Enhanced commissioning costs $7,000 of this.

Bill Harmon, the mechanical consultant on the projects, noted that as systems become more sophisticated, commissioning is necessary, especially 3rd party commissioning. This is a win-win for owner. When costs for construction are considered, the extra dollars for commissioning aren't really extra because costs down the road without commissioning would be higher. Value of 3rd party commissioning is bringing in independent review. The teams found the commissioning agent to be very supportive and avoided threat of who's right. The process has to be a team effort.

Carl Chinn, a building engineer and the owner's representative, has seen a lot of new buildings and has operated them for the first two years. This one was the most complex because of systems such as the thermal storage. Largely because of commissioning, it was one of the easiest to manage in the first year. The design was well done as well.

Jim Cook of LKA mentioned that commissioning should be brought in during design and meetings should occur during construction. It is a very interactive process. Dunn Construction was very supportive of the process, but had never done this and there was not an adversarial relationship.

One of the problems identified through commissioning was in the atrium. The design in the atrium has evaporative cooling with low and high returns. When the units are in heating mode they have low return. When in cooling mode they have high return. During commissioning, discovered control sequence was backwards. A traditional TAB effort would not have discovered this problem.

The energy analysis cost $6,000 and predicted 44% energy cost savings. Bill Harmon's office provided ongoing energy analysis through the design process (costs not given).

## 51. Cost Issues

The project budgeted $20,000 for certification and LKA took on the final submittal. Documentation by contractor was invaluable. If contractors had not pulled this together, project would have lost a number of points.

The use of high performance glass and shading resulted in downsizing of chiller and electrical service to chiller. Carl Chen and Bill Harmon discussed the coordination between the mechanical and electrical consultants. By combining the light shelves with radiant panels, they justified cost of radiant panels. LEED guidelines help spur this coordination.

The project also realized some savings by using local materials.

The project had some daylighting modeling done. There are light shelves and exterior shadings incorporated into façade. There is also a large light well to bring light into the core areas. The lighting design includes dimmable ballasts and photocells to maintain 28 fc at work surface. The daylighting design was verified by commissioning.

## 52. Funding Sources

The project received a high performance building grant of $20,000 from OEMC.

The budget for the building included LEED certification, so no other funds were required.

## 53. Operation and Maintenance

Carl Chinn tracked energy, water and waste water costs for 20 months. The normalized cost was $1.12/sf/yr. The building has ice storage which shifts peak demand. In the first year, 77% of peak kW charges were during off peak. The chiller also runs more efficiently at night.

## 54. Occupant Satisfaction

Curtis Martinel, an assistance building official at PPRDC, said they have received great feedback on building in terms of layout, functionality, and environmental aspects. Tours are given regularly and people are very impressed with the building.

Carl Chinn discussed the lighting levels and the fact that 28 fc didn't work for everyone. They went through the spaces with a light meter and made sure they achieved 28 fc; some areas received too little. The light levels were adjusted and there are no more complaints. During the winter solstice, there is some direct solar so installed blinds. Blinds are being used year round so daylighting benefits are muted.

## 55. Other LEED issues

Carl Chinn stated that utility costs are going up with transition to new building managers. The first concern is occupant comfort, but need new team to buy into LEED. One example is bioswales. Should have tall plant material, but it's being mowed. Same with native grass area.

Carl Chinn also noted that not enough emphasis put on LCCA. In addition, the story isn't told inside the building and it's important to make the public aware of building features.

The team repeatedly noted that since LEED was a goal from the start, the project went more smoothly.

## 56. Would you require future projects to be LEED certified?

If LEED is incorporated up front, a project team can make it work. LEED costs more if you don't do it right.

# City of Fort Collins Vehicle Storage Building

## 57. Project Overview

Ron Kechter of the City of Fort Collins represented the project team for the interview. The vehicle storage building for the City of Fort Collins Utilities is 15,250 sf and houses their equipment (dump trucks, back hoes, etc.). The project was completed in May, 2005 and earned Silver certification.

The initial design went from a box to one that optimizes daylighting through a sawtooth roof. The daylighting and cool roof would have not been done without LEED.

The walls are SIP panels (4") with interior finish being FRP (fiber reinforced plastic) and block veneer (4"). The garage doors are insulated at R-19. They chose to go with radiant floors served by condensing boilers. The project used an exemplary amount of recycled materials: metals, concrete, asphalt; and also recycled construction wastes. The building has a white roof that is keeping the roof much cooler. They also put concrete around the building rather than asphalt.

One significant change was to the orientation of the building. This allowed the team to optimize for daylighting and alleviated operational issue with snow on north side. The project probably would have had snow melt system if they had they not changed the orientation.

In the side of the hill there are concrete bins where sewage can be dumped and filtered. Water goes to retention pond. Debris is collected and taken to dump (light dry). Before this, they had to dump into pit, clear pit and had big mounds of debris that created an eyesore. This design was not driven by LEED.

Project has xeriscaping that was driven by LEED and city.

Only RMI/Ensar had LEED experience. Design team and contractor had no LEED experience. Contractor, Heath Construction, was very supportive of effort. Waste Not Recycling helped contractor implement waste management plan.

## 58. Project Cost Overview

The project started with a goal to achieve LEED certification. The initial budget allocated about 5% to address LEED. The project had some over runs, but the overruns were not because of LEED.

The project cost was 2.47 million, and includes design and construction fees of $190000, phones, equipment. Construction costs were $1.95 million.

The additional cost of in-floor radiant with condensing boilers over ceiling radiant heat was about $30,000. This includes the cost of the boilers.

The ventilation system is controlled by CO and NO and temperature. It is just an exhaust system with louvers. In the winter time, the louvers caused a draft so they retrofitted with shrouds on the exterior for better control. The cost was only about $3,000.

The structural insulated panels are 4" nominal and the cost was a wash compared to a steel structure.

The project received an innovation point for the use of recycled materials. The recycled asphalt cost a little bit more but is a better percolator than structural fill. There was no extra cost for recycled aggregate in the concrete.

The cost for LEED registration and certification fees, and commissioning was $10,884. Commissioning (only fundamental) required so much paper work.

LEED added $120,000 to $125,000 to costs.
Ensar was part of design budget

## 59. Cost Issues

LEED costs (5%) built into budget originally. The project cost under $200/sf for construction (not including site work). Increase in costs attributed to facility requirements (crash rails, labs, detention facility, etc.)

## 60. Funding Sources

There were no outside funding sources. (The Police Facilities project received funding through OEMC and local utilities.)

## 61. Operation and Maintenance

[Gary Shroeder is a good source for utility costs.]

The electric utilities garage was built in the early 1990's and is very similar, but does not have daylighting and other features. The city has had a problem with the ceiling mounted radiant panels melting the cabs on some of the trucks.

## 62. Occupant Satisfaction

The vehicle storage has extensive daylighting features. The occupants like the building, but there is no concrete evidence of impact of daylighting.

The building is very bright. All interior surfaces are painted white.

The building is more of an asset to the community: aesthetically and the fact that it is a green building.

## 63. Other LEED issues

Ron talked about all the paperwork associated with LEED, especially with commissioning. He would prefer to see more time spent on system performance. The documentation for commissioning was excessive for this size project. He stated that documentation for the entire LEED submittal is fairly streamlined; it is the commissioning documentation that is out of line.

The project is pursuing measurement and verification, and the city sees this of great value in terms of assessing building performance.

## 64. Would you require future projects to be LEED certified?

The city is certifying their Police Facilities office building. This is a design-build project of about 100,000 sf with a requirement of LEED Silver certification. They will have a white roof, are using concrete in parking lot. They will have concrete on south side of building and asphalt on north side to promote snow melt on north. The project has good orientation.

The building will have 1" polyurethane spray foam of exterior of building to reduce heat loss and reduce infiltration. (This is a 24-hour building, and added insulation is cost effective.)

The construction costs are under $200/sf, so it is very affordable. The bigger impact on the budget is the design elements to respond to needs of police environment (crash rails, detention facility, etc.).

Detailed energy analysis was performed, but with design build process, consideration of options was limited. Had the RFP addressed these alternatives, there may have been more flexibility. The final system is efficient. The rooftop units will have evaporative condensers. No energy target was established.

The City is also looking at requiring Gold certification on projects. This is being set by the city council and city manager. The Silver level was set by staff. The utilities have influenced this as well.