

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

Year 1 Final Report - Executive Summary
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Steering Committee

Bob Newport and Chris Choi, U.S. EPA, Region 5

Jennifer Wang, Kindy Kruller, Elise Zelechowski, and Kevin Dick, Delta Institute

David O'Donnell, City of Chicago, Department of Environment

Michael Berkshire, City of Chicago, Department of Zoning and Land Use Planning

Rachel Scheu, Anne Evens, Larry Kotewa and Kathryn Eggers, Center for Neighborhood Technology

Doug Widener, U.S. Green Building Council – Chicago Chapter

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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- Saint Xavier University, Rubloff Hall, Chicago, IL

Project Director

Doug Widener, U.S. Green Building Council-Chicago Chapter

Project Researcher

Center for Neighborhood Technology

USGBC-Chicago Chapter, Research Subcommittee

Neil Leslie, Gas Technologies Institute

Helen Kessler, HJKessler Associates

George Tuhowski, Leopardo Companies

Jason Westrope, Development Management Associates, LLC.

Likwan Cheng, City Colleges of Chicago

Will Cordray

Alicia Ponce, ap.MonArch LLC

Shweeta Manchanda

Jeff Pekarek, Trane

Rich Prohov, Prohov & Associates, LTD.

Ephi Maglaris

Tony Holub, DKA Design

Case Study Designer

Tony Holub, DKA Design

Additional Contributors

Susan Casey, Jessica Spanier, Michael Welton, Center for Neighborhood Technology
Karin Miller, USGBC-Chicago Chapter Project Intern
Cathy Turner, New Buildings Institute

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.

For questions about this report, please contact:

Doug Widener, U.S. Green Building Council – Chicago Chapter, dwidener@usgbc-chicago.org
Stephanie Folk, Center for Neighborhood Technology, sfolk@cntenergy.org

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)

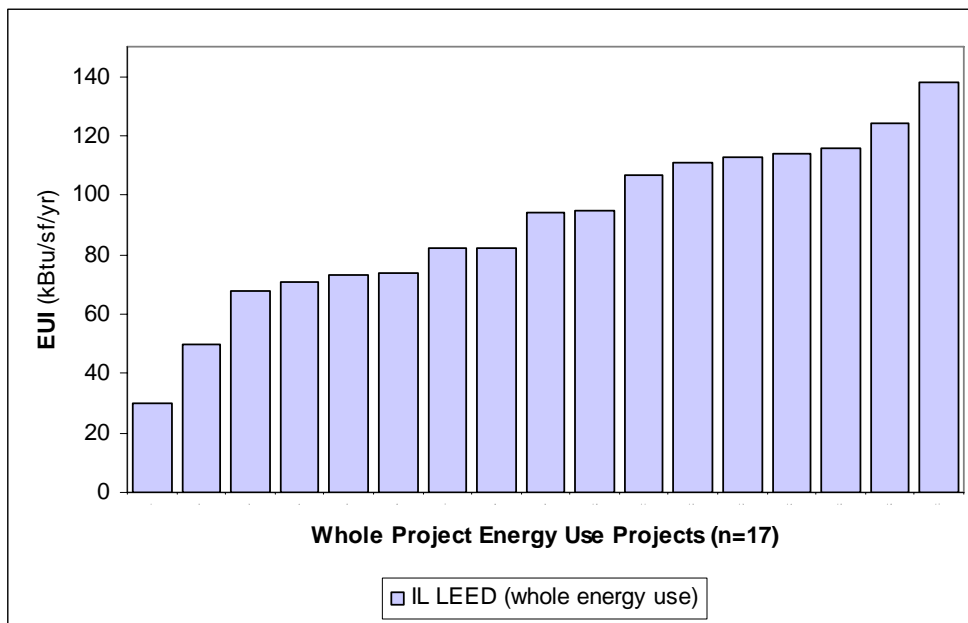


Figure ES1: Distribution of Participating Whole Project Energy Use Project EUIs

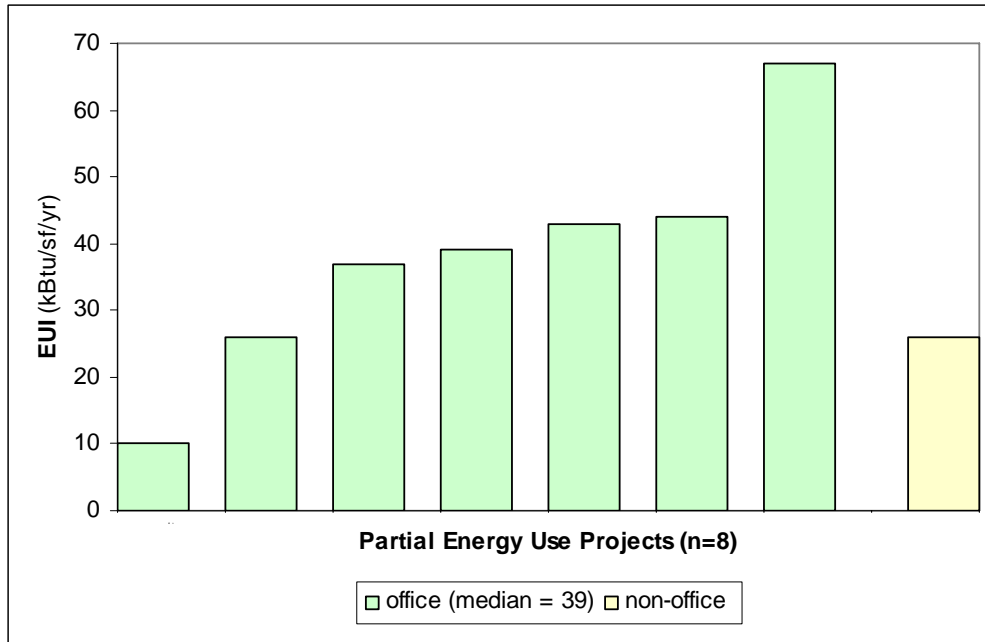


Figure ES2: Distribution of participating Partial Energy Use Project EUIs

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 (CO₂e) /square foot/year for whole project energy use projects is 25.8 lbs/sf/year. For partial energy use projects the median CO₂e is: 13.8 lbs/sf/year. CO₂e 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.

For questions about this report, please contact:
Doug Widener, U.S. Green Building Council – Chicago Chapter, dwidener@usgbc-chicago.org
Stephanie Folk, Center for Neighborhood Technology, sfolk@cntenergy.org

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