Regional Green Building Case Study Project:
A post-occupancy study of LEED projects in Illinois

Year 1 Final Report
Fall 2009

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Participating Buildings
The 25 participating projects in this study were considered anonymous unless projects gave approval to be listed in this report. We thank all participating projects and their representatives for their help throughout this study. This project would not have been possible without your involvement.

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About the U.S. Green Building Council – Chicago Chapter

The U.S. Green Building Council – Chicago Chapter's over 1,600 members represent the entire spectrum of Illinois' green building community, from real estate professionals, architects, engineers, designers and trade associations to contractors, product manufacturers, state and local government officials, homebuilders and homeowners. The U.S. Green Building Council – Chicago Chapter is the local affiliate of the U.S. Green Building Council (USGBC), a national non-profit composed of leaders from every sector of the building industry working to promote buildings that are environmentally responsible, profitable and healthy places to live and work. USGBC's Leadership in Energy and Environmental Design (LEED) Green Building Rating System is the nationally accepted benchmark for the design, construction, and operation of high performance green buildings. LEED provides a roadmap for measuring and documenting success for every building type and phase of a building lifecycle. In Illinois, the Chicago Chapter furthers the work of USGBC through a variety of programs, events, education and research initiatives, advocacy campaigns, and resources for the local green building community. The Chapter's skilled and diverse membership is its most valuable asset. Our members participate in the Chapter's eleven committees that develop programs and events for various segments of the region's green building community and/or assist the Chapter in a variety of operational functions that help us achieve our goals. The Chapter's six regional branches provide local programming, advocacy, and networking opportunities throughout Illinois.

To learn more about the USGBC – Chicago Chapter visit www.usgbc-chicago.org.

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1. Executive Summary

The *Regional Green Building Case Study Project* analyzes the post-occupancy performance and costs and benefits of 25 LEED projects in Illinois related to: measured energy and greenhouse gas emissions, water, commute transportation, construction and operating costs, green premium, health and productivity impacts, and occupant comfort.

While this project is neither the first nor the largest study to analyze the costs and benefits, or post-occupancy energy performance of LEED projects, this study is unique both in its scope and collaborative approach. This project is one of the first post-occupancy studies to employ such a broad scope of metrics. It is also among the first to collect multiple years of post-occupancy data and provide ongoing analysis of initial participants while adding additional projects in subsequent years. The project employed a stakeholder engagement model based on regional partnerships, and a valuable back and forth dialog with project stakeholders. This dialog included preparing detailed individual building performance reports for each participating project and follow up meetings with project stakeholders so that project representatives could better understand their buildings' actual performance.

The measured performance results of these 25 Illinois LEED projects are a snapshot in time of these specific projects. Extrapolating the results from this data set to represent the performance of all LEED projects in Illinois, or all LEED projects in general, is not valid. It is expected that another set of participants will yield different results because of the mix of unique buildings and building activities. It is also quite likely that the performance of these same projects will change over time due to occupancy, operations, maintenance, and systems changes.

This executive summary provides an overview of the aggregate results and highlights key findings. The full report provides additional details about the participants, results, methodology, and includes case studies for nine of the participating projects and one sample of an individual performance report that was generated for each participating project. Case studies are in Appendix C. The representative individual building performance report is in Appendix D.

Participants

All LEED projects in Illinois were eligible to participate in this study if they could provide at least 12 consecutive months of post-occupancy energy use data. The 25 study participants represent projects certified at all LEED levels and under the following LEED programs: New Construction (LEED NC), Existing Buildings (LEED EB), Commercial Interiors (LEED CI), and Core and Shell (LEED CS). The projects range in size from 3,200 to 4.2 million square feet and represent a variety of building activities including: Education, Lodging, Mixed Use, Office, Public Assembly, Public Order & Safety and Other.

Results: *Energy Performance*

The energy performance analysis utilized the metric energy use intensity (EUI), which is reported in kBtu/square foot/per year for all fuels. The 25 Illinois LEED projects were split into two categories for energy performance analysis:

1. **Whole Project Energy Use Projects** (17 projects) - where complete energy data was provided for a building or project space, including heating/cooling, lighting and load attributed to the building occupants. The median EUI for whole project energy use project participants in the Illinois LEED Study is 94 kBtu/square foot/year.

2. **Partial Energy Use Projects** (8 projects) - where only partial energy data was provided; for example a tenant in a Commercial Interiors (CI) space provided the electricity bill for lighting and plug load when their heating and cooling costs are built into the lease and/or not metered. The median EUI for partial energy use project participants in the Illinois LEED Study is 38 kBtu/sf/year.

The two charts below show the distribution of EUIs for whole project and partial energy use projects in the Illinois LEED Study. (Figures ES1 and ES2)

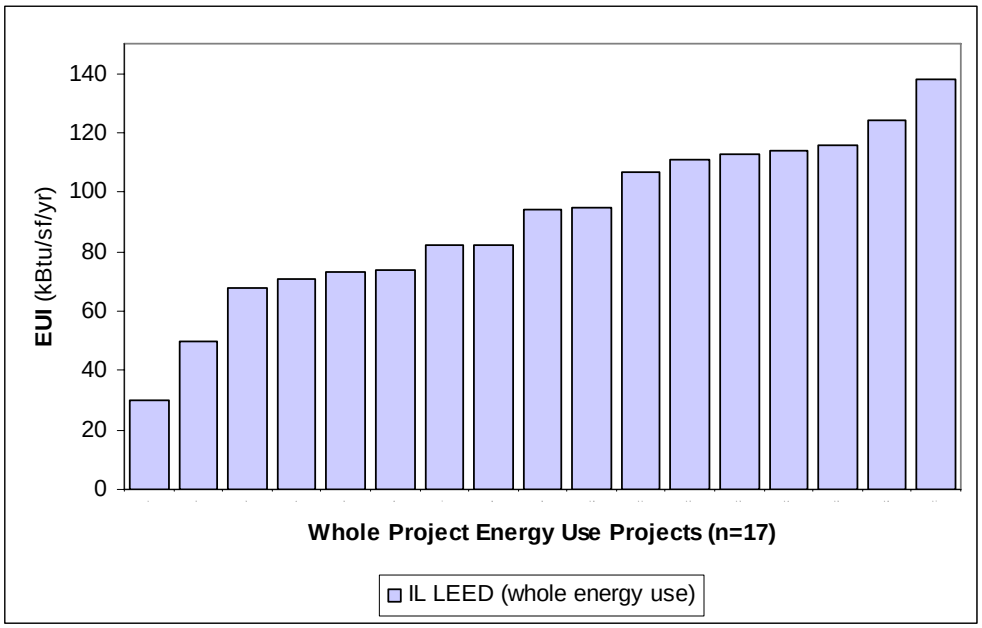


Figure ES1: Distribution of Participating Whole Project Energy Use Project EUIs

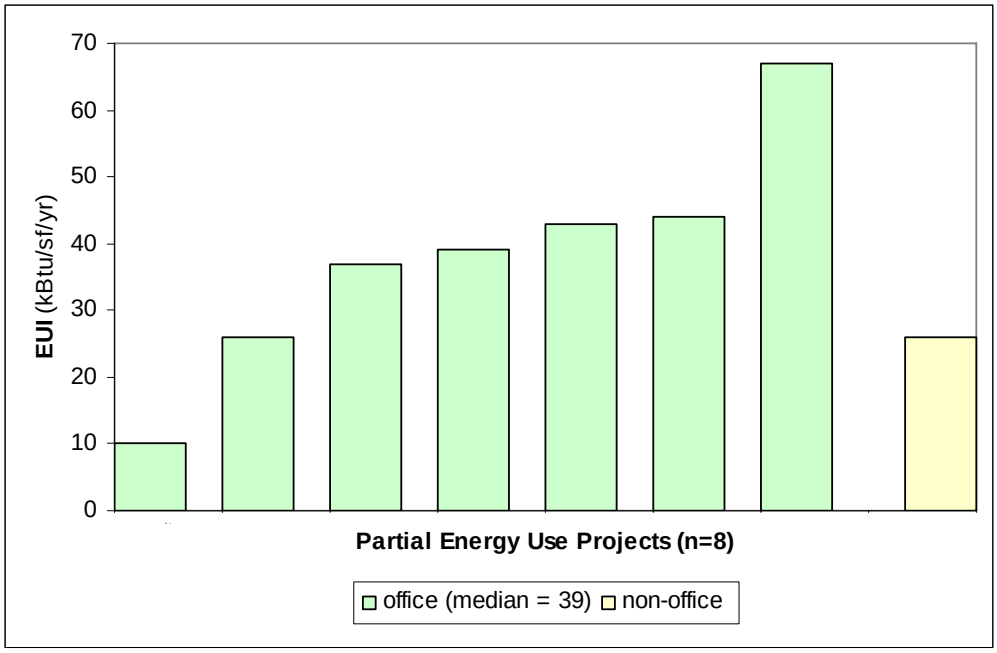


Figure ES2: Distribution of participating Partial Energy Use Project EUIs

The Illinois LEED projects that focused on energy optimization credits (LEED NC EA Credit 1) and achieved a higher number of EA Credit 1 points performed better. Separating projects by principal building activity, it appears that the Illinois LEED projects that achieved a higher number of EA Credit 1 have a lower EUI. It is not surprising that projects that prioritize energy efficiency as a key LEED strategy are likely to perform better than those projects that do not focus on energy efficiency or choose to prioritize points in other LEED categories. Yet, the Illinois LEED project sample size is small and further research is needed to determine if there is a statistically significant association.

Results: *Greenhouse Gas Emissions*
The median calculated greenhouse gas emissions (GHG) in pounds of carbon dioxide equivalents (CO_2e) /square foot/year for whole project energy use projects is 25.8 lbs/sf/year. For partial energy use projects the median CO_2e is: 13.8 lbs/sf/year. CO_2e emissions were calculated by analyzing each project's fuel use and mix and applying emissions factors. Sources of emissions factors are listed in Appendix A.

Results: *Water Use*
The median water use for the Illinois LEED study projects is 7.7 gallons/square foot/year and 5.9 gallons/occupant/day. No projects submitted water data separating interior from exterior water use, though two projects indicated no water was used for exterior landscaping. The wide range in annual water use is from 15 thousand gallons to more than 33 million gallons, and is attributed to individual project size, principal activity and occupancy. Twelve projects submitted water use data.

Results: *Commute Transportation*
Employees from 9 Illinois LEED projects participated in an optional transportation commute survey. The study commute transportation analysis focused on 3 metrics:

1. Vehicle Miles Traveled (VMT)
2. Transportation Energy Intensity (TEI)
3. Use of amenities for LEED pts

1. The participants in the Illinois LEED study have shorter commutes, 9.2 miles one way, than the national average of 12.1 miles. The median percent of commute miles in a passenger vehicle (auto, van, truck, etc.) for participating projects in the Illinois LEED study is 89%. The median vehicle miles travelled via passenger vehicle for Illinois LEED study participants is 3,645 miles/employee/year.

2. Transportation energy intensity (TEI) reflects the amount of energy associated with commuting to and from a building. For the Illinois LEED study TEI is calculated from vehicle miles traveled in passenger vehicles. The median TEI for participating projects is 18,608 kBtu/employee/year.

3. The third component of the transportation survey assessed the use of transportation amenities and services by employees in the Illinois LEED Study projects. All nine projects surveyed earned Alternative Transportation Credits as part of their LEED certification.
    - Public Transportation Access credits: 6 of 9 projects achieved, 4 of those 6 utilized.
    - Bike Storage credits: 8 of 9 achieved, 4 of those 8 utilized.
    - Parking capacity and carpool preferred parking: 5 of 9 achieved, 4 of those 5 utilized.

Employees at 7 of 9 projects utilized carpooling as a commute mode. The data collected suggest that employees do not often understand what employer transportation policies, amenities and services are available to employees such as, pre-tax transit benefits, guaranteed ride home or compressed work schedules. Onsite food service or kitchen facilities were the most common utilized amenity.

Results: *Construction & Operating Costs, and Green Premium*
There is a wide variation among the Illinois LEED Study projects results suggesting that, similar to conventional buildings, construction costs vary widely and may be attributed to principal building activity and individual project's goals and specifications. The median Illinois LEED study construction cost was $211/square foot (15 projects reporting). Green premium also varies widely and is also driven by individual project goals and total construction cost. The median Illinois LEED study green premium was 3.8% (8 projects reporting). Additionally, eight projects stated a reduction in operating costs.

Results: *Health and Other Benefits*
Health and other benefits are not well documented among the Illinois LEED projects. Three or fewer projects noted savings in infrastructure costs, increase in property value, and/or higher rental rates. Two Illinois LEED study projects noted reduced asthma, less absenteeism, less sick time. Two projects noted ancillary benefits including increased awareness of their core business and staff recruitment attributed to LEED certification. No projects noted an increase in any of these metrics.

Results: *Occupant Comfort*

Occupant satisfaction is high, especially related to indoor air quality and lighting. The lowest ratings given by occupants were related to temperature and acoustics, but still generally positive. Most of the dissatisfaction with temperature related to employee's ability to control temperature in their workspace. Employees from 11 projects chose to participate in an optional survey. The survey asked employees to rank aspects of the work environment on a scale of 1-5 in five categories: light level, noise, temperature, air quality/ventilation and overall building comfort.

Conclusions and Recommendations

1. There is a wide variation in measured performance among this set of 25 LEED projects in Illinois related to measured energy and greenhouse gas emissions, water, commute transportation, construction and operating costs, green premium, health and productivity impacts, and occupant comfort.

   Specifically related to energy performance, many Illinois LEED projects perform better than conventional commercial interiors and buildings, but as with conventional buildings, there is a large variation amongst projects. A significant finding is that the Illinois LEED whole project energy use projects that achieved a higher number of EA Credit 1 (LEED NC) points performed better. This finding makes sense; projects that prioritize energy efficiency as a key LEED strategy are likely to perform better than those projects that do not focus on energy efficiency or choose to prioritize points in other LEED categories.

2. Ongoing performance measurement and analysis is critical to quantify a building's environmental impacts and efficiency over its lifecycle. A building's performance changes over time, so future building performance evaluations must incorporate and interpret the impact of changes in individual building use, occupancy and operations and maintenance, as well as systems improvements. Three of the case study projects in Appendix C discuss how their operations have changed post-occupancy and the resultant impact of the changes on their buildings' energy use. Studies such as this Illinois LEED Study are vital in that they provide building owners valuable feedback that can inform continuous improvement strategies.

3. A building's best benchmark is its own performance. Individual building measured performance baselines provide the best benchmarks for building owners to set realistic, achievable, continuous improvement goals. Since every building is unique in its use, occupancy, operations, maintenance and systems, actual post-occupancy measured performance that reflects actual operating conditions of the specific building will be the best benchmark. Other benchmarks, such as comparisons to other buildings (LEED and non-LEED, including CBECS and Energy Star) or any modeled predictions are temporal or limited in use, even as methodologies and data sets evolve to provide more accurate comparisons.

4. More research is needed in the following areas to support building performance initiatives: standardized metrics, data collection protocols and tools, appropriate benchmarks, and routine post-occupancy evaluations.
   Specifically, more data and research methodologies are needed to quantify the:
   - Health, indoor environmental quality and productivity benefits of green buildings.
   - Market-driven financial benefits and risks, both short and long-term.

- Impact of building location on building performance- particularly the energy and greenhouse gas emissions associated with transportation to and from the building.

5. Simple tools are needed to interpret building performance to distinguish operational and behavioral performance impacts from systems related impacts. These tools must be employed at scale to quickly target efficiency opportunities for continuous improvements and meaningful reductions to meet greenhouse gas and other environmental impact reduction goals.

6. Measured, ongoing building performance evaluation supports important and distinct research goals. Ongoing building performance evaluation is critical at the *individual building level* to provide understandable, relevant and actionable feedback to building owners, operators and occupants. Ongoing building performance evaluation is also critical at a *macro level* to support LEED program evaluation to inform policymakers and other LEED stakeholders. Although there is more consensus on the methodologies and metrics at the micro level than the macro level, the methodologies utilized for building performance evaluation are evolving and will be refined over time.

2. Introduction

The *Regional Green Building Case Study Project* was funded through the generous support of the Grand Victoria Foundation and is a collaborative, multi-year research study between the U.S. Green Building Council-Chicago Chapter; the City of Chicago; U.S. EPA, Region 5; Delta Institute; and the Center for Neighborhood Technology (CNT). The study is directed and advised by a steering committee of individual representatives from each of the study's partnering organizations with the U.S. Green Building Council – Chicago Chapter serving as the lead entity. CNT was contracted as the research coordinator for the study and was responsible for data collection and analysis. The unique attributes of each of the project partners attest to the strength of regional collaboration. Each partner's insight into aspects of the study methodology and the relationships with the regional green buildings contributed to a valuable stakeholder engagement model and overall study.

The goals of the study's first year were: 1) to identify an appropriate research methodology for collecting regional green building performance data; 2) to develop a representative study of regional green buildings' post-occupancy performance based on the methodology; 3) to communicate the results of the study to developers, government officials, and residents of the region, and based on the results of the previous steps; and 4) to develop a final report including a set of recommended next steps for further study development and support beyond the project's first year.

While the first year results are an important first step in quantifying and understanding post-occupancy performance of LEED projects in Illinois at one point in time, it is important to understand the larger context of the study. This study points to the need for ongoing performance data to understand how changes in operations, occupancy, maintenance and systems and other factors affect building performance. All projects that participated in the first year of this study will be invited to submit an additional 12 months of data as a part of the study's second year. (Participants in year 1 submitted an average of 23 months of energy data.) Furthermore, an additional 25 LEED certified buildings/projects in Illinois will be solicited for participation in the second year. The broadest finding of this study is that regularly collecting and analyzing building performance post-occupancy is a critical component in operating a green, high performance building. Tracking performance over time will provide valuable data to both the individual building stakeholders: owners, operators, occupants and designers, as well as policymakers and LEED program evaluators.

Measured building energy performance data is critical in order to plan or implement any local, regional or national greenhouse gas emission reduction strategies. Energy use in buildings account for nearly 70% of greenhouse gas emissions in the City of Chicago and 61% of emissions regionally (CNT, 2008). Therefore, energy efficiency initiatives to reduce energy use in new and existing buildings are a primary strategy for emissions reductions and require measured energy use data for creating baselines as well as quantifying reduction-strategy impacts. The demand for post-occupancy performance data is driving both voluntary and regulatory policies that incent and mandate building energy use performance reporting, both in green and conventional buildings. Beginning in April 2009, all new projects registered under LEED 2009 are required to annually report monthly energy and water data for a period of 5 years. Additionally the cities of

Washington DC; Austin, TX; New York, NY; Seattle, WA; and Portland, OR; and the State of California have independently adopted legislation (or legislation pending) for building energy use reporting and/or disclosure for commercial buildings (and in some cases, residential buildings).

Building Performance Study Precedents

Though this Illinois LEED study project is among the first to examine post-occupancy performance on a regional scale, it is certainly not the first to tackle this topic (Torcellini et al., 2006; Turner, 2006; GSA, 2008; Turner and Frankel, 2008). *The Energy Performance of LEED® for New Construction Buildings* (Turner and Frankel, 2008) is the largest post-occupancy energy performance evaluation of LEED buildings to date. This national LEED study carried out by the New Buildings Institute on behalf of USGBC (referred to in this report as the national LEED study) found that the median energy usage of the 121 participating LEED buildings is 25-30% less than the national average. A 2008 General Services Administration (GSA) post-occupancy study saw a similar 26% energy savings in 12 federal buildings (GSA, 2008). An analysis of 643 Energy Star rated office buildings showed lower operating expenses from energy costs compared to non-Energy Star buildings (Miller, Spivey, and Florance 2008).

The national LEED study results also revealed a high degree of variability between the modeled/predicted energy use intensity (EUI) and the actual EUI, with 30% of buildings performing significantly better than their models and 25% performing significantly worse. Other reports and studies also echo the limitations of building energy use models to accurately predict actual energy use (Torcellini et al., 2006; Bordass, Cohen & Field, 2004).

The results, as well as the methodologies for assessing green building performance are subject to debate among researchers in the field (Muldavin, 2008; Gifford, 2008; Newsham et al., 2009; Scofield, 2009). Most researchers do agree that green and energy efficient buildings can perform as expected, can perform better than non-green buildings, and can be cost effective to build and operate. But for these outcomes to become the norm, measured, actual performance data must be collected and analyzed for green buildings, and the feedback to building stakeholders must be useful and actionable. The *U.S. Green Building Council Strategic Plan for 2009-2013* cites the lack of data on green building performance as one of the seven key issues facing the green building industry (USGBC, 2008). Its research agenda identified post-occupancy performance research as one of its key national research priorities (USGBC, 2007). USGBC's new requirement that all projects seeking certification under LEED 2009 must submit post-occupancy performance data echoes and responds to this need. Additionally, USGBC's recently announced Building Performance Initiative which will collect and analyze post-occupancy data from existing LEED certified buildings is another significant step towards filling this knowledge gap. This Illinois LEED study will make its aggregate data available to the U.S. Green Building Council and where appropriate, to national databases to allow for easy inclusion with and comparison to other relevant green building research.

Several initiatives, both existing and forthcoming are addressing the need for standardized data collection protocols, metrics and tools for the building industry (Fowler, Solana & Spees, 2005; Sharrad, 2007; National Institute of Building Science, 2008). These efforts demonstrate a comprehensive approach to evaluating and benchmarking building performance, going beyond measuring energy use or costs alone toward incorporating a diverse set of performance metrics (Fowler, undated; Hewitt et al., 2005; Wilson, 2007; ASHRAE, USGBC, CISBE 2008; USGBC 2007;

USGBC 2008). The methodology used by the U.S. Green Building Council Chicago Chapter's *Regional Green Case Study Project* is informed by and complimentary to the existing research.

Benchmarking and Study Caveats

Throughout this report the study's results are presented in comparison with other national building data sets. This is done to provide a context for the data presented, though it is important to note that making a direct comparison between the results of this study and other data sets is difficult and inconclusive because the data sets aren't a perfect match. This study benchmarks to 3 other data sets: the national LEED study published by NBI in 2008, the 2003 Commercial Buildings Energy Consumption Survey (CBECS), which is a national data set of energy use in the nation's commercial buildings, and to Energy Star, a joint program of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE).

The CBECS data set provides the best currently available comparison for commercial buildings, but is an imperfect benchmark. It is important to note the CBECS building profile in terms of size and principal building activities is drastically different than the buildings in this Illinois study, making direct comparisons with both National and Midwest CBECS data difficult. USGBC encountered similar limitations with CBECS data (which it also used as a benchmark in the national LEED Study) and, accordingly, is currently working with leading statisticians and econometricians to develop more reliable methodologies and benchmarking protocols to better assess and compare post-occupancy performance of LEED buildings.

The Energy Star benchmark utilizes the CBECS data set to rate buildings on a scale of 1 to 100 adjusting for weather variations and basic operating conditions including, occupancy, operating hours, and energy using equipment and features. The Energy Star rating is calculated from source energy use and is available for 14 commercial building types. While an Energy Star rating is a useful metric, especially because it normalizes national energy data and is easy to understand, it has its limitations for comparison with this Illinois data set. One significant limiting factor is that less than 30% of the Illinois projects could be rated using Energy Star tools.

Important caveats to this study and its findings include*:*

- Sample size – This study's sample, while significant in that it represents a large number of eligible LEED projects in Illinois, is notably small, making the amalgamated results not applicable to generalization across a larger set of buildings. In studies with small sample sizes, outlying projects (whether they be good/poor performers individually or merely samples with concentrations of buildings with principal building activities of high/low energy use) can influence the aggregate results greatly. As the industry develops more robust building data, this will help to soften the impacts of outlying data, making the data more statistically relevant and accurate, thus painting a truer picture of the ongoing performance of the region's green buildings.

- Building Size – The largest percentage (33%) of buildings in the Illinois LEED Study are between 25,000-50,000 sf., compared to the National LEED Study where the largest percentage (34%) of buildings are larger and range between 100,000-500,000 sf. Both these LEED data sets are quite different from the 73% of buildings in the CBECS data set that are less than 10,000 sf. This is one reason that CBECS has been found to be an unreliable data set to use for benchmarking and why USGBC is currently researching other more appropriate methods for comparing LEED buildings versus non-LEED.

- Building Activity - Many of the projects in the study have principal building activities that are under-represented in the benchmarking data sets. Forty eight percent of the Illinois LEED study participants fall into two principal building activity categories: Public Assembly (24%) and Public Order and Safety (24%). These two categories make up a much smaller proportion of both the National LEED Study (5% and 4% respectively) and CBECS (4% and 1.5% respectively). Similarly, 85% of Energy Star rated buildings are of three types, the largest representation is offices (40%), compared to 17% (3 of 18 buildings) in the Illinois study. The difference in LEED building activities representation to the comparison data sets is one reason USGBC is pursuing other methodologies in this regard.

- Version of LEED certification and ASHRAE 90.1– Most participating projects were certified under LEED NC version 2.0 or 2.1, which provided less stringent energy performance baseline standards and incentives for pursuing additional energy optimization points than more recent versions of LEED. Newer versions of LEED provide higher baseline standards including the latest version of the ASHRAE 90.1 standard and increased incentives on energy performance. Additionally, LEED 2009 requires that all buildings submit operational data, post-occupancy as a requirement of certification.

During phase 2, this study will incorporate USGBC's refined methodologies and benchmarking protocols as appropriate to ensure that it is comparable to any subsequent USGBC studies and to utilize the best available science for assessing and comparing post occupancy building performance.

3. Participant Characteristics

This report presents the post-occupancy performance of 25 projects with 22 owners from the *Regional Green Building Case Study Project.* This section describes the Illinois LEED Study participants by **LEED Program, Certification Level, Size** and **Principal Building Activity**. Results are reported in Section 4. Please note that this report uses the terms *Building* and *Project* very specifically throughout. Project refers to all participants in this study, whether it is a stand-alone building or a space within a building, typically but not always a tenant space**.** Building refers to a stand-alone structure.

The 25 projects were split into groups for description and analysis. For example, the projects are sometimes classified according to principal building activity (PBA) as defined by CBECS to compare with the national CBECS data set. To evaluate energy performance, the team separated the projects into two categories:

1. **Whole Project Energy Use Projects** - where complete energy data was provided for a building or project space, including heating/cooling, lighting and load attributed to the building occupants. (n= 17 projects)
2. **Partial Energy Use Projects** - where only partial energy data was provided; for example a tenant in a Commercial Interiors (CI) space provided the electricity bill for lighting and plug load when their heating and cooling costs are built into the lease and/or not metered. (n= 8 projects)

Details about participating projects are described further in Appendix B.

Please note that throughout this report the population (n= value) changes when comparing participants to other benchmarks or studies (such as the CBECS or the National LEED Study) so that like type buildings or projects are compared. For example, whole project energy use projects are only compared to whole building energy use benchmarks. Specifically, the National LEED Study only evaluated whole building energy use projects, so when this study references the national study, it's comparing only to the Illinois LEED Study's 17 whole project energy use projects. Since energy information was the only mandatory data element required for participation in this study, the population size (n= value) changes depending on the number of projects that provided data for other metrics, and is noted accordingly.

3a. Participant Projects by LEED Program

Nearly 2/3 of the projects in this study were certified under the LEED for New Construction (NC) program. All LEED NC projects in this study utilized versions 2.0 or 2.1. (Note that LEED NC version 2.2, starting June 2007, mandated that projects achieve a minimum of 2 energy optimization points under LEED Energy and Atmosphere Credit 1.) The remainder of the Illinois LEED Study projects were certified under other LEED programs, including Existing Buildings (LEED EB), Commercial Interiors (LEED CI), and Core and Shell (LEED CS). (Figure 1)

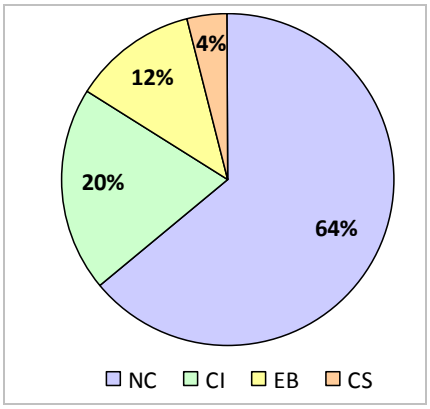


Figure 1: Projects by LEED Program

3b. Participant Projects by LEED Certification Level

All four LEED certification levels are represented in the Illinois LEED Study though more than 50% of participating projects achieved LEED Silver. (Figure 2)

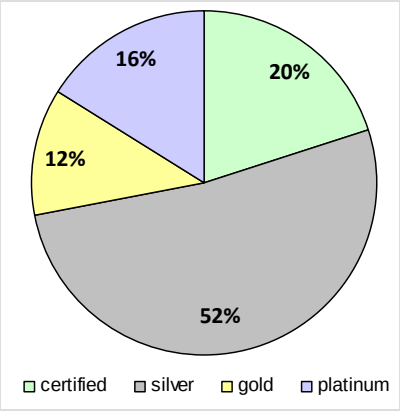


Figure 2: Projects by LEED Certification Level

3c. Participant Projects by Geography

The projects are located throughout the State of Illinois. To preserve the anonymity of the individual projects, specific locations will not be identified (except for case studies). However, utilizing zip codes and the LEED 2009 regionalization categories for the Heartland Region, 92% of participating projects are in the Mid-Density and Urban Core locations. The four location categories defined by the Heartland Region under LEED 2009 are: Urban Core, High Density, Mid-Density and Low Density. All aggregate energy data was weather normalized to account for climate variations across Illinois.

3d. Participant Projects by Size

The projects (n= 25) that participated in the IL LEED study ranged in size from 3,200 to 4.2 million square feet. (Figure 3)

Project Size (1000 sf)	n	**Whole Project Energy Use** n=17 (LEED NC and EB) **Illinois LEED Study**	n	**Partial Energy Use Projects** n=8 (LEED EB, CI and C&S) **Illinois LEED Study**
0-10	1	4%	4	16%
10-25	5	20%	0	4%
25-50	6	24%	1	4%
50-100	2	8%	0	4%
100-500	1	4%	1	4%
>500	2	8%	2	0%
TOTAL	*17*	*68%*	*8*	*32%*

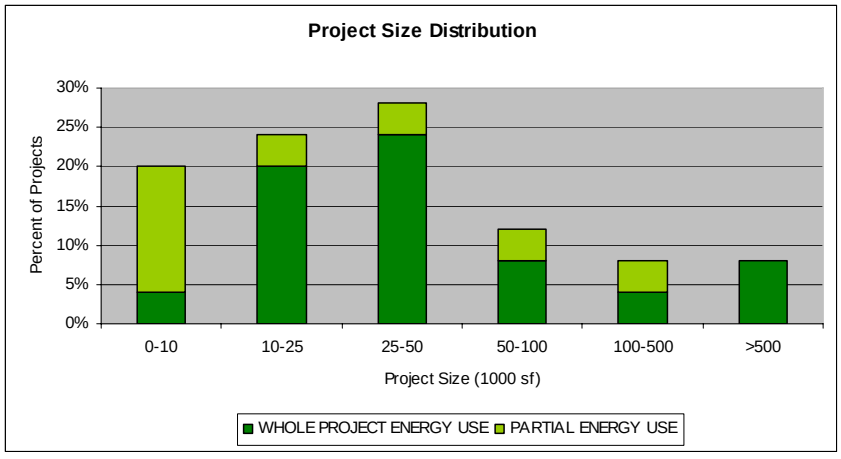


Figure 3: Size Distribution of Projects in the IL LEED Study

Figure 4 below compares the size of buildings in the Illinois LEED Study to two benchmarks: CBECS and the National LEED Study. The distribution of buildings by size in the Illinois LEED Study shows similarities to the National LEED Study, though the size distribution is quite different from the CBECS dataset. The largest percentage (33%) of buildings in the Illinois LEED Study are between 25,000-50,000 sf, compared to the National LEED Study where the largest percentage (34%) of buildings are larger and range between 100,000-500,000 sf. Both these LEED data sets are quite different from the 73% of buildings in the CBECS data set that are under 10,000 sf. (Figure 4)

Building Size (1000 sf)	n	Illinois LEED Study	CBECS 2003 Midwest	National LEED Study (NBI 2008)
0-10	1	6%	73%	8%
10-25	5	28%	16%	26%
25-50	6	33%	6%	14%
50-100	2	11%	3%	16%
100-500	1	6%	2%	34%
>500	3	17%	0.15%	2%
TOTAL	**18**	**100%**	**100%**	**100%**

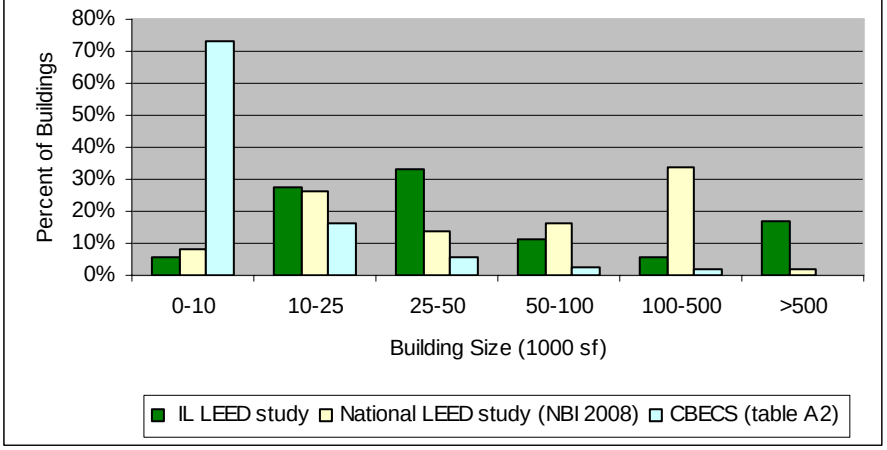


Figure 4: Size Distribution of Buildings in the Illinois LEED Study Compared to CBECS and National LEED study by number of buildings

Because the sample size of the Illinois LEED Study is so small and the distribution based on size is not completely similar, it is not accurate to presume that the projects and buildings in the Illinois LEED Study are representative of the larger data sets: National LEED Study or CBECS buildings.

3e. Participant Projects by Principal Building Activity (PBA)

As part of the data submission, each project's contact identified their project's primary (and in some cases secondary) building activity (PBA) or building use type from a drop-down menu. The category choices are from the CBECS PBA definitions. Of the 14 PBAs defined by CBECS, six are represented in this study. (Figure 5)

Project Activity Type	N
Education	1
Lodging	3
Mixed-use	2
Office*	9
Public Assembly	4
Public Order & Safety	4
Other	2
TOTAL	**25**

* Includes stand-alone and tenant office spaces.

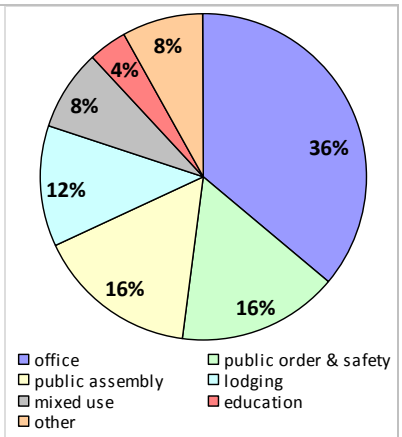


Figure 5: Projects by Building Use Type or Principal Building Activity (PBA)

Figure 6 below compares principal building activity distribution in the Illinois LEED Study to two benchmarks: CBECS and the National LEED Study.

Principal Building Activity	n	Illinois LEED Study Whole Project Energy Use (LEED NC and EB) n=17	CBECS 2003 (table A2) Midwest Region n=1,305,000	National LEED Study (NBI 2008) n=121
Education	1	6%	5%	8%
Lodging	3	17%	3%	6%
Office	2	12%	18%	29%
Mixed Use	2	12%	-	15%
Public Assembly	4	24%	4%	5%
Public Order & Safety	4	24%	1.5%	4%
Other	1	6%	2%	3%
Categories not used in this study	-	-	66%	30%
TOTAL	**17**	**100%**	**100%**	**100%**

Figure 6: Principal Building Activities in the Illinois LEED Study Compared to CBECS and National LEED study, by percent of buildings

The Illinois LEED Study's largest principal building activity categories are Public Assembly (24%) and Public Order and Safety (24%). These categories make up a much smaller proportion of both the National LEED Study (5% and 4% respectively) and CBECS (4% and 1.5% respectively). Because the sample size of the Illinois LEED Study is so small and the distribution based on principal building activity is not completely similar, it is not accurate to presume that the projects and buildings in the Illinois LEED study are representative of the larger data sets: National LEED Study or CBECS buildings. (Figure 6)

4. Results & Findings

This section presents the results of the post-occupancy evaluation of the 25 participants in the Illinois LEED Study. **Section 4a** presents **energy**, **greenhouse gas emissions** and **water** performance metrics. **Section 4b** presents **financial**, **health** and **other benefits**. **Section 4c** reports **transportation** metrics. The single data element that was mandatory for inclusion in this study was post-occupancy measured energy use. Therefore, the energy performance results section is most robust and presented first. Additional performance data were optional elements to participation and the number of projects that submitted data for each element is noted in those sections. Additional information on methodology, including data collection and sources is in Appendix A. The results are presented in the following sections:

4a.Performance Metrics Results
1. Energy performance
2. Greenhouse gas emissions
3. Water performance

4b. Financial, Health and Other Benefits Results
1. Construction cost and green premium
2. Health & other benefits
3. Occupant Comfort Survey

4c. Transportation Metrics from Employee Commute Survey
1. Vehicle Miles Traveled (VMT)
2. Transportation Energy Intensity (TEI)
3. Use of amenities for LEED pts

4A. Performance Metrics Results: Energy, Greenhouse Gas Emissions & Water

4a-1. Energy Performance Results

This section presents the results of the energy performance analysis. The results include:

- Energy use intensity (EUI) in kBtu/sf/year
- Energy performance benchmarking to CBECS by All Buildings and by PBA
- Energy Performance by LEED level
- Energy Performance by LEED NC ENERGY Optimization Points: Energy and Atmosphere (EA) Credit 1
- Actual measured energy performance compared to modeling
- Energy performance by ASHRAE 90.1 version
- Energy performance conclusions

Benchmarking: This study compares performance of whole energy projects (n=17) to the Commercial Building Energy Consumption Survey (CBECS 2003), to the results of the *Energy Performance of LEED for New Construction Buildings* study (National LEED Study), and to Energy Star (when appropriate for given building type). Partial energy use projects (n=8) are compared to a CBECS benchmark for electrical energy intensity as an estimate of tenant load with the caveat of being an imperfect benchmark because none of the projects separately metered or sub-metered tenant load.[1] This report therefore emphasizes the whole project energy use results and performance comparisons, as they give a more complete picture of energy use, with results of the partial energy use projects also provided where appropriate.

[1] Tenant load is defined for this analysis as lighting, cooking, refrigeration, office equipment, computers, water heating and other. CBECS Table E4: Electricity Consumption (Btu) Intensities by End Use for Non-Mall Buildings, 2003.

Energy Use Intensity (EUI)

The median EUI for whole project energy use project participants (n=17) in the Illinois LEED Study is 94 kBtu/square foot/year. These projects are performing slightly better (5%) than the regional Midwest average for all commercial building stock from the Commercial Building Energy Consumption Survey (CBECS 2003). The median EUI for CBECS Midwest for all commercial buildings is 99 kBtu/sf/year (CBECS 2003 Table C5). Fifty nine percent of whole project energy use projects in the Illinois LEED Study performed better than CBECS Midwest buildings. The CBECS National median EUI of all commercial buildings is 90 kBtu/sf/year (CBECS 2003 Table C3). Forty seven percent of the Illinois LEED Study whole project energy use projects performed better than the CBECS National median EUI.

The Illinois LEED Study median EUI for partial energy use project participants (n=8) is 38 kBtu/sf/year. The imperfect comparative CBECS tenant load benchmark EUI for offices = 42 kBtu/sf/year. The partial energy use Office projects (n=7) performed 7% better than the CBECS Office average, with half of the projects in the Illinois LEED Study performing better than the CBECS tenant load benchmark.

The two charts below show the distribution of EUIs for whole project and partial energy use projects in the Illinois LEED Study. (Figures 7 and 8)

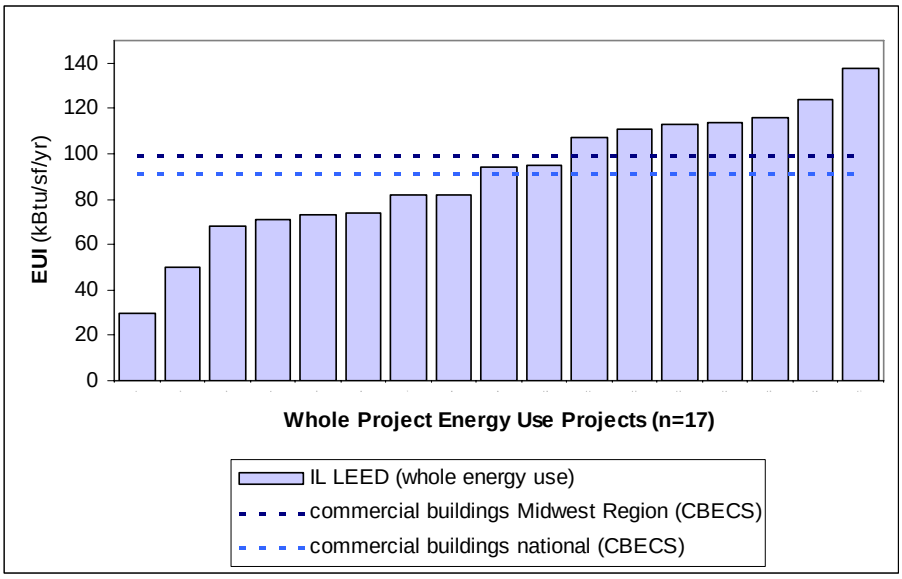


Figure 7: Distribution of Participating Whole Project Energy Use Project EUIs

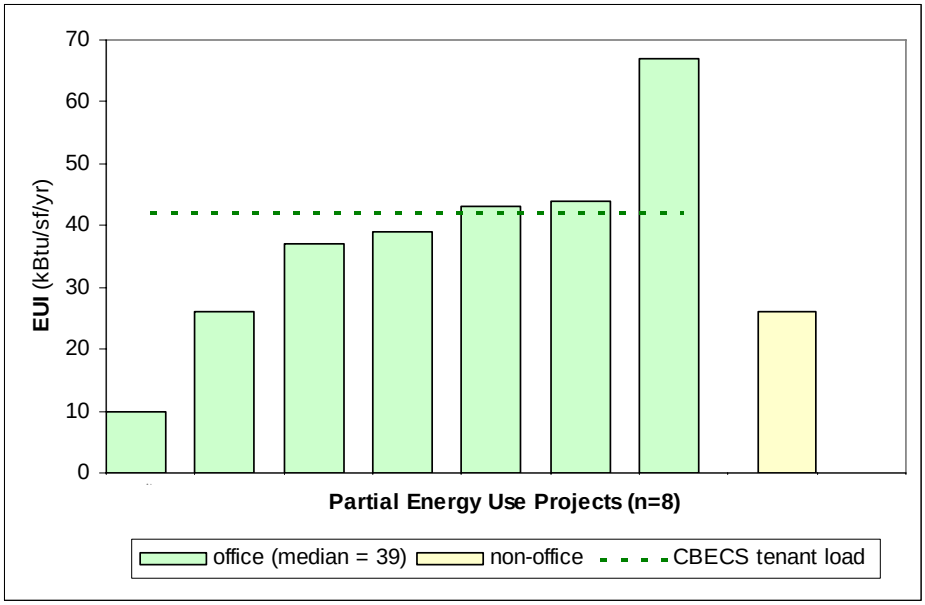


Figure 8: Distribution of participating Partial Energy Use Project EUIs

For whole project energy use projects (n=17), the minimum EUI is 30 kBtu/sf/year and the maximum is 138 kBtu/sf/year. The National LEED Study showed a similar distribution of EUIs as shown below in Figure 9. The LEED buildings in the National LEED Study performed 24% better than the CBECS national average for all commercial building stock.

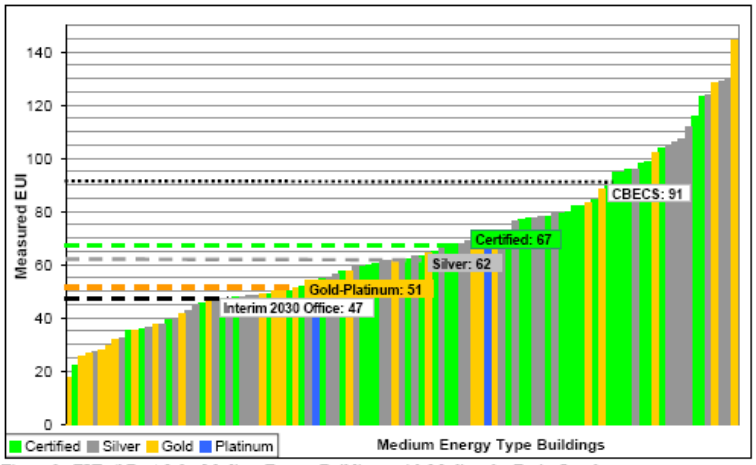


Figure 9: EUI distribution from *Energy Performance of LEED for New Construction Buildings, 2008, page 2.*

Nearly 30% of projects in the Illinois study were potentially eligible to be rated using Energy Star from the data provided. Ratings ranged from a minimum of 31 to a maximum of 89. Several buildings that were not eligible to receive an Energy Star rating were eligible for an energy performance target benchmark created by the EPA using subsets of the CBECS data. The individual Energy Star and EPA performance target benchmarks are not presented here because of data reliability and comparability concerns. However, the results were presented to the owners in their written reports. See Appendix A Methodology for further information.

Energy Performance Benchmarking to CBECS by All Buildings and by PBA

The range of measured EUIs of whole energy use projects, from a minimum of 30kBtu/sf/year to a maximum of 138 kBtu/sf/year, illustrates the difficulty in defining a "typical" commercial building in terms of its energy profile. In the Illinois LEED study the median EUI for whole energy use projects is 94 kBtu/sf/year compared to an average for all commercial buildings in the Midwest of 99 kBtu/sf/year. Figure 10 below shows that 10 of 17, or 59% of projects, performed better (lower EUI) than the average CBECS Midwest commercial building, some significantly better, while 7 of 17 performed worse (higher EUI). The significant variation shown from a "typical" commercial building is related to the uniqueness of individual buildings, both in design and operations, but also to principal building activity (PBA).

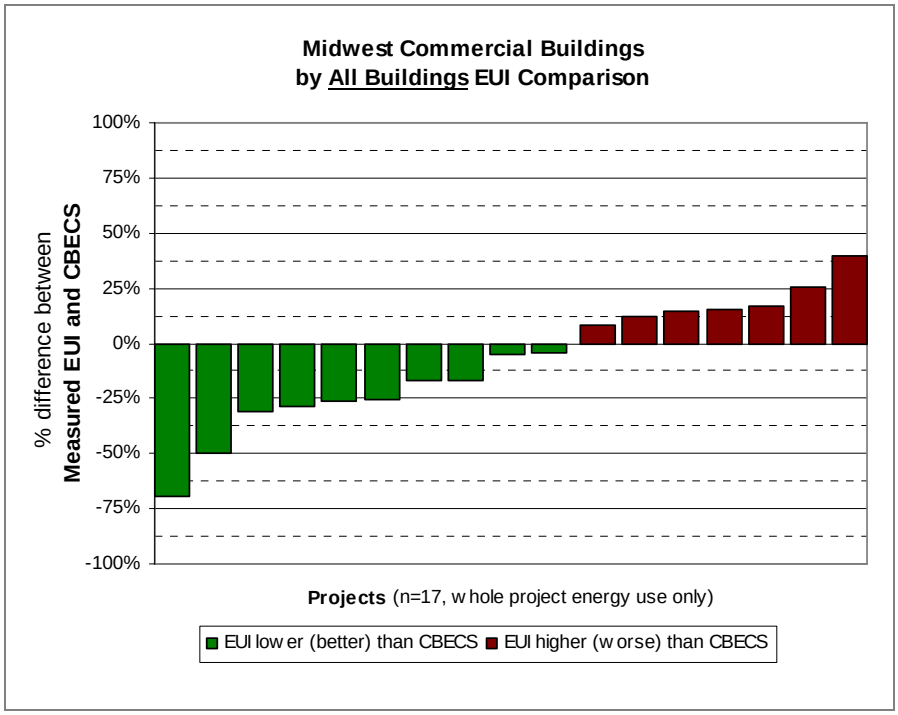


Figure 10: EUI performance compared to CBECS All Buildings

Source: CBECS Table C5. Consumption and Gross Energy Intensity by Census Region for sum of Major Fuels for Non-Mall Buildings, 2003. Midwest Region.

Another way to view the Illinois LEED Study participants' performance is to compare individual project performance to the appropriate principal building activity CBECS benchmark. (Figure 11) Though this comparison loses the regional focus of the above comparison it begins to address the difficulty of making comparisons across various principal building activities. The savings distribution across projects of similar principal building activity is similar to the comparison above, with one additional project showing a better than CBECS savings.

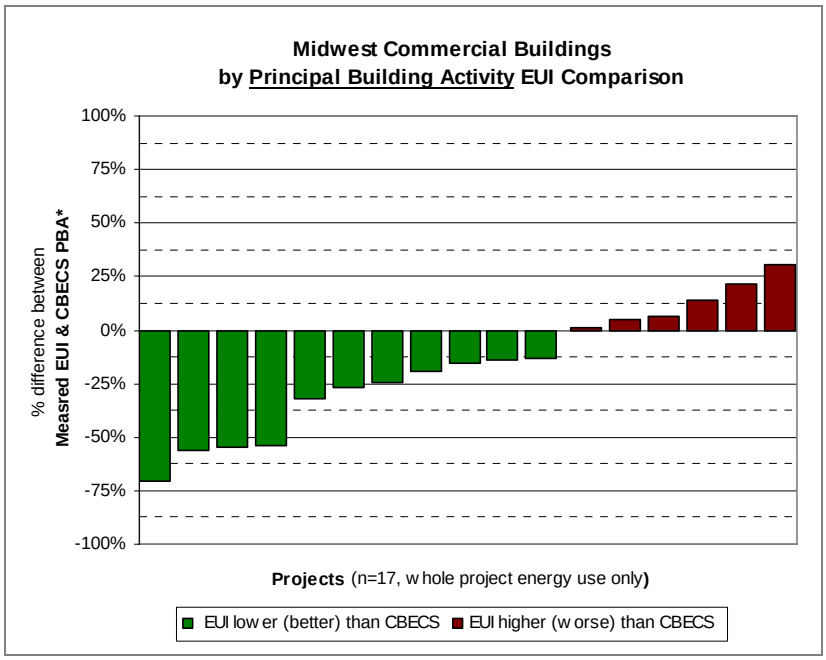


Figure 11: EUI performance compared to CBECS Principal Building Activity

Source: CBECS Table C5. Consumption and Gross Energy Intensity by Census Region for sum of Major Fuels for Non-Mall Buildings, 2003. Midwest Region.

Separating projects by principal building activity shows a more narrow range of EUIs among similar building use types. See Figure 12 below. Unfortunately, the Illinois LEED Study sample size is too small to draw statistically significant conclusions about Illinois LEED building performance and building use/activity. The CBECS PBAs shown below for the projects in this study are: Education, Lodging, Office, Mixed Use, Public Assembly, Public Order & Safety and Other. Please note the PBAs are listed alphabetically and intentionally left un-identified in the graph to preserve project anonymity.

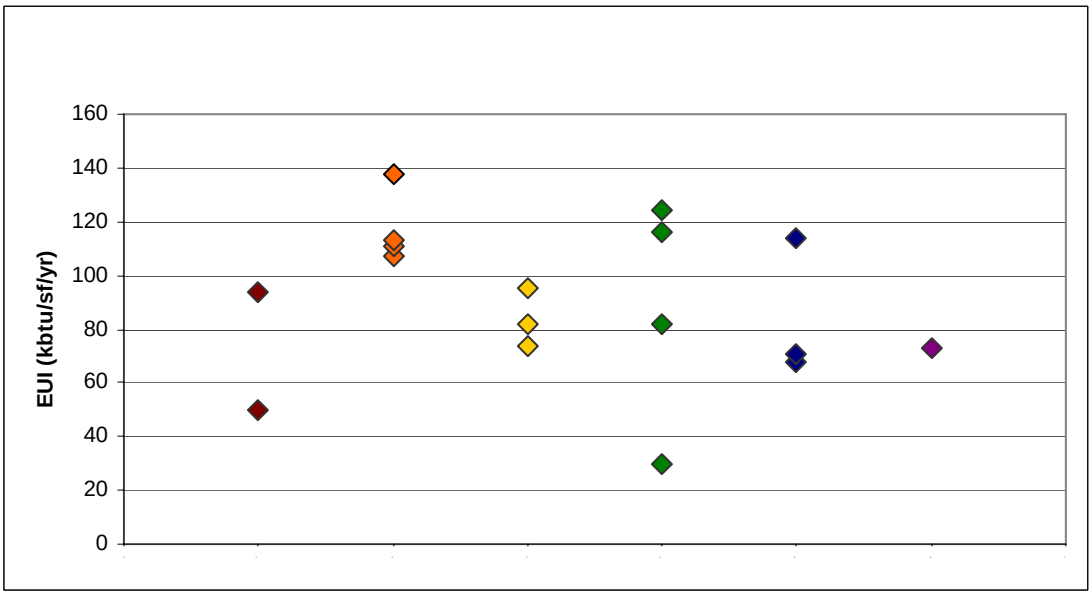


Figure 12: EUI performance by Principal Building Activity

As noted in the Introduction, due to the weaknesses of a comparison to CBECS that are identified above, USGBC is currently working with leading researchers on an updated benchmarking methodology and this study will likely incorporate this new methodology once identified.

Energy Performance by LEED Level

Increased LEED level did not correlate to increased energy performance in this study. This is one difference between this Illinois LEED Study and the National LEED Study and is likely attributable to the small sample size of the Illinois LEED Study.

Energy Performance by LEED NC Energy Optimization Points: Energy and Atmosphere (EA) Credit 1

The following graph (Figure 13) shows energy use intensity and EA points with colors to indicate principal building activity. Like the analysis above, the CBECS PBAs shown below for the projects in this study are: Education, Lodging, Office, Mixed Use, Public Assembly, Public Order & Safety and Other, and are left un-identified to preserve project anonymity. From the graph it appears that buildings that achieved higher numbers of EA credit 1 have a lower EUI. Within each PBA, there are variations in performance, as expected; yet the general trend in the PBAs indicates lower energy intensity with higher numbers of EA credit 1 points earned, with the gray dotted line representing the trendline for all buildings. The principal building activities shown in blue, red and green illustrate this relationship most strongly. It is not surprising that projects that prioritize energy efficiency as a key LEED strategy are likely to perform better than those projects that do not focus on energy efficiency or choose to prioritize points in other LEED categories, but clearly the sample size is small in this Illinois study, and further research is needed to determine if there is a statistically significant association.

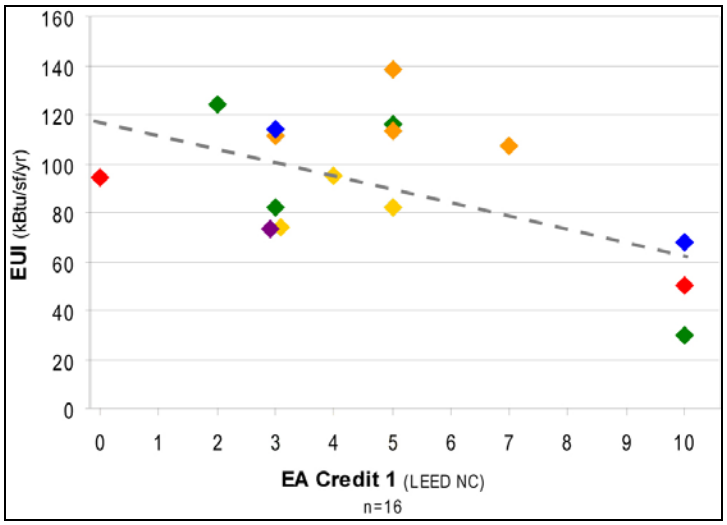


Figure 13: EUI (by Principal Building Activity) by LEED Energy Optimization Point Range (LEED NC EA Credit 1)

Actual Measured Energy Performance Compared to Modeling

Seventeen projects provided full or partial LEED energy modeling data. The data were provided through either:

- The project contact
- A project design team member or
- Access to LEED Online, the online tool for submitting LEED project data to USGBC

This section compares modeled design intent to measured performance. Predicted and measured savings percentages are relative to a modeled code baseline. Baseline and Design are defined below.

Baseline is the modeled energy use for the project if it had simply been built to the respective ASHRAE 90.1 Standard referenced in the LEED version under which a project was certified without additional efficiency measures. **Design** is the modeled energy use with all planned energy efficiency measures. *Regulated and unregulated loads were included in all models.*

A building is performing as expected if "Measured" energy usage is at or below "Design". As noted in the National LEED Study, a number of factors could explain a discrepancy between "Design" and "Measured" energy use. Often those factors include, "a difference between initial assumptions and actual conditions, such as changes in occupancy levels, activities conducted in the building, and building operating and maintenance practices."[2] Variations between modeled and actual energy use is common industry-wide. For further explanation about both the variations and limitations of energy models see: *Energy Performance of LEED for New Construction Buildings Final Report.* The report provides a concise yet comprehensive explanation of the use of energy models in LEED buildings.

To facilitate comparison between projects, a project's measured energy savings relative to its design (design minus measured) and measured energy savings relative to its baseline (baseline minus measured) were calculated. These energy savings are expressed as a percentage.

$$\text{Savings} = \frac{\text{Design} - \text{Measured}}{\text{Design}} \quad \text{and} \quad \text{Savings} = \frac{\text{Baseline} - \text{Measured}}{\text{Baseline}}$$

Four projects' (25% of the projects with design models) measured EUI was better (had a lower EUI) than their design model (n=16), expressed as the percentage savings between design and measured. (Figure 14)

[2] *Energy Performance of LEED® for New Construction Buildings Final Report*

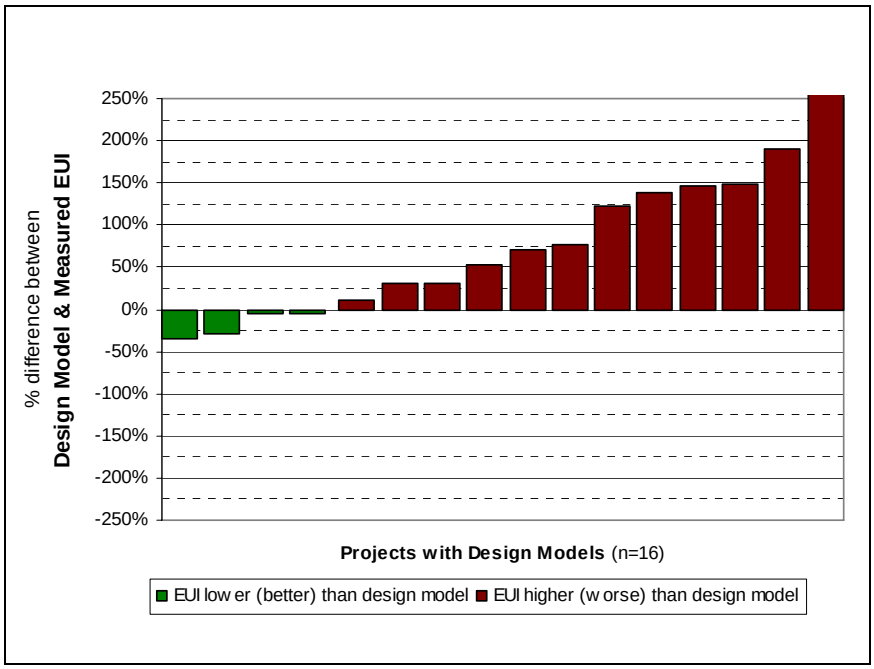


Figure 14: Design Model and Measured EUI Comparison

Ten projects' (59 % of the projects with baseline models) measured EUI was better (had a lower EUI) than their baseline model (n=17), expressed as the percentage savings between baseline and measured. (Figure 15)

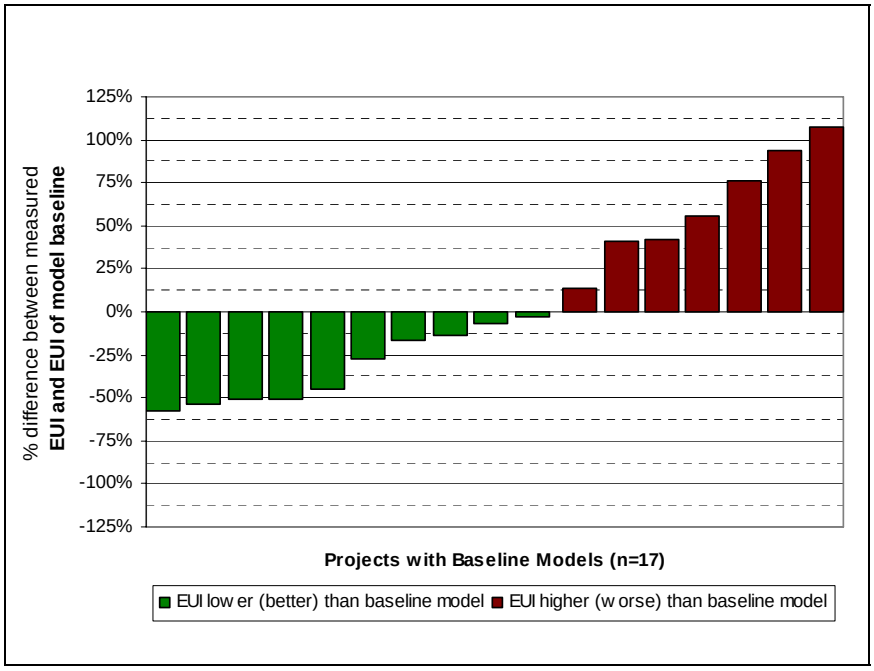
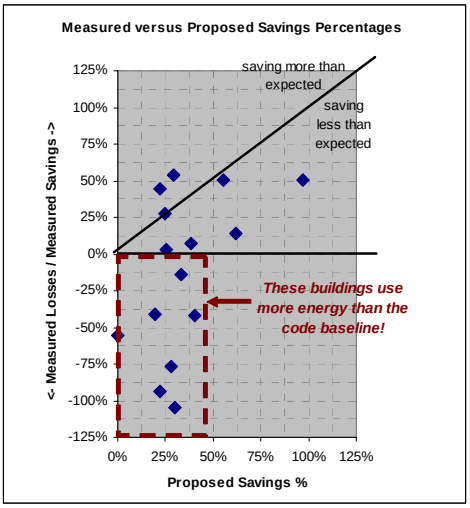


Figure 15: Baseline Model and Measured EUI Comparison

As shown in Figures 14 and 15 above, there is a large amount of variation among individual project savings percentages versus model. The National LEED Study saw a similar scatter. Figure 16 below compares the Illinois LEED Study's models scatter to the National LEED Study.



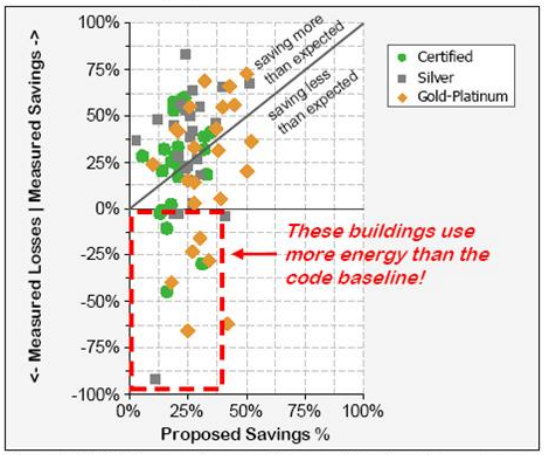


Figure ES- 5: Measured versus Proposed Savings Percentages

Figure 16: Illinois LEED Study Model Scatter Comparison (n=15) to National *Energy Performance of LEED for New Construction Buildings*

Energy Performance by ASHRAE 90.1 version

Ten of the 17 projects that provided energy models utilized the 1999 version of the ASHRAE 90.1 Standard. The 4 projects that used the 2001 or 2004 ASHRAE 90.1 Standards did not necessarily achieve better energy performance. This is likely due to the Illinois LEED Study's small overall sample size, but specifically the even smaller number of projects (n=4) that utilized the later ASHRAE 90.1 Standards. (Note 3 projects did not indicate which ASHRAE standard the project team utilized.)

Another difference to note between this study and the National LEED Study is related to the methodology of analyzing a model's unregulated load. The National LEED Study methodology used, "in all cases, the original modeling for regulated loads plus 25% of total baseline."[3] This is consistent with ASHRAE 90.1 which specifies estimating a project's unregulated load at 25% of the regulated load when unregulated load calculations aren't available. The National LEED Study noted that a review of 270 LEED projects in 2006 showed less than half included any information on unregulated load in their energy model. The National LEED Study therefore calculated unregulated load for all projects in the study. Since all 17 projects that submitted energy models for the Illinois LEED Study did include unregulated load calculations, the research team did not utilize the same methodology as the National LEED Study. In summary, for the Illinois LEED Study the team utilized the unregulated load as provided as a part of the energy model, as opposed to the national LEED methodology of using the 25 percent of baseline regulated load to account for unregulated load. This is an important difference between the two studies and is to be noted when making any comparison between the two data sets in this regard.

[3] *Energy Performance of LEED® for New Construction Buildings Final Report, p41*

Energy Performance Conclusions

1. The Illinois LEED Study projects performed slightly better (5%) than the regional average for all commercial buildings.*
2. The Illinois LEED Study buildings that achieved a higher number of LEED energy optimization points** have a lower EUI (i.e. perform better.)
3. No correlation was found between Illinois LEED study projects' LEED level attained & performance, or cost & performance.
4. Design models were not a reliable indicator of performance.
5. Post occupancy energy performance measurement and ongoing analysis of energy use is vital to establish improved operations and performance over time.
6. A more appropriate benchmarking methodology other than CBECS is needed to better understand LEED building performance related to energy use versus non-LEED buildings.

*Whole project energy use projects only. Compared to all commercial buildings in Midwest region. Source: CBECS 2003 Table A5.
** LEED NC EA Credit 1. Range from 0-10.

4a-2. Greenhouse Gas Emissions Performance Results

This section presents the results of the greenhouse gas emissions performance analysis. The results include:

- Calculated greenhouse gas emissions (GHG) in pounds of CO_2e/sf/year

Carbon dioxide equivalents (CO_2e) is the widely used metric to report the quantity of greenhouse gas emissions from carbon dioxide, methane and other greenhouse gases weighted by their global warming potential. For this report the CO_2e emissions were calculated by analyzing each project's fuel use and mix and applying emissions factors. Sources of emissions factors are listed in Appendix A, Methodology.

The median, minimum and maximum greenhouse gas emissions (GHG) performance of all projects (n=25) are shown below. (Figure 17)

	n	Median CO_2e (lbs/sf/year)	Minimum CO_2e (lbs/sf/year)	Maximum CO_2e (lbs/sf/year)
Whole project energy use projects	17	25.8	10.8	34.8
Partial energy use projects	8	13.8	3.5	15.9

Figure 17: Greenhouse Gas Emissions (GHG) Performance of Participants in pounds of CO_2e/sf/year

Previous climate research reports that energy use in buildings represents 70% of emissions in the City of Chicago and 61% of emissions in the six-county Chicago metropolitan area[4]. Thus buildings are the primary target of emissions reduction strategies in the area. The Illinois LEED Study projects are taking steps to reduce greenhouse gas emissions in Illinois, first by designing energy efficient LEED buildings, second by making the effort to understand their energy use post-occupancy, and finally by, hopefully, taking actions to improve energy performance over time.

[4] Baseline year 2000. Chicago Climate Action Plan: Our City. Our Future. City of Chicago, 2008. No emissions baseline inventory for state of Illinois.

4a-3. Water Use Performance Results

This section presents the results of the water use performance analysis. The results include:

- Water use in gallons/year
- Water use in gallons/square foot/year
- Water use in gallons/occupant/day

Twelve projects in the Illinois LEED Study submitted water data for analysis (n=12). No projects submitted water data separating interior from exterior water use, though two projects indicated no water was used for exterior landscaping. One project submitted water efficiency documentation from their LEED application. The water use performance of Illinois LEED Study projects (n=12) are shown below. (Figure 18)

Illinois LEED Study	**Gallons/year** n=12	**Gallons/sf/year** n=12	**Gallons/occupant/day** n=10
Median water use	873,000	7.7	5.9
Minimum water use	15,000	2.7	2.8
Maximum water use	33,211,200	70.0	58.0

Figure 18: Water Use Performance of Participants in Gallons

The wide range of water use among Illinois LEED Study projects is likely attributed to the wide range of principal building activities (PBA), occupancy, and the size of individual project/building. Benchmarks are not available for aggregate analysis due to the variation among the participant population; however individual projects received water use benchmarks by principal building activity when available. To note, the project with the maximum water use per square foot (70.0 gallons) noted that they had experienced landscaping issues the first year post-occupancy, were aware of the high water use, have taken action, and anticipate their water use to decrease in subsequent years.

4B. Financial, Health and Other Benefits Results

Section 4b presents the **financial**, **health** and **other benefits** including:

1. Construction cost and green premium
2. Health & other benefits
3. Occupant Comfort Survey

4b-1. Construction Costs and Green Premium Results

This section presents the construction costs and green premium results, presented as:

- Construction costs in $/sf
- Green premium in $/sf
- Green premium as percent of total construction cost

Fifteen projects submitted total project costs (n=15). Two of the 15 projects separated hard and soft costs. The median, minimum and maximum construction costs and green premium are shown below in Figure 19.

Illinois LEED Study	**Project Cost ($/sf)** n=15	**Green Premium** after grants and incentives **($/sf)** n=9	**Green Premium** after grants and incentives as percent of total cost **(%)** n=8
Median	$211.16	$ 7.26	3.8
Minimum	$ 32.81	$ 1.00	0.6
Maximum	$437.81	$ 23.59	6.9

Figure 19: Participant Project Construction Costs and Green Premium

There is a wide variation among the Illinois LEED Study projects in first costs to build and the relationship between green premium and project costs was not always straight forward. For example the project with the highest green premium by percent of total cost (6.9%) had one of the lowest total construction costs ($ 82/sf.) Similarly, the project with the highest green premium in dollars per square foot ($23.59/sf) had the highest construction cost ($437.81/sf), but did not have the highest green premium percent. The Illinois LEED Study results suggest that, similar to conventional buildings, construction costs vary widely and may be attributed to principal building activity and individual project's goals and specifications.

Similar to the clustering shown for energy performance in section 4a-1, separating the Illinois LEED Study projects by CBECS PBA shows a narrower variation in project cost. (Figure 20) Again, the PBAs in this study are: Education, Lodging, Mixed Use, Office, Public Assembly, Public Order & Safety and Other. Please note the PBAs are listed alphabetically here and intentionally left un-identified in the figure to preserve project anonymity.

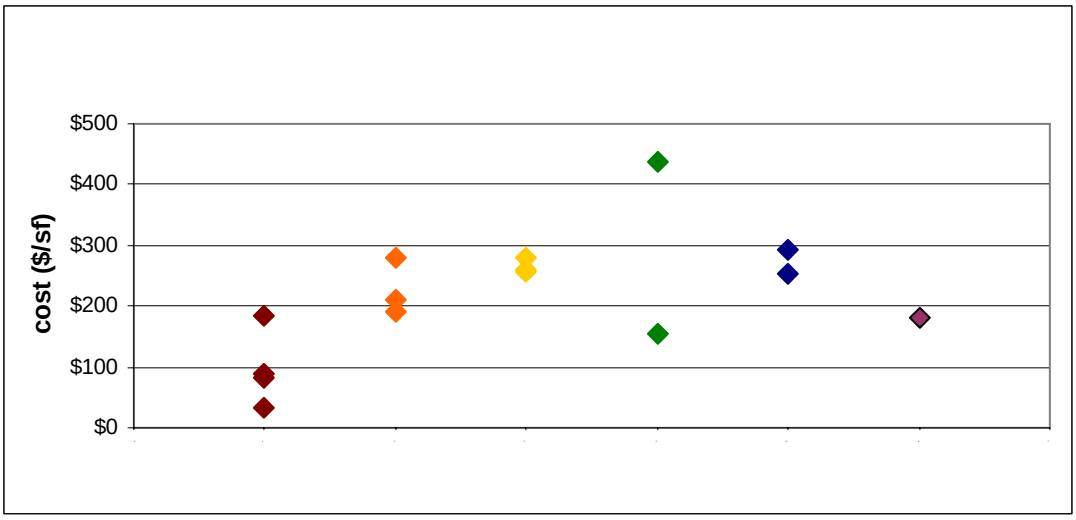


Figure 20: Cost by Principal Building Activity ($/sf)

4b-2. Health and Other Benefits Results

This section presents results of Illinois LEED projects' health and other benefits. The project team solicited data, though optional, on the following health and other benefits including changes post-occupancy in:

- Staff turnover
- Staff recruitment
- Productivity
- Sick days
- Absenteeism
- Property value
- Infrastructure costs
- Operational costs
- Buildings operations complaints
- Other benefits (open ended)

For owners of tenant properties, the team also requested data documenting:

- Lease-up rates
- Rents charged

Most projects did not provide data for most elements and/or indicated the data wasn't being tracked. The results indicate that health and other benefits of green buildings are not being tracked consistently among Illinois LEED projects. The responses are summarized below.

- Changes in operating cost received the highest number of responses (n=8). All eight stated a reduction in operating costs.
- Three projects stated savings in infrastructure costs.
- Two projects stated an increase in property value.
- Two projects stated reduced asthma incidents among staff.
- Two projects attributed their LEED certification to increased awareness of their core business and a noted a staff recruitment benefit.
- One project stated commanding higher rent.
- One project documented 60 less hours in sick time per year.
- One project is collecting absenteeism data, but doesn't have a full year.

4b-3. Occupant Comfort Survey Results

This section presents the results of an optional occupant comfort survey administered online to employees of participating projects in the Illinois LEED Study. The 33 question survey asked employees to rank comfort aspects of the work environment on a scale of 1-5 (1 = most comfortable to 5= most uncomfortable) in five categories: light level, noise, temperature, air quality/ventilation and overall building comfort.

The survey also allowed for write-in responses. The survey questions were based on the survey utilized by the New Buildings Institute as part of the National LEED Study. See Appendix A-Methodology for more information on the survey instrument. Eleven projects participated in the occupant survey (n=11). One project owner of a residential facility also chose to offer the survey to residents as well as employees.

Figure 21 below shows the average comfort rating for each participating project, a green diamond, and the overall average, a yellow circle. The zero rating is neutral- neither comfortable nor uncomfortable. Overall, occupant satisfaction in Illinois LEED projects is high. The highest rated categories for the Illinois LEED Study participants were lighting and air quality. The lowest rated category was temperature. The individual questions with the highest dissatisfaction related to the occupant's inability to adjust controls in their space.

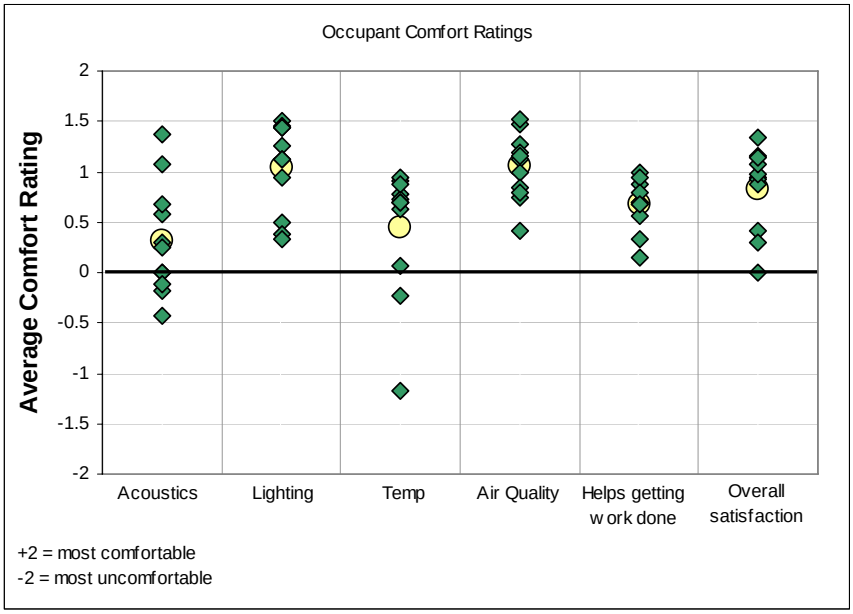


Figure 21: Occupant Comfort Survey Ratings

Financial & Other Benefits Performance Conclusions

1. Financial benefits: Wide variation in first costs to build that are primarily driven by programmatic requirements.
2. Median reported green premium = 3.8%
3. Health and other benefits are not well documented.
4. Occupant satisfaction is high.

4C. Transportation Performance Impacts Results

Section 4c presents performance results of transportation metrics from the employee commute survey including:

4. Vehicle Miles Traveled (VMT)
5. Transportation Energy Intensity (TEI)
6. Use of amenities for LEED pts

An optional employee commute survey was administered online to employees of participating projects in the Illinois LEED Study. The 17 question survey asked employees about their typical work commute mode(s) and distance, as well as employee utilization of a range of amenities and services provided by the employer to encourage utilizing alternative transportation modes. Some of the amenities and services are policy related, such as pre-tax transit benefits, guaranteed ride home or compressed work schedules, and are not related to LEED credits. Others are directly related to the Alternative Transportation credits in LEED such as physical amenities provided on site like bike storage or preferred parking, or services available based on site location such as public transportation access.

Nine projects participated in the employee commute survey (n=9.)

Vehicle Miles Traveled (VMT)

The survey asked employees the distance of their daily commute as well as home zip code and intersection so the research team could calculate distance to work. For each of the participating buildings the geo-coded addresses were consistent with an individual's reported commute distance, within 5%. In addition to commute distance, respondents were asked to indicate all modes of transportation they use, such as drive alone, drive or ride with others, bicycle, train and more and individuals who traveled by passenger vehicle were asked to identify the class of vehicle they typically use. For all projects (n=9) in the Illinois LEED Study, the median percent of commute miles in a passenger vehicle (auto, van, truck, etc.) is 89%. The median, minimum and maximum distance and vehicle miles traveled in passenger vehicles (VMT) are shown below in Figure 22.

Illinois LEED Study	Commute distance one way (miles)	% commute miles in passenger vehicle (VMT)	VMT/employee/year (miles)
Median	8.2	89%	3,645
Minimum	4.9	5%	206
Maximum	22.6	100%	9,413

Figure 22: Participant Vehicle Miles Traveled in Passenger Vehicles

On average, the employees in the Illinois LEED study have shorter commutes, 9.2 miles one way, than the national average of 12.1 miles. [5] Additionally, four of the nine buildings indicated more than one mode of travel per employee per day (1.2 -2.0.) Three of these four buildings also had the lowest number of vehicle miles traveled by passenger auto per employee per day; The fourth building's employees traveled further than the national average. In this small sample, the data suggest that if employees have access to multiple transportation modes for commuting, VMT may decrease. Six of nine projects achieved public transportation access

[5] Summary of Travel Trends 2001 National Household Travel Survey for U.S. Department of TransportationFederal Highway Administration, 2004. http://nhts.ornl.gov/2001/pub/STT.pdf accessed 7/29/09

credits from LEED and employees in four of these six buildings utilized public transportation. Employees in seven of the nine buildings reported utilizing carpooling as a typical mode to work.

Transportation Energy Intensity (TEI)

Alex Wilson in an article titled: *Driving to Green Buildings: The Transportation Energy Intensity of Buildings*[6] proposed using transportation energy intensity (TEI) as a building performance metric to measure the impact of building location on its performance. In this study, transportation energy intensity reflects the amount of energy associated with commuting to and from a building. Transportation energy is computed by converting energy used from commuting to kBtu. Wilson writes, "The transportation energy intensity of buildings has a lot to do with location. An urban office building that workers can reach by public transit or a hardware store in a dense town center will likely have a significantly lower transportation energy intensity than a suburban office park or a retail establishment in a suburban strip mall." In the Illinois LEED study, the research team calculated the TEI from the vehicle miles traveled (VMT) by passenger vehicles. Ideally the team would include the TEI from all modes, (bus, train, etc.), but the survey instrument did not have the granularity to include distance traveled on each mode, though it included number of modes, total distance and distance on longest mode. Therefore, TEI here is the transportation energy intensity calculated from VMT traveled in passenger vehicles, which is 89% of all commute miles. Figure 23 below illustrates the annual energy consumption per employee from driving.

Illinois LEED Study	VMT/employee/year (miles)	Annual energy consumption from driving (kBtu/employee/year)
Median	3,645	18,608
Minimum	206	811
Maximum	9,413	50,984

Figure 23: Participant Annual Energy Consumption per Employee from VMT in Passenger Vehicles

TEI can be used to compare the energy impact of transportation with impact of a building's energy use. Expressing a building's TEI in kBtu/sf/year facilitates a direct comparison to its EUI, also expressed in kBtu/sf/year. However, the per square foot metric proved difficult to utilize in the Illinois LEED Study because of the wide range of principal building activities and their associated staff sizes. For example, the small TEI of a large building with few employees, such as an exhibition space, cannot reasonably be compared to the TEI of a typical office space with a dramatically different square footage per employee. In other words, occupant density is a significant factor when comparing the TEI of different buildings. In Wilson's article, he normalized for occupant density by focusing on offices with an average of 240 square foot per person. The Illinois LEED Study could not normalize all results by square foot occupant density because of the range of principal building types and small sample size.

Therefore, TEI is reported in the Illinois LEED Study as kBtu/employee/year using VMT/employee/year as the metric for calculating the transportation energy. The research team believes that this metric is useful because it can be utilized across building types with varying occupant density, and it is easily understood. Additionally, by tracking VMT/employee/year, the units are consistent with other transportation data sources that report household VMT in VMT/household/year. Furthermore both kBtu and VMT can be converted to carbon impacts,

[6] *Driving to Green Buildings: The Transportation Energy Intensity of Buildings*, Environmental Building News, Sept. 2007.

which will be useful for tracking greenhouse gas emission reductions. Relating transportation to a building's location and energy use is a relatively new research topic and more research is needed to understand and quantify the impact of building location on building performance.

Amenities for LEED credits

The third component of the transportation survey was to assess what amenities and services were used by employees in the Illinois LEED Study projects, particularly those amenities that earned LEED credits. All nine projects surveyed earned Alternative Transportation Credits as part of their LEED certification.

Specifically:

- Public Transportation Access credits: 6 of 9 achieved, 4 of those 6 utilized.
- Bike Storage credits: 8 of 9 achieved, 4 of those 8 utilized.
- Parking capacity and carpool preferred parking: 5 of 9 achieved, 4 of those 5 utilized.

As noted earlier, employees at 7 of 9 projects utilized carpooling as a commute mode. This means that 2 projects that didn't earn LEED credits for carpooling amenities have employees that utilize carpooling as a typical transportation mode. The two projects surveyed that had 100% VMT by passenger vehicle, fittingly, earned the least number of Alternative Transportation credits.

The other questions regarding amenities and services indicated that overall there was a high level of confusion about what amenities are available to employees. For example, most projects had responses from employees that indicated "I sometimes utilize" as well as "My employer does not offer" for the same question. Onsite food service or kitchen facilities were the most common utilized amenity.

Transportation Performance Impacts Conclusions

1. More research is needed to understand the impact of building location on building performance. Metrics are needed, and VMT per employee or occupant may be a good measure.
2. Employees do not understand what employer transportation policies, amenities and services are available to them to reduce VMT.

5. Results Dissemination & Next Steps

Project Results Dissemination

This written report which summarizes the performance of the 25 Illinois LEED projects is being produced and distributed broadly both in print and online to convey the long-term goals of this multi-year project and share the data from the project's first year. In addition to this summary report, detailed case studies from nine participating projects explore their performance in greater detail and also explore the unique opportunities and lessons learned from each project's perspective. These case studies are included as Appendix C to this report and are also available online at the U.S. Green Building Council - Chicago Chapter's web site as well as the web sites of collaborating organizations. These case study projects will also serve as venues for upcoming Chicago Chapter programs to provide relevant examples of LEED implementation and performance for the Chapter's educational programming.

The dissemination of results from the Illinois LEED study preceded this report and began in March 2009 with a meeting for owners and representatives of the participating projects. This meeting included an overview of study results and an explanation of the detailed report of individual project's performance that was generated for each project. A month later there was a second meeting of this group to clarify and discuss individual building results outlined in the report. Representatives from 13 projects participated in the introductory meeting and 8 projects sent a representative to the follow up session. An additional three projects were, at their request, contacted individually for in-person or telephone interpretation of their project data.

Project results were also communicated at the Greening the Heartland Conference held in Detroit in June 2009, at a general meeting of the Chicago Chapter in March 2009 and at an educational Chapter program held in early June. Additionally, project director Doug Widener presented the study results in several meetings and presentations to various stakeholders including the City of Chicago Mayor's office and the Union League Club of Chicago's Environment Committee. Project steering committee member and a key member of the CNT project team, Rachel Scheu, presented the findings at the Real Estate Investment Association meeting in Chicago and to the Public Building Commission of Chicago. Additional outreach events are planned throughout the Chapter's branch network.

The study will be widely publicized in press releases across the state and beyond as well as in a project web site to share project results and next steps with the larger public accessible from the Chapter's web site at: www.usgbc-chicago.org

Next Steps

The second year of the Regional Green Building Case Study Project is generously supported by the Grand Victoria Foundation and the Illinois Clean Energy Community Foundation, as well as in-kind support of project steering committee members. As detailed in the report, the project's second year will include the solicitation of another 25 LEED certified projects in the state, and another full year of data will also be collected from all interested participating projects from year one. Based on an initial assessment, it is likely that at least 75 percent of the projects will participate in the second year.

Additionally, the project steering committee and contracted research entity will further refine the project's methodology, including working to integrate more appropriate benchmarking methods in conjunction with USGBC and its recently announced Building Performance Initiative. Building recruitment for the project's second year will begin in late 2009 and follow up reports will be published in 2010-2011.

Appendix A – Methodology

The following section further describes the methodology employed in the Illinois LEED Study including:

- Criteria for participation
- Participant Recruitment
- Data Collection & Analysis
- Participant Communications Process

Criteria for Participation

Participation in the study was open to projects in the state of Illinois that meet the following criteria:

1. LEED certified (or LEED certification pending), any LEED rating system (NC, EB, CI etc.)
2. Construction complete; space occupied and operating for at least 12 months
3. Project can provide *at least* 12 consecutive months of energy utility data

Participant Recruitment

Fifty four projects were invited to participate in the study; of which 70% percent expressed positive interest and submitted project authorization forms. Thirteen projects dropped from the study for a number of factors including: a) Erroneous or incomplete energy data from the utility, b) Project part of a campus where individual building energy use isn't separately metered, c) Less than one year of occupancy, d) Project contact did not have capacity or time to participate. Ultimately the results from 25 projects, (46% of the 54) are presented in the report.

Data Collection & Analysis

Data collection and analysis were separated into 5 topic areas:

1) General Project Information
2) Energy and Greenhouse Gas Emissions
3) Water
4) Costs, Indoor Environmental Quality & Other Benefits
5) Surveys- Occupant comfort and Employee commute

To maximize participation only areas 1 & 2, General Project Information and Energy data were mandatory for participation. Areas 3-5 were optional.

1. General Project Information

Project contacts manually entered basic project information, including: Building identification and location, primary building activity, size, LEED level achieved, sustainable features, project team, etc.

2. Energy and Greenhouse Gas Emissions

The project team offered two options for collecting the minimum of 12 months energy utility data: 1) Owner manually entered monthly bill data including meter read dates, billed onsite usage, billed total cost and, when available, indication if actual or estimated or, 2) Owner provides account and meter numbers and the research team collected energy data directly from the utility. Forty eight percent of the projects requested or required assistance from the steering committee to collect energy data.

Collecting energy utility data

Option 1 – owner supplied	13
Option 2 – steering committee assistance	12

The methodology accommodated multiple energy fuel types and multiple metered projects, making the study open to both single tenant as well as large, multi-tenant projects.

The energy data used to calculate a project's energy use intensity EUI reflects:

- **Purchased energy** only, consistent with ASHRAE 90.1 and EnergyStar, meaning that onsite renewable energy is not included. Net metering became available in Illinois in 2008 and is not yet prevalent in Illinois.[7] Twenty percent of the projects (n=5) have onsite renewable energy and two of those projects provided metered renewables data.

Participating LEED Projects with renewables

Projects with onsite renewable energy	5/25
Projects with metered onsite renewable energy	2/25

The two projects that provided metered renewable energy did receive a breakdown (per fuel source) of the impact of their onsite generation in their individual report, including greenhouse gas emission reductions.

- **Site energy use** as measured at the building. The research team chose to report site energy use as the most useful metric for owners although recognizing that source energy measured at the generation source (nuclear, coal, etc), including transmission and distribution loss, is a more complete evaluation of environmental performance. They chose site vs source because a) Site energy is the basis for calculating source energy and is most closely related to utility bill information that the building owners have, and b) Site energy is what building owners can most realistically control, and therefore was deemed most useful. However, the individualized performance reports that the building owners received did account for energy source when reporting greenhouse gas emissions.

- **Annualized energy use.** While this study required a minimum of 12 months of utility data to evaluate performance, there was no maximum number of months specified and participants were encouraged to provide as many months of post-occupancy data as available. Eighteen of twenty five projects (76%) provided more than the minimum required for participation, with a study average of 23 months. Larger periods of data show long-term performance trends and minimize sporadic changes attributable to short-term scenarios or problems. The research team normalized all aggregate energy data in order to compare variable date ranges and years.

- **All end uses**, including all unregulated load. Although ASHRAE 90.1 (and LEED) separate regulated and unregulated energy use, the majority projects in this study are not metered to separate energy use attributed to operating building systems from the energy use related to occupant activity.

[7] http://www.illinoisattorneygeneral.gov/environment/netmetering.html and http://www.awea.org/smallwind/illinois.html

Energy Models
Seventeen projects provided full or partial LEED energy modeling data. The data were provided through either: a) the project contact, b) A project design team member or c) LEED Online access. Most of the projects (12 of 17, 71%) provided the modeling data directly to the project team through the project contact or a member of the design team. Many of the projects submitted their LEED application via binders, prior to the LEED Online submittal process.

Unregulated Load in Energy Models
All 17 projects that submitted energy models for the Illinois LEED Study included unregulated load. Thus the research team did not utilize the same methodology as in the National LEED Study in which the New Building Institute employed the original modeling for regulated loads plus 25% of total baseline. The Illinois LEED Study research team did not review any models for changes compared to as-built or operating conditions, nor did they modify any models for consistency across projects.

Energy Star
Energy Star ratings utilize statistically representative models using CBECS survey data to compare against similar buildings. A rating of 50 indicates that the building performs better in energy performance than 50% of all similar buildings nationwide, and a rating of 75 indicates that the building performs better than 75% of all similar buildings nationwide. One of the challenges the team encountered with Energy Star was a consistent method to determine a building's peer group. Using Energy Star, more than 50% of a building's gross floor area must be defined by one of Energy Star's 14 space types, AND combined floor area of any space classified as "Other" cannot exceed 10% of the total gross floor area (excluding parking). This makes mixed use buildings particularly challenging. Additionally, the 14 space types are not the same as CBECS principal building activity classifications. Furthermore, owner designated LEED program type designations are also frequently different than both Energy Star and CBECS. EPA advises portfolio managers against "forcing" buildings into a category. A second challenge was that Energy Star rating system is based on source energy, and accounts for weather variations and key physical and operating characteristics of the individual building. For the additional projects that weren't eligible to receive an Energy Star rating, but were given an energy performance target benchmark[8], the values for the performance targets are not normalized for climate nor adjusted for activities which may affect energy use, so the team did not want to mix the two types of results. The third challenge the project team encountered was incomplete or questionable additional occupancy and equipment information as well uncertainties regarding individual meters designated to EPA's building activity categories. Therefore, the project team decided not to present the individual project distribution of Energy Star ratings and EPA performance target benchmarks because of data reliability and comparability concerns. However, these results were presented to the individual project owners.

Greenhouse Gas Emissions Factors
Greenhouse gas emissions analysis was done utilizing the fuel splits of each project and applying the appropriate emissions factors. The team utilized natural gas emissions factors from the U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks and the IPCC 2006 Guidelines for National Greenhouse Gas Inventories. For electricity, the team applied regional CO2 emissions

[8] http://www.energystar.gov/ia/business/tools_resources/new_bldg_design/2003_CBECSPerformanceTargetsTable.pdf

factors associated with the local North American Electric Reliability Council region from the U.S. EPA's Emissions & Generation Resource Integrated Database (eGRID.)

3. Water

Project contacts manually entered water data, including meter read dates, billed on-site usage, billed total cost and indication if actual or estimated. Twelve projects in the Illinois LEED Study submitted water data.

4. Costs, Indoor Environmental Quality & Other Benefits

The project team solicited data, though optional, on a variety of costs and other benefits. The Illinois LEED Study research team did not review documentation for this information nor did they modify data for consistency across projects. Requested information included cost of project, return on investment, green premium, types of financing mechanisms, and changes post-occupancy in:

- Staff turnover
- Staff recruitment
- Productivity
- Sick days
- Absenteeism
- Property value
- Infrastructure costs
- Operational costs
- Buildings operations complaints
- Other benefits (open ended)

For owners of tenant properties, the team also requested data documenting:

- Lease-up rates
- Rents charged

5. Surveys: Occupant Comfort and Employee Commute

The Illinois LEED Study offered two optional surveys for employees of projects participating in the *Regional Green Building Case Study*. The surveys were conducted online. One survey assessed **occupant comfort** while the other examined **employees commute** patterns. Twelve projects elected to offer at least one, often both, surveys.

5a. Occupant Comfort Survey: The New Buildings Institute (NBI) generously shared the occupant comfort survey that they administered as part of the 2008 *Energy Performance of LEED for New Construction Buildings* Study. The NBI survey was modeled after *Buildings in Use* work done by Jacqueline Vischer[9]. The 33 question survey asked employees to assess the comfort and satisfaction with their work environment in the following areas: Temperature, Light level, Air Quality/Ventilation, Noise and overall Building Comfort. CNT administered the survey to employees of 11 projects. One of these projects also elected to survey residents.

5b. Employee Commute Survey: The employee commute survey had 17 questions designed to:

- Calculate transportation energy intensity (TEI) value: the energy impact associated with a building from work commute

9 Vischer, J., Preiser, W., eds, 2005, Assessing Building Performance. Elsevier Butterworth-Heinemann, Burlington, MA.

- Assess if/how LEED pts achieved influence commute mode through amenities & services offered by employers
- Assess if/how commute affects employee satisfaction

Employees from 9 projects participated in the employee commute survey.

Participant Communications Process

Each project owner (or owner's representative) designated a primary contact to provide data to the research team. Aside from in person meetings at the beginning and end of the project, the majority of communication was done via email and telephone.

Each project received an individualized detailed report summarizing the performance of their project. The report included a summary of key project information, graphics and explanatory text of their individual performance analysis metrics in the following sections:

- Purchased energy use and costs
- Energy use intensity (EUI)
- Energy use compared to energy models (when available)
- Energy use compared to benchmarks
- Greenhouse gas emissions
- Water use (when reported)
- Costs and benefits associated with project (when reported)
- Survey results (when applicable)

A representative sample of a building report is in Appendix D.

Before the individual project reports were distributed to the project contacts, the USGBC-Chicago Chapter hosted a meeting for all building owners and their representatives to explain the information included in the reports and how to interpret the analysis. After the reports were distributed, the USGBC-Chicago Chapter hosted a follow-up meeting to discuss individual project results in a small group format with members of the project research team, the steering committee and volunteers from the USGBC-Chicago Chapter Education and Research Committee, as well as representatives of other participating projects in the Illinois LEED Study. The project team did not diagnose or suggest specific building system or controls remedies. Both meetings included a brief presentation of the aggregate analysis presented in this report. The project team's intent in providing individual detailed reports and multiple follow-up meetings was to give the project participant owners clear, useful and actionable post-occupancy evaluations.

Nine projects volunteered to share their post-occupancy evaluation as case studies, and the steering committee and volunteers from the USGBC-Chicago Chapter Education and Research Committee worked with the individual project contacts to produce the case studies.

The project team hopes that the reports will not be filed away, but will be used as a post-occupancy performance baseline for ongoing performance monitoring and improvement. The project team's intent is to collect data in subsequent years to evaluate whether the evaluations served their function and performance improvements are achieved.

Appendix B – Participant Characteristics Details

Project Activity Type	n	With energy model
Education	1	1
Lodging	3	3
Mixed-use	2	2
Office*	9	3
Public Assembly	4	4
Public Order & Safety	4	4
Other	2	0
TOTAL	25	17

Figure Appendix 1: Participant Project Counts by Type, Modeling. All Projects.
* Includes stand-alone and tenant office spaces, some of which were certified under LEED CI.

Project Activity Type	n	Measured	Design	Baseline
Education	1	73	56	47
Lodging	3	82	99	131
Mixed-use	2	91	59	98
Office – stand alone	1	50	45	101
Office – tenant offices	*2*	*47*	*71**	*71*
Public Assembly	4	99	52	73
Public Order & Safety	4	112	61	96
Other	-	-	-	-
TOTAL	17			

Figure Appendix 2: Modeled and Measured Median EUIs (kBtu/sf/year) by Principal Building Activity (Projects with modeling)
* One tenant office space did not provide Design energy model.

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Appendix C – Case Studies


Photo: 2008 balloggphoto.com

CNT Center for Neighborhood Technology

General Info

location	2125 W North Ave
city	Chicago, IL
program	office
completed	Aug 2003
occupants	62 (avg 2005-2008)
hourly operation	60 hrs/wk
yearly operation	12 mo/yr
gross square footage	14,964 sf
construction cost	$1,200,000
cost per sf	$82 per sf

Project Team

owner	Center for Neighborhood Technology
architect	Jonathan Boyer (now of Farr Associates)
consulting engineer	EME Consulting Engineers
lighting	Siemens
commissioning	JT Katrakis & Associates
environmental consultant	JT Katrakis & Associates
general contractor	Phoenix Builders

Key Features

mechanical	high-efficiency systems thermal ice chiller system
lighting	daylight in 90% of spaces
envelope	superinsulated tight building envelope

Summary

LEED rating system	New Construction v2.0/2.1
achieved rating	Platinum 52 pts
energy use intensity	55 kBtu/sf/yr
greenhouse gas emissions	15.4 lbs CO_2e/sf/yr
water usage	7.2 gal/sf/yr

LEED categories		
sites	11	14
water	4	5
energy	14	17
materials	8	13
indoor quality	10	15
innovation	5	5

The Center for Neighborhood Technology (CNT) is a 30 year old non-profit organization focused on urban sustainability. Their LEED® Platinum office in the Wicker Park community of Chicago serves as a physical example of their commitment to livable and sustainable communities. The building was the second LEED Platinum building completed in Chicago and the thirteenth in the country.

CNT purchased the 15,000 sf former weaving factory (circa 1920s) in 1987 and occupied the upper two floors employing a fairly green build-out for the time. By 2000, their staff had grown and they decided to renovate the entire facility to the highest level of the relatively new LEED® standards. The decision to renovate an older building in a dense neighborhood reflects the value the organization places on existing urban infrastructure: energy and materials of an existing building stock, and the value of location-efficient neighborhoods.

CNT believes that designing and building to LEED® standards is merely one milestone in a building's history and that sustainable strategies must be implemented throughout its lifespan. Sustainability must be integrated into ongoing operations and maintenance practices. "Constructing to LEED® Platinum was a natural choice given CNT's long-standing commitment to sustainable development", explains Kathy Tholin, CNT's CEO. "But our job is far from complete. Now that we're utilizing the space, sustainability means focusing on ongoing operations and maintenance. We're striving for continuous improvement."

CNT had three primary goals for building green: 1. Achieve LEED® Platinum at a cost comparable to conventional rehab, 2. Prioritize energy efficiency, and 3. Serve as a demonstration project for others. To meet their first goal and keep costs low, CNT utilized 'state-of-the-shelf' technologies and standard, high-quality construction practices. They chose to include two demonstration projects to support their goal of educating others: a thermal energy storage system and a 4.8kW photovoltaic (PV) solar panel array.

CNT achieved LEED® Platinum certification by covering all of the green building basics including low-flow water fixtures, low VOC paints and adhesives and a high percentage of recycled and regionally sourced materials. The PV panels and ice storage chiller system reduce the burden on the local electric distribution system during periods of high electricity demand. A rain garden and permeable parking lot decrease the quantity and rate of stormwater runoff entering Chicago's combined sewer system. And the site is located within one quarter mile of three bus routes and one fixed rail line so the staff can utilize many transportation modes. Additionally, the office provides secure bike parking, both indoors and out, a shower and changing room with storage, pre-tax transit benefits and a car-sharing membership to all employees.

ENERGY OPTIMIZATION

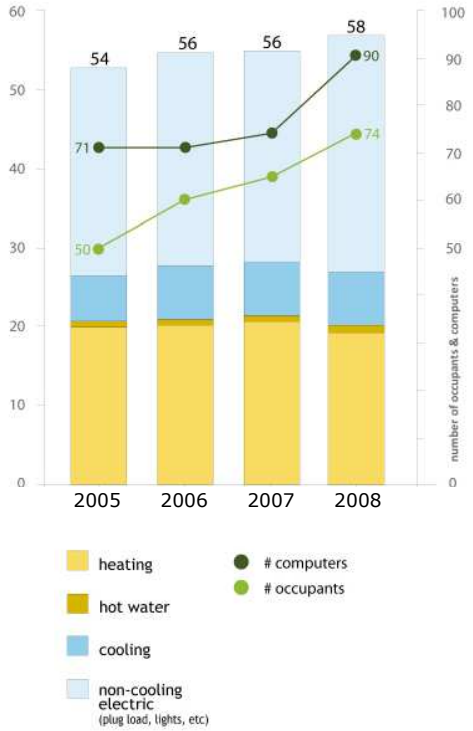
Since 2005, CNT has realized approximately 45% annual energy savings compared to if the building was simply constructed to code. This savings is approximately $18,000 per year. CNT attributes the savings to their focus on energy efficiency as a key component of the renovation. CNT achieved all 10 energy optimization points within LEED EA Credit 1 for a total of 14 of 17 points in the LEED Energy and Atmosphere category. The CNT building also earned the Energy Star rating in 2008 (score=89) and intends to re-apply in 2009.

Because CNT has been tracking their energy use for several years they have enough information to begin to see trends over time. For example, the building's energy use has increased each year, from 54 kBtu/sf/year in 2005 to 58 kBtu/sf/year in 2008. Heating and cooling loads are relatively consistent, reflecting the yearly weather variations in Chicago, but the quantity of electrical office equipment and number of employees has increased 27% and 48% respectively.

This suggests that the increase in annual energy use is due primarily to an increase in non-cooling electrical use, lighting and plug load, which is the electrical equip-

"The increased electrical use makes sense given the additional occupants and electrical devices we increasingly rely on," says Rachel Scheu Green Building Research Coordinator at CNT. "Cell phone chargers, larger and multiple computer monitors and all the electronic display devices in conference rooms and lobbies are more prevalent now than even as recently as five years ago," Scheu added.

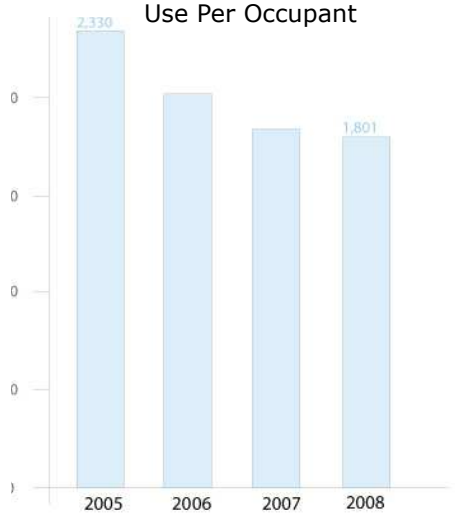
Energy Consumption



But when CNT looked at the non-cooling electrical use per occupant, they found that the non-cooling load per occupant actually decreased from 2,330 kWh/occupant in 2005 to 1,801 kWh in 2008.

Larry Kotewa, CNT's Senior Electrical Engineer said, "This makes sense since the lighting equipment and operation didn't change, and the added computer related plug load was either Energy Star rated or carried a higher efficiency rating."

Non-Cooling Electricity Use Per Occupant



● LEED Energy & Atmosphere 14 of 17

EA credit 1 (10pts)	Optimize Energy Performance
EA credit 2.1	On-Site Renewable Energy 5%
EA credit 3	Enhanced Commissioning
EA credit 5	Measurement & Verification
EA credit 6	Purchased Green Power

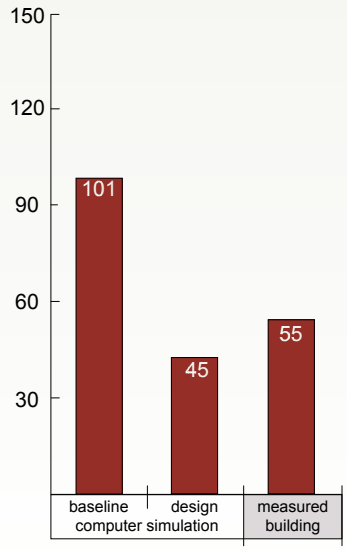
● Purchased Energy Costs 2005-2007

	total	electricity	gas
annual energy use	826,401 kBtu	10.30 kWh/sf	.2 therms/sf
annual energy cost	$1.29 sf/yr	$1.03 sf/yr	$0.26 sf/yr

● Measured Energy Usage

55 EUI

● Energy Benchmarking



● LEED Sustainable Sites 11 of 14

SS credit 1	Site Selection
SS credit 4.1	Public Transit Access
SS credit 4.2	Bicycle Commuting
SS credit 4.4	Parking Capacity
SS credit 5.1	Restore Open Space
SS credit 5.2	Development Footprint
SS credit 6.1	Stormwater Rate & Quantity
SS credit 6.2	Stormwater Quality
SS credit 7 (2pts)	Heat Island Reduction
SS credit 8	Light Pollution Reduction

● LEED Water Efficiency 4 of 5

WE credit 1 (2pts)	Water Efficient Landscaping
WE credit 3 (2pts)	Water Use Reduction

● LEED Materials & Resources 8 of 13

MR credit 1 (3pts)	Existing Building Reuse
MR credit 4 (2pts)	Recycled Content Materials
MR credit 5 (2pts)	Local/Regional Materials
MR credit 6	Rapidly Renewable Materials

● LEED Indoor Environmental Quality 10 of 15

EQ credit 3 (2pts)	Construction IAQ Mgmt. Plan
EQ credit 4 (3pts)	Low Emitting Materials
EQ credit 5	Indoor Pollutant Source Control
EQ credit 6.1	Controllability of Systems
EQ credit 7 (2pts)	Thermal Comfort
EQ credit 8.2	Daylighting & Views

● LEED Innovation in Design 5 of 5

ID credit 1.1	Education and Training
ID credit 1.2	Exemplary Green Power Purchasing
ID credit 1.3	Exemplary Energy Performance
ID credit 1.4	Rapidly Renewable Material
ID credit 2	LEED Accredited Professional


Photo: 2005 Center for Neighborhood Technology

SITE

With an excess of 45% pervious land cover the site produces less runoff. In most small storms, the runoff from the parking lot is captured completely on site and, overall, the runoff from the parking lot to the combined sewer is reduced by 30%. A disconnected downspout and a 600 sf rain garden reduce the runoff that enters the combined sewer from the buildings roof by 20% for a 100-yr 24-hr storm event in Chicago. The rain garden can infiltrate all runoff that enters it and has the capability to absorb more, but the majority of CNT's roof has interior gutters that cannot be disconnected and captured on site.

OCCUPANT COMFORT

CNT staff completed two occupant comfort surveys, one in March 2007 and another in October 2008. The responses were generally favorable, with over 50% satisfaction in 21 of 26 questions in 2007 and 20 of 26 questions in 2008. Questions about lighting and ventilation scored highest both years with question about noise from lights receiving no unfavorable responses on either survey. Noise concerns were generally related to the configuration of the building's open office. Questions about temperature comfort also received mostly favorable responses, though both years a question regarding one's ability to adjust the temperature was the only question to receive a majority of unfavorable responses. "In any office environment, there's always going to be a large variation in individuals' comfort thresholds," says Larry Kotewa. "We didn't design the office to have individual space controls, so this is to be expected. We work to keep everyone's comfort at an acceptable level."

TRANSPORTATION

CNT recognizes that the energy spent commuting to and from the office is an important component of an organization's environmental impact and, as a result, location was an important factor in the decision to stay and renovate their building rather than move to a new site. Consequently location also plays an important role in CNT's overall greenhouse gas emissions. According to a 2008 transportation survey, only 28% of the staff's commute miles (656 miles/employee/year) are in passenger vehicles. Even though staff occasionally drive to work, most (83%) report using alternative transportation modes (public transportation, bike, walk or combination) as their default commute mode to work.


Photo: 2005 CNT

Nearly 38% of staff regularly bike to work at least once a week, and during Chicago's annual bike to work week competition in June, the CNT staff bike commuting percentage rises above 95%.

CNT cites the building location as a key component to keeping Vehicle Miles Traveled (VMT) by automobile relatively low. "Cities are more location-efficient, meaning key destinations are closer to where people live and work," said CNT President Scott Bernstein. "They require less time, money, fuel, and greenhouse gas emissions for residents to meet their everyday travel needs. People can walk, bike, car-share, take public transit." Transportation policies, even at the individual employer level play a role in encouraging alternative transportation modes. Fifty percent of CNT's employees participate in pre-tax transit benefits and all employees are offered free memberships in I-Go Car Sharing, the Chicago-based car sharing company launched within CNT. Bike racks and shower facilities see the most use in summer yet a number of staff continue to bike to work year round.

COSTS AND FUNDING

CNT completed the renovation for $82/sf, a relatively inexpensive project green or non-green. In order to balance the goals of maximizing energy efficiency and minimizing costs, CNT focused on the basics of energy efficiency: high levels of insulation, high-efficiency mechanical systems and a tight building envelope. "Going beyond the requirements of the energy code makes good economic sense since we're intending on staying a long time," Tholin added. "We're meeting each one of our goals and realizing energy cost savings each year."

CONSTRUCTION LESSONS LEARNED

Because CNT began their renovation in 2000 when the LEED rating system was relatively new, the project team had to do a lot of leg work sourcing appropriate materials, products and processes to satisfy the criteria. But it was worth it to be at the front of an evolving industry. Being an early adopter of LEED has brought additional benefits, says Sharon Feigon, who served as CNT's Project Manager for the renovation. "The Platinum rating introduced a new audience to CNT's programs and research, and the certification has definitely benefited our core business, "she said. But employees are the greatest beneficiaries. "We've created a healthier, desirable, and more sustainable work environment."

OCCUPANCY LESSONS LEARNED

Post-construction, CNT is monitoring the building's performance to ensure the building is operating correctly and to better understand the impact of changes in the building's use and occupancy over time. "Tracking and understanding our building performance is the essential first step towards improvement", says Rachel Scheu. CNT is monitoring their energy and water utilities and is also tracking staff commuting distance and modes to understand the environmental impact of their building: both from its use and its location. CNT currently uses two tools to track performance: EPA's Portfolio Manager and a web-based tool developed in-house. The CNT-designed interactive tool calculates and displays energy use, carbon emissions, water use and transportation energy impacts of their building, and helps the staff understand their building performance.

FUTURE GOALS AND OBJECTIVES

By monitoring building performance post- LEED certification, CNT has identified several future strategies to improve its performance. With energy use, they've identified reducing base load per occupant as a priority over systems improvements in the short-term. With transportation, CNT's research staff is researching methods to quantify the transportation energy impact of a building based on its location. Staff and tenant education is an ongoing project at CNT. And finally, as with most initiatives at the Center for Neighborhood Technology, they hope to collaborate with others and share what they've learned. *cnt.org*

CNT Center for Neighborhood Technology

"By understanding the performance of our own LEED Platinum building, we've made the commitment to continuously to measure and improve," Kathy Tholin.


Photo: 2008 balloggphoto.com

U.S. GREEN BUILDING COUNCIL CHAPTER SM
Chicago

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Photo: Children's Discovery Museum

Normal Illinois has become nationally recognized for its forward thinking policies and commitment to green building. The town of about 50,000 residents is home to Illinois State University and serves as the link between central Illinois and Chicago. Normal is integrating green elements into the design and operation of new and existing buildings. Green building has progressed faster in Normal than most other cities in the Midwest, and the tipping point for this movement was the Children's Discovery Museum, located in what is now being called Uptown Normal.

In addition to being the first building in Normal to achieve LEED® Silver certification, the Children's Discovery Museum is also the first Children's Museum in the country to do so. The Museum, which houses three floors of fun hands-on exhibits for visitors, receives 140,000 visitors each year.

The Normal Town Council supported sustainable design and chose to pursue LEED® certification on this project in spite of a lack of experience with the process. As a result of committing to the implementation of sustainable building practices, a great deal of learning has come along with the revitalization of Uptown Normal. In fact, the town has now committed a portion of the uptown redevelopment project to become a LEED for Neighborhood Development pilot project. This will make the project one of the first LEED certified downtown redevelopments in the country. Everyone, from the Town council to the building maintenance and operations team, is now advancing what it means to be a leader in environmental design.

Children's Discovery Museum

General Info

location	101 E. Beaufort
city	Normal, IL
program	museum
completed	Nov 2004
occupants	400
hourly operation	58 hrs/wk
yearly operation	12 mo/yr
gross square footage	34,392 sf
construction cost	$5,300,000
cost per sf	$154 per sf

Project Team

owner	Town of Normal
architect	Russel Francois
MEP engineer	Farnsworth Group
commissioning	Farnsworth Group
contractor	Core Brothers

Key Features

mechanical	high efficiency heat exchangers
	heat recovery wheels
ventilation	CO_2 monitoring
lighting	electronic ballasts
envelope	energy star reflective roof
renewable energy	roof built to accommodate future solar panels

Summary

LEED rating system	New Construction V 2.1
achieved rating	Silver 34 pts
energy use intensity	90 kBtu/sf/yr
greenhouse gas emissions	5.46 lbs CO_2e/sf/yr
water usage	24.6 gal/sf/yr

LEED categories

ENERGY OPTIMIZATION

The Children's Discovery Museum was designed to minimize its impact on the environment by focusing in part on energy efficiency. High efficiency HVAC equipment with a building automation system, a white reflective roof to reduce cooling load, high efficiency lighting, a lighting control system, and natural daylighting on the north and west sides are all measures implemented to achieve energy efficiency in the Museum. In the first two years of operation some of the building's power came from renewable energy sources which reduced its dependence on green house gas emitting power plants. Cleaning is done throughout the day so the building can be completely shut down by 11pm thereby limiting the hours that lighting, heating, and cooling are provided for human comfort. Rolling back temperatures at night saves energy that is not required when the building is unoccupied.

The "climber" is the Musuem's first and most popular exhibit, but it provides a challenging aspect to conditioning the building and coordinating the mechanical equipment. Because all three floors are open to one another through the "climber" the HVAC systems must accommodate such a unique space while maintaining comfort.

Occupancy has exceeded expectations, there are more rental events, and the number of visitors has increased as the museum has added more exhibits beyond the original design. This significantly changes the patterns and energy use from the initial energy model.

The Building Automation System (BAS) used to vary the amount of ventilation had to be replaced two years after installation due to problems with comfort and incompatibility with the HVAC system.

Photo: Children's Discovery Museum

● LEED Energy & Atmosphere 13 of 17

EA credit 1 (10pts)	Optimize Energy Performance
EA credit 3	Enhanced Commissioning
EA credit 4	Reduced Ozone Depletion
EA credit 6	Purchased Green Power

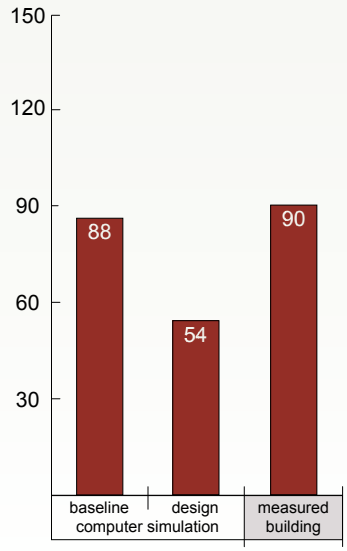
● Purchased Energy Costs

	total	electricity	gas
annual energy use	3,146,6113 kBtu	18.1 kWh/sf	0.28 therms/sf
annual energy cost	$1.92 sf/yr	$1.51 sf/yr	$0.41 sf/yr

● Measured Energy Usage

90
EUI

● Energy Benchmarking



● LEED Sustainable Sites 6 of 14

SS credit 1	Site Selection
SS credit 2	Urban Redevelopment
SS credit 4.1	Public Transit Access
SS credit 4.2	Bicycle Commuting
SS credit 7.2	Roof Heat Island Reduction
SS credit 8	Light Pollution Reduction

● LEED Water Efficiency 2 of 5

WE credit 1 (2pts)	Water Efficient Landscaping

● LEED Materials & Resources 6 of 13

MR credit 2 (2pts)	Construction Waste Mgmt.
MR credit 4 (2pts)	Recycled Content Materials
MR credit 5 (2pts)	Local/Regional Materials

● LEED Indoor Environmental Quality 11 of 15

EQ credit 1	Carbon Dioxide Monitoring
EQ credit 3 (2pts)	Construction IAQ Mgmt. Plan
EQ credit 4 (4pts)	Low Emitting Materials
EQ credit 5	Indoor Pollutant Source Control
EQ credit 7 (2pts)	Thermal Comfort
EQ credit 8.2	Daylighting & Views

● LEED Innovation in Design 4 of 5

ID credit 1.1	Recycled Content
ID credit 1.2	Local/Regional Materials
ID credit 1.3	Green Power
ID credit 2	LEED Accredited Professional

SITE

Proximity to Normal's Amtrak and bus transfer stations (also used as an exhibit) was a key factor in the site selection. Locating the Museum in the redeveloped uptown neighborhood contributes to the density of the area, making it accessible to a larger audience, and reducing the energy visitors use getting to the Museum. The Children's Discovery Museum is one of five main buildings planned to face a common round-about in uptown Normal. Each of these buildings will eventually be LEED certified. Water runoff from surrounding buildings will be collected in the future round-about fountain/ water garden to provide all irrigation for additional site plantings.

The project was able to recycle the original building which was torn down to make room for the new Museum. A balcony which is not currently used due to safety concerns is now being considered for the installation of planting areas to help block sun and cool the building along the west side of the building.

MATERIALS

In total, materials used in the building contain more than 20% recycled resources. Many of the ceilings in the museum are exposed to structure thus eliminating the need for ceiling tiles and further reducing the use of virgin materials. In addition, there is a recycling program in place for the building occupants.

INDOOR ENVIRONMENTAL QUALITY

Indoor Air Quality was a primary objective of the Museum. The design team chose low emitting materials in the interior build out even with initial skepticism to the overall performance of these greener alternatives. This was especially true of products with low or no Volatile Organic Compounds (VOCs). Despite this initial hesitation, the materials that were chosen have performed very well. The Children's Discovery Museum continues to mandate the use of low emitting materials by requiring low VOC products for any new exhibits within the Museum. Additionally, hydrogen peroxide based cleaners are used for disinfecting, and other cleaning products are Green Seal® certified. This maintains the excellent air quality established during construction and provides a healthy space for visitors and staff alike.

OCCUPANT COMFORT

The Children's Discovery Museum has drawn people from more than 150 miles away and has helped the economic development of uptown Normal. Despite ongoing construction in the surrounding area, there has not been a drop-off in the number of visitors. In fact, the Museum enjoys a continued increase of visitors which is not typically expected. In addition, staff within the building are positive about the continued follow-through of sustainable choices in cleaning and maintenance of the LEED® certified building.

"Even when it's full it still feels very open, one of the best loved facilities in Bloomington and Normal," Jeff Pekarek, Trane

Photo: Ken Kashen


Photo: Children's Discovery Museum

Children's Discovery Museum

COST AND FUNDING

The project exceeded its original budget pursuing LEED Silver, but it was important to the Museum to be a leader in sustainable design and operations. Becoming the first LEED certified children's museum was a way to demonstrate their commitment. Additional costs included purchasing Green-E Certified renewable energy, and the inclusion of extra janitorial systems to reduce the quantity of chemicals released into the wastewater system. The building was constructed to accommodate solar panels on the roof, but ultimately the panels themselves were not installed. The Museum is now seeking to install the photovoltaic array with additional funding.

OCCUPANCY LESSONS LEARNED

The main entrance location on the northwest side makes it difficult to heat the building in winter due to strong winds blowing in as visitors arrive in larger groups.

Additional commissioning done by a third party for the original engineers is underway to try to find out where 15-20% of the energy consumption is coming from. The CDM team was dissatisfied with the original commissioning results.

"Everyone was scared to death of the cost of LEED and the difficulties of achievement. Don't be afraid, it was much easier than everyone thought."

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The Rancho Verde site, named in honor of the pre-dominantly Hispanic workforce in the Chicago landscape industry, has been developed by Chicago GreenWorks LLC (GreenWorks) to co-locate affiliated green industry businesses on the site. The Eco-Industrial Park occupies 12.5 acres on the west side of Chicago. Christy Webber Landscapes (CWL), a landscape design, construction, and maintenance company, is the anchor tenant on the site. Other landscape businesses occupy the remainder of the site, including a wholesale nursery.

Historically, the site had been used for an iron works company, a dump, and an auto pound. This reclaimed brownfield site is now alive, growing, and green. Seven parcels ranging in size from 1 to 4 acres ring an interior public street which provides access to the front door of each business in Rancho Verde. The street is paved with pervious block, and is the first such public street in Chicago.

Through the LEED® platinum rating awarded to Christy Webber Landscapes in 2007, Green Works intends to prove that sustainable design is accessible and economically viable for all developments.

Christy Webber Landscapes

General Info

location	2900 W Ferdinand St
city	Chicago, IL
program	mixed-use, office & shop
completed	December 2006
occupants	38 occupants
hourly operation	48-60 hours/week
yearly operation	varies seasonally
gross square footage	16,505 sf
cost per sf	$252 per sf

Project Team

owner	Chicago Green Works
architect	Farr Associates
MEP engineer	Hill Mechanical
lighting	CCJM Engineers
landscape architect	Hitchcock Design Group
civil engineer	Terra Engineering
contractor	The George Sollitt Construction Co

Key Features

mechanical	radiant heating
	variable frequency drives/motors
	heat recovery system
	thermal energy storage
water	green roof, rainwater collection
ventilation	natural ventilation
	under floor air distribution
renewable energy	solar thermal-hot water
	geothermal heat pumps
	wind turbines
	on-site hydropower

Summary

LEED rating system	New Construction v2.0
achieved rating	Platinum 52 pts
energy use intensity	75 kBtu/sf/yr
greenhouse gas emissions	19.2 lbs CO_2e/sf/yr

LEED categories		
sites	12	14
water	4	5
energy	13	17
materials	5	13
indoor quality	13	15
innovation	5	5

ENERGY OPTIMIZATION

The total projected energy use of the Christy Webber Landscapes building is 61% less than baseline. In fact, the building's energy use is less than a baseline building's heating use alone. Insulation values throughout the building are significantly higher than required by Chicago code. An east-west building orientation, reflective roof, displacement ventilation, smaller footprint, and exterior window shading were important factors in improving the overall building energy efficiency.

Renewable sources provide 12.5% of the building's annual energy usage. CWL headquarters uses four renewable energy systems including an active solar thermal water, active solar thermal air, an Aerotecture® wind turbine, and a geo-thermal system. The primary source for heating and cooling the building is derived from earth mass below the site. A system of pipes loops fluid through twenty 220' deep shafts and into the building's heat pumps. Heat is extracted from the earth in winter and is transferred to the earth in summer.

The energy use intensity (EUI) for the realized building is significantly higher than the designed EUI, and it was suggested that this discrepancy may be partially due to a greater and more variable occupancy than what was anticipated. There are now 1.5 times more employees than were assumed in the energy model. Additional electricity usage and cooling for those employees may account for some of the discrepancy. Also, the building's gas bills have been based on estimates recently rather than actual readings which could also explain the differences.

● LEED Energy & Atmosphere 13 of 17

EA credit 1 (10pts)	Optimize Energy Performance
EA credit 3	Enhanced Commissioning
EA credit 4	Reduced Ozone Depletion
EA credit 6	Purchased Green Power

● Purchased Energy Costs

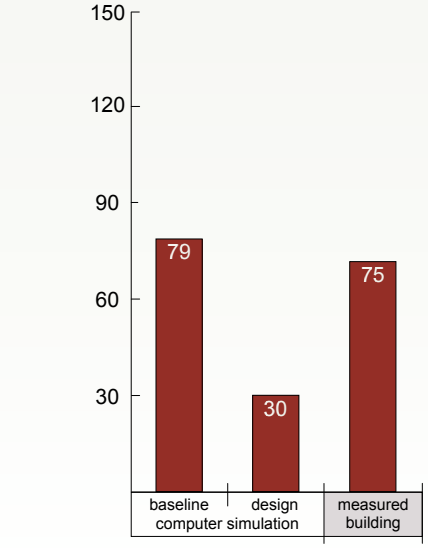
	total	electricity	gas
annual energy use	1,232,291 kBtu	11.9 kWh/sf	0.34 therms/sf
annual energy cost	$1.66 sf/yr	$1.23 sf/yr	$0.43 sf/yr

● Measured Energy Usage

75 EUI

● Energy Benchmarking

*design model includes renewables



● LEED Sustainable Sites 12 of 14

SS credit 1	Site Selection
SS credit 3	Brownfield Redevelopment
SS credit 4.1	Public Transit Access
SS credit 4.2	Bicycle Commuting
SS credit 4.3	Alternative Fueled Vehicles
SS credit 4.4	Parking Capacity & Carpooling
SS credit 5.2	Development Footprint
SS credit 6.1	Stormwater Rate & Quantity
SS credit 6.2	Stormwater Quality
SS credit 7 (2pts)	Heat Island Reduction
SS credit 8	Light Pollution Reduction

● LEED Water Efficiency 4 of 5

WE credit 1 (2pts)	Water Efficient Landscaping
WE credit 3 (2pts)	Water Use Reduction

● LEED Materials & Resources 5 of 13

MR credit 2 (2pts)	Construction Waste Mgmt.
MR credit 4 (2pts)	Recycled Content Materials
MR credit 5.1	Local & Regional Materials

● LEED Indoor Environmental Quality 13 of 15

EQ credit 1	Carbon Dioxide Monitoring
EQ credit 2	Ventilation Effectiveness
EQ credit 3 (2pts)	Construction IAQ Mgmt. Plan
EQ credit 4 (4pts)	Low Emitting Materials
EQ credit 6.1	Controllability of Systems
EQ credit 7 (2pts)	Thermal Comfort
EQ credit 8 (2pts)	Daylighting & Views

● LEED Innovation in Design 5 of 5

ID credit 1.1	Green Housekeeping
ID credit 1.2	Educational Outreach
ID credit 1.3	Nursery Water Use Savings
ID credit 1.4	Exemplary Performance SSc5.2
ID credit 2	LEED Accredited Professional

SITE

Rain that doesn't infiltrate directly into the earth is directed to a series of planted bioswales that enhance filtration and clean the contaminated run-off common to city streets. A central rain garden collects storm water from the entire site and slows or eliminates its passage into the sewer.

A green roof covers the main office portion of the Christy Webber Landscapes building, shielding the roofing membrane. Additional benefits include: rain absorption, building shading, and evaporation—all of which help to cool the structure. This in turn keeps the surrounding environment cooler, reducing the urban heat island effect.

WATER

Water resources have also been effectively managed. Variable flushing toilets and low flow fixtures reduce domestic water use by 30%.

Rain water that runs off of the 10,000sf shop building is collected into a dual system of cisterns which combined can hold more than 32,000 gallons of water and supply a large portion of the watering needs for the landscape business.

MATERIALS

The project has also made effective use of regional materials, recycling practices, and reduced waste to landfills. The project is also leading the way in the use of educational displays and exhibits to relay the sustainable strategies employed to visitors.

INDOOR ENVIRONMENTAL QUALITY

Indoor environmental quality was especially important due to challenging conditions at the company's former facility. At the former facility, where there was a direct connection between the shop and offices, staff noted the space smelled of diesel fuel and dust coated the office furniture.

Steps for improving indoor environmental quality included the use of low VOC paints, green cleaning supplies, operable windows, and daylighting. Fresh air in winter is preheated in a rooftop greenhouse where plants improve air quality by adding oxygen to the fresh air stream. A rooftop energy recovery ventilator (ERV) transfers energy from stale exhaust air to the incoming fresh air.

Christy Webber Landscapes

COST AND FUNDING

Christy Webber Landscapes was able to put together a redevelopment agreement with the City of Chicago's Department of Zoning and Land Use Planning on a write down, making the extra cost of green building sensible for a private business.

Roger Post of Christy Webber Landscapes managed almost every aspect of the project from the hand dryers to the geothermal system. The intention was to try and prove that by working with the City of Chicago as a private developer (Chicago GreenWorks LLC), and Christy Webber Landscapes as the funder/financier that a small business could make it happen. As the owners of both entities, there was a tie between building something "green" and the ability to get the land needed to run the business.

LESSONS LEARNED

The developers and tenants realize the importance of effective commissioning. The project went for enhanced commissioning which helped them make adjustments after occupancy. Overall the experience served as a catalyst for additional greening of business and field operations.

Lessons learned by the business owner, Christy Webber, included focusing on practical design solutions and sticking to the overall goals of the project. Her advice includes doing thorough research and making sure that green measures are situationally appropriate. The rainwater cisterns and pumps were not as reliable as hoped; a bypass system had to be installed to ensure that the nursery stock could be watered. The lighting system is not working well because of "noise" in the electrical system of Chicago and ballast replacement costs are adding up. The building construction process required an experienced construction manager for certain specialized parts of the design such as the greenhouse and the rain water cisterns.

"The practicality of design features should always be considered before making them public." On this particular project, schematic design included a roof-top green house. The company chose to move forward with this design feature, despite the later discovery that its inclusion would cost considerably more than a traditional green house. Additionally, the electrical operation boxes for the windows were not waterproof in a structure where water is a necessity and had to be replaced.

FUTURE GOALS

'After moving into this LEED Platinum building, our company became more committed to green design and operations. The focus shifted away from the green building to greening our business ("outside") operations. Overall, we realize that the study will not help us green our outside operations, but it does remind us of the internal steps we should be taking'.

-Kristen Kepnick- CWL Staff

'Looking ahead, we are curious for insights into what a LEED building does as it ages. How does it take advantage of new technology? How does it deal with once cutting-edge technology as it becomes obsolete?'

-Roger Post- CWL Staff

The tenants are keen to see the how the future of the green efforts shape up and how they can adapt to growing operations, changing needs, and new technology.

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Evelyn Pease Tyner Interpretive Center

Set amidst Air Station Prairie, a 32.5 acre remnant of a tall-grass prairie that once stretched for millions of square miles across much of the Midwest, the Tyner Center serves as both gateway to Air Station Prairie and an example of how human made structures can harmonize with the environment.

Opened in April 2007, this 3,000 sf LEED® Platinum building educates visitors about the history and ecology of the local Illinois prairie ecosystem, while serving as a showcase for cutting edge technologies in green building. As a demonstration of green techniques, visitors can take home and employ what they learn at the center.

The building was designed by combining the principles of Japanese pagodas that sit lightly on the land with Aldo Leopold's land ethic, 'to live on a piece of land without spoiling it.' Blurring the distinction between inside and out, the team utilized natural materials and colors that complement and mimic the prairie, harnessed renewable resources for energy needs, provided decks that 'elevate' visitors onto the prairie, replaced lost land from the building's footprint with a green roof, interpreted the site and building with education panels, and augmented the remnant prairie with additional native landscape.

Designers worked with Village of Glenview staff, Glenview residents, Glenveiw school districts, Glenview Park District staff, members of North Branch Restoration, and Evelyn Pease Tyner to develop a center that capitalized on the prairie as an educational instrument. In recognition of Evelyn's tireless commitment to open space preservation, environmental education, and community spirit, the Center was dedicated in her name.

Since opening, the Center has achieved a high level of interest from the surrounding communities, schools, and nature lovers, who use it seven days a week. Over 33 organizations and groups have held education programs at the Center.

General Info

location	2400 Compass Road
city	Glenview, IL
program	museum
completed	October 2006
occupants	varies
hourly operation	10-30 hours/week
yearly operation	52 wks/yr
gross square footage	3,000 sf
cost	$2,200,000

Project Team

owner	Village of Glenview/Glenview Park District
architect	Wight & Company
MEP engineer	Wight & Company
landscape architect	Conservation Design Forum
commissioning agent	HJ Kessler & Associates
contractor	Pepper Construction

Key Features

mechanical	heat recovery system, water furnace
envelope	increased insulation, green roof, insulating and high performance glass, exterior window shading
ventilation	natural ventilation, operable windows, increased ventilation rate, displacement ventilation
renewable energy	solar photo voltaic panels, ground source heat pumps
lighting	high efficiency lighting, daylighting sensors, occupancy sensors

Summary

LEED rating system	New Construction V 2.0
achieved rating	Platinum 53 pts
energy use intensity	30 kBtu/sf/yr
greenhouse gas emissions	10.8 lbs CO_2e/sf/yr
water usage	5.8 gal/sf/yr

LEED categories

sites	9	14
water	4	5
energy	16	17
materials	7	13
indoor quality	12	15
innovation	5	5

ENERGY OPTIMIZATION

Every aspect of the building incorporates bioclimatic design strategies, which earned it 'zero energy' status. By setting the building on an east/west orientation, solar gain was avoided through the use of large overhanging eaves on the south facing façade while minimal eaves to the north and 20 foot high windows provide visitors incredible views of the prairie. Operable windows in every space allow prevailing breezes to ameliorate temperatures without using energy. Careful attention to cross ventilation design means that the building is comfortable in the summer without mechanical systems running.

Turning the building inside out and reducing its overall footprint created a smaller internal volume that is easier to heat and cool with on-site renewable energy produced by the solar panels and geothermal loop. Overhead, a green roof on the majority of the footprint also helps retain warm and cold air during their respective months of use. These strategies contribute to a 97.1% reduction in energy use when comparing the energy model* to baseline code requirements.

Maximum envelop efficiency was achieved with a roof R-value of 38, wall U-value of .039, and a window glass shading coefficient of 0.25. The geothermal system has a cooling efficiency of 15.39 EER and heating efficiency of 4.45 C.O.P. Overall light density was designed to 1.1 watts/sq.ft. and the building includes occupancy sensors in washrooms and on outdoor light fixtures. Light fixtures in the learning center automatically adjust lighting output based on available daylight. In addition, a control system monitors the entire HVAC system.

The original use for the building was intended to be minimal, with visitation by appointment only. Since the Glenview Park District has assumed operations, they have opened the building for public drop in visitation, as well as scheduled group visits. The building is also now open during the winter, which was not originally accounted for in the initial energy model.

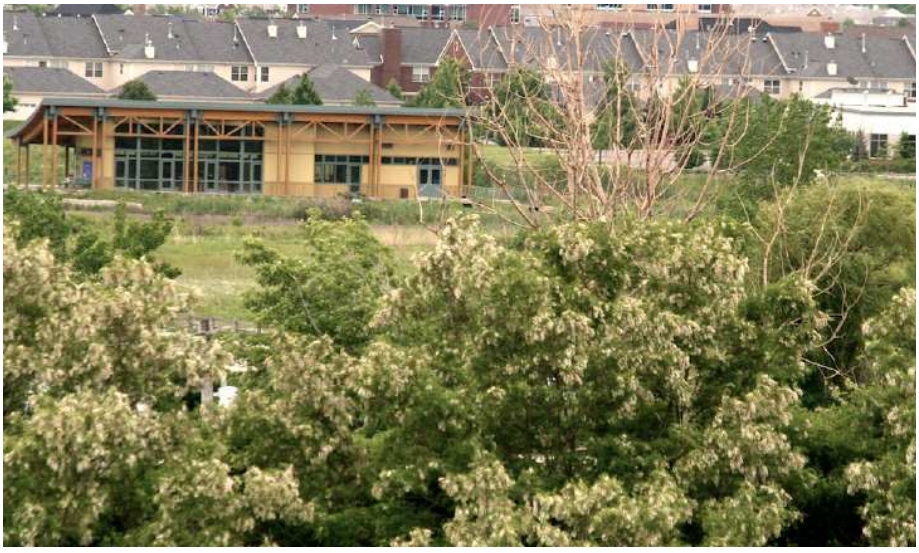


Photo: Paul Schlismann Photography

● LEED Energy & Atmosphere

EA credit 1 (10pts)	Optimize Energy Performance
EA credit 2.1 (3pts)	Renewable Energy
EA credit 3	Enhanced Commissioning
EA credit 4	Refrigerant Management
EA credit 5	Measurement & Verification

● Purchased Energy Costs

	total	electricity	PV*
annual energy use	89,719 kBtu	8.8 kWh/sf	65,078 kBtu
annual energy cost	$1.08 sf/yr	$1.08 sf/yr	–

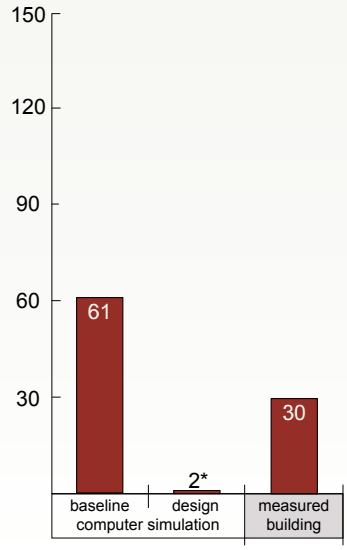
*not purchased nor included in the totals

● Measured Energy Usage

30 EUI

● Energy Benchmarking

*design model includes renewables



● LEED Sustainable Sites 9 of 14

SS credit 3	Brownfield Redevelopment
SS credit 4.1	Public Transit Access
SS credit 5.1	Reduced Site Disturbance
SS credit 5.2	Reduced Site Disturbance
SS credit 6.1	Stormwater Rate & Quantity
SS credit 6.2	Stormwater Quality
SS credit 7 (2pts)	Heat Island Reduction
SS credit 8	Light Pollution Reduction

● LEED Water Efficiency 4 of 5

WE credit 1 (2pts)	Water Efficient Landscaping
WE credit 3 (2pts)	Water Use Reduction

● LEED Materials & Resources 7 of 13

MR credit 2.1 (2pts)	Construction Waste Management
MR credit 4.1 (2pts)	Recycled Content Materials
MR credit 5.1 (2pts)	Local/Regional Materials
MR credit 6	Rapidly Renewable Materials

● LEED Indoor Environmental Quality 12 of 15

EQ credit 1	Carbon Dioxide Monitoring
EQ credit 2	Ventilation Effectiveness
EQ credit 3 (2pts)	Construction IAQ Mgmt. Plan
EQ credit 4 (4pts)	Low Emitting Materials
EQ credit 7 (2pts)	Thermal Comfort
EQ credit 8 (2pts)	Daylighting & Views

● LEED Innovation in Design 5 of 5

ID credit 1.1	Exceptional Water Efficiency 43%
ID credit 1.2	100% Vegetated Roof Coverage
ID credit 1.3	Exceptional Energy Performance 97%
ID credit 1.4	Green Building Education Program
ID credit 2	LEED Accredited Professional

SITE

Through good planning and analysis, the design team capitalized on the natural environment of the site. By placing the building on a pin foundation, the entire footprint is elevated, creating minimal site excavation and disturbance. This engineering technique allowed the building to rest between two existing wetlands without compromising either one and allows water to fluctuate between the wetlands without harming the building.

Site investigations found spoil piles overlaying extant hydric soils. The spoils were excavated, exposing the existing soil profiles that were re-vegetated and incorporated into the wetland complex. This brought the natural environment immediately up to the building's deck, increased wildlife habitat, and improved on-site ecosystems by removing contaminated spoil piles.

Increased land area for restoration and wildlife habitat was realized in two ways. The first being the green roof, which was planted with native and selected non-native species, replacing lost land area from the building footprint. The second was a result of shared parking discussions that were agreed upon by The Glen (shopping center), Metra (commuter rail), and office establishments across the street, thereby eliminating the need for required on-site parking.

WATER

Every drop of rain that falls on this site is intercepted and/or infiltrated. This was accomplished through a number of measures. A green roof was constructed to better manage rain falling on the building; runoff that does leave the roof moves into a re-established prairie where it migrates through the soil before entering wetland systems adjacent to the building. Annual rainfall is intercepted by the biomass of native prairie, both existing and restored around the building, also allowing for evapotranspiration back into the atmosphere. Permeable pavers are used in the small area of parking. Rain filters into open graded aggregate and either back into the soil or into a perforated pipe where it enters the wetland complex as cool, clean, filtered water - now a resource to native flora and fauna. The protection of in situ soils was critical so infiltration occurs where rain falls around the building.

Within the building, water is conserved through low flow toilets and urinals (1.1/1.6 gpf and 0.5 gpf), water sensors on lavatories (0.5 gpm), and reduction from four bathrooms to two, which also reduced total building area.

MATERIALS

Materials for the Center were carefully selected to minimize their environmental impact and promote a healthy interior environment. Wheatboard panels were used for interior wall surfaces and cabinetry. Tackable cork board was installed on walls to add color and texture in addition to functioning for display. Dakota Burl sunflower seed countertops offer an imaginative use of an agricultural by-product. Cotton batts and soy bean based spray foam insulation demonstrate that rapidly renewable construction materials can also contribute to the thermal and acoustical performance of a building.

Overall, the building materials contained a total recycled content exceeding 13%, more than 20% were locally sourced and manufactured, and 90.45% of all construction waste from wood, steel, concrete, brick pavers, drywall and cardboard was diverted from landfills.

The use of low VOC finish materials, along with displacement ventilation, operable windows, CO_2 monitoring, MERV 13 air filtration and humidification all contributed to an interior that is healthy and comfortable. Because the project is meant to endure and be enjoyed by future generations, all materials, finishes, components, and systems were selected and installed with this long-term endeavor in mind. Educational aspects of the project were embedded into the exterior façade to allow the interior space to remain an open volume for varied venues and uses. Permanent furniture within the main space is limited to a few simple built-in benches with top-opening lids for storage. This allows for flexibility in the arrangement of tables and chairs to accommodate multiple functions.

Evelyn Pease Tyner Interpretive Center

TRANSPORTATION

The project is located near Glenview's Metra commuter rail station which encourages visitors to avoid driving. Metra parking lots and side streets afford shared parking opportunities, allowing the project to reduce required parking to a mere two spaces, two accessible spaces, and a bus lane that accommodates safe drop off and loading for visiting school groups.

COST AND FUNDING

The green roof, photovoltaics, geothermal heat pump and pervious pavement were incremental costs that have higher initial costs than conventional strategies. But the Village of Glenview chose to use these technologies as a demonstration to visitors who might then employ these technologies in their own homes to be more sustainable.

The Evelyn Pease Tyner Interpretive Center received two grants for the project totaling $250,000. The grants awarded included a Section 319 grant (The Clean Water Act) for the green roof and porous pavers, and Illinois Clean Energy Community Foundation Grant for the geothermal system and the photovoltaic cells.

CONSTRUCTION LESSONS LEARNED

In general, the design process was very smooth as a result of clear expectations for the project. Administrative changes at the Village of Glenview resulted in additional time more so than project particulars despite the cost being significantly higher than originally anticipated.

Additional advice includes: research the expansion and contraction characteristics of rapidly renewable materials; verify that building automation systems are compatible with all the devices they control; horizontal geothermal energy transfer fields are cost effective; ventilation and shading contribute to the overall efficiency of solar roofing slates; and sloping vegetated roof soil stabilization creates some structural challenges.

OCCUPANCY LESSONS LEARNED

The center continues to gain valuable information by regular monitoring of the renewable energy systems and energy use by the construction manager. This effort has resulted in a better understanding of the building operation and efficiency that can be maintained over time.

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When it was completed in 1891, the Monadnock Building was the world's tallest masonry bearing wall structure and still is. The 1893 addition and subsequent restoration of the Monadnock is a nationally acclaimed melding of historic character and modern convenience. This LEED® Commercial Interiors (CI) pilot project involves a 3,200 square foot office build out for a sustainable architecture and planning firm.

Farr Associates is widely regarded as one of the most sustainable planning and architecture firms in the country. Their mission is to design sustainable human environments that put human social and economic benefit on par with aesthetic and environmental aims. Farr Associates' planners and architects work in integrated design teams to create award-winning designs that provide the most client benefit for the least cost. Their best work results from close collaboration with clients on projects that aspire to attain social, economic and environmental goals, often at the crossroads of urbanism and architecture.

Farr Associates works primarily on green and LEED Buildings and felt it was vital to "walk the walk" and retrofitted their office space using the LEED for Commercial Interiors rating system.

"I can't imagine a sustainable business without a sustainable work place. Yet even after having this office in place for several years, I am struck by how resistant to change building owners are. It is tragic that given how easy it is to do, they choose to do things the wrong way; even given that a sustainable workplace enhances the quality of work life." -Doug Farr, President & Founding Principal, Farr Associates

ENERGY OPTIMIZATION

Green power is electricity generated from renewable resources such as solar, wind, geothermal, small and low-impact hydropower, and biomass. This has proved to be environmentally preferable to electricity generated from conventional energy sources such as coal, oil, nuclear power, and natural gas. The office purchased 100% green power for two years from Renewable Choice Energy. This purchase of 29,789 kWh prevents for two years 41,466 pounds of CO2 pollution. This is equivalent to taking four cars off the road or planting six acres of trees. The firm intends to purchase another two years of green power, as soon as the previous commitment is finished.

In the Monadnock Building, each tenants electricity is sub-metered; therefore tenants are aware of the energy that they are using. This is in contrast to conventional office spaces where tenants pay a flat lease rate and never know the amount of energy they use. Submetering motivates occupants to take control of how much energy they use.

Farr Associates

● General Info

location	53 W Jackson Blvd
city	Chicago, IL
program	office
completed	Feb 2004
occupants	18 daily
hourly operation	50 hrs/wk
gross square footage	3200 sf
cost per sf	$32.81 per sf

● Project Team

owner & architect	Farr Associates
engineering & commissioning	ETA Engineers
contractor	Bill Donnel - Monadnock Building

● Key Features

LEED rating system	Commercial Interiors v1.0 pilot
achieved rating	Silver 27 pts
energy use intensity	39 kBtu/sf/yr
greenhouse gas emissions	14 lbs CO_2e/sf/yr

● LEED categories

sites	3	7
water	0	2
energy	5	12
materials	4	14
indoor quality	10	17
innovation	5	5

● Purchased Energy Costs

	total	electricity
annual energy use	124,565 kBtu	_
annual energy cost	_	_

*does not include heating

● Measured Energy Usage

39 EUI

SITE

Rather than constructing a new space, an existing site was chosen for rehabilitation. Choosing this type of site prevents urban sprawl and developing on greenfields. It was also selected for its central location in the heart of Chicago. The Monadnock building is in the center of a mass transportation system that is surrounded by two hundred train, bus, and 'L' stops, enabling all office staff to take public transportation to and from work.

MATERIALS

The interior is outfitted with sustainable and local materials. Twenty percent of the building materials were manufactured within 500 miles of the Monadnock building, and 10% contain high-recycled content. The office is furnished with salvaged and refurbished furniture; the conference table is a salvaged antique bowling lane. The linoleum surfaces are made from solidified linseed oil, a renewable resource.

The office only uses environmentally friendly and/or Green Seal approved products to clean the space. The purpose of this is to minimize health risks due to cleaning while keeping the indoor air and space free of toxins. This practice ensures their health is not affected while cleaning the space while also benefiting the employees.

INDOOR ENVIRONMENTAL QUALITY

People spend 90% of their time indoors. Accordingly, the firm selected finishes and paints that contain low volatile organic compounds or VOCs. VOCs are emitted as gases from certain solids or liquids, and have no color, smell, or taste. They include a variety of chemicals, some of which may have short and long-term adverse health effects. Concentrations of many VOCs are consistently higher indoors (up to ten times higher) than outdoors. The milk-based paint used contains beeswax, lavender and cloves, natural materials that do not emit any VOCs. All adhesives used in the space and in the furniture are low VOC. The recycled carpet has a Green Label Plus Certification, a rating that ensures carpets with very low off-gassing.

As a result of the office's corner location, differential exterior wind pressures provide cross ventilation. Occupants have the ability to control their indoor environment and allow natural ventilation.

The abundant windows and tall ceilings that were designed for the rudimentary lighting in the 1890's allow for full advantage of natural lighting and expansive views from every corner of the office.

LESSONS LEARNED

A build out in an existing, historic office space was difficult and not all of the plans could be realized due to restrictions.

FUTURE GOALS AND OBJECTIVES

For the future, Farr Associates will focus on using local and green materials in the build out of their space. There were very limited offering for local materials that are green in 2003 but market offerings have increase dramatically and many materials can now be sourced locally.

Farr Associates

● LEED Sustainable Sites	3 of 7
SS credit 2	Urban Redevelopment
SS credit 3.1	Public Transit Access
SS credit 3.3	Parking Availability
● LEED Energy & Atmosphere	5 of 14
EA credit 1.2 (2pts)	Lighting Controls
EA credit 5 (2pts)	Energy Measure/Payment Account
EA credit 6	Green Power
● LEED Materials & Resources	4 of 14
MR credit 3.3	Reused Furniture 30%
MR credit 4 (2pts)	Recycled Content Materials 20%
MR credit 5.1	Regional Materials
● LEED Indoor Environmental Quality	10 of 17
EQ credit 1	Outdoor Air Monitoring
EQ credit 2	Increased Ventilation
EQ credit 4 (3pts)	Low Emitting Materials
EQ credit 6.1	Controllability of Lighting
EQ credit 7 (2pts)	Thermal Comfort
EQ credit 8 (2pts)	Daylight 90% of spaces
● LEED Innovation in Design	5 of 5
ID credit 1.1	Sustainability Education
ID credit 1.2	Exemplary Green Power Purchasing
ID credit 1.3	Exemplary Furniture Reuse
ID credit 1.4	Green Housekeeping
ID credit 2	LEED Accredited Professional

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Kohl Children's Museum


Photo: John Miller/Hedrick Blessing

Surrounded by native prairie grasses, the new Kohl Children's Museum opens onto a south-facing garden courtyard that connects to an outdoor exhibit area. The plan offers a flexible interior for changing exhibits, which support the strategic direction of the museum and are often showcasing environmentally minded topics.

Kohl Children's Museum achieved LEED® Silver certification by designing the building and outdoor space holistically. Paved surfaces have been kept to a minimum and integrated indigenous plants help absorb run-off from the parking lot. Clerestory windows allow for ample natural light in the building, and the roof material reflects summer heat. Most building materials were purchased within 400 miles of the Museum site.


Photo: Kohl Children's Museum

General Info

location	2100 Patriot Blvd
city	Glenview, IL
program	museum
completed	Sept 2005
occupants	80-400
hourly operation	84 hrs/wk
yearly operation	12 mo/yr
gross square footage	47,000 sf
construction cost	$15,000,000
cost per sf	$319 per sf
exhibition cost	$3,000,000

Project Team

facility manager	Curt Adams
architect	Booth-Hansen
HVAC engineer	Kethmark & Associates
elect engineer	Commercial Lights
mech engineer	Concept Plumbing
landscape	Peter Lindsey Schaudt Landscape
contractor	Pepper Construction

Key Features

mechanical	high efficiency systems
	variable frequency fans/drives/motors
ventilation	natural ventilation, operable windows
	increased ventilation rate
	under-floor air distribution
lighting	daylighting w/ controls
	occupancy sensors
envelope	reflective roof,
	reflective high performance glass

Summary

LEED system	New Construction v2.0
achieved rating	Silver 38 pts
energy use intensity	123 kBtu/sf/yr
greenhouse gas emissions	32.8 lbs CO_2e/sf/yr
water usage	18.9 gal/sf/yr

LEED categories

sites	8	14
water	3	5
energy	8	17
materials	6	13
indoor quality	8	15
innovation	5	5

ENERGY OPTIMIZATION

The building envelope was constructed with metal studs and stucco finish because of its durability and low maintenance requirements. The envelope was super insulated with blanket insulation (a breathable vapor barrier system) in the walls. Clerestory windows were placed to maximize daylight effectiveness and transmit light from the sun deep into the building's core.

Exhibit areas are heated and cooled by individual fan coil units controlled by a building automation system. The benefit is individual and localized controllability instead of a single central system. This model along with the highest efficiency equipment was instrumental in reducing energy use of the building.

The actual EUI, energy use intensity, for the building was significantly higher than the baseline or design models. Computer simulation projected that the building would be 32% better than the baseline ASHRAE 90.1 model, but the actual measured energy use was higher. This suggests that the lighting for the exhibits was not part of the original computer modeling and those lighting fixtures were not specifically designed with energy efficiency in mind. Additionally, occupancy hours have extended to include hours for rental events which could also affect the differnce between the model and actual use. In order to reduce energy use, the museum has offered flexible employee work hours so employees do not have to travel to work everyday. Time between user occupancy and cleaning have been decreased thru better scheduling so mechanical systems that condition the spaces can avoid switching on/off.

Daylighting proved to be a bit of a challenge, with the position of the clerestory windows up high, there is more indirect light than is usable, and at the time of construction, no electronic sensors were included to dim the electrical lighting to save energy.


Photo: Mark Ballogg

● LEED Energy & Atmosphere 8 of 17

EA credit 1 (5pts)	Optimize Energy Performance
EA credit 3	Enhanced Commissioning
EA credit 4	Reduced Ozone Depletion
EA credit 6	Purchased Green Power

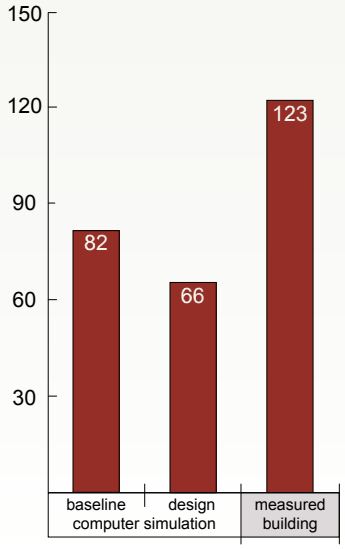
● Purchased Energy Costs

	total	electricity	gas
annual energy use	5,783,283 kBtu	21.2 kWh/sf	0.51 therms/sf
annual energy cost	$2.49 sf/yr	$2.00 sf/yr	$0.49 sf/yr

● Measured Energy Usage

123 EUI

● Energy Benchmarking



● LEED Sustainable Sites 8 of 14

SS credit 1	Site Selection
SS credit 4.1	Public Transit Access
SS credit 4.2	Bicycle Commuting
SS credit 4.3	Low Emitting Vehicles
SS credit 6.1	Stormwater Rate & Quantity
SS credit 7 (2pts)	Roof Heat Island Reduction

● LEED Water Efficiency 3 of 5

WE credit 1 (2pts)	Water Efficient Landscaping
WE credit 3.1	Water Use Reduction 20%

● LEED Materials & Resources 6 of 13

MR credit 2 (2pts)	Construction Waste Mgmt.
MR credit 4 (2pts)	Recycled Content Materials
MR credit 5.1	Local/Regional Materials
MR credit 6	Rapidly Renewable Materials

● LEED Indoor Environmental Quality 8 of 15

EQ credit 1	Carbon Dioxide Monitoring
EQ credit 3 (2pts)	Construction IAQ Mgmt. Plan
EQ credit 4 (4pts)	Low Emitting Materials
EQ credit 5	Indoor Pollutant Source Control

● LEED Innovation in Design 5 of 5

ID credit 1	Innovation & Exemplary Performance
ID credit 2	LEED Accredited Professional

SITE

Kohl Children's Museum was constructed on a brownfield. The site was originally a naval air base with 82% of the exisiting site serving as runways for the former facility. The open space has been restored closer to its natural state. Originally, the goal was to keep all water on site but due to the site' soil clay content that wasn't entirely achievable. The parking lot has bio-swales and a concise design which has kept paved areas to a minimum, and native planting areas were specifically located for the museum's programmatic use. One of the challenges for the project was a completely flat site, but keeping excavation materials on site to provide landscape forms turned out to be an unexpected opportunity.

MATERIALS

The project used a number of eco-friendly materials including wheat board ceiling panels, linoleum floors, recycled carpet tiles with no adhesives, and low VOC paints. All exhibits are designed within the parameters of the LEED guidelines too keep with the museum's mission.

INDOOR ENVIRONMENTAL QUALITY

The need for quality air is reinforced by the large numbers of children, adults and elderly who spend much time inside. The museum's main make up unit is variable, from any given indoor conditions the intake/exchange can range from 15%-100% outdoor air. Air quality versus energy efficiency is a tough balance but a situation where compromise is necessary given the fresh air needs of occupants and visitors.

COST AND FUNDING

LEED® was not anticipated at the conception of the project and the original budget was very tight when discussion regarding certification began. Once costs were quantified, additional funds were added to attain LEED Silver. Landscaping and elements of the mechanical system were the primary considerations, but pursuing LEED® helped the museum secure funding that otherwise would not be available. A state foundations grant was included in the original financing. Additionally, a grant was awarded by the Illinois Clean Energy Community Foundation to provide signage identifying and explaining the recycling program, high efficiency windows, and various other products to the public. Considerations are being made post-construction with anticipated help of Federal Stimulus money for potentially adding rainwater collection, solar roof panels, and wind turbines.


Photo: Mark Ballogg


Photo: Mark Ballogg

LESSONS LEARNED

The design team faced challenges when the soil was discovered to have more clay than anticipated, making a geothermal well field too expensive. Dual flush toilets were not allowed by the Village as the technology was not up to the standards at the time of construction. When looking back on the project, the design team suggested that if the project were to be done again nothing would have been done differently, but today's better technology and more available funding would make the budget easier and the project more cost effective.

Siting the building is a very important step in design, and this is something that was felt to have been achieved in the project. Solar orientation, micro climate, and understanding advantages of the particular site were kept in mind throughout the project.

OCCUPANCY LESSONS LEARNED

The Native grass areas took longer to establish than anticipated. Other factors such as weather conditions did not help for planting.

"It's important to make your best effort to determine the intended uses of the building and design toward that. Then demand a system that works within that." Curt Adams, Vice President, Facilities

FUTURE GOALS AND OBJECTIVES

Building sustainable is very possible. As of now, Kohl staff admit they are only scratching the surface of building green. Each finished project betters the next. Everyone that uses the building gains positive information and an understanding of green technology, design, construction, and operation.

Photo: Mark Ballogg

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Merchandise Mart

Chicago's Merchandise Mart, a landmark structure built in 1930, claims the title of the world's largest commercial building. The process of undertaking the renovations necessary for the Merchandise Mart to earn a LEED® Silver for Existing Buildings certification took three years and involved everything from fixing water leaks and replacing windows to establishing an on-site recycling center for construction waste. Merchandise Mart officials did not have the option of shutting down the building, so the engineers and architects had to win the cooperation from thousands of tenants.

The process for certifying this large and complex building was grounded in an organizational culture committed to environmental stewardship and market-transforming leadership. The actual certification process involved regular project team meetings, capable subcommittees focused on specific tasks, and constant communication. The certification required a willingness to envision and implement innovative solutions that helped achieve LEED points, and made sense as part of the long-term commitment to sustainability by the building and its owners--Merchandise Mart Properties, Inc. (MMPI).

MMPI has been reducing environmental impacts through products, procedures and equipment for many years. From their thermal storage facility that saves hundreds of thousands of dollars in electricity costs every year to its participation in the Clean Air Counts initiative which works to reduce smog forming pollutants and energy consumption in the greater Chicago area, the Mart has continuously been an industry leader. Although the LEED certification process helped augment, formalize, and document many of the Mart's green practices, the management views LEED as part of an ongoing effort to improve sustainability throughout the company's practices. "We don't view this as a completed project," noted MMPI Myron Maurer, Senior Vice-President. "We have developed the tools. Now we use those tools in our day-to-day operations. The Mart Center is going to continue to refine and improve our green building practices. This is a way of life at MMPI."

To accomplish the certification, the Merchandise Mart maintained a collaborative team of internal staff and a hired LEED/sustainability consultant, the Delta Institute in partnership with EnVise, LLC.

General Info

location	222 Merchandise Mart Plaza
city	Chicago, IL
program	office, retail, showroom
occupants	5,000 occupants
hourly operation	60 hours/week
yearly operation	52 wks/yr
gross square footage	4,200,000 sf

Project Team

owner	Merchandise Mart Properties, Inc.
facility manager	Merchandise Mart Properties, Inc.
MEP engineer	EnVise
commissioning agent	EnVise
environmental consultant	Delta Institute

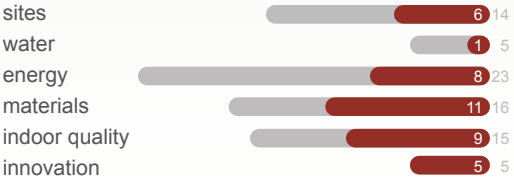
Key Features

mechanical	variable frequency fans/drives/motors energy monitoring system
lighting	occupancy sensors
materials	low VOC paints and finishes

Summary

LEED system rating	Existing Buildings v 2.0
achieved rating	Silver 40 pts
energy use intensity	75 kBtu/sf/yr
greenhouse gas emissions	22.4 lbs CO_2e/sf/yr
water usage	7.9 gal/sf/yr

LEED categories



ENERGY OPTIMIZATION

The Mart achieved LEED points in the Energy and Atmosphere category for having continuous metering of many different systems including; separate building electric meters, natural gas meters; separate meters that allow aggregation of all indoor process water use and all outdoor irrigation water use; cooling load; boiler efficiencies; constant and variable motor loads; variable frequency drive (VFD) operation; and air distribution static pressures and ventilation air volumes.

Tenants are metered for electricity usage and receive the benefit for their efforts in conserving energy. The buildings purchasing department offers energy conserving lights and conversion kits to assist tenants.

In conjunction with additional metering of building systems, steps were taken to reduce consumption through upgrades to existing lights, conversion of halogen lamps to compact fluorescents, installation of motion sensors in private offices, and adding variable frequency drives to constant speed pumps and fans. Electricity consumption was reduced close to 10% based on these measures within the first year of certification.

● LEED Energy & Atmosphere

EA credit 3.1	Staff Education
EA credit 3.2	Building Systems Maintenance
EA credit 3.3	Building Systems Monitoring
EA credit 4	Additional Ozone Protection
EA credit 5 (2pts)	Enhanced Metering
EA credit 5.4	Emission Reduction Reporting
EA credit 6	Sustainable Building Costs

● Purchased Energy Costs

	total	electricity	gas	chiller
annual energy use	315,963,126 kBtu	11.2 kWh/sf	.21 therms/sf	1.36 ton hrs/sf/yr
annual energy cost	–	–	–	–

● Measured Energy Usage

75 EUI

● LEED Sustainable Sites 6 of 14

SS credit 1 (2pts)	Site & Exterior Management
SS credit 2	Development Density
SS credit 3.1	Public Transit Access
SS credit 3.2	Bicycle Commuting
SS credit 6.1	Site Heat Island Reduction

● LEED Water Efficiency 1 of 5

WE credit 3.1	10% Water Use Reduction

● LEED Materials & Resources 11 of 16

MR credit 1.1	Construction Waste Management 75%
MR credit 2.1	Sustainable Products 10%
MR credit 3 (2pts)	IAQ Compliant Products 90%
MR credit 4 (2pts)	Sustainable Cleaning Products 60%
MR credit 5 (3pts)	Occupant Recycling 50%
MR credit 6	Reduced Mercury Light Bulbs

● LEED Indoor Environmental Quality 9 of 22

EQ credit 1	Outdoor Air Delivery Monitoring
EQ credit 3	Construction IAQ Mgmt Plan
EQ credit 9	Contemporary IAQ Practice
EQ credit 10 (6pts)	Green Cleaning

● LEED Innovation in Design 5 of 5

ID credit 1.1	Innovation in Upgrades, O & M
ID credit 1.2	Innovation in Upgrades, O & M
ID credit 1.3	Innovation in Upgrades, O & M
ID credit 1.4	Innovation in Upgrades, O & M
ID credit 2	LEED Accredited Professional

WATER

Like many older buildings, much of the Mart's plumbing system dates back to when the building was built in 1930. This presented challenges for the building, for instance the flush valves that control water flow of toilets are inaccessible as they are hidden behind marble walls that reflect the design aesthetic of the time. Over time, building management changed out fixtures in the most frequently used areas of the building to make the most impact on water efficiency and to realize quicker paybacks, rather than changing out all fixtures in the building and disturbing or destroying all the marble and other quality materials already in place. In order to achieve the water efficiency prerequisite and credit, the Mart showed that by having low-flow fixtures on the most highly used fixtures, they met the qualitative intent of the prerequisite/credit and fulfilled all quantitative requirements.

The Merchandise Mart also upgraded its computer room air conditioning system with a refurbished unit that recycles water thru a cooling tower versus straight domestic water. This renovation saves the building over 6 million gallons of water per year.

MATERIALS

The Mart was able to achieve green cleaning products points because of their participation in Clean Air Counts. In fact, the Mart was an early adopter in 1990 of green cleaning products and practices. The Mart's internal housekeeping staff as well as its outside housekeeping contractors are all required to use LEED-qualified green cleaning products whenever possible.

Their approach to recycling dates back two decades when MMPI began to identify the most market-ready recyclables, metal, paper and construction waste, which were integrated into an ever-expanding recycling program. Over the past two decades MMPI added cardboard and other fibrous material, glass, plastic, and aluminum. In the last few years they have implemented battery, electronic waste, fluorescent lamp and ballast recycling. MMPI has also piloted a composting program during the last two Neocon World's Trade Fairs it hosted, where the audience is conscientious and dedicated to sustainability in the built environment. In addition to straight forward recycling, the Merchandise Mart also reuses materials through the process of donations to local charities and facilities like the Delta Institute's ReBuilding Exchange where they promote the reuse of building materials and the practice of deconstruction for environmental and community benefit.

INDOOR ENVIRONMENTAL QUALITY

The Mart was able to easily achieve indoor air quality products points because of the groundwork laid by its participation in the Chicago region's Clean Air Counts program, in which the building voluntarily reduced its use of VOC-containing products. Already being familiar with IAQ-compliant products internally, the Mart advanced the program by revising its construction standards document to require all outside contractors to meet the IAQ-compliant products requirements as well for paints, coatings, adhesives, sealants, carpets, etc.

Merchandise Mart

INNOVATION

The Mart earned several innovation credits in its LEED-EB certification. One of the innovations was the Green Spot, an educational program space for building occupants and visitors in which tenants' green products are displayed with descriptions of their green features in a visible spot on the first floor of the Mart. Because the Mart hosts some 3 million visitors annually, the Green Spot serves to visibly engage a large audience in the green products housed in this green facility.

As the producers of NeoCon World's Trade Fair, the largest design exposition and conference for the built environment, Merchandise Mart Properties, Inc. has devoted a special component of the NeoCon programming called "GREENlife" to address sustainable initiatives. From an educational track featuring the best and brightest green speakers in the industry, to a special "Green Guide" that highlights green products and serves as a tool for attendees to increase their awareness of all the green products in the Show, to special exhibits showing current green trends and issues that are at the forefront of the green cause, the Merchandise Mart has been steadfast in using NeoCon as a platform for raising the bar in terms of green design and educating the 50,000+ attendees (including interior designers, architects, corporate and real estate executive, facilities executives, media and student of interior design) on the importance of green design.

COST AND FUNDING

The Illinois Department of Commerce and Economic Opportunity provided two grants to assist in the consulting process for pursuing LEED with a focus on quantifying and pursuing improvements in recycling and energy conservation.

OCCUPANCY LESSONS LEARNED

MMPI's own offices at the Merchandise Mart are also integrating continued sustainability measures. They recently upgraded the electric metering to real-time display, which they believe will allow them to focus on how energy is used during occupied and unoccupied periods. In addition the MMPI offices are piloting new lighting technology that has created a platform for future office renovations. They believe this will not only assist in lowering the office's energy consumption but can be used as a model for other tenants within the building.

FUTURE GOALS AND OBJECTIVES

"Wanting to be a pioneer for sustainable building practices, The Merchandise Mart signed on to the environmental movement early and we are now realizing its many advantages," said Mark Bettin, VP of Engineering, MMPI. "Not only does going green have a positive effect on our environment, but it makes sense economically. USGBC studies have shown green building practices [can lead to] a 30% energy savings, 30-50% water savings, and 50-97% waste savings. Additionally, we are providing a value-added service to our tenants and employees by offering a comfortable, healthy workplace which will ultimately increase productivity."

*text contributed by Lloyd Davidson, Vice President, General Manager, Merchandise Mart Properties, Inc.

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The Midwest Energy Efficiency Alliance (MEEA) advocates for sound energy policy and regulations, promotes energy efficiency programs, emerging technologies and training programs, and brings together a network of stakeholders to advance energy efficiency. Their LEED® CI certified office space physically demonstrates the organization's commitment to energy efficiency and green building. In particular, elements such as energy-saving kitchen appliances, copy machine, and advanced lighting system clearly demonstrate to the staff, board, and visitors that MEEA is "walking the walk."

"Even as a nonprofit and knowing there would be additional costs involved, the decision to build a LEED-certified space was ultimately an easy one. LEED fits with our mission and has provided us with direct insights into the challenges and opportunities that exist when improving the efficiencies of an existing facility." -Wendy Jaehn, Executive Director, Midwest Energy Efficiency Alliance

ENERGY OPTIMIZATION

MEEA's general office area features large windows and abundant daylight. The space was intentionally built with private offices consolidated to the building core. This strategy allows the maximum amount of daylight to enter the office at the perimeter which reduces the need for electrical lights. The ENERGY STAR® qualified interior windows, donated by Marvin Windows, further increase daylight penetration into the interior offices. 90% of desks have a direct view of the outdoors. The refrigerator and dishwasher are ENERGY STAR qualified, saving energy year-round.

INNOVATION

MEEA received innovation credits for reusing at least 90% of their office furnishing, implementing educational programs and establishing a green purchasing policy. Descriptive signs inform about each green building element in the office for visitors and staff to learn about the space. Tours are also offered, pointing out the green elements, for any group that has a meeting in the conference room.

SITE

The office's location near the transportation hub of the Chicago Loop means that employees are able to take advantage of public transit alternatives to single occupant commuting. In fact, 100% of staff regularly use alternative modes of transportation.

MEEA Midwest Energy Efficiency Alliance

General Info

location	645 N Michigan Ave
city	Chicago, IL
program	office
completed	April 2006
occupants	18
hourly operation	45 hrs/wk
gross square footage	5,000 sf
construction cost	$246,666
cost per sf	$49 per sf

Project Team

owner	Midwest Energy Efficiency Alliance
architect	Powell Kleinschmidt
MEP engineer	KENT Consulting Engineers
commissioning	The Weidt Group
contractor	Building Owner of 645 N Michigan

Summary

LEED rating system	Commercial Interiors v2.0
energy use intensity	10 kBtu/sf/yr
achieved rating	Certified 24 pts
greenhouse gas emissions	3.5 lbs CO_2e/sf/yr

LEED Categories

sites	3	7
water	0	2
energy	5	12
materials	6	14
indoor quality	5	17
innovation	5	5

Purchased Energy Costs

	total	electricity
annual energy use	48,450 kBtu	2.8 kWh/sf
annual energy cost	$0.36 sf/yr	$0.36 sf/yr

*does not include heating nor cooling

Measured Energy Usage

10 EUI

MATERIALS

MEEA's office build-out features attractive and durable products containing recycled content, FSC certified wood, and low VOC off-gassing potential. Carpet and resilient flooring for the office build-out was selected for its recycled content and installed using a no-VOC wet-set adhesive. The office carpet, by LEES Carpet, contains 20% post-consumer and 19% post-industrial recycled content sourced partially from water bottles. The kitchen and server room feature Mannington's 'Relay' 40% post-industrial recycled content flooring. The office space uses Cirrus acoustic ceiling tile, by Armstrong, which boasts 4% post-consumer and 78% post-industrial content. It is light colored to help reflect daylight, reducing the need for artificial lighting. Wood doors are certified as sustainably harvested by the Forest Stewardship Council (FSC) and are manufactured with low VOC adhesives to minimize off-gassing. The office's doors and cabinets also contain 40% post-industrial recycled content. RACO interior aluminum framing (70% post-industrial content) supports MEEA's built-out offices. USG provided locally-produced gypsum board with a 95% post-industrial recycled content and facing paper made from 100% recycled newsprint. All painted surfaces make use of Benjamin Moore Eco Spec Green Seal certified coatings. Eco Spec products are formulated without solvents, thereby eliminating the VOCs found in conventional latex paints. Avonite solid surface shelving was used in the copy room and kitchen area. The countertops and shelving contain 40% post-industrial recycled content. Ninety percent of the furniture was reused and/or purchase refurbished. Recycling bins are located in the kitchen and at each desk to collect fiber, metal, and plastic refuse.

OCCUPANT COMFORT

The open space and natural light provided by MEEA's LEED certified space helps increase workplace performance and provide a healthier atmosphere in which to work. Anecdotally, MEEA feels these features increase productivity in their office.

CONSTRUCTION LESSONS LEARNED

During the build out of the space, MEEA learned that it takes time to educate contractors who have not built to LEED specifications before. An additional challenge was finding the right products and ultimately, more time was needed because of this for the build-out and move. MEEA moved in the day after the contractors painted and were still wrapping up the construction. Yet with the low-VOC paint, staff hardly noticed the paint smell just one day after painting.

OCCUPANCY LESSONS LEARNED

MEEA was thrilled with the comparative post-occupancy data provided by the Regional Green Building Case Study report. They were aware that the energy efficient lighting system, ENERGY STAR appliances, and reliance on daylighting required minimal energy, but were unaware the office's energy consumption was well below the average.

FUTURE GOALS AND OBJECTIVES

Since moving into their LEED certified space, MEEA has used their office as a showcase to visitors. Additionally, they have offered the building manager a free seat at a Building Operators Certification class (one of MEEA's programs which trains building engineers how to increase HVAC and building system efficiency). Overall, MEEA's LEED office space and continued partnership with the USGBC Chicago Chapter have bolstered their mission of furthering energy efficiency throughout the Midwest.

MEEA Midwest Energy Efficiency Alliance

● LEED Sustainable Sites	3 of 7
SS credit 2	Development Density
SS credit 3.1	Public Transit Access
SS credit 3.3	Parking Availability

● LEED Energy & Atmosphere	5 of 12
EA credit 1.1 (2pts)	Lighting Power
EA credit 1.2	Lighting Controls
EA credit 1.4	Equipment & Appliances
EA credit 4	Purchased Green Power

● LEED Materials & Resources	6 of 14
MR credit 1.1	Long Term Lease
MR credit 3.3	Reused Furniture 30%
MR credit 4 (2pts)	Recycled Content Materials 20%
MR credit 5.1	Regional Materials
MR credit 7	Certified Wood

● LEED Indoor Environmental Quality	5 of 17
EQ credit 4 (4pts)	Low Emitting Materials
EQ credit 8.3	Views for 90% of Seated Spaces

● LEED Innovation in Design	5 of 5
ID credit 1.1	60% Reuse Furnishings
ID credit 1.2	90% Reuse Furnishings
ID credit 1.3	Educational Programs
ID credit 1.4	Green Purchasing Policy
ID credit 2	LEED Accredited Professional

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Rubloff Hall Saint Xavier University

Arthur Rubloff Residence Hall is the first LEED® residence hall in the greater Chicago area, attaining Gold Certification. Saint Xavier University intends to use the building as a model for best practices in developing future LEED® buildings on campus. This project is viewed as the first in a line of future green buildings for an institution committed to sustainability.

The five-story, 37,084 square foot student dormitory building includes residence hall offices, a student lounge, and student residence rooms. The second through fourth floors are student residence rooms. The fifth floor consists of a large conference room, mechanical rooms and a green roof area. There is a large corridor link that connects the second floor residence corridor to the existing McCarthy residence hall. The building construction is steel frame with masonry.

The main driver for designing Rubloff Hall 'green' is the recognition of increased productivity from a building that is comfortable, enjoyable, and provides healthy conditions. Comfortable occupants are less distracted, able to focus better on tasks, and appreciate the physiological benefits of daylighting, environmentally sensitive materials, outside views, occupant control and thermal comfort.

"Becoming environmentally conscious with our building methods enhances the quality of life for students and those of us who work here," said Paul Matthews, assistant vice president for facilities management; "It's good business."

"The whole premise of sustainability is 'let's keep it out of the landfill,'" Matthews said. "We have a teaching opportunity here. We want students to be the stewards of this building. There are recycling bins conveniently located on each floor, and we are expecting students to recycle. Bike racks have been mounted in several of the students' closets to encourage an alternate means of transportation around campus."

General Info

location	10240 S Central Park Ave
city	Chicago, IL
program	student residence hall
completed	Aug 2006
occupants	89 occupants
hourly operation	168 hours/week
gross square footage	37,084 sf
total project cost	$9,543,792
cost per sf	$255

Project Team

owner	Saint Xavier University
architect	Solomon Cordwell Buenz
MEP engineer	Environmental Systems Design
civil engineer	Terra Engineering
acoustical engineer	Shiner & Associates
specifications	Archi Tech
commissioning agent	Sieben Energy Associates
contractor	Henry Brothers

Key Features

mechanical	high efficiency condensing boilers
	R-407C refrigerant in chillers
	variable frequency fans, drives, pumps
controls	energy monitoring system
	occupancy sensors and controls
ventilation	displacement ventilation
	energy recovery and demand controls

Summary

LEED rating system	New Construction V 2.1
achieved rating	Gold 46pts
energy use intensity	101 kBtu/sf/yr
greenhouse gas emissions	24.1 lbs CO_2e/sf/yr

LEED categories

sites	11	14
water	4	5
energy	7	17
materials	5	13
indoor quality	15	15
innovation	5	5

ENERGY OPTIMIZATION

Energy optimization measures included building envelope improvements, high efficiency equipment, energy recovery, building automation controls, and advanced ventilation systems including both natural and mechanical strategies.

The building envelope was improved by increasing wall insulation to R-27, selecting tinted glass, utilizing window shades, a highly reflective white membrane roof, and a vegetated roof covering 750 sf (10%).

State-of-the-art ventilation systems were a high priority for the residence hall. Common areas are served by a dual path VAV air handler with displacement ventilation and perimeter fin-tube radiant heat. The student residences are served by a constant volume make-up air handler with a plate-type heat recovery module to reclaim energy from exhaust air. Student rooms are served by VAV fan terminal units oriented in a high-rise stacked configuration. Heating water is supplied by condensing boilers rated at 93% efficiency. Chilled water is supplied by a high efficiency chiller that incorporates a remote mounted chiller barrel and R-407C refrigerant. Piping to the air handlers, fin-tube and unit heaters is in a four pipe configuration which provides simultaneous heating and cooling capability for occupant thermal comfort. The fan coil loop is configured in a two pipe arrangement which provides either heating or cooling but not both simultaneously.

Electrical lighting is provided by two-level fluorescent fixtures in offices, lounges, and conference rooms. All common area lights are controlled with occupancy sensors. The Building Automation System (BAS) allows for HVAC systems to interact, reducing operational energy by taking advantage of reduced ventilation in unoccupied spaces and economizer cycles.

The projected building energy usage was modeled using Carrier Haps Version 4.21. This computer analysis indicated that the project could be 32% more efficient than if it has been built to minimum energy code requirements.

The University estimates that if the residence hall had been conventionally built, the building would consume approximately 1,042,309-kilowatt hours of electricity and 6,800 therms of energy per year. The estimated energy cost for the building is approximately $89,000 annually or $3.06 per square foot. The measured energy use for operating the building during the study period is significantly lower, approximately $1.32 per square foot.

● LEED Energy & Atmosphere 7 of 17

EA credit 1 (4pts) ASHRAE 90.1 1999	optimize energy performance 30% increased efficiency
EA credit 3	enhanced commissioning additional overview
EA credit 4	refrigerant management no CFC based refrigerants
EA credit 6	renewable energy purchased 600,000 kWh for 2 yrs

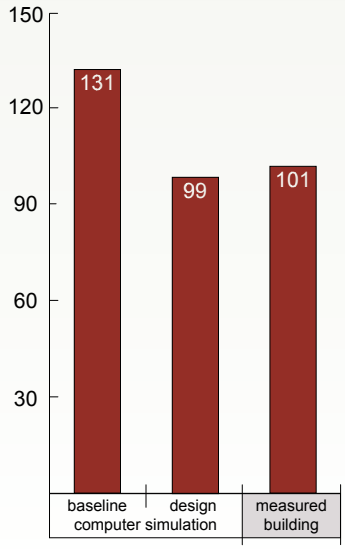
● Purchased Energy Costs

	total	electricity	gas
annual energy use	3,748,858 kBtu	13.7 kWh/sf	0.54 therms/sf
annual energy cost	$1.32 sf/yr	$0.69 sf/yr	$0.63 sf/yr

● Measured Energy Usage

101 EUI

● Energy Benchmarking



● LEED Sustainable Sites 11 of 14

	Site Selection
SS credit 1	Development Density
SS credit 2	Public Transit Access
SS credit 4.1	Bicycle Commuting
SS credit 4.2	Parking Capacity & Carpooling
SS credit 4.4	Restore Open Space
SS credit 5.1	Restore Habitat
SS credit 5.2	Development Footprint
SS credit 6.1	Storm water Rate & Quantity
SS credit 6.2	Storm water Treatment
SS credit 7 (2pts)	Heat Island Reduction

● LEED Water Efficiency 4 of 5

WE credit 1 (2pts)	Water Efficient Landscaping
WE credit 3 (2pts)	Water Use Reduction

● LEED Materials & Resources 5 of 13

MR credit 2 (2pts)	Construction Waste
MR credit 4 (2pts)	Recycled Content Materials
MR credit 5.1	Local & Regional Materials

● LEED Indoor Environmental Quality 15 of 15

EQ credit 1	Carbon Dioxide Monitoring
EQ credit 2	Ventilation Effectiveness
EQ credit 3 (2pts)	IAQ Management Plan
EQ credit 4 (4pts)	Low Emitting Materials
EQ credit 5	Indoor Pollutant Control
EQ credit 6 (2pts)	Controllability of Systems
EQ credit 7 (2pts)	Thermal Comfort
EQ credit 8 (2pts)	Daylighting & Views

● LEED Innovation in Design 5 of 5

ID credit 1.1	Green Building Education
ID credit 1.2	Exemplary Performance EAc1
ID credit 1.3	Integrated Pest Management
ID credit 1.4	Green Housekeeping
ID credit 1.5	LEED Accredited Professional

SITE

The entire roof is covered in a highly reflective "white roof" material, and more than 10 percent of the roof surface, or 750 square feet, consists of a series of grids of rectangular porous 2' by 4' plastic trays containing low-maintenance ground cover sedum to absorb and filter rainwater while reducing urban heat island effects. The vegetated component of the roof system slows the release of stormwater and filters captured rainwater before releasing it to the roof drains that convey run-off to the ground. The water then drains into Lake Marion on the campus and is used to water landscaping around the building.

WATER

Water used for landscaping comprises nearly 30% of potable water use in the eastern U.S. and the Midwest. Beyond the water being consumed to irrigate lawns and other landscape features, there are significant implications of this water use in terms of the amount of energy required to pump and treat the water before and after usage. Saint Xavier University built an irrigation system to use water from the campus lake to help meet the irrigation needs of landscaping around Rubloff Hall, helping to conserve a valuable natural resource.

INDOOR ENVIRONMENTAL QUALITY

The building automation systems act as the "brain" of the building and controls all major systems. The HVAC system will automatically adjust for the amount of carbon dioxide in the air for each space.

OCCUPANT COMFORT

The University has observed that students have a preference for Rubloff Hall, and the University's second green residence hall, O'Brien Hall, as compared to the conventional residence halls. There are a number of factors that appear to contribute to these preferences, including the daylighting, better indoor air quality, and lower noise levels associated with the building systems in Rubloff and O'Brien versus universities conventionally-built residence halls.

Rubloff Hall Saint Xavier University

COST AND FUNDING

Saint Xavier University estimates the cost premium to reach LEED Gold was $269,100 (2.8%). However with longer-life building features and lower operating costs, the savings will be greater than the construction cost premium and payback will be reached in less than 5 years.

Rubloff Hall's energy efficiency can also be evaluated by comparing the annual use of gas and electricity to two conventionally built residence halls on campus with similar floor plans and size, Morris Hall and McCarthy Hall. Data on energy use in the three buildings from the time period fiscal year of 2006 – 2007 is shown in the table below:

Energy Use at Saint Xavier Residence Halls

	Natural Gas	Cost	Electricity	Cost
Morris Hall	22,513 therms	$32,363.31	534,019 kWh	$37,496.83
McCarthy Hall	29,726 therms	$34,591.46	716,134 kWh	$50,448.27
Rubloff Hall	16,513 therms	$19,003.20	430,912 kWh	$30,022.09

CONSTRUCTION LESSONS LEARNED

Advanced tools, including a web-based direct digital control (DDC) system, helped the University troubleshoot the HVAC system and eased the commissioning process. As with any complex process, allowing adequate time for schedules is important. For example, test and balance completion was an issue with the University's condensed schedule of occupancy. This moved 90% of the commissioning activities into the occupied period. There were times when issues arose beyond the University's control as when the air flow stations for air handlers arrived late, forcing control optimization and balancing verification into the occupancy period. Although every building project is unique, Saint Xavier University has been able to apply knowledge gained from the design and construction process of Rubloff Hall towards other campus facilities.

OCCUPANCY LESSONS LEARNED

Constructing Rubloff Hall allowed Saint Xavier University to be one of the original signatories of the American College and University Presidents Climate Commitment (ACUPCC) as well as becoming members of organizations like the Association for the Advancement of Sustainability in Higher Education (AASHE). However, as an educational institution, Saint Xavier University saw Rubloff Hall as an opportunity for leadership not only outside of campus, but also within the university community. Students from the grounds department now help install green roofs throughout the campus. Educational kiosks have been expanded to cover the entire green campus. Rubloff Hall has also allowed Saint Xavier to better understand how green systems and technologies need to function holistically. Rubloff Hall is being used as a model for other planned green buildings on campus.

FUTURE GOALS AND OBJECTIVES

Saint Xavier University planned and built Rubloff Hall as a LEED certified building to bring to life some of the values and priorities of the University, including enhancing the sustainability of the campus and leading by example. Reflecting on these goals, the project is a major success. The building has also been economically sustainable for the University.

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Appendix D – Sample Report to Building Owners

PROJECT REPORT SUMMARY FOR CHRISTY WEBBER LANDSCAPES' HEADQUARTERS/RANCHO VERDE

1. Study Background

The goal of U.S. Green Building Council Chicago Chapter (USGBC) *Regional Green Building Case Study* project is to collect and analyze post-occupancy building performance data and present case studies on the costs and benefits of implementing LEED® design and operations in the state of Illinois. Though similar studies have been undertaken before few include analysis of post occupancy building performance and none are specific to this region of the country. This project's scope and timeline was ambitious and your project's participation has been extremely valuable. Thank you.

During the fall and winter 2008/09, the team collected and analyzed post-occupancy building performance data for 25 projects. The USGBC-Chicago Chapter will release a full report in early 2009. This report summarizes your project results from data that you generously provided to the Center for Neighborhood Technology.

Table of Contents

2. General Project Information

Building	**Chicago GreenWorks Rancho Verde/Christy Webber Landscape Headquarters**
Building use	Mixed use – office and shop space
Address	2900 West Ferdinand St, Chicago IL 60612
Date completed	December 2006
Project square footage (gross, non-parking, conditioned area)	16,505 square feet
LEED® info	
LEED® certification category, version, level, pts earned and date	LEED-New Construction, Version 2.1 Platinum, 52 points, November 2007
LEED® energy optimization points	10
Occupant/computer counts	34-38 people varies seasonally (staff has grown approximately 20%), 45 computers
Operations hours/week and months/year	48 - 60 hours/week varies seasonally
Features	
HVAC & energy systems	Radiant floor heating, variable frequency fans/drives/motors, energy monitoring system, heat recover system, thermal energy storage
Ventilation	Natural ventilation, operable window, underfloor air distribution
Lighting	High efficiency lighting, daylighting, daylighting sensors, occupancy sensors
Envelope	Shop building roof is light-colored and rainwater runoff is collected from it, green roof, exterior window shading
Renewable energy	Solar thermal-hot water, geothermal, ground source heat pumps, on-site wind turbines, on-site hydropower

3a. Performance Results – Energy

The energy performance results reported here were calculated from data you provided and represent **actual measured** performance. *All calculations are based on energy use from the following date range: June 2007 – May 2008.*

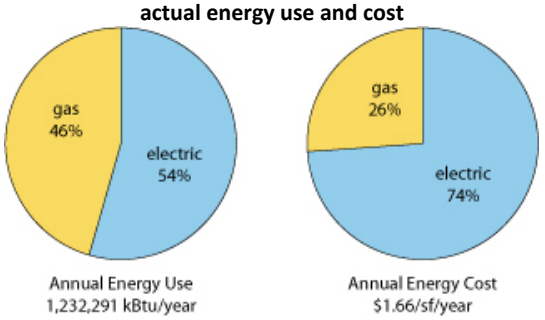
Actual Purchased Energy Use and Costs

This information helps illustrate how you use energy and how you spend money on energy.

Table 1 Summary of your project's energy use and costs*

	Total	Electricity	Gas
Annual energy use	1,232,291 kBtu	11.9 kWh/sf	0.34 therms/sf
Annual energy cost ($/sf/yr)	$1.66	$1.23	$0.43

Figure 1 Comparison of your project's actual energy use and cost



Energy Use Intensity (EUI)

Energy Use Intensity or EUI refers to the amount of energy that your project uses expressed in kBtu per square foot per year. The lower the value, the better the project is performing.

EUI is calculated by converting all reported fuel sources and units (kWh, therms, etc.) to thousands of Btus (kBtu). This value is divided by the square footage of the project space to allow for easy comparison amongst projects of varying size.

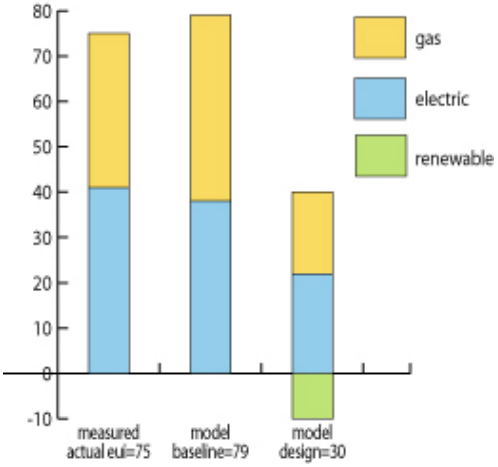
Why not just report annual fuel use?
Energy Use Intensity (EUI) is a standard metric used to compare buildings. Other benchmarks, such as Energy Star, also report EUI.

Figure 2 Your project's actual EUI

Actual energy use compared to energy models for this project *(i.e. how you compare to yourself)*

This graph compares your projects actual energy use to the energy use predicted by the energy models that were submitted for LEED certification, described below.

Figure 3 Comparison of actual energy use to modeled energy use for your project



"Baseline" is the modeled energy use for the project if it had simply been built "to code" without efficiency measures. "To code' is the minimum standard allowable by law. In general, as standards are developed/updated, their performance targets are higher. Municipal code requirements may not update the standard version required as quickly, or at all. Therefore projects modeled using more recent versions of ASHRAE 90.1 may be setting higher performance targets than some municipal code requirements. *Your project used the ASHRAE 90.1 – 2004 standard.*

"Design" is the modeled energy use with all planned energy efficiency measures. *Regulated and unregulated loads were modeled for this building.*

A building is performing as expected if "Actual" energy usage is at or below "Design". A number of outside factors could explain a discrepancy between "Design" and "Actual" energy use. Often those factors include a difference between initial assumptions and actual conditions, such as changes in occupancy levels, activities conducted in the building, and building operating and maintenance practices.

Variations between modeled and actual energy use is common industry-wide.

Continued Actual energy use compared to energy models for this project *(i.e. how you compare to yourself)*

Table 2 Summary of modeled energy use for your project

	Baseline	Design
Modeled EUI for your project (kBtu/sf/year)	79	30
How your actual EUI, *75*, compares to each model	5% lower	146% higher

Remember, when comparing EUI a *lower* value means a project is performing better, *higher* number means a project is not performing as well.

Performance Benchmarking *(i.e., how you compare to others)*

The following benchmarks are provided to add context to your project's energy performance. However, since every building is unique, your best benchmark is your own project's performance over time.

National USGBC Study from New Buildings Institute[1]

The New Buildings Institute (NBI) and the U.S. Green Building Council (USGBC) published a report in March 2008 that examined the actual energy performance of 121 LEED® New Construction (NC) buildings. The researchers concluded that "the median measured EUI was 69 kBtu, 24% below (better than) the CBECS national average for all commercial building stock." NBI benchmarks are shown in shades of purple in the chart at right and defined below.

"NBI LEED (all)" is the median EUI for all 121 buildings in the study.

"NBI LEED Gold-Platinum" is the median EUI for all median energy use for Gold and Platinum LEED® projects in the study.

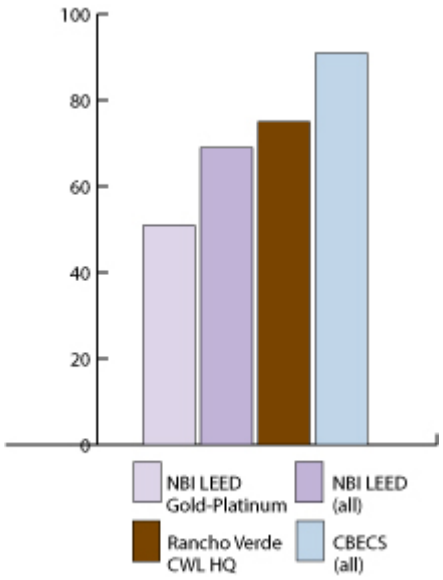
Commercial Building Energy Consumption Survey(CBECS)

CBECS is a database of building energy consumption maintained by the Energy Information Agency (EIA) of the U.S. Department of Energy. It may be helpful to think of CBECS as a census of buildings administered every 4 years. This report references the 2003 survey.

The survey asks respondents for details on building energy sources and consumption, energy-using equipment, and selected conservation measures. The survey samples conventional commercial buildings as well as green ones and doesn't differentiate between the two. The CBECS benchmarks are shown in shades of blue in the chart at right and defined below.

"CBECS all" refers to commercial buildings in CBECS (national)[2]

Figure 4 Benchmarking your EUI (in brown) to others*



*benchmark values are a median

Table 3 Summary of your project's energy use compared to selected benchmarks

	NBI LEED (all)	NBI LEED (Gold-Platinum)	CBECS (all)
Benchmark EUI (kBtu/sf/yr)	69	51	91
How your actual EUI, *75*, compares to the benchmark	9% higher	47% higher	18% lower

Remember, when comparing EUI a *lower* value means a project is performing better, and a *higher* number means a project is not performing as well

1 Turner, C. and Frankel, M. (2008). Energy Performance of LEED® for New Construction Buildings. for U.S. Green Building Council. New Buildings Institute, White Salmon, WA.

2 Turner, C and Frankel M. (2008). From CBECS www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/

3b. Performance Results – Greenhouse Gas Emissions

The consumption of electricity and natural gas account for about 60% of greenhouse gas emissions in the Chicago region (according to Chicago Climate Action Plan).

The building emissions reported here are calculated from your projects actual energy use and are reported in carbon dioxide equivalents (CO_2e) to account for the varying global warming potential of carbon dioxide and other greenhouse gases.

Table 4 Summary of your project's greenhouse gas emissions

	Emissions (lbs CO_2e/yr)	**Emissions** (lbs CO_2e/sf/yr)
Measured greenhouse gas emissions	316,395	19.2

3c. Performance Results – Transportation Energy Intensity (TEI)

Transportation energy intensity (TEI) is a metric that is commonly used to measure how efficiently freight is transported. Here it is used as a metric to compare energy use from commuting to energy use in buildings. The project's TEI is calculated by converting the vehicle miles traveled (VMT) by passenger vehicle to energy consumed in kBtu. TEI is a developing metric and, as yet, there are no benchmarks available to compare your performance to others.

The data to determine your project's TEI was collected from the optional employee commute survey. See section 5B for further analysis and Appendix B for a complete report of responses and written comments.

Table 5 Summary of your project's transportation energy intensity (TEI)

	VMT (miles driven/occupant/yr) *	**Energy Consumption** (kBtu/yr)	**Energy consumption** (kBtu/occupant/yr)*	**Energy consumption** (kBtu/sf/yr)
All employees** (34 people)	2,883	474,680	13,961	28.8

*occupant refers to staff only and does not include building visitors

** all employee data extrapolated from information provided by survey respondents. See section 5b for details.

4. Other Costs and Benefits Summary

To date, there is no definitive, industry standard benchmark for the cost of green buildings. The research concludes that green buildings can provide financial and other quantifiable benefits but, as with conventional buildings, there is a large variation due, in part, to building use. Some buildings perform better or worse than others and some buildings cost more or less to build and operate than others, irrespective of whether or not they are LEED®.

The *Regional Green Building Case Study Project* strives to contribute to ongoing research of this topic and, to this end, gathered information about the financial, health and productivity (indoor environmental quality) costs and benefits of each project. Below is a summary of the answers provided by the project contact for this particular project.

Summary of your project's financial, indoor environmental quality (IEQ) and other benefits (as reported):

- The cost of your project was reported as $251.86/sf (total cost)
- No green premium or ROI noted
- Financed with a bank construction loan and remediation and infrastructure funding was provided by tax increment financing through the City of Chicago
- Benefits (as reported by project contact):
  - The building attracts a lot of attention, so people that may not have heard of CWL otherwise have inquired about employment
  - Indoor air quality in the building CWL previously occupied was very poor. Staff have experienced reduced respiratory issues (including asthma) as a result of moving into the Rancho Verde building.
- No indication of confidentiality concerns pertinent to this case study project.

5. Survey Results

In an effort to augment the building performance data provided by project contacts CNT offered 2 optional surveys for staff of projects included in the *Regional Green Building Case Study*. The surveys were conducted online; one survey assessed occupant comfort while the other examined employee commuting patterns. Your project elected to participate in both surveys. This section provides a summary of the survey results and further details are in the appendices.

5a. Occupant Comfort Survey Results

The occupant comfort survey included 33 questions designed to better understand the functional comfort of the building for those who work in it. Respondents were asked to rank different aspects of the work environment on a scale of 1 to 5 and were prompted to write in observations for each category of questions:

- light level
- noise
- temperature
- air quality/ventilation comfort

Participation statistics for your project

Overall response rate: 62%
Total invitation sent: 34
Number of responses: 21

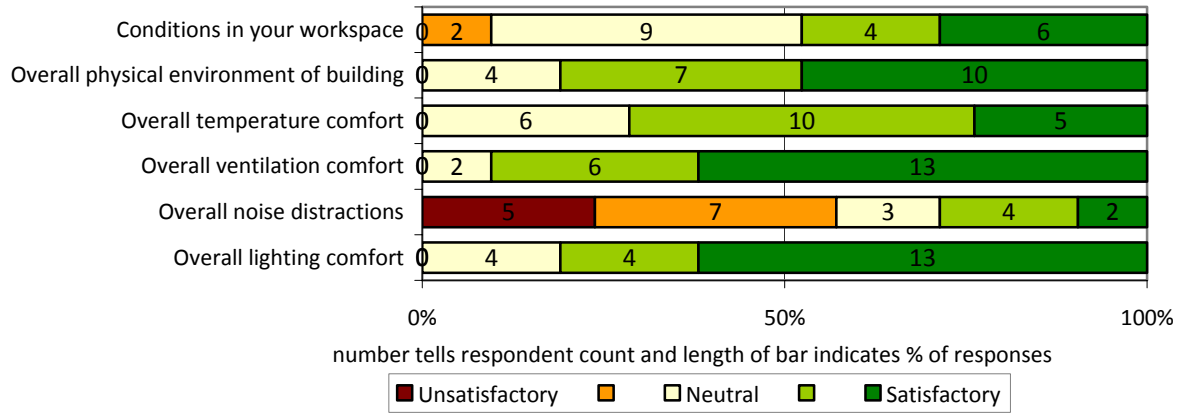
Summary of your project's occupant comfort

The responses to the survey questions were generally positive, indicating a good degree of occupancy comfort. The majority of responses were favorable for 16 of the 26 questions and 12 questions received no unfavorable responses at all. The question regarding the amount of daylight scored the highest; the other questions in the lighting category also scored well with only a few unfavorable responses regarding glare from windows. The air quality category also scored well with only a little dissatisfaction regarding ability to adjust ventilation.

The questions regarding noise did not score well with 4 such question receiving a majority of unfavorable responses. The question regarding background noise levels scored the lowest and had no satisfactory responses. There was also some dissatisfaction communicated with building temperature, particularly temperature shifts and ability to adjust room temperature.

A complete list of responses and written comments can be found in Appendix A.

Figure 5 Summary response distribution for the occupant comfort survey



5b. Employee Commute Survey Responses

The employee commute survey included 17 questions designed to calculate the amount of energy associated with getting staff to and from the building (transportation energy intensity TEI), to asses if/how commute affects occupant satisfaction, and to assess what amenities or services offered by employers are being utilized. This section provides a summary of the survey results. See appendix B for a complete report of responses and written comments.

There are no definitive benchmarks to compare transportation energy commute performance because TEI is a developing metric. Efforts to determine the best methodology for calculating the employee commute impacts on building performance is ongoing. The project team thanks you for participating in this optional survey; you are at the vanguard of green building performance evaluations.

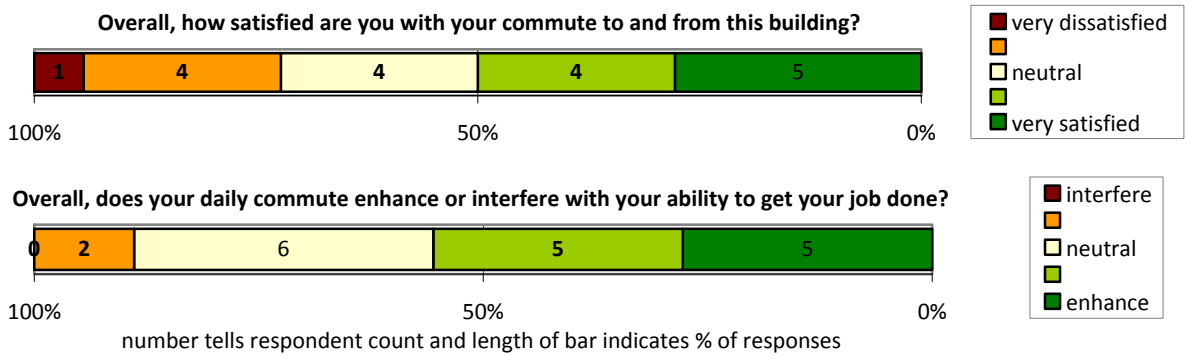
Participation Statistics for your project

Overall response rate: 56%
Total invitation sent: 19
Number of responses: 34

Summary of your project's commute satisfaction

Half the respondents are satisfied with their commute and none think it interferes with their ability to do their job. That's good.

Figure 6 Summary response distribution for the employee commute survey



Commute distance and modes

Sixteen of the respondents, 47%, drive alone (or with children under 16) at least a few days per week and a few carpool or utilize alternative forms of transportation, such as bike and bus. It is encouraging to see that staff members are taking advantage of alternative methods of transportation, especially since this project received 4 LEED points for Alternative Transportation.

Figure 7 Distance traveled TO this building

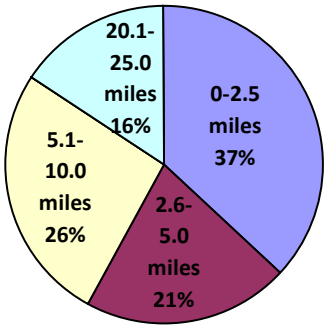


Figure 8 Frequency of transportation modes to work

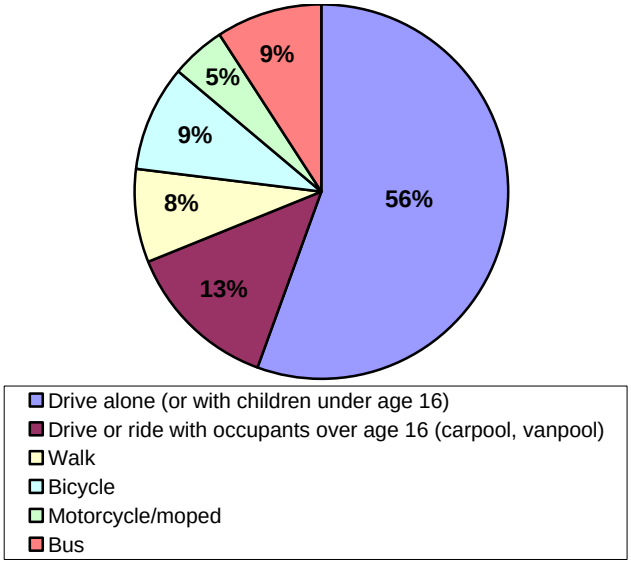


Table 6 Summary of your commute statistics

	Christy Webber Landscapes*
Average 1 way commute distance national average = 12miles	6.6 miles
Total vehicle miles traveled (VMT) in a passenger vehicle (% of total commute miles)	98,027 miles/yr (92 %)

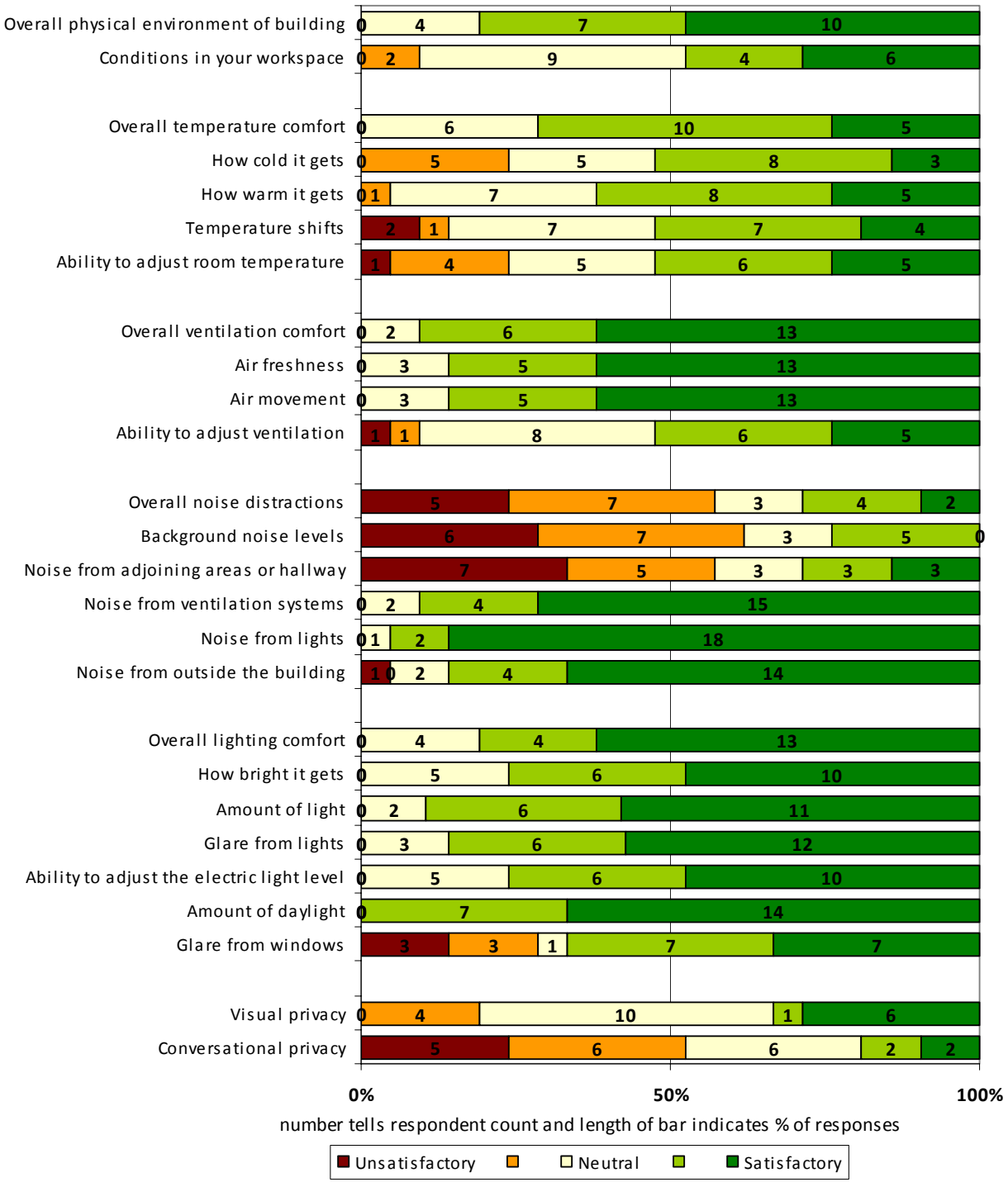
* based on extrapolation of information provided by survey respondents

Transportation amenities/ services utilized

All but one respondent indicated that they utilize employer provided vehicles for trips during the work day. Most respondents indicated that they do not use priority or reserved parking for carpools or hybrids nor do they use the changing room intended for bicyclists and walkers, though almost everyone was aware of the availability of these amenities. And, it is worth noting, that there was some indication of confusion regarding telecommuting and other amenities because some people indicated that their employer does not offer an option that others use regularly or on occasion (see Appendix B Question 8 for details).

Appendix A. Full report of responses from the occupant comfort survey

Figure 9 Response distribution for the occupant comfort survey



Written responses to the occupant comfort survey

Other observations about temperature level and control:

answered question	7
skipped question	14

Response Text. Each box contains the written comments of one respondent.
Fast response by system to adjust in temp once manually adjusted.
The temperature fluctuates at different areas in the office. My old desk area was always cold but my new one is comfortable.
more often than not the temperature is fine but occasionally it is too cold or too hot in certain areas
many different factors as to the appropriate temp required in a section, who is at their desk, is it the first day of the week, more people in the office equals more warm bodies, is it sunny giving the illusion or warmth - Overall the changes that need to occur are minor and thankfully for comfort sack we have controls throughout the building.
we are often cold in our section, but we sit stationary more than others in the office
I am constantly chilly in this building and have not figured out a way to adequately control the temperature around me.
There are definite swings in temperature, and it's certainly not consistent throughout the office. some parts are very cold, while others are warm, even if the settings on the thermostat are the same.

Other observations about air quality:

answered question	3
skipped question	18

Response Text. Each box contains the written comments of one respondent.
Great! None of the shop fumes enter the office space like the old office.
We have a very nice system in place and in addition to that we have all the windows should we really need to open up the office for fresh air.
I'm not sure if we have the ability to adjust the actual ventilation, so I put "poor or no controls"; even though that may not be entirely accurrate

Other observations about noise:

answered question	9
skipped question	12

Response Text. Each box contains the written comments of one respondent.
Noise from humans talking
Since there are no walls the noise travels very far. When the front desk gets a phone call it can be heard from the middle of the office.
I believe once the desk tops were covered with linoleum that helped a little with the noise. We still need to be respectful of the open space and control our volume or that of any visitors. In addition we have conference rooms that can be used more readily than perhaps we are accustomed to.
When THERE ARE A LOT OF PEOPLE INTHE OFFICE, THE NOISE LEVEL BECOMES DISTRACTING.
Outside noise is negligible, even though we are right next to the Union Pacific Rail Yard.
open office space tends to get noisy
We are able to open the windows, but the neighboring Metra yard is often noisy and stinky.
I work in the large "main"; office and often have difficulty making phone calls or trying to think at my desk due to high volume levels around me.
Voices and overall noise definitely travels in here; there are sometimes when people are talking and I have to ask them to be quiet because the person on the phone is having trouble hearing me.

Other observations about light levels and control:

answered question	9
skipped question	12

Response Text. Each box contains the written comments of one respondent.
A hat or sunglasses is needed quite often to shield the sun while walking though the building or working at my desk.
Sometimes the glare is blinding
The sun light is blinding sometimes during the day as it comes through the top windows.
Glare from the winter sun is a big problem. At least twice a day it is difficult to see the computer screen at a number of desks, and the sun's glare is also often in your eyes while sat at these desks.
some shadowing in December because direct light is allowed in which causes shadowing and glare
During the winter, there is glare from the windows which at one time during the day or another disrupts people's work (due to the light hitting their computer monitors)
Certain areas of the office at certain times of day have major light issues due to sunlight coming in at bad angles. The people who are affected by this have resorted to wearing baseball caps sideways, trying to build walls to block light, etc to allow them to use their computer and/or work comfortably.
There are times throughout the day in which I have to wear a hat to block the sunlight from blinding me while sitting at my desk, or I have shield my eyes one way or another in various parts of the office depending on what time of day. Those are the only complaints I have about the lighting in here.
Sometimes the sun shines a little extreme through the accounting office windows

What is the one thing that you like most about this building?

answered question	15
skipped question	6

Response Text. Each box contains the written comments of one respondent.
The daylight, the good air and temp.
It being environmentally friendly (being "green").
the natural light and open atmosphere
The warm or cool floors.
BRIGHT ATMOSPHERE, REAL SUNLIGHT
The position of the windows The simplicity of the design
Visually appealing and good natural light.
Makes me feel good that we are helping the earth by all systems that run the building either using the sun or the earth.
space
Having my own area to work in.
It really is a nice, bright place to work. Though it is sometimes difficult to work due to the open nature of the space, there are other areas that are usual available which are more private.
I like the windows for the natural light and views to the outside.
chicks dig it
The windows!
Natural light.

What is the one thing you would most like to see improved about this building?

answered question	14
skipped question	7

Response Text. Each box contains the written comments of one respondent.
Sound buffer from co-worker talking--too open conversation heard across the entire open floor plan.
Blocking some of the sun that comes in so that we are able to do our job without being blinded.
the consistency of the heating/cooling system, glare from the windows in the winter months
Noise absorption by the materials used. It would be nice to still have the openness while also combating the office volume that can increase sometimes more than it should.
NOISE LEVEL WHEN FULL
The noise reduction in the office and hallways
Office noise and sun glare issues.
The lighting has been a problem, more about the company's inability to stand by the product. There are still several problems with our plumbing and windows because the contractor didn't do a good job.
temperature control
There is a gap where the outside door in front of my desk does not meet the floor - Cold air can come right in!
Sound control. As previously stated, it can difficult to carry on a conversation, use the phone, even think straight due to volume level in the main room.
should have built it bigger
noise levels reduced
Noise level is terrible

Appendix B. Full report of responses for the employee commute survey

Question 1. Which of the following most fits your normal work schedule?

Answer Options	Response Frequency	Response Count
3 days a week	0.0%	0
4 days a week	0.0%	0
5 days a week	94.7%	18
9 days in 2 weeks	0.0%	0
Other (please specify)	5.3%	1
	answered question	19
	skipped question	0

Other (please specify)	6 days per week if not more

Question 2. ONE WAY, how many miles do you commute from home TO your usual work location?
(Do NOT use roundtrip or weekly distance. Include errands or stops made daily on the way to work. You may enter a whole number or a decimal value. If you do not know the distance, you can calculate using www.maps.google.com or www.mapquest.com).

Response Text. Each box contains the written comments of one respondent.					
1.5	2.5	3	4	6.5	20
2	2.5	3.1	6	7	20
2	2.5	4	6	9	22
2					

Question 3. Please identify all modes of transportation that you use to commute to this building in a typical week. You may select multiple modes in a single day (for example, choose 'Walk' and 'Bus' if you walk from your home to and from the bus stop).

Answer Options	Mon	Tues	Wed	Thur	Fri	Sat	Sun	Response Count
Drive alone (or with children under age 16)	16	16	15	16	16	3	2	16
Drive or ride with occupants over age 16 (carpool, vanpool)	4	4	4	4	4	0	0	4
Walk	2	2	2	2	2	1	1	2
Bicycle	2	3	2	3	2	1	1	3
Motorcycle/moped	1	1	1	1	1	1	1	1
Bus	3	2	3	2	2	1	1	3
Train (commuter rail, subway, light rail, Amtrak)	0	0	0	0	0	0	0	0
Streetcar or trolley	0	0	0	0	0	0	0	0
Ferryboat	0	0	0	0	0	0	0	0
Taxi	0	0	0	0	0	0	0	0
Telecommute	0	0	0	0	0	0	0	0
Do NOT work (day off, compressed work week, etc)	0	0	0	0	0	5	5	5
Work at another location	0	0	0	0	0	0	0	0
Other mode (please specify)								0
							answered question	19
							skipped question	0

Question 4. IF you selected "Drive alone (or with children under age 16)" or "Drive or ride with occupants over age 16 (carpool, vanpool)" for question 3, What CLASS of vehicle do you typically drive to this building?

Answer Options	Response Frequency	Response Count
Hybrid vehicle	0.0%	0
Passenger car (non-hybrid)	61.1%	11
Van	0.0%	0
Sports utility vehicle	27.8%	5
Pickup truck	11.1%	2
Other (please specify)	0.0%	0
	answered question	18
	skipped question	1

Question 5. IF you selected "Drive alone (or with children under age 16)" or "Drive or ride with occupants over age 16 (carpool, vanpool)" for question 3, how many people are usually in the vehicle, including yourself?

Answer Options	Response Frequency	Response Count
One	33.3%	2
Two	66.7%	4
Three	0.0%	0
Four or more	0.0%	0
	answered question	6
	skipped question	13

Question 6. IF your daily commute to work includes multiple transportation modes (for example: drive to commuter train, commuter train to central business district, taxi to office etc.), What MODE is the LONGEST leg of your commute (in distance, not time)? (if you use a single mode to commute, skip to question 8)

Answer Options	Response Frequency	Response Count
Drive (alone or with occupants)	16.7%	1
Walk	0.0%	0
Bicycle	0.0%	0
Motorcycle/moped	0.0%	0
Bus	0.0%	0
Train	0.0%	0
Streetcar or trolley	0.0%	0
Ferryboat	0.0%	0
Taxi	0.0%	0
Not applicable, I don't commute using multiple modes	66.7%	4
Other (please specify)	16.7%	1
	answered question	6
	skipped question	13

Other (please specify)	I sometimes bike or take the bus instead of driving, but rarely use multiple modes. When I do, I am on the bus for the longest portion.

Question 7. How many miles do you travel on the LONGEST leg of your commute?

answered question	4
skipped question	15

Response Text. Each box contains the written comments of one respondent.	
2.5	5
2.6	22

Question 8. Please indicate if you utilize any of the following amenities at your workplace.

Answer Options	I use regularly	I use occasionally	I do not use	My workplace does not offer	I don't know if my workplace offers	Response Count
Employer-provided vehicle for trips during the workday	6	11	1	0	0	18
Reimbursable taxi or transit trips during the workday	1	3	8	2	4	18
An immediate ride home in case of emergency (guaranteed ride home)	0	2	9	3	4	18
Employer subsidy or coordination for carpools or vanpools	0	3	3	9	3	18
Priority, reserved or discounted parking for carpools or vanpools	0	1	12	4	1	18
Priority, reserved or discounted parking for hybrid vehicles	0	1	17	0	0	18
Parking cash outs	1	0	3	9	5	18
Pre-tax transit benefits	0	0	3	6	9	18
Secure and/or indoor parking for bicycles	1	2	10	4	1	18
Changing room with lockers (or similar storage)and/or showers for bicyclists and walkers	0	3	15	0	0	18
On-site childcare, banking, dry cleaning, fitness center or other services	1	0	1	15	1	18
On-site food service or other kitchen facilities	9	4	1	4	0	18
Childcare, banking, dry cleaning, fitness center, or other services within 5 minute walking distance from building	1	1	1	13	2	18
Food service options within 5 minute walking distance from building	1	0	3	12	2	18
Telecommuting, compressed workweek or flex time	0	1	3	13	1	18
					answered question	18
					skipped question	1

Question 9. Overall, does your daily commute enhance or interfere with your ability to get your job done?

Answer Options	very satisfied		neutral		very dissatisfied	Rating Average	Response Count
select one	5	4	4	4	1	2.56	18
						answered question	18
						skipped question	1

Question 10. Overall, does your daily commute enhance or interfere with your ability to get your job done?

Answer Options	enhance		neutral		interfere	Rating Average	Response Count
select one	5	5	6	2	0	2.28	18
						answered question	18
						skipped question	1

Question 11. What is your 5 digit home zip code? Note: This information will only be used to calculate distance and will not be used for any other purpose.
Not reported due to confidentiality concerns.

Question 12. What is the closest major intersection to your home? (For example: 49th St. & Locust Ave.) Note: Do NOT list home address. This information will only be used to calculate distance and will not be used for any other purpose.
Not reported due to confidentiality concerns.

Question 13. While you are at work do you leave the workplace during your shift and then return to work?

Answer Options	Response Frequency	Response Count
No	17.6%	3
Yes	82.4%	14
	answered question	17
	skipped question	2

Question 14. IF you selected 'Yes' to question 13, how far do you typically travel for each trip away from the workplace?

Answer Options	Less than 5 miles	5 to 15 miles	More than 15 miles	Not applicable	Response Count
1st trip	10	5	0	0	15
2nd trip	3	5	0	1	9
3rd trip	4	2	0	2	8
				answered question	15
				skipped question	4

Question 15. IF you selected 'Yes' to question 13, what mode of travel do you use for each trip away from the workplace?

Answer Options	Vehicle	Public transit	Bicycle	Walk	Not applicable	Other (please specify below)	Response Count
1st trip	15	1	0	0	0	0	15
2nd trip	8	0	0	0	1	0	9
3rd trip	6	0	0	0	2	0	8
Other mode (please specify)							0
						answered question	15
						skipped question	4

Question 16. What is the one thing you like most about your commute?

answered question	14
skipped question	5
That it is close to home	
It is short!	
It is pretty easy, no highways.	
That it is a short commute.	
QUICK	
Fairly close and fairly traffic free (for the most part).	
The short trip	
short and quick.	
The time, there is very little traffic when I come to work.	
It is short.	
That I live in a location that I have options of what roads to take home.	
It's short - only 3 miles from shop. can bike if I get truck problems	
It's not far from home!	
I can wake up @ 7:15. Shower, walk the dog, get coffee, and still get to work by 8:00.	

Question 17. What is the one thing you would most like to see improved about your commute?

answered question	13
skipped question	6
More safety to take public transportation	
Less traffic.	
NOTHING	
I don't believe anything can be done about it, but the trip home is BRUTAL.	
rush hour travel times AM and PM	
Damaged streets (pot holes), Litter, Debris (broken glass, garbage)	
nothing.	
Sending less time driving	
More transit options! I have to take two buses to get to Sacramento and Chicago, which is still a 1/2 mile walk from our building. I do not mind walking, but it is a really unpleasant area - passing prostitutes and tow truck drivers and risking your life dodging vehicles racing on the service drive so they can bypass the light at Sacramento and Franklin. By bus = 45 minutes min, by car = 15 minutes max.	
That it was shorter.	
nothing	
Public transportation more accessible or at least to find a safe mode of transit from Chicago Ave to the building would be nice, whether that's arranging a partner type commute or something.	
I don't own a car, so I walk home from work most nights. I really don't like having to walk by the tow truck drivers, gang bangers, and “working” girls that hang out on the frontage road along Sacramento heading to Chicago Ave.	

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