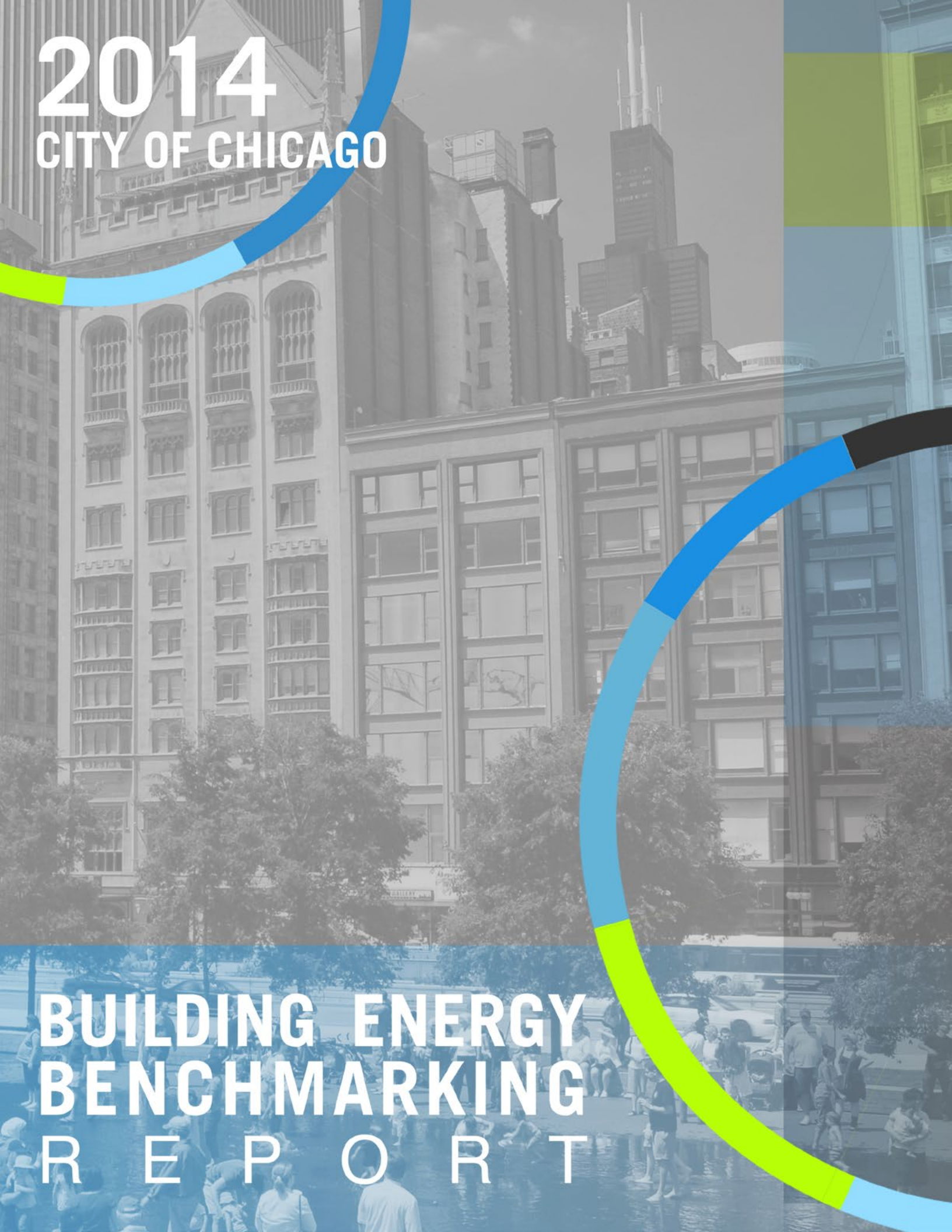
2014
CITY OF CHICAGO



BUILDING ENERGY BENCHMARKING REPORT

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I. EXECUTIVE SUMMARY

As an economic hub, a global destination, a great place to live, and a leader on environmental sustainability, Chicago is defining what it means to be a world-class city. Chicago's 500,000 buildings are vibrant connections to the city's history, and these buildings house the activities that are carrying Chicago forward into the 21st century. The energy used by buildings powers Chicago's economy and profoundly impacts the natural environment.

By raising energy performance awareness and transparency, Chicago's Building Energy Use Benchmarking Ordinance[1] unlocks information to help accelerate efforts to save energy and strengthen the economy. The ordinance delivers on ambitious energy priorities outlined in Sustainable Chicago 2015, Mayor Emanuel's three-year action agenda to make our city more livable, competitive, and sustainable.[2]

In 2014, the initial phase of Chicago Energy Benchmarking required municipal and commercial buildings larger than 250,000 square feet to track whole-building energy use, verify data accuracy, and report to the City. The policy is creating a foundation of information for efforts to unlock significant energy savings, and phased implementation through 2016 will include commercial, municipal, and residential buildings larger than 50,000 square feet.

CHICAGO ENERGY BENCHMARKING FINDINGS FROM CALENDAR YEAR 2013

As a national leader on energy benchmarking, Chicago is driving citywide engagement and uncovering actionable insights to help understand and improve building energy performance. Key 2014 findings from the data include:

1. Widespread first-year building participation:

- 348 buildings spanning 260 million square feet reported in 2014 (including voluntary or early compliance by 77 facilities)
- 11% of citywide energy consumption was covered by reporting buildings
- 78% of Chicago's communities housed reporting buildings
- 90%+ compliance among buildings required to report in 2014

2. Unprecedented, sector-specific data on energy use in Chicago's largest buildings:

- Building size or age appears to have little effect on energy intensity,[3] but building space use is a primary driver of energy intensity
- Median ENERGY STAR® Score was 76 out of 100 (for buildings eligible to receive a score)
- Chicago energy performance is in-line with comparable buildings in other major markets, including New York City, Philadelphia, and Washington, D.C. and it exceeds national averages for comparable US buildings
- Commercial offices comprise 61% of the buildings required to report in 2014. Other property types include healthcare, schools, higher education facilities, and 'other' buildings

3. Enormous opportunity to save money, reduce emissions, and create jobs from improving all buildings' energy intensity to 50th percentile (average) and 75th percentile (above-average), by sector:

- 13%–23% total energy reduction[4]
- $44M–77M energy cost savings
- 460,000–844,000 tons of avoided greenhouse gas emissions (equivalent to removing 95,000–175,000 cars from the road)
- More than 1,000 jobs from investments to achieve these savings

The following pages explore overall and sector-specific findings on the energy performance of many of Chicago's largest buildings, along with specific actions for pursuing cost-effective efficiency improvement.

> **"Energy benchmarking engaged the real estate and energy communities to increase transparency of building energy use and has uncovered tens of millions of dollars in potential savings. Delivering those savings will increase competitiveness as we work toward a brighter economic and environmental future for our city."**
>
> **- Mayor Rahm Emanuel**

[1] Full text of the Chicago Building Energy Benchmarking Ordinance available at: http://www.cityofchicago.org/energybenchmarking
[2] Sustainable Chicago 2015 Action Agenda: http://www.cityofchicago.org/sustainability
[3] Energy intensity is the energy consumption per square foot of building area. While energy intensity is a key factor related to overall energy efficiency, other factors such as occupancy, operating hours, and specific building attributes should be taken into consideration to determine if a building is considered highly energy efficient
[4] Total reduction in weather-normalized source energy use for buildings required to report in 2014

TAKING ACTION TO IMPROVE ENERGY EFFICIENCY

The following suggestions outline concrete actions to begin improving energy performance:[5]

1. Designate an energy champion for each facility and/or organization.
2. Track annual and interval (monthly/weekly/real-time) energy use data to understand energy use and to identify potential savings.
3. Develop an energy performance improvement plan with specific short-term, medium-term and long-term goals.
4. Perform an energy audit to identify savings opportunities (including low-cost and no-cost actions).
5. Perform retro-commissioning on existing systems to maximize efficiency and ensure efficient operations.
6. Conduct an occupant survey to identify areas for comfort and savings improvement.
7. Develop energy efficient design standards for new construction, renovations, and equipment purchasing.
8. When planning facility improvements, work with a design professional to set goals for energy efficiency.
9. Investigate utility and tax incentive programs to help fund efficiency improvements.
10. When renovating, consider installing capability to support potential future renewable energy installations.
11. Perform routine maintenance and regularly test building equipment to ensure high energy performance.
12. Explore green building certifications (including ENERGY STAR) that recognize energy efficiency.

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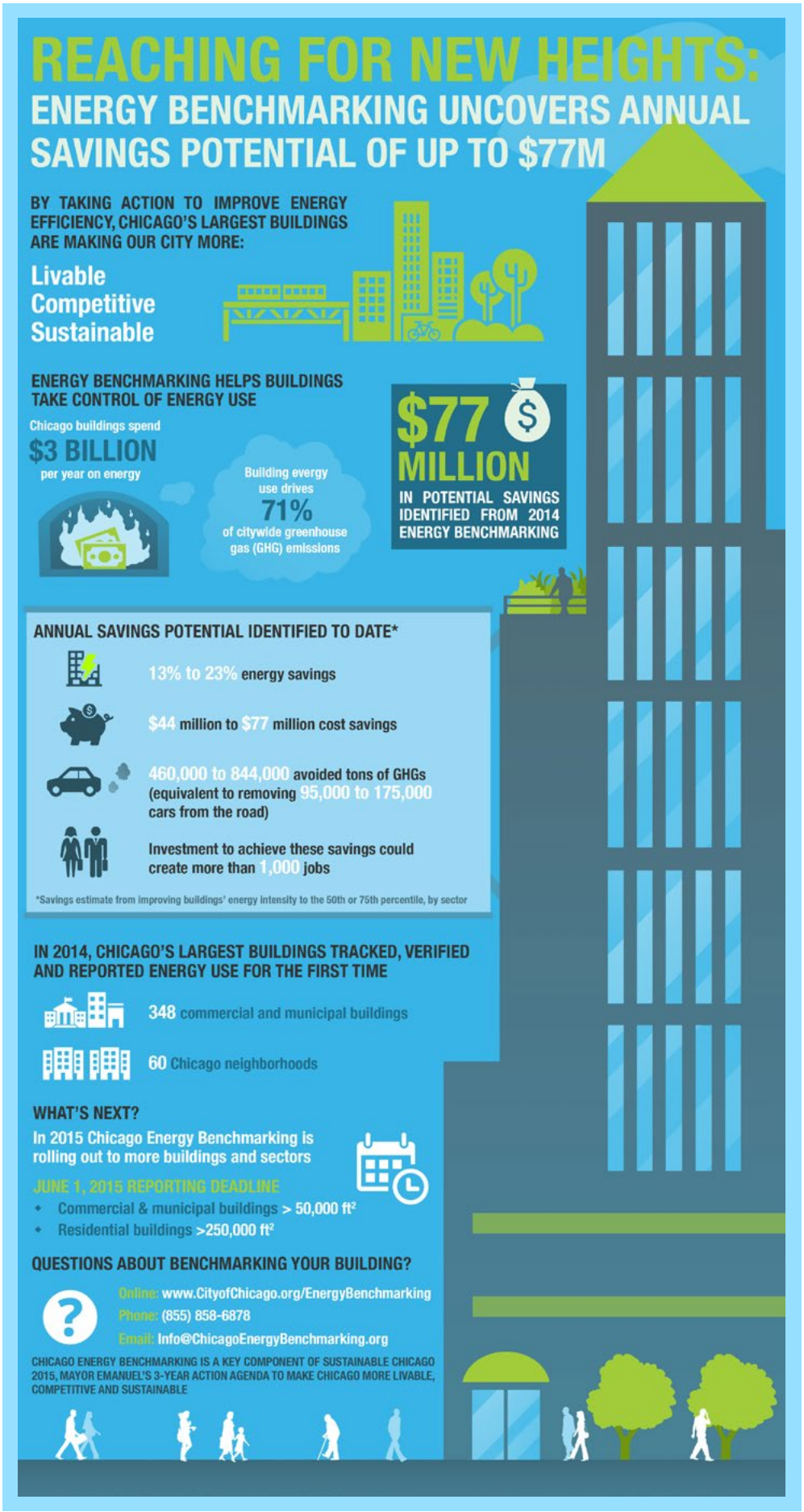
[5]American Institute of Architects' Chicago Chapter AIA 2030 Working Group www.aiachicago.org and ASHRAE Illinois Chapter http://www.illinoisashrae.org/

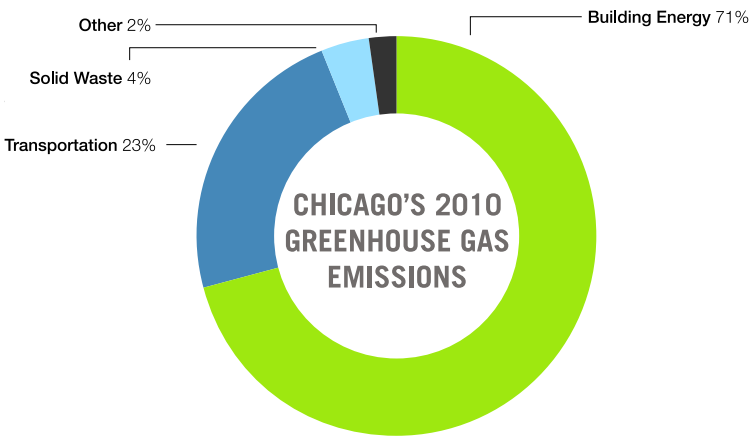
2014 CHICAGO ENERGY BENCHMARKING AT-A-GANCE:



II. INTRODUCTION TO CHICAGO ENERGY BENCHMARKING

Chicago's renowned skyline is filled with the places where we live, work and play, and the energy used to power these buildings directly affects our economy and environment. Collectively, Chicagoans spend $3 billion per year on energy use in buildings, which contributes 71 percent of total citywide greenhouse gas emissions (see Figure 1).[6] Increasing building energy efficiency provides a significant opportunity for cost savings, increased competitiveness, and improved resiliency across the city.

FIGURE 1: SOURCES OF CHICAGO GREENHOUSE GAS EMISSIONS (2010)



CHICAGO ENERGY BENCHMARKING AND SUSTAINABLE CHICAGO 2015

In 2012, Mayor Rahm Emanuel released Sustainable Chicago 2015, a three-year action agenda to make Chicago more livable, competitive, and sustainable. This plan includes a call to increase the transparency of building energy performance. With higher than 90% compliance in 2014, the Chicago Building Energy Benchmarking Ordinance is helping to deliver on Chicago's sustainability vision.[7]

WHAT IS BENCHMARKING?

According to the U.S. Department of Energy, energy benchmarking is the process of accounting for and comparing a building's current energy performance with its energy baseline, or comparing a building's energy performance with the energy performance of similar buildings.[8]

Benchmarking improves stakeholders' understanding of building energy performance, allowing individuals and organizations to better analyze trends and make better-informed decisions to accelerate efficiency. The U.S. Environmental Protection Agency cites an average three-year energy use reduction of seven percent in benchmarked buildings from 2008 to 2011, based on analysis of more than 35,000 buildings.[9] These and other findings suggest significant savings potential is associated with energy benchmarking.

CHICAGO ENERGY BENCHMARKING OVERVIEW

In 2014, Chicago Energy Benchmarking called on municipal and commercial buildings larger than 250,000 square feet to benchmark, verify data, and report to the city:

- BENCHMARK: Track whole-building energy use and basic building characteristics using the free ENERGY STAR Portfolio Manager online tool.
- VERIFY DATA: Every three years, confirm the accuracy of reported data with an in-house or third-party verifier who holds a City-recognized license or energy credential.[10]
- REPORT TO THE CITY: Report basic building information and energy data to the City by June 1st of each year through Portfolio Manager.

2014 SUPPORT AND TRAINING

Within six months of passing Chicago's benchmarking ordinance, the City and its partners launched the Chicago Energy Benchmarking Help Center and a series of free, public training sessions to support buildings and other stakeholders. To date, there have been:

- 800+ Help Center phone and email interactions from March 2014 to August 2014
- 375 individual participants in 16 free trainings led by local and national energy experts

[6] Chicago 2010 Regional Greenhouse Gas Emissions Inventory: http://www.chicagoclimateaction.org/pages/research___reports/8.php
[7] Please refer to the appendix of this report for additional detail on 2014 compliance
[8] United States Department of Energy: Building Energy Use Benchmarking Guidance: http://www1.eere.energy.gov/femp/pdfs/eisa432_guidance.pdf
[9] ENERGY STAR Portfolio Manager Data Trends – Benchmarking and Energy Savings: http://www.energystar.gov/sites/default/files/buildings/tools/DataTrends_Savings_20121002.pdf
[10] The current City-recognized licenses and credentials for data verification are: Building Energy Assessment Professional (BEAP), Building Energy Technologies certificate (BET), Building Operator Certification (BOC), Certified Energy Manager (CEM), Licensed Architect, and Professional Engineer (PE)

2014 COVERED BUILDINGS AND REPORTED INFORMATION

Buildings required to report in 2014 include five primary property types, each of which includes both commercial and municipal buildings. The five property types are based on reported space use within each building:

- Commercial Office Buildings
- Healthcare Facilities
- K-12 Schools
- Higher Education / University Facilities
- Other Property Use Types

Using free ENERGY STAR Portfolio Manager online software, buildings covered by the benchmarking ordinance share basic property information and monthly energy fuel use, which inform standard, annualized energy metrics. See the Benchmarking Definitions for key metrics provided through energy benchmarking.

For some building attributes, such as the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) designation, reported building information was supplemented with additional external data sources.

Consistent with the Chicago Energy Benchmarking Ordinance, only aggregated calendar year 2013 building data that was reported in 2014 will be made public. The ordinance authorizes the City to share building-specific data with the public in the second year of reporting.

KEY METRICS & DEFINITIONS

One of the benefits of energy benchmarking is the use of common language and metrics to better understand building energy performance. Key terms used throughout this report include:[11]

ENERGY STAR Portfolio Manager: Free, online software developed by the U.S. Environmental Protection Agency to help buildings benchmark, verify, and report energy use and property information (www.EnergyStar.gov/PortfolioManager).

ENERGY STAR Score: A 1 to 100 rating calculated by Portfolio Manager to assess a property's overall energy performance, based on national data to control for differences among building uses and operations. Twenty-one property types are currently eligible for an ENERGY STAR score. A score of 50 represents the national median, while 100 represents a top performer; a score of at least 75 may make buildings eligible for ENERGY STAR Certification.

Fuel Mix: Fuel mix reflects the percentage of total annual energy use provided by each energy type (electricity, natural gas, district steam, etc.)

Greenhouse Gas (GHG) Emissions: Carbon dioxide (CO2) and other gases released as a result of energy generation, transmission, and consumption. GHG emissions contribute to climate change and are expressed in tons of carbon dioxide equivalent (CO2e).

Gross Floor Area (Building Size): Total interior floor space between the outside surfaces of a building's enclosing walls, expressed in square feet. This includes tenant space, common areas, stairwells, basements, storage, and interior parking.

Site Energy Use: Energy consumed on-site at a building, as measured by utility bills, and expressed in kBTUs.

Source Energy Use: Energy required to operate a property, including on-site consumption, as well as energy used for energy generation, transmission, and distribution; expressed in kBTUs.

Weather-Normalized Energy Use: Site and/or source energy (kBTUs) that a property would have consumed under 30-year average weather conditions, based on actual energy use for a given time period. This metric controls for temperature fluctuation (such as a very warm summer in a particular year) and allows energy comparisons over time.[12]

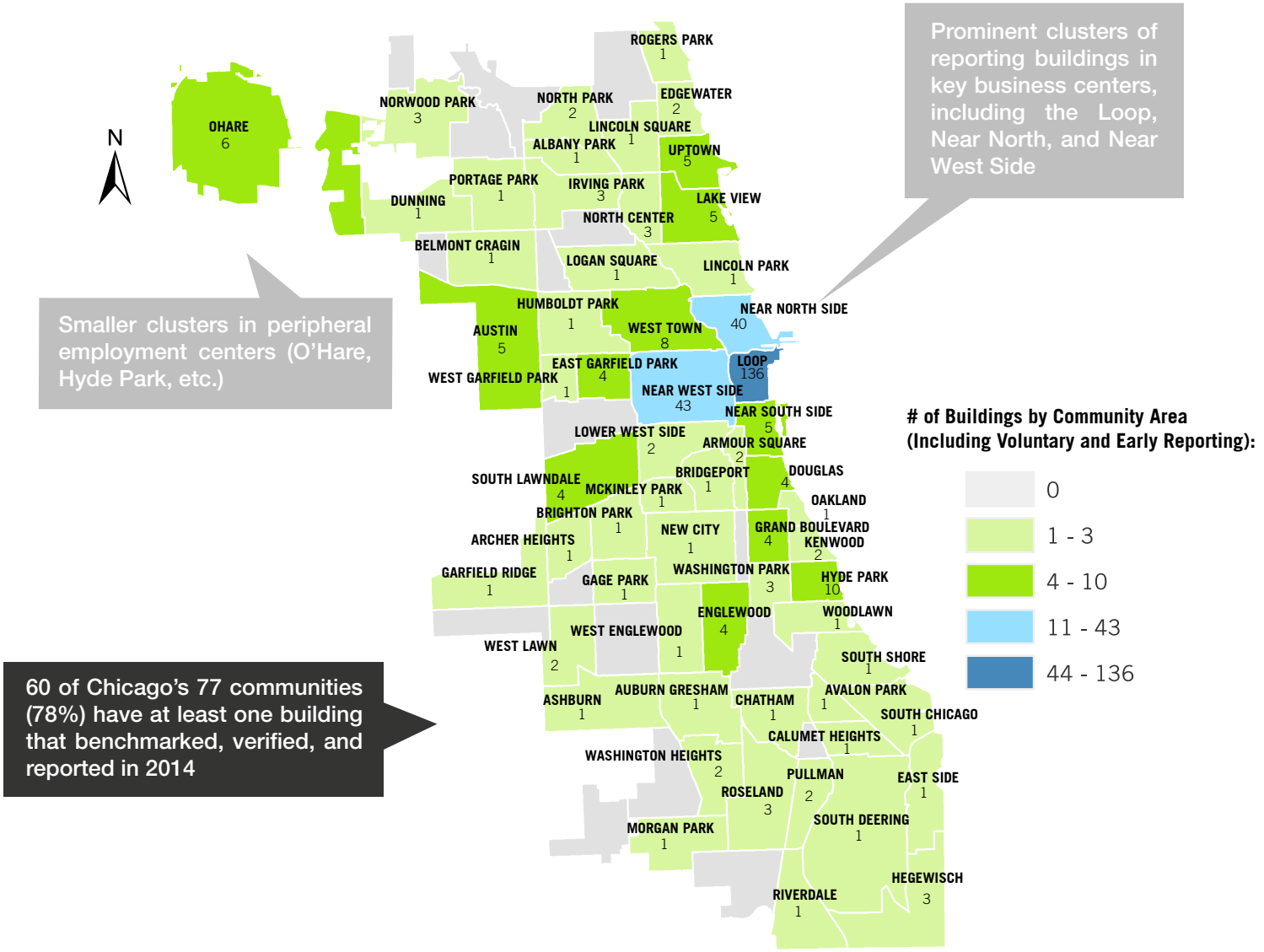
Energy Use Intensity (EUI): Energy use per square foot of gross floor area, expressed in kBTUs/square foot.

The Energy Modeling Practice Guide from the American Institute of Architects (AIA)[13] provides a useful summary of many of these energy metrics.

[11] Based on US Environmental Protection Agency's ENERGY STAR Portfolio Manager definitions: https://portfoliomanager.energystar.gov/pm/glossary
[12] For more information on weather normalization, see the Portfolio Manager Technical Reference on Climate and Weather: https://portfoliomanager.energystar.gov/pdf/reference/Climate%20and%20Weather.pdf
[13] AIA. An Architect's Guide to Integrating Energy Modeling In the Design Process. See pages 9-14 for discussion of metrics: http://www.aia.org/aiaucmp/groups/aia/documents/pdf/aiab096060.pdf

CHICAGO ENERGY BENCHMARKING ACROSS OUR NEIGHBORHOODS

Chicago Energy Benchmarking is raising awareness of energy performance across the city, with at least one building reporting in 2014 in 60 of Chicago's 77 neighborhoods.



Map provided by Elevate Energy
Number of buildings: 348

Chicago Energy Benchmarking invites building owners and managers, residents, and businesses to engage in how energy use in buildings impacts our communities:

- How many large buildings are located in the neighborhoods where you live and work?
- What roles do these buildings play in your community, and what types of activities take place there?
- How do the large buildings in your neighborhoods consume energy, and how efficiently are these buildings performing?
- As a building owner, manager, or tenant, what steps can you take to improve energy performance?

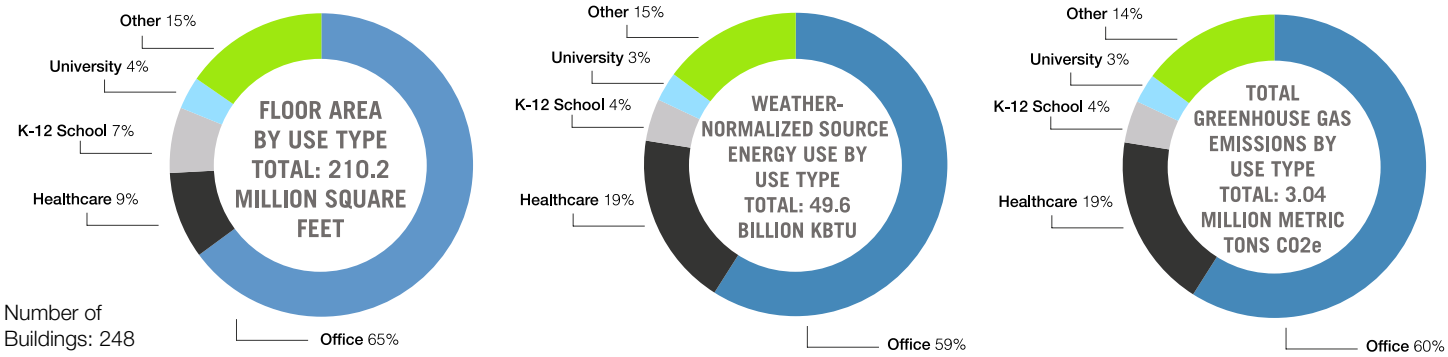
III. SUMMARY OF BENCHMARKING RESULTS

The first year of reported Chicago Energy Benchmarking data is creating unprecedented awareness of building energy performance and potential savings.

OVERVIEW OF BUILDINGS REPORTING IN 2014

The information presented in this report focuses on 254 buildings larger than 250,000 square feet required to report calendar year 2013 data by June 1, 2014.[14] The data from these 254 properties (referred to as "reporting buildings") forms the basis of all subsequent analysis presented in this report.[15] Because these are the largest nonresidential properties in Chicago, they may not be representative of all the city's buildings, but their results do provide concrete energy insights and a baseline for future analysis.

FIGURE 2: FLOOR AREA, ENERGY USE, AND GREENHOUSE GAS EMISSIONS BY BUILDING SECTOR



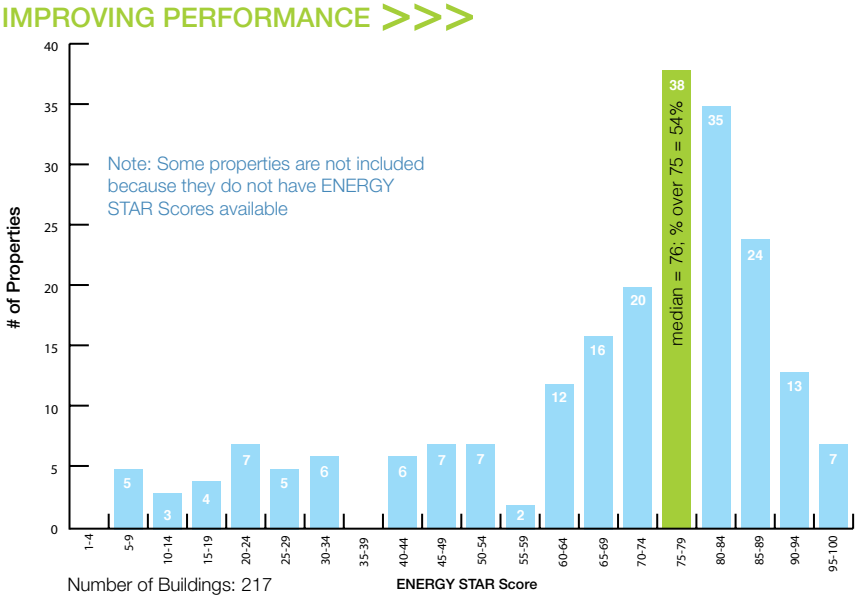
The 254 reporting buildings have been categorized into five major building sectors; Figure 2 (which is based on the 248 out of 254 buildings with weather-normalized energy metrics) shows the breakdown of floor area, energy use, and greenhouse gas emissions from these five sectors. Analysis of benchmarking data found that space use within buildings was the most important determinant of energy use intensity, and the following sections of this report include additional analysis of energy use in each of the five major building sectors.

OVERVIEW OF ENERGY STAR SCORES

Of the reporting buildings, 217 were eligible to receive a 1 to 100 ENERGY STAR score, which assesses a building's energy performance relative to a representative national sample, while controlling for weather, space uses, occupancy, hours, and other factors.[16] A building with an ENERGY STAR score of 75 or above may be eligible for ENERGY STAR certification, a label provided by the ENERGY STAR program that designates the top-performing buildings for energy efficiency.

The median ENERGY STAR score is 76 out of 100, which is significantly higher than the national median ENERGY STAR score of 50. Energy performance trends may differ in future years as more buildings are phased into the Chicago Energy Benchmarking Ordinance. Chicago's results are comparable to other cities with publicly-available data for nonresidential buildings over 250,000 square feet, including New York City (median score of 75),[17] Philadelphia, PA (median score of 77),[18] and Washington, D.C. (median score of 80).[19]

FIGURE 3: ENERGY STAR SCORE DISTRIBUTION (ALL PROPERTY TYPES)



[14] A total of 348 buildings reported information in 2014. The analysis of 254 buildings excluded 77 early and voluntary compliers, 9 buildings identified as outliers, and 8 buildings with incomplete or inconsistent data

[15] Please refer to the appendix for more information on data analysis methodology and the results presented in this report

[16] As of 2014, 21 building types can receive ENERGY STAR scores (including offices, K–12 schools, hotels, and multifamily residential buildings), based on the availability of comparable data. ENERGY STAR scores are not currently available for less common property types

[17] Data from New York City is from calendar year 2012 and is available at: http://www.nyc.gov/html/gbee/html/plan/ll84_scores.shtml

[18] Data from Philadelphia is from calendar year 2013 and is available at: http://www.phillybuildingbenchmarking.com/

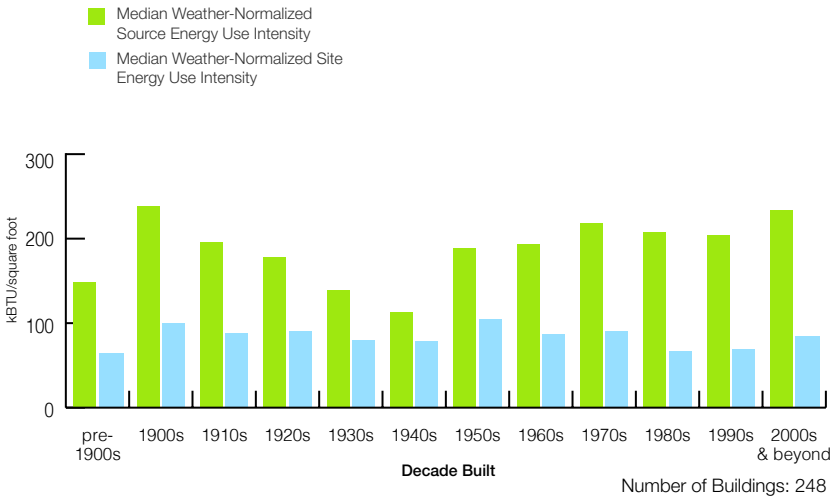
[19] Data for buildings from 50,000 – 150,000 square feet not available for buildings in Washington, D.C. Data for buildings over 150,000 square feet is from calendar year 2012 and is available at: http://green.dc.gov/node/784702

ENERGY USE INTENSITY IN RELATION TO BUILDING AGE

Although energy intensity doesn't account for differences in space use, operating hours, equipment, and other building attributes, it provides a key standard measure of building energy use, similar to miles-per-gallon ratings on automobiles. Among reporting buildings, the annual median weather-normalized source energy use intensity is 202 kBTU per square foot.

Chicago's calendar year 2013 data (reported in 2014) shows that age has little effect on energy intensity (see Figure 4). More specifically, buildings of any age can demonstrate a low *site energy intensity*. Statistical analysis shows a weak correlation between building age and *source energy intensity*, with newer buildings reporting slightly higher energy intensity than older ones.[20] This relationship applies across the five building sectors. Many factors could account for older buildings reporting lower source energy use intensities, including construction materials, architectural styles, and building system characteristics. Future data availability and additional research could shed more light on the relationships between building age, energy intensity, and other energy performance factors.

FIGURE 4: SITE AND SOURCE ENERGY USE INTENSITY OF BUILDINGS, BY DECADE OF CONSTRUCTION



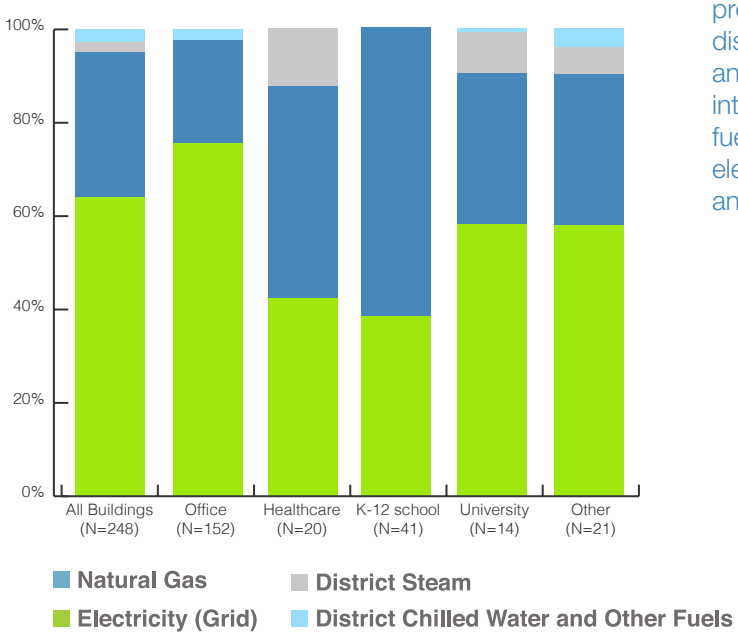
Site energy is the energy consumed on-site by the building, as measured on utility bills.

Source energy incudes on-site consumption as well as energy used for generation, transmission, and distribution of the site energy.

Definitions adapted from the ENERGY STAR Portfolio Manager Glossary: https://portfoliomanager.energystar.gov/pm/glossary

FUEL MIX AND ENERGY USE INTENSITY

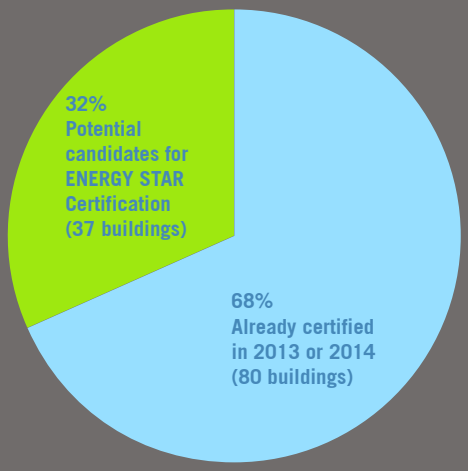
FIGURE 5: AVERAGE FUEL MIX BY BUILDING SECTOR



Building energy fuel mix (i.e. the portion of the building's energy use provided by different energy types such as electricity, natural gas, district energy, etc.) varies significantly by property type (Figure 5), and fuel mix influences differences among buildings' source energy intensity. Buildings with a higher percentage of electricity in the fuel mix are associated with higher source energy use because electricity has higher losses from energy generation, transmission, and distribution than other fuel types.

[20] Multiple linear regression analysis was conducted to understand the relationship between weather-normalized site energy use intensity (EUI) and various building attributes, such as building use, year of construction, building size, fuel mix, occupancy, number of space uses, and LEED certification. The relationship between weather-normalized site EUI and year of construction was statistically significant at the 95% confidence level (p-value = 0.01) with an estimated coefficient of 0.20 and standard error of 0.08

FIGURE 6: BUILDINGS WITH ENERGY STAR SCORES OF 75 OR ABOVE



Number of Buildings: 117

RECOGNIZING TOP ENERGY PERFORMERS

Fueled by growing sustainability engagement in the business community, market demand, and supported by environmental policies such as the City of Chicago's Sustainable Development Policy,[21] Chicago is a national leader in green buildings, with more than 500 LEED-certified projects[22] and 171 ENERGY STAR certified facilities.[23]

Of the 217 Chicago reporting buildings that received ENERGY STAR Scores, 117 had scores above 75. Only 80 of these buildings, however, actually received ENERGY STAR certification in 2013 or 2014, which can distinguish high-performing real estate in the marketplace (Figure 6). The remaining 37 could be eligible for efficiency recognition, and have not taken advantage of this leadership opportunity.

BUILDING SIZE, NUMBER OF SPACE USES, AND ENERGY USE

Analysis of benchmarking data shows that building size and the number of space uses have little to no correlation to energy intensity.[24] Publicly available benchmarking data from New York City, Philadelphia, and Washington, D.C.[25] shows different relationships between building size and energy intensity. While reported energy intensity for New York and Philadelphia's largest commercial and municipal buildings (all nonresidential properties larger than 250,000 square feet) was higher than that of smaller buildings (50,000–250,000 square feet), this pattern did not appear in Washington, D.C.

Subsequent years of Chicago data may provide additional insight on the link between building size and energy intensity.

ENERGY SAVINGS OPPORTUNITY

Analysis of benchmarking data shows a wide range of energy intensity, with high-intensity buildings using three to seven times more energy per square foot than low-intensity buildings in the same sector. The potential savings opportunity if all buildings achieved the median (50th percentile) or the 75th percentile for energy use intensity in their sector is enormous:

- 13–23% reduction in weather-normalized source energy use (total of 6.5–11.2 million MMBTU/year)
- $44–77 million in energy cost savings
- 460,000–844,000 tons of avoided greenhouse gas emissions (equivalent to removing 95,000–175,000 cars from the road)
- Energy efficiency investments of $152–265 million
- More than 1,000 jobs would result from the investments to achieve these savings

[21] The City of Chicago's Sustainable Development Policy: http://www.cityofchicago.org/dam/city/depts/zlup/Sustainable_Development/Publications/GreenMatrix2011DHED.pdf
[22] The US Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED). The number of LEED-certified projects in Chicago was found by reviewing the USGBC LEED Project Directory: http://www.usgbc.org/projects
[23] ENERGY STAR Directory of Certified Buildings and Plants: https://www.energystar.gov/index.cfm?fuseaction=labeled_buildings.locator
[24] Multiple linear regression analysis was conducted to understand the relationship between weather-normalized site energy use intensity (EUI) and various building attributes, such as building use, year of construction, building size, fuel mix, occupancy, number of space uses and LEED certification. The relationship between weather-normalized site EUI and building size was not statistically significant (p-value = 0.28), with an estimated coefficient and standard error both equal to 0. The relationship between weather-normalized site EUI and number of space uses was also not statistically significant (p-value = 0.58), with an estimated coefficient of 1.08 and standard error of 1.93
[25] Results from New York, NY, Philadelphia, PA, and Washington, D.C. are based on original analysis of publicly-available whole-building energy use information from these cities

STEVENS BUILDING

Address: **17 N. State Street**
Neighborhood: **Loop**
Constructed: **1913**
Management Firm: **Marc Realty**
Architect: **D.H. Burnham and Company**
Building Size: **380,000 square feet**

"Prior to benchmarking, Marc Realty had been implementing energy efficiency measures, such as LED lighting retrofits, but did not have a tool to accurately measure and capture the savings and results. After working with a service provider to complete energy benchmarking, the building management team was able to gain visibility into the impact of their efforts and receive recognition.

Marc Realty will continue to track energy usage and ENERGY STAR scores for 17 buildings with the support of our service provider, and we will use the results to identify the greatest opportunities for energy savings and to earn building recognition."

– Marc Realty

Left to Right: James Sadowski – Director of Operations, Mike Forde – Chief Engineer

Photo credit: Marc Realty

IV. SECTOR FOCUS: COMMERCIAL OFFICE BUILDINGS

Energy efficiency in commercial office buildings can directly affect the most fundamental drivers of the commercial real estate industry, including lease rates, occupancy, tenant retention, and asset value. Today's commercial office tenants, investors, and other stakeholders often consider the economic and environmental impact of buildings' energy use, as well as other benefits related to energy efficiency.

A recent summary of research on property values of green buildings by the Institute for Market Transformation found that commercial buildings certified under the LEED and ENERGY STAR programs outperformed their peers on rents by margins from 5 to 25 percent and also had higher market values relative to non-certified buildings, with a range of 10 to 25 percent in sale price premiums.[26]

Energy costs are also on the rise, according to the US Department of Energy; a report from 2012 shows that that average energy costs in commercial buildings have been increasing since the late 1990s and are expected to increase steadily to 2035.[27] Comprising more than half of reporting buildings,[28] commercial offices represent significant energy use and savings potential. The most energy-intensive office buildings used seven times more energy per square foot than the least energy-intensive buildings, suggesting large opportunities for the highest energy-intensity buildings to improve performance.

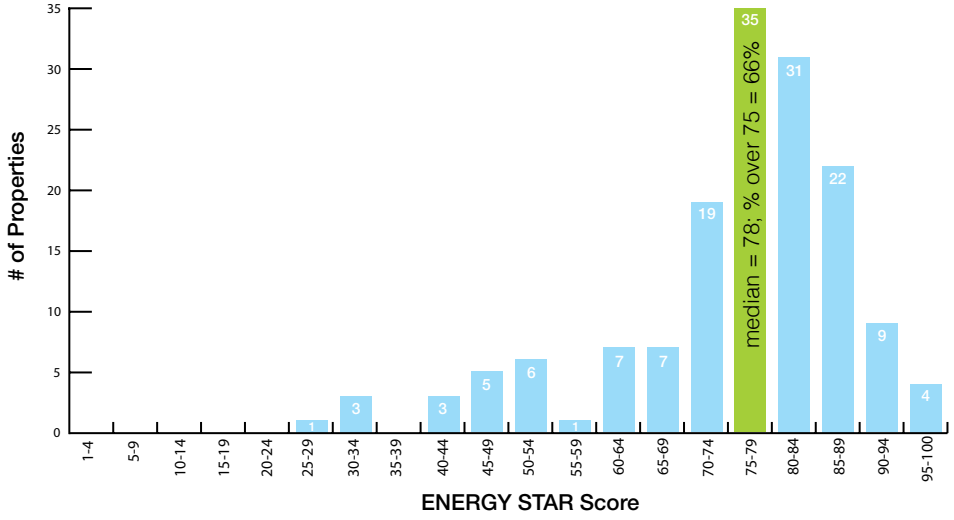
OFFICE BUILDING SECTOR ENERGY PERFORMANCE

The median reported ENERGY STAR score for Chicago's largest commercial offices was 78 out of 100 (Figure 7), similar to the median for all reporting buildings of 76 out of 100 (Figure 3 on page 7). The median score of 78 suggests higher-than-average energy performance for the majority of these buildings. ENERGY STAR scores for Chicago office buildings larger than 250,000 square feet were similar to those of similarly sized office buildings in New York City, Philadelphia, and Washington, D.C., which have median ENERGY STAR scores of 75, 77, and 81, respectively.[29]

Out of the total 37 reporting buildings that received an ENERGY STAR score of 75 or above and may be eligible for ENERGY STAR certification but are not yet certified, 23 are office buildings. An additional 34 buildings may be nearly eligible for ENERGY STAR certification, and would need an increase in their score of 15 points or less to reach the minimum score of 75 needed for certification. These 34 buildings are similar in terms of age, size, and other general characteristics as the buildings with scores of 75 or above, and could possibly reach the 75th percentile and above (and earn recognition for their efforts) by focusing efforts to improve their performance.

FIGURE 7: ENERGY STAR SCORE DISTRIBUTION FOR OFFICE BUILDINGS

IMPROVING PERFORMANCE >>>



Number of Buildings: 153

2014 Chicago Energy Benchmarking identified 23 office buildings with ENERGY STAR scores above 75 that may be eligible for national ENERGY STAR recognition.

[26] Green Building and Property Value: A Primer for Building Owners and Developers. Institute for Market Transformation and The Appraisal Institute. 2013. https://www.appraisalinstitute.org/assets/1/7/Green-Building-and-Property-Value.pdf

[27] US Department of Energy, Buildings Energy Data Book. Commercial Energy Prices, by Year and Major Fuel Type ($2010 per Million Btu). http://buildingsdatabook.eren.doe.gov/TableView.aspx?table=3.3.1

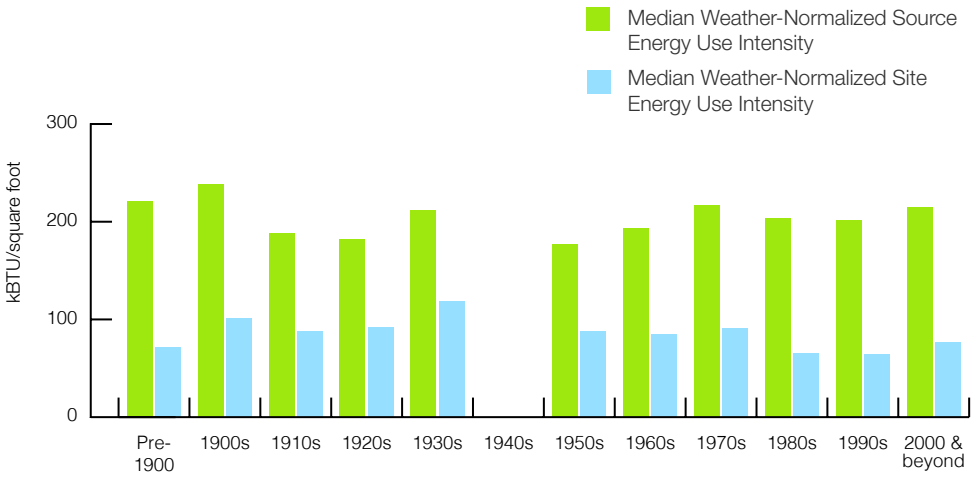
[28] "Reporting buildings" include those required to report in 2014, but does not include voluntary and early reporters, buildings identified as outliers, or buildings that did not have weather-normalized energy metrics. Please refer to the appendix of this report for more details on the data analysis methodology

[29] Results from New York, NY, Philadelphia, and Washington, D.C. are based on original analysis of publicly-available whole-building energy use information from these cities

OFFICE BUILDING AGE AND ENERGY INTENSITY

Chicago's office buildings 250,000 square feet or larger were constructed from the 1870s to 2010. Figure 8 shows that building age has little effect on source or site energy intensity. Buildings from the 19th century showed similar levels of source/site energy use intensity as buildings from the 2000s, indicating that office buildings of any age can have similar levels of energy consumption per square foot. (Source energy is always higher than site energy because it accounts for losses in energy generation and transmission.)

FIGURE 8: SITE AND SOURCE ENERGY USE INTENSITY OF OFFICE BUILDINGS BY DECADE OF CONSTRUCTION

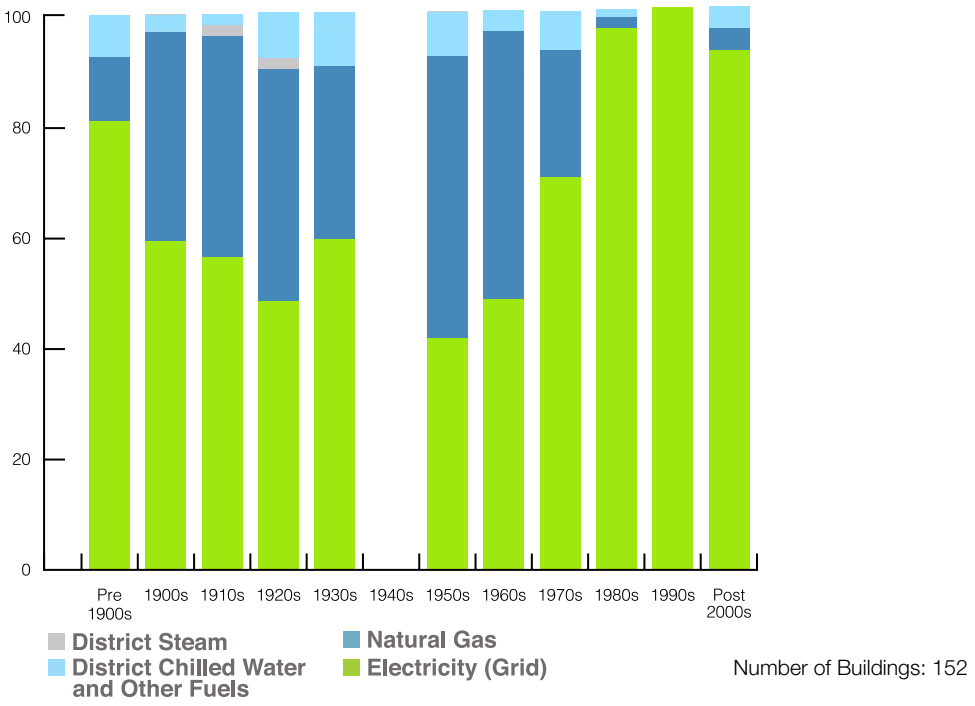


Number of Buildings: 152

OFFICE BUILDING FUEL MIX

Approximately one-third of Chicago's reporting office buildings are all-electric, many of which are high-rise buildings constructed since the 1970s (Figure 9), as well as some older buildings that have been converted. Energy efficiency opportunities in office buildings vary based on the specific fuel mix found in each building, and benchmarking provides additional information regarding the relative impact of each fuel.

FIGURE 9: AVERAGE FUEL MIX OF OFFICE BUILDINGS BY DECADE OF CONSTRUCTION

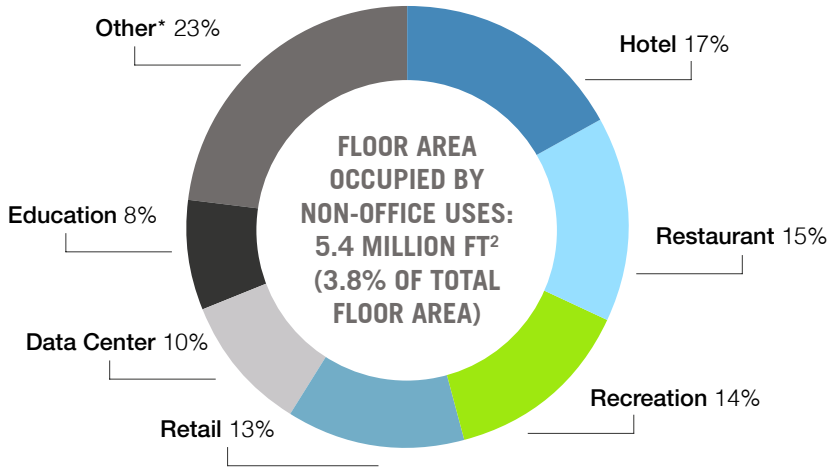


Number of Buildings: 152

OFFICE BUILDING SECONDARY SPACE USE AND ENERGY INTENSITY

Energy intensity in office buildings increased based on the percentage of floor area dedicated to auxiliary uses, which include retail shops, hotels, restaurants, data centers, and educational areas. Figure 10 shows a summary of the types of auxiliary space uses in office buildings. Focusing energy efficiency improvements in the high energy-intensity auxiliary use areas could dramatically reduce energy intensity in the buildings with these additional use types.

FIGURE 10: AUXILIARY SPACE USE IN OFFICES BY PERCENTAGE OF FLOOR AREA OCCUPIED (DOES NOT INCLUDE PARKING)

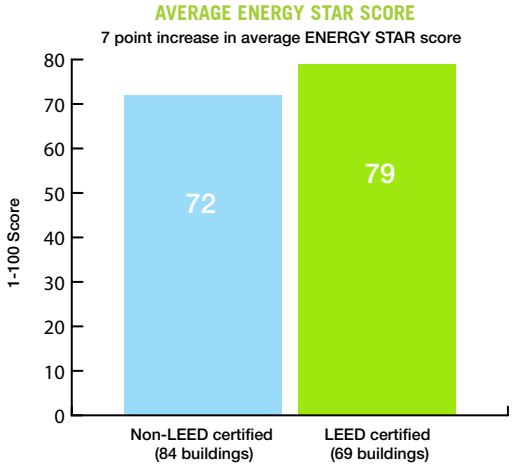


* The Other category includes multiple uses, such as bank branches, multifamily housing, medical offices, meeting halls, and other space uses that are not easily categorized.

OFFICE BUILDING LEED CERTIFICATION AND ENERGY PERFORMANCE

Of the 77 reporting buildings that are currently LEED-certified in Chicago, 69 of them (90 percent) are commercial office buildings. These 69 LEED-certified office buildings achieved ENERGY STAR scores that are nine percent higher, on average, than non-certified office buildings, equal to a 7 point increase in scores. These initial findings bolster the case that LEED design elements and operational practices correspond to tangible energy efficiency benefits in Chicago.

FIGURE 11: AVERAGE ENERGY STAR SCORES FOR LEED-CERTIFIED AND NON LEED-CERTIFIED REPORTING OFFICE BUILDINGS



TAKING ACTION TO IMPROVE ENERGY EFFICIENCY IN OFFICE BUILDINGS

In addition to the actions outlined on page 5, the following steps can be particularly useful to improve energy efficiency in commercial office buildings:[30, 31]

1. Develop energy-efficient design standards for future tenant build-outs.
2. Install tenant-level sub-metering.
3. Offer green lease options to tenants, which provide a financial incentive for tenants to take additional actions to improve the energy efficiency of their spaces.
4. Work with tenants and employees to increase their understanding of how behavior affects energy use.
5. Refer tenants to the Chicago Green Office Challenge,[32] an impact-driven program that encourages friendly competition among commercial offices and individuals to adopt sustainable practices at work and at home.
6. Optimize start-up time, power-down time, and equipment sequencing.
7. Employ energy management strategies for office-related equipment, starting with computers and vending machines.
8. Improve operations and maintenance practices by regularly checking and maintaining equipment to ensure it is functioning efficiently.

[30] Adapted from the U.S. Environmental Protection Agency's ENERGY STAR publication Commercial Real Estate: An Overview of Energy Use and Energy Efficiency Opportunities
[31] American Institute of Architects' Chicago Chapter AIA 2030 Working Group www.aiachicago.org and ASHRAE Illinois Chapter http://www.illinoisashrae.org/
[32] Chicago Green Office Challenge: http://www.ChicagoGOC.com

VON STEUBEN METROPOLITAN SCIENCE CENTER

Address: **5039 N. Kimball Avenue**
Neighborhood: **North Park**
Constructed: **1929-30**
Building Owner / Manager: **Chicago Public Schools**
Architect: **Paul Gerhardt**
Building Size: **262,000 square feet**

"At the core of Chicago Public Schools vision is a collective effort by all Departments to provide the resources needed to prepare students for success in college, career and life.

For the Department of Facilities, this means providing students with a safe and comfortable learning environment in the most efficient and cost effective manner. The CPS Department of Facilities believes that energy efficiency plays a major role in meeting these objectives. Benchmarking using the ENERGY STAR Portfolio Manager tool allows for CPS to measure, monitor and collect building energy performance information that helps to make better data driven decisions that can lead to increases in operational and energy efficiency."

– Chicago Public Schools

Brian Martin – Energy Manager, Chicago Public Schools

Pre-engineering students from Von Steuben School attended the International Manufacturing Technology Show in September 2014.

Left credit: Leslie Schwartz Photography, for a project by McGuire Igleski & Associates, Inc.
Center credit: Chicago Public Schools
Right credit: Friedrich W. Von Steuben Metropolitan Science Center Website

V. SECTOR FOCUS: SCHOOLS, HEALTHCARE, HIGHER ED & OTHER FACILITIES

K–12 schools, healthcare, higher education, and other facilities that benchmarked calendar year 2013 data (and reported in 2014) represent the vast diversity of Chicago's building stock and space uses, with unique energy savings opportunities in each of these sectors. With greater variation in activities housed within schools, healthcare, higher education, and other facilities – and in light of a smaller reported sample size than for commercial offices – energy use data and savings assessment must align with facility-specific attributes and opportunities. The following pages describe preliminary sector-specific findings, which will be revisited as ordinance coverage expands to additional buildings in future years.

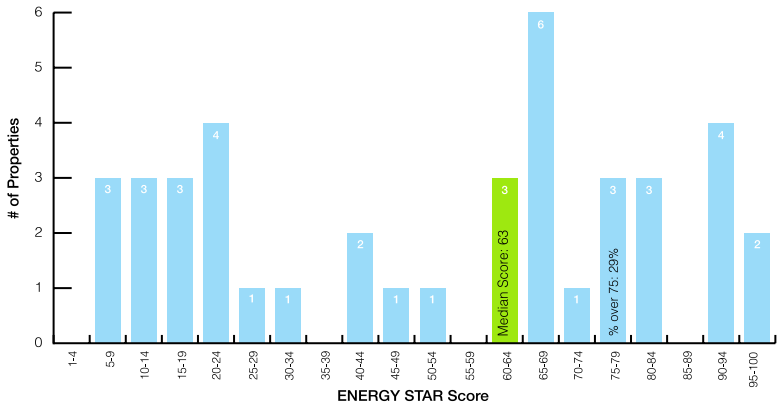
K–12 SCHOOL SECTOR FINDINGS:

As centers for education throughout our city, Chicago's schools offer opportunities for cost-effective energy improvements that enhance learning through lighting, high indoor air quality, and other enhancements.

With many school buildings typically closed during nights, weekends, and holidays, and in light of summer operating hours, schools have significant opportunities to align energy use with operating hours. Building energy efficiency efforts offer a unique educational opportunity to teach science, technology, engineering, and math (STEM), while also reducing energy and delivering operating cost savings.

FIGURE 12: ENERGY STAR SCORE DISTRIBUTION FOR K–12 SCHOOLS

IMPROVING PERFORMANCE >>>

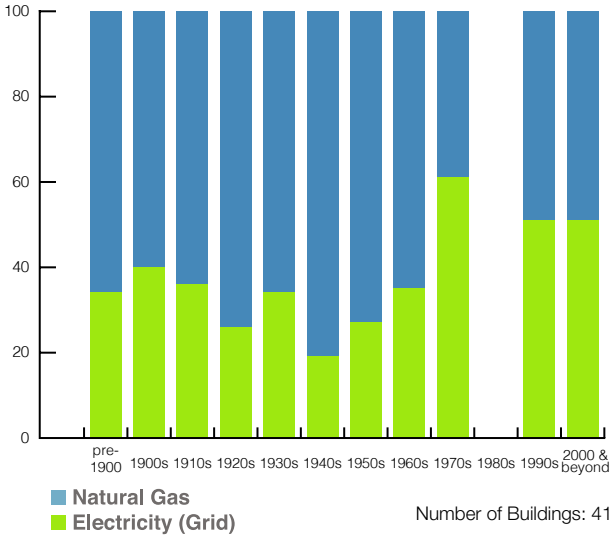


Number of Buildings: 41

In 2014, 41 schools reported energy use information under the ordinance.

The median reported ENERGY STAR score for Chicago K–12 schools was 63 (Figure 12), with a wide range of energy performance relative to national averages. Twelve schools reported ENERGY STAR scores above 75 and 18 schools reported scores below 50, which may signal opportunities for best practice sharing and implementation among these buildings.

FIGURE 13: AVERAGE FUEL MIX IN K–12 SCHOOLS BY DECADE OF CONSTRUCTION



Number of Buildings: 41

Only two fuels – electricity and natural gas – were used in reporting school buildings. The typical fuel mix of a school is about one-third electricity and two-thirds natural gas; newer schools have a larger share of electricity than older schools. Many older schools may find opportunities for energy efficiency by improving the consumption of natural gas in boilers, heaters, and other equipment, while newer schools may have more opportunities by addressing electricity usage.

TAKING ACTION TO IMPROVE ENERGY EFFICIENCY IN K-12 SCHOOLS:

In addition to the actions outlined on page 5, the following steps can be particularly useful to improve energy efficiency in K-12 school buildings:[33, 34]

1. Educate students and staff about how their behaviors affect energy use, including student-led energy monitoring, analysis, and opportunity identification.
2. Install energy-efficient lighting systems and controls that enhance light quality and reduce heat gain.
3. Upgrade and maintain heating and cooling equipment, including chlorofluorocarbon chillers, boilers and other central plant systems to meet energy efficiency standards.

[33] Adapted from the U.S. Environmental Protection Agency's ENERGY STAR publication Schools: An Overview of Energy Use and Energy Efficiency Opportunities
[34] American Institute of Architects' Chicago Chapter AIA 2030 Working Group www.aiachicago.org and ASHRAE Illinois Chapter http://www.illinoisashrae.org/

ANN & ROBERT H. LURIE CHILDREN'S HOSPITAL OF CHICAGO

Address: **225 E. Chicago Avenue**
Neighborhood: **Near North Side**
Constructed: **2012**
Architect: **Zimmer Gunsul Frasca, Solomon Cordwell Buenz, and Anderson Mikos Architects**
Building Size: **1,255,000 square feet**

"Ann & Robert H. Lurie Children's Hospital of Chicago prides itself on being state of the art, which extends into our facilities management approach. Energy benchmarking is a large part of that strategy, allowing us to track energy performance and the impact of energy efficiency projects.

One of those projects, building retro-commissioning, led to recommendations that could yield more than $220,000/year in savings. Although the hospital never closes, we are also reducing energy use in portions of the hospital that are unoccupied during nights and weekends – about 40% of the building – and are achieving surprisingly large savings at little cost. Our projects are estimated to reduce 5% of electricity and 17% of natural gas consumption."
– Ann & Robert H. Lurie Children's Hospital

Karl Schroeder – Lead Energy Efficiency Engineer, Facilities Department

Photo credit: Ann & Robert H. Lurie Children's Hospital of Chicago

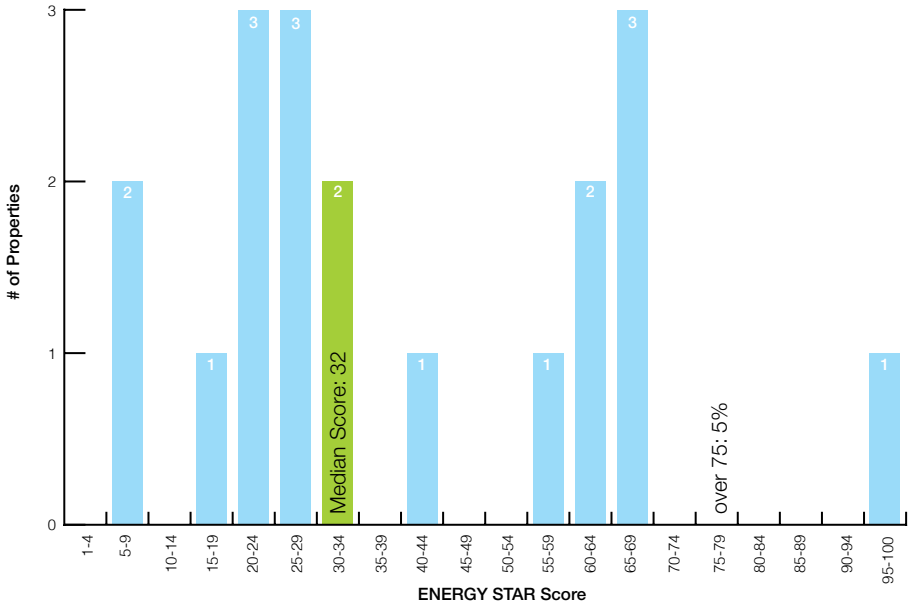
HEALTHCARE SECTOR FINDINGS

Healthcare facilities – including hospitals, medical clinics, and doctors' offices – comprised 9 percent of reported floor space and 19 percent of energy use, making healthcare the most energy-intensive building category. National reports on building efficiency also find healthcare buildings to be particularly energy intensive, likely due to specialized medical equipment, extended operating hours, and specific operating requirements associated with healthcare services.[35] Unlike many complex healthcare industry costs, energy efficiency is often a savings opportunity within a medical facility's control.

With 20 reporting healthcare buildings, Chicago's calendar year 2013 data (reported in 2014) reflects a relatively small sector sample, which may not be representative of all healthcare facilities in the city. A median healthcare sector ENERGY STAR score of 32 (Figure 14) implies that many healthcare facilities in Chicago were performing below the national median, but operating differences among healthcare facilities may warrant further analysis. Nonetheless, the one Chicago healthcare facility with an ENERGY STAR score above 95 offers a striking example of top energy performance. Energy efficiency-focused working groups such as the Chicago Green Healthcare Initiative[36] provide opportunities for peer-learning and collaboration among healthcare facilities, with potential to support sector-wide energy performance improvement.

FIGURE 14: ENERGY STAR SCORE DISTRIBUTION FOR HEALTHCARE BUILDINGS

IMPROVING PERFORMANCE >>>



Total Number of Buildings: 19

Despite lower ENERGY STAR scores than other reporting building sectors, Chicago's healthcare facilities performed at approximately the same level as similarly-sized facilities in New York City, Philadelphia, and Washington, D.C., which reported median ENERGY STAR scores of 44, 53, and 32, respectively.[37]

Due to low operating margins in non-profit healthcare facilities, the bottom-line impact of a dollar saved on energy costs can be equivalent to generating $10-20 in new revenue.[38]

TAKING ACTION TO IMPROVE ENERGY EFFICIENCY IN HEALTHCARE FACILITIES

In addition to the actions outlined on page 5, the following steps can be particularly useful to improve energy efficiency in healthcare facilities: [38, 39]

1. Identify portions of the building that are unoccupied during evenings and weekends, and reduce heating, cooling and ventilation to these areas when unoccupied.
2. Purchase medical equipment with energy efficient options.
3. Balance air and water systems.
4. Educate staff and patients about how their behaviors affect energy use.

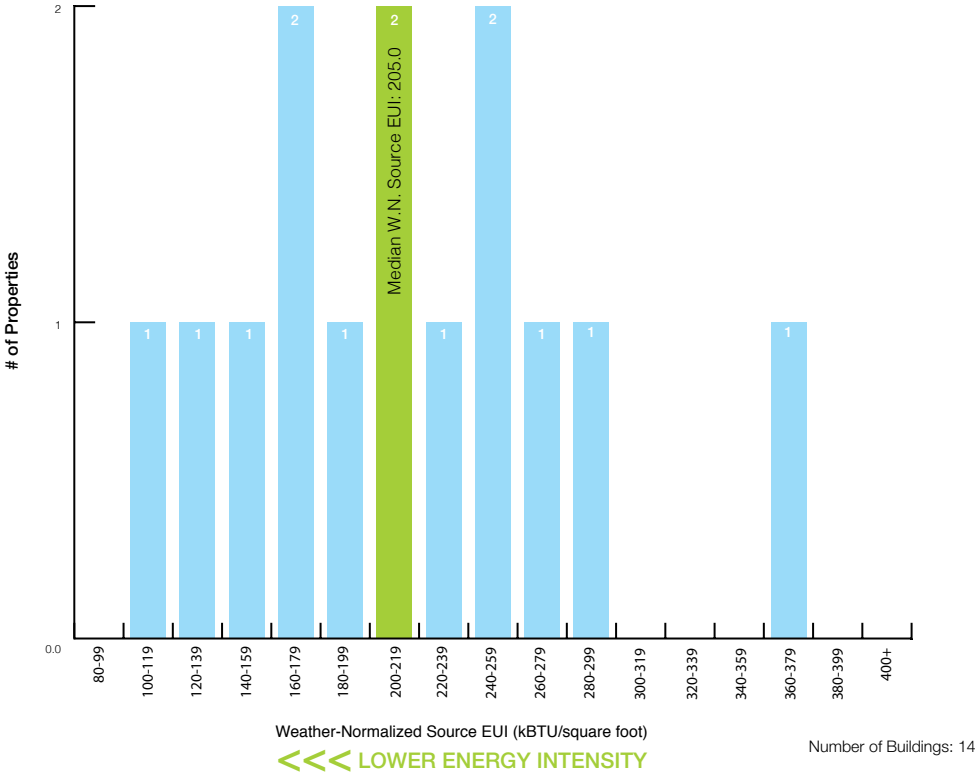
[35] U.S. Energy Information Administration. Large hospitals tend to be energy-intensive. August 23, 2012. http://www.eia.gov/todayinenergy/detail.cfm?id=7670
[36] Chicago Green Healthcare Initiative: http://www.chicagogreenhc.org
[37] Results from New York, NY, Philadelphia, PA, and Washington, D.C. are based on original analysis of publicly-available whole-building energy use information from these cities
[38] US Environmental Protection Agency, Healthcare: An Overview of Energy Use and Energy Efficiency Opportunities
[39] American Institute of Architects' Chicago Chapter AIA 2030 Working Group www.aiachicago.org and ASHRAE Illinois Chapter http://www.illinoisashrae.org/

HIGHER EDUCATION SECTOR FINDINGS

Higher education buildings represent the smallest category in this report, with just 14 buildings covering less than ten million square feet, but significant opportunities still exist for energy savings. By improving energy efficiency, colleges and universities can distinguish themselves as environmental leaders and save money for repair and renovation, hiring of new faculty, new construction, and other core activities.

In light of a small sample size of buildings reporting in 2014, and because ENERGY STAR Scores are not currently available for the buildings in this sector, it is difficult to draw clear conclusions about energy performance in Chicago's higher education buildings. Energy use comparisons across universities and colleges are further complicated by the high degree of variation among them, including such unique spaces as classrooms, offices, libraries, labs, theaters, and dining halls. Based on reported data, Chicago's most energy-intensive higher education facility was approximately three times more energy-intensive than the least energy-intensive building, indicating opportunity for universities, colleges, and related institutions to explore energy savings potential. In parallel with healthcare sector efficiency efforts, universities and colleges are ripe for cross-institutional collaboration, facilitated by groups like the recently formed Alliance to Retrofit Chicago Higher Education (ARCH).[40]

FIGURE 15: WEATHER-NORMALIZED SOURCE ENERGY USE INTENSITY DISTRIBUTION FOR HIGHER EDUCATION BUILDINGS



Number of Buildings: 14

TAKING ACTION: IMPROVING ENERGY EFFICIENCY IN HIGHER EDUCATION FACILITIES

In addition to the actions outlined on page 5, the following steps can be particularly useful to improve energy efficiency in higher education facilities: [41,42]

1. Sub-meter campus buildings so that energy use can be more accurately measured and tracked.
2. Establish an energy reduction competition by building or department.
3. Educate students and staff about how their behaviors affect energy use on campus, particularly in residence hall settings.
4. Work with an energy services provider to help manage and improve energy performance across complex academic campus facilities.

[40] ARCH is a collaborative effort developed by local universities to work together to identify best practices for reducing energy consumption
[41] Adapted from the ENERGY STAR Publication Higher Education: An Overview of Energy Use and Energy Efficiency Opportunities
[42] American Institute of Architects' Chicago Chapter AIA 2030 Working Group www.aiachicago.org and ASHRAE Illinois Chapter http://www.illinoisashrae.org/

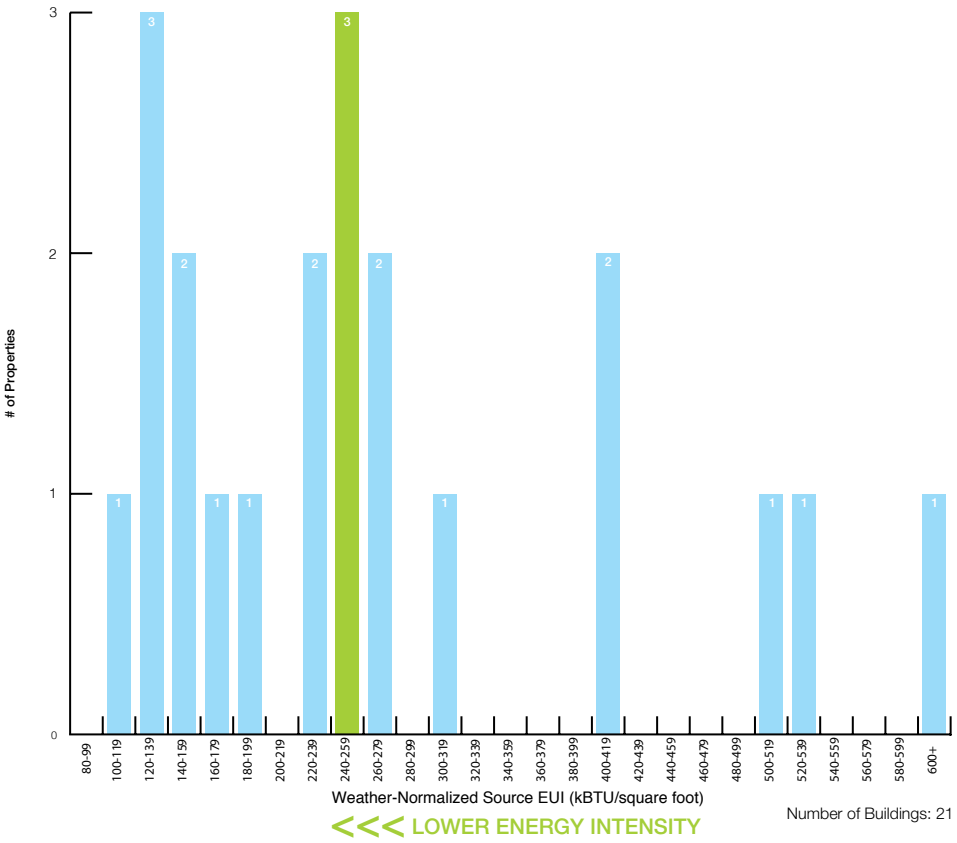
"OTHER" BUILDING SECTOR FINDINGS

In 2014, 21 additional buildings reported energy benchmarking data, including a variety of "other" facilities located in seven Chicago neighborhoods that play a wide range of roles in their communities and beyond. Many of the buildings in this category are municipal park facilities, museums, recreational attractions, and other facilities that receive large numbers of annual visitors.

Reflecting vastly different building uses, this group of benchmarked facilities had one of the widest ranges of energy use, with the most energy-intensive "other" buildings consuming up to six times more energy than the lower-intensity buildings. With a median size of more than 1,000,000 square feet (compared with overall median building size of 540,000 square feet), these buildings are also among the largest reporting buildings. Although their uniqueness makes it difficult to compare building energy performance among this group, consistent energy benchmarking will enable progress tracking over time. Some of the buildings in this sector are not eligible for an ENERGY STAR Score, so energy use intensity is shown in Figure 16. Potential energy savings actions stand to improve energy efficiency across the vast square footage of some of Chicago's best-known buildings.

By aligning energy management with these buildings' missions and operations, Chicago's "other" benchmarked facilities can reinvest energy savings into core activities and emphasize the value of energy efficiency with employees and guests.

FIGURE 16: WEATHER-NORMALIZED SOURCE ENERGY USE INTENSITY DISTRIBUTION FOR ALL OTHER BUILDINGS



TAKING ACTION: IMPROVING ENERGY EFFICIENCY IN "OTHER" BUILDING TYPES

In addition to the actions outlined on page 5, the following steps can be particularly useful to improve energy efficiency in 'other' building types: [43,44]

1. Educate visitors and employees about how their behaviors affect energy use.
2. Improve operations and maintenance practices by regularly checking and maintaining equipment to ensure it is functioning efficiently.
3. Optimize start-up time, power-down time, and equipment sequencing.
4. Revise janitorial practices to reduce the hours that lights are turned on each day.

[43] Suggestions adapted from the ENERGY STAR Publication Commercial Real Estate: An Overview of Energy Use and Energy Efficiency Opportunities
[44] American Institute of Architects' Chicago Chapter AIA 2030 Working Group www.aiachicago.org and ASHRAE Illinois Chapter http://www.illinoisashrae.org/

VI. NEXT STEPS

With a wealth of new information resulting from just one year of Chicago Energy Benchmarking implementation, data reported in 2014 provides a foundation for ongoing efforts to raise awareness, increase transparency, and accelerate action on energy efficiency.

In 2015 and 2016, hundreds of additional buildings will begin to benchmark, report, and verify information under the Chicago Energy Benchmarking Ordinance, which will enhance both the quantity and quality of energy performance information available to the real estate community and other stakeholders.

Building upon successful outreach efforts in 2014, facilities covered by the ordinance in future years will have access to a full range of free materials, training, and pro-bono support opportunities. Using information reported in 2014 as a baseline, the City of Chicago will continue to collaborate with local, regional, and national partners to analyze energy trends and uncover insights on energy use in our building stock. The City and partners will also work to share these insights with individuals and organizations in buildings to increase knowledge and action around energy efficiency opportunities.

2015-2017 CHICAGO ENERGY BENCHMARKING ROLL OUT:

If you are a:

- Commercial or municipal building 250,000 square feet or larger:
  - ♦ Continue to benchmark and report annually by June 1 of every year
  - ♦ Next verification required in 2017
- Commercial or municipal building from 50,000–250,000 square feet:
  - ♦ Benchmark, report and verify for the first time by June 1, 2015
  - ♦ After 2015, continue to benchmark and report by June 1st each year; next verification required in 2018
- Residential multifamily building 250,000 square feet or larger:
  - ♦ Benchmark, report and verify for the first time by June 1, 2015
  - ♦ After 2015, continue to benchmark and report by June 1st each year; next verification required in 2018
- Residential multifamily building from 50,000–250,000 square feet:
  - ♦ Benchmark, report and verify for the first time by June 1, 2016
  - ♦ After 2016, continue to benchmark and report by June 1st each year; next verification required in 2019

BENCHMARKING PARTNERSHIPS AND COLLABORATIONS:

The City of Chicago will continue to partner with local and national organizations to implement its benchmarking ordinance and report on and analyze energy use trends in the results. Chicago is one of ten cities selected to participate in the City Energy Project,[45] a collaboration between the Institute for Market Transformation and the Natural Resources Defense Council, which aims to dramatically improve citywide energy efficiency through helping to implement benchmarking and other city-specific policies and programs. Chicago is also working with the C40 Cities Climate Leadership Group, U.S. Environmental Protection Agency, the U.S. Department of Energy, other cities with benchmarking policies, and other energy leaders to ensure that we are collaborating on national efforts to increase energy efficiency through sharing of best practices, data standardization, and other efforts.

The first year of Chicago Energy Benchmarking marks the beginning of a transformation in building energy awareness, transparency, and efficiency action.

[45] City Energy Project: http://www.cityenergyproject.org

CHICAGO ENERGY BENCHMARKING ANALYSIS OPPORTUNITIES IN 2015 AND BEYOND

Energy benchmarking will become most valuable once multiple years of energy consumption data are available, which will begin to occur in 2015 for the initial group of reporting buildings. With multiple years of data, buildings can see and understand various performance trends occurring over different time frames. Analysis tools may also assist buildings and other organizations, such as utilities, to utilize benchmarking data to better target specific energy efficiency projects in reporting buildings. More important, the information can be used to continue to drive energy efficiency action at the building level and throughout the Chicago market. The ordinance authorizes the City to share building-specific data with the public after one year, or in 2015 for buildings that were first-time reporters in 2014.

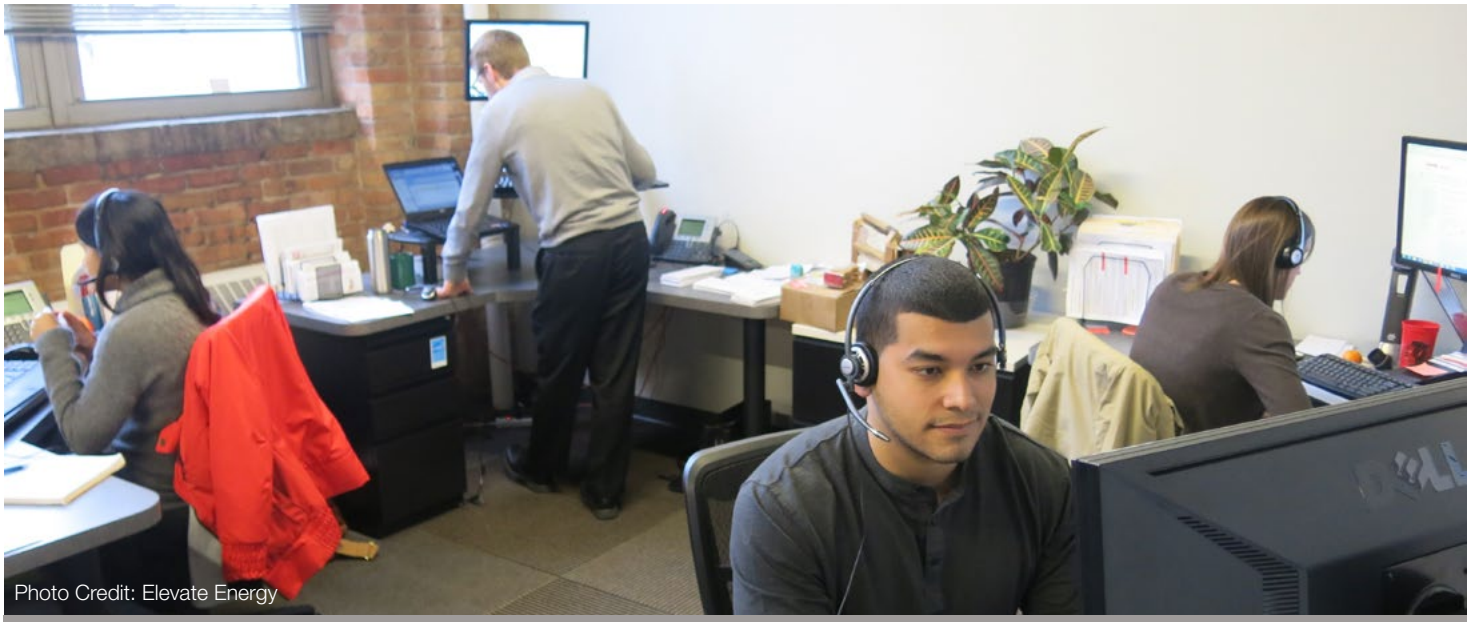


Photo Credit: Elevate Energy

HELP CENTER AND TRAINING

The City of Chicago and its partners will continue to provide the full-time Help Center, free trainings, and other online resources to support the benchmarking process.

HELP CENTER:

PHONE: (855)858-6878

EMAIL: Info@ChicagoEnergyBenchmarking.org

ONLINE: Visit www.CityofChicago.org/EnergyBenchmarking for more information and to sign up for free, upcoming training opportunities

CHICAGO ENERGY BENCHMARKING VOLUNTEER TRAINERS INCLUDE:

Ga-Young

Saagar

Benny

Jose

Edna

AUDITORIUM BUILDING AT ROOSEVELT UNIVERSITY

Address: **430 S. Michigan Avenue**
Neighborhood: **South Loop**
Constructed: **1889**
Architect: **Sullivan and Adler**
Building Size: **610,000 square feet**

"Celebrating 125 years, Roosevelt University's iconic Auditorium Building represents innovation in showing that buildings of any age can work toward energy efficiency. We are using EPA's ENERGY STAR Portfolio Manager tool to track and analyze energy use across our campus, and apply that knowledge to energy management decisions.

With funding and support from the Illinois Clean Energy Community Foundation, the Illinois Department of Economic Opportunity, and utility incentive programs, we're applying benchmarking insights to an Energy Master Plan that will reduce the Auditorium Building's consumption by 20% within 5 years, a goal related to our participation in Retrofit Chicago's Commercial Buildings Initiative."

– Roosevelt University

From left to right: Paul J. Matthews – Assistant Vice President, Campus Planning and Operations; Gus Kalady – Chief Engineer; Anthony Bugajsky – Engineer; Nick Ahrens – Engineer; Tom Sliwinski – Electrician Foreman; Steve Hoselton – Associate Vice President, Campus Planning and Operations; Jeff DeBrizzio – Assistant Chief Engineer; Scott Wrobel – Engineer; Gary Evans – Engineer

Photo credit: Roosevelet University

VII. ACKNOWLEDGEMENTS

Chicago Energy Benchmarking represents a coordinated effort to accelerate efficiency action and strengthen building performance, and it is a vital component of cross-sector work to make Chicago even more livable, competitive, and sustainable. The City of Chicago appreciates the extensive collaboration to create and implement an information-focused policy to drive energy, cost, and greenhouse gas emission savings that will benefit residents and businesses for years to come.

Thank you to all of the building owners, managers, engineers, service providers, and other stakeholders who tracked, reported, and verified benchmarking information in 2014. This work would not have been possible without the remarkable contributions of the Chicago Energy Benchmarking Working Group and a broad alliance of Chicago Energy Benchmarking supporters (please refer to the list of contributors included below). Special thanks to the Commonwealth Edison Company (ComEd) and Peoples Gas for making aggregated electricity and natural gas data accessible to facilitate their customers' benchmarking efforts and to the Institute for Market Transformation for their support of this report.

Chicago Energy Benchmarking also reflects cooperation among multiple municipal departments and advisors, including the Office of the Mayor, the Department of Business Affairs and Consumer Protection, the Department of Buildings, the Department of Innovation and Technology, the Mayor's Sustainability Council, and the Chicago Green Ribbon Committee.

Karen Weigert
Chief Sustainability Officer
Office of the Mayor
City of Chicago
December, 2014

This 2014 Chicago Energy Benchmarking Report was created with input, analysis, and other support from the following organizations and individuals:

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Elevate Energy:
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Alessandro Panella

Resource Media:
Aileo Weinmann
Debbie Slobe

American Institute of Architects AIA-Chicago 2030 Working Group:
Jason Chandler
Rand Ekman
Marya Graff
Jose Rodriguez

Document design by:[46]
SocialRaise
Kevin LaManna
Cassie Dennis
Mike Varouhas
Dana Chen

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Finally, the City of Chicago thanks the **U.S. Environmental Protection Agency** for its ongoing, critical support for the ENERGY STAR Portfolio Manager tool, as well as additional support for benchmarking training and other energy efficiency resources.

[46] Icon and Graphic Attributions Page 1 (Seo-report), Page 11 (City Buildings), Page 15 (School), Page 17 (Hospital Buildings), Page 19 (Modern House), Page 20 (Fast Forward Double Right Arrows), Page 23 (Users Group), Page 24 (Index Folder) - Icons made by Freepik: http://www.freepik.com from Flaticon: http://www.flaticon.com licensed under CC BY 3.0: http://creativecommons.org/licenses/by/3.0/
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VIII. APPENDIX

This appendix contains details on the benchmarking process and the data analysis methodology used to create the findings in this report, as well as information on data verification, compliance, and data quality. Additional results from the data analysis that was conducted for this report are also provided.

CHICAGO ENERGY BENCHMARKING DATA SOURCES AND ANALYSIS METHODOLOGY

A. Chicago Energy Benchmarking Requirements for Building Attribute Data[47]

All commercial and municipal buildings over 250,000 square feet were required to benchmark, report, and verify information by June 1, 2014. In total, 348 buildings provided whole-building energy use data and other key information to the City through the ENERGY STAR Portfolio Manager tool, a level of standardized energy reporting never before achieved in Chicago. Of these buildings, 77 reporting buildings were early or voluntary compliers. The 348 reporting buildings include:

- Approximately 11% of building energy use in Chicago
- Over 250,000,000 square feet of building area (approximately 12% of total floor area in Chicago)

Each building owner/manager or their designated benchmarking lead entered basic building information into Portfolio Manager, including:

- Year built, occupancy level, space uses, and total gross floor area, which excludes any exterior spaces or parking areas
- Primary function and property use details for each specific space use, including weekly operating hours, number of computers, percent heated / cooled, etc.
- Chicago Energy Benchmarking ID: a six-digit number assigned by the City

B. Whole-Building Utility Data

Chicago Energy Benchmarking requires buildings to enter monthly consumption of whole-building energy use for all fuel sources into the Portfolio Manager tool. There are three primary sources for the data, including: requesting whole-building energy use directly from utilities, compiling energy data directly from utility bills (when the building owner / manager is the accountholder for all accounts), or requesting data from tenants (only in extremely rare cases when other sources are not available).

Through collaboration among the City of Chicago, ComEd, and Peoples Gas, buildings covered by the Chicago Energy Benchmarking Ordinance can access whole-building electricity and natural gas data directly from the utilities at no additional charge. All utility data provision includes safeguards for accountholder privacy.

Additional information on these whole-building data offerings is available through Chicago's primary utilities:

- **ComEd (electricity):** ComEd's Energy Usage Data System (EUDS) allows building owners and property managers to retrieve aggregate energy usage data for multi-tenant commercial and residential buildings. EUDS instructions and enrollment forms are available at www.ComEd.com/EnergyTools.
- **Peoples Gas (natural gas):** Peoples Gas offers aggregated natural gas use data for buildings covered by the energy benchmarking ordinance. A link to instructions and information request forms are available at http://www.peoplesgasdelivery.com/business/aggregation.aspx.

C. Calculated Energy Metrics and Treatment of Outliers

Once building data has been entered, submitted, and verified by each reporting building, the Portfolio Manager tool calculates key energy performance metrics, such as site and source energy use, weather-normalized site and source energy use, weather-normalized site and source energy use intensity, the ENERGY STAR score, and greenhouse gas emissions. Several of these metrics are used throughout this report to describe energy use and energy performance. The City of Chicago collected data for the reporting buildings from the ENERGY STAR Portfolio Manager tool, identified outliers as described below, and conducted additional data analysis to reveal trends in energy performance.

A total of 348 buildings reported information in 2014, including 77 early and voluntary compliers that are excluded from data analysis. Of the 271 reporting properties that were required to report in 2014, nine properties are excluded from data analysis due to reported weather-normalized site and/or source energy use intensities that are three or more standard deviations above or below the mean energy use intensities for their building use category.

Eight additional reporting buildings were excluded from data analysis due to incomplete or inconsistent data or other data entry issues, such as providing energy consumption information covering periods longer than 65 days in one data entry. The Portfolio Manager tool requires 12 full consecutive calendar months of energy data with at least bi-monthly energy data for all active meters and fuel types to calculate the full range of energy metrics provided by the tool. This leaves 254 buildings that are included in the data analysis.

[47] The full text of the ordinance and the ordinance rules and regulations are available at the Chicago Energy Benchmarking website: www.cityofchicago.org/energybenchmarking

DATA VERIFICATION, COMPLIANCE, AND DATA QUALITY

A. Data Verification

The Chicago Energy Benchmarking Ordinance requires covered buildings to have a credentialed professional verify that energy and building data is tracked and reported correctly once every three years, starting with the first year of reporting under the ordinance. In most cases, data verification will take the form of an ENERGY STAR Data Verification Checklist, generated automatically by Portfolio Manager, which must be signed by a recognized professional, kept by the building owner, and produced upon request by the City. The City currently recognizes six different credentials for data verification:

1. Building Energy Assessment Professional (BEAP) certification, offered by ASHRAE
2. Building Energy Technologies (BET) certificate, offered by Wilbur Wright College, City Colleges of Chicago
3. Building Operator Certification (BOC), offered by Midwest Energy Efficiency Alliance (MEEA)
4. Certified Energy Manager (CEM), offered by Association of Energy Engineers (AEE)
5. Licensed Architect, offered by the Illinois Department of Financial and Professional Regulation
6. Professional Engineer, offered by the Illinois Department of Financial and Professional Regulation

The following criteria, found in the Rules and Regulations of the Benchmarking Ordinance, must be met for any credential accepted for data verification:

- Demonstrates trained individuals' proficiency in building energy benchmarking and familiarity with ENERGY STAR Portfolio Manager;
- Demonstrates trained individuals' working knowledge of energy-efficient operations, measures, and technology;
- Provides opportunities for ongoing skill maintenance and/or re-training as technologies, tools, and practices evolve;
- Provides a means of tracking graduates or credentialed individuals by name and with a unique identifier (such as a license, identification, or credential number); and
- Makes training materials and records available for review by the Department of Business Affairs and Consumer Protection or its designee and is found to be in compliance with preceding criteria.

B. Compliance Information

In 2014, the City identified 277 buildings that were required to comply with the ordinance. Two hundred and seventy one of these buildings reported information to the City through Portfolio Manager, leaving six buildings that did not report. 17 of the reporting buildings omitted data verification information required by the ordinance and/or did not provide critical building information (such as total gross square footage or total energy use). 254 buildings in-compliance out of 277 covered buildings yields a 2014 compliance rate of 92 percent.

C. Data Quality

The verification requirement described above and strong support resources set the stage for high-quality data from reporting buildings. While external sources for validation are limited due to the uniqueness of benchmarking dataset, initial analysis indicates that data quality is high. Approximately 85 percent of properties entered values for optional building attributes, rather than relying on default values from Portfolio Manager. Only six percent of properties indicated that their energy use information was estimated rather than based on utility bills. Also, only nine buildings (2.5 percent of all reporting buildings) were identified as outliers and only ten buildings (2.8 percent of all reporting buildings) were missing critical information such as square footage.

Data reported and calculated by Portfolio Manager were compared to external data sources, and Chicago buildings' performance was compared to similar Chicago buildings by sector to further assess data quality. A comparison of reported square footage values to external sources (such as data from the Cook County Assessor's Office and CoStar information) indicate that square footage did not appear to be taken from external sources; these external sources are not necessarily inaccurate, but may not provide the particular metrics needed for energy benchmarking. Within sectors, energy use intensity distributions for the offices and K–12 Schools sectors (which have large sample sizes) appear to be regularly-shaped distributions, with few outliers.

METHODOLOGY FOR ENERGY SAVINGS OPPORTUNITY ANALYSIS

The following methodology was used to estimate the potential energy savings opportunity if all buildings achieved the 50th percentile or 75th percentile for weather-normalized site energy use intensity in their sector. Outliers and buildings that lacked weather-normalized metrics (due to incomplete or inconsistent data) were excluded from the analysis. Building-specific analysis was completed, and individual building results were summed to find the total potential savings across all reporting buildings.

A. Energy Savings

In order to show the full impact of possible energy reductions, the energy savings metrics are based on reduction of weather-normalized source energy. The first step of calculating the energy saving metrics includes calculation of weather-normalized site energy use reductions; these site energy use reductions are then converted to weather-normalized source energy use reductions based on building-specific ratios of source energy use to site energy use.

B. Energy Cost Savings

The metrics for cost savings and investments needed to achieve those cost savings are based on reductions of weather-normalized site energy, because energy costs are tied more directly to site energy use that source energy use. The percentage of annual weather-normalized site energy use reduced in each building was calculated. This percentage reduction in weather-normalized site energy use was then applied to weather-normalized electricity

use and weather-normalized natural gas use, to find the annual reduction of these two fuels in each building. Average costs of $0.075/kWh of electricity and $8.14 per 1000 cubic feet of natural gas (equivalent to approximately $0.79 per therm) were applied to determine the potential cost savings; these average costs are based on current information on energy costs in the Chicago market provided by local experts.

C. Avoided Greenhouse Gas Emissions

The percentage of annual weather-normalized site energy use reduced in each building was multiplied by annual greenhouse gas (GHG) emissions (as calculated by Portfolio Manager) to find annual GHG reductions in each building, expressed in metric tons of carbon dioxide equivalent (CO_2e). The conversion from GHG reductions to the cars removed from the road is based on the assumption that one car emits 4,750 kg CO_2e per year, taken from the EPA calculator found at: http://www.epa.gov/cleanenergy/energy-resources/refs.html

D. Energy Savings Investments and Estimated Job Creation

Energy cost savings were multiplied by an assumed payback period of 3.5 years to find the estimated investments needed to achieve the energy cost savings. While some buildings would likely need to identify projects with longer payback periods to improve to the 50th and 75th percentile of weather-normalized site energy use intensity in their sector, the use of the shorter payback period allows for a conservative estimate of investments and jobs. (A payback period of 5 years would increase the estimated investments by 43%).

The number of jobs resulting from the investments is based on the assumption that 50% of the energy savings investments would be used for labor costs, and that the average salary for a skilled laborer implementing energy efficiency projects is $70,000/year. Assumptions are based on input from local experts and energy efficiency service providers in the Chicago market.

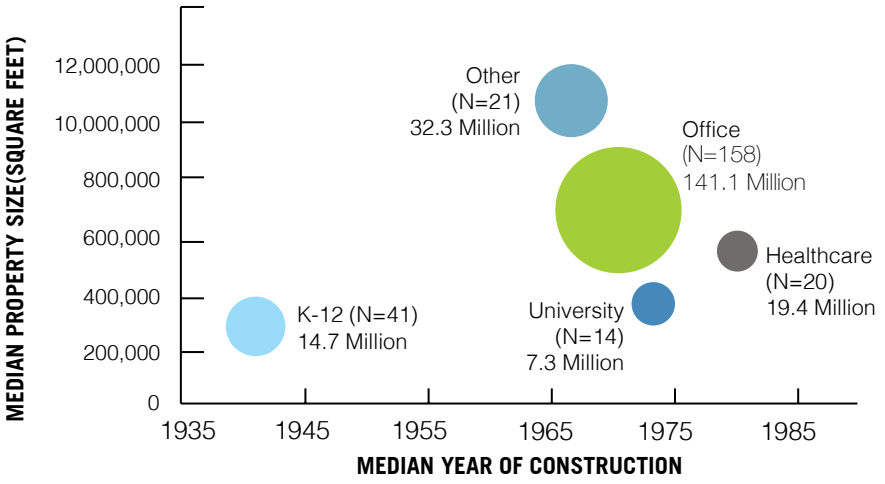
Detailed, sector-by-sector energy performance data and aggregate building information is provided in the following pages.

ADDITIONAL DETAIL ON REPORTED BUILDING ENERGY USE

Figure 17 summarizes the municipal and commercial buildings over 250,000 square feet that benchmarked, verified, and reported information in 2014, and shows the median year of construction, median size (gross square footage), and total gross square footage for each building sector. Table 1 lists the sector-specific median values of square footage and year of construction, as well as the total gross square footage and the range of years of construction of the buildings in each sector. Outliers have been removed from Figure 17 and Table 1; also excluded were the 8 buildings with incomplete or inconsistent data (or other data entry issues).

In some cases, a subset of the 254 reporting buildings was used in the analysis presented in this report, based on the metrics available for the reporting buildings. For example, only 217 of the 254 buildings were eligible to receive an ENERGY STAR score, and only 248 of the 254 buildings received weather-normalized energy use metrics.

FIGURE 17: MEDIAN YEAR OF CONSTRUCTION, MEDIAN SQUARE FOOTAGE, AND TOTAL GROSS FLOOR AREA BY BUILDING SECTOR



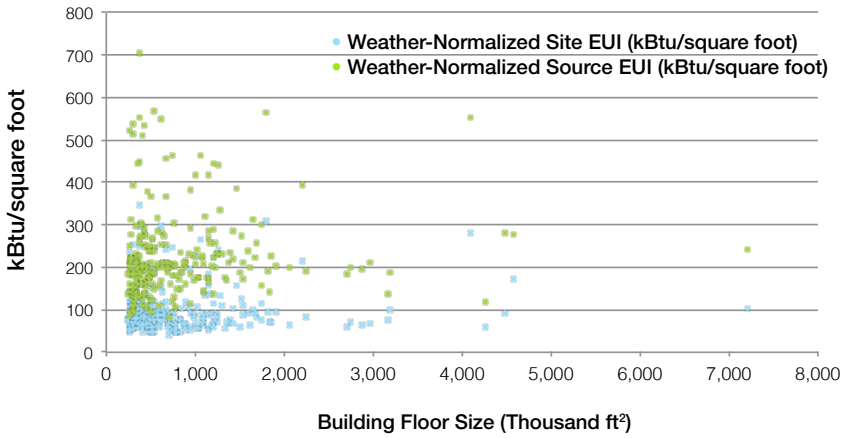
Number of Buildings: 262

TABLE 1: SUMMARY OF REPORTING BUILDING CHARACTERISTICS BY SECTOR

Property Category (Primary Use)	# Bldgs.	Median Building Size (ft2)	Total Square Footage (ft2)	Median Year Built	Range of years Constructed
Office	158	702,512	141,106,128	1972	1870 - 2010
Healthcare	2O	668,678	19,439,875	1981	1903 - 2013
K-12 School	41	327,566	14,701,353	1939	1898 - 2005
University	14	447,259	7,304,957	1974	1910 - 2007
Other	21	1,008,416	32,305,846	1970	1879 - 2009
TOTAL (ALL TYPES)	**254**	**555,808**	**214,858,159**	**1971**	**1870 - 2013**

Figure 18 plots each reporting building's weather-normalized source energy use intensity (EUI) and each building's weather-normalized site EUI by building square footage. Figure 18 shows little correlation between building size and site or source energy use intensity.

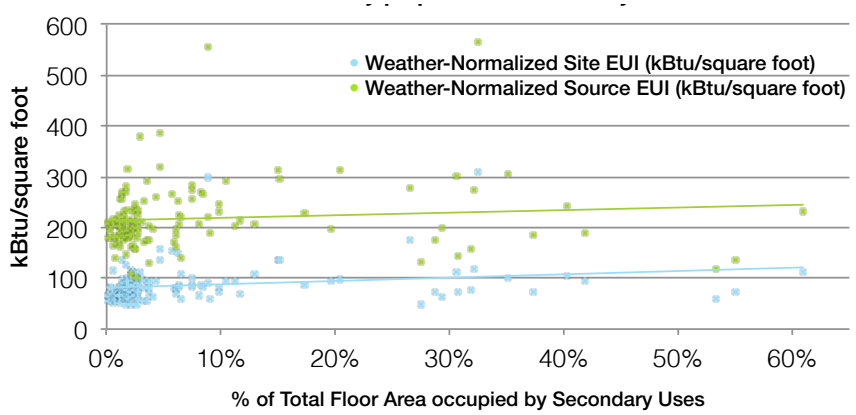
FIGURE 18: BUILDING SQUARE FOOTAGE COMPARED TO WEATHER-NORMALIZED SITE ENERGY USE INTENSITY (EUI) AND WEATHER-NORMALIZED SOURCE EUI



Number of Buildings: 248

Figure 19 plots the percentage of each building's floor area occupied by non-primary (auxiliary) use types against the weather-normalized source energy use intensity (EUI) and weather-normalized site EUI. As the percentage of floor area occupied by auxiliary uses increases, the weather-normalized site EUI and weather-normalized source EUI also increase slightly. Statistical analysis reveals that the correlation between percentage of auxiliary space use and increased EUI is only significant in office buildings.[48]

FIGURE 19: PERCENTAGE OF AUXILIARY BUILDING SPACE USES COMPARED TO WEATHER-NORMALIZED SOURCE ENERGY USE INTENSITY (EUI) AND WEATHER-NORMALIZED SITE EUI



Number of Buildings: 132
(Only properties with auxiliary uses)

Table 2 provides sector-by-sector breakdowns of ENERGY STAR Score quartile ranges and median ENERGY STAR Scores for the benchmarking data reported in 2014. Future Chicago ENERGY STAR scores may be subject to any updates or revisions to the Portfolio Manager tool.

TABLE 2: ENERGY STAR SCORE QUARTILE RANGES BY SECTOR

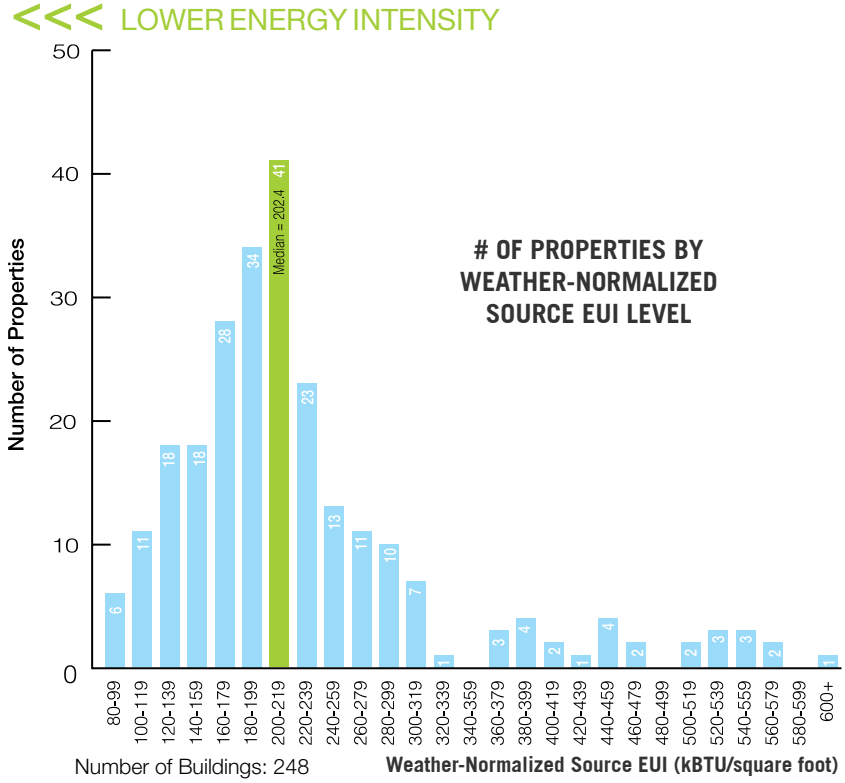
Property Category (Primary Use)	ENERGY STAR Score				
	4th Quartile Bottom performers	*3rd Quartile Medium-low performers*	*Median*	*2nd Quartile Medium-high performers*	*1st Quartile Top performers*
Office N=153	<= 71.0	71.1 - 77.9	78.0	78.1 - 83.9	>= 84.0
Healthcare N=19	<= 21.0	21.1 - 31.9	32.0	32.1 - 62.9	>= 63.0
K-12 School N=41	<= 20.5	20.6 - 62.9	63.0	63.1 - 78.4	>= 78.5
University N=0	n/a	n/a	n/a	n/a	n/a
Other N=4	<= 56.3	56.4 - 82.9	83.0	83.1 - 87.9	>= 88.0
TOTAL (ALL TYPES) N=217	**<= 60**	**60.1 - 75.9**	**76.0**	**76.1 - 82.9**	**>= 83.0**

Note: Some properties are not included because they do not have ENERGY STAR Scores available

[48] Multiple linear regression analysis was conducted to understand the relationship between weather-normalized site energy use intensity and various building attributes, such as building use, year of construction, building size, fuel mix, occupancy, number of space uses and LEED certification. The relationship between weather-normalized site EUI and the percentage of non-primary space use was not statistically significant (p-value = 0.98) with an estimated coefficient of -0.76 and standard error of 26.69. A separate regression for office buildings only, which controlled for additional variables that were only available for offices (worker density, computer density, and weekly operating hours) found that the relationship between weather-normalized site EUI and the percentage of non-primary space use was statistically significant (p-value = 0.01) for office buildings, with an estimated coefficient of 52.48 and standard error of 22.18

Figure 20 provides the distribution of weather-normalized source energy use intensity across all reporting buildings. Among the 248 reporting buildings, the median weather-normalized energy use intensity is 202 kBTU per square foot per year.

FIGURE 20: DISTRIBUTION OF ENERGY USE INTENSITY (ALL PROPERTY TYPES)



Weather-normalized site energy use intensity (EUI) reflects the energy intensity of a building's reported energy consumption as it is typically measured on utility bills. Table 3 shows the median weather-normalized site EUI and quartile ranges for each building sector and for all reporting buildings.

Table 3: Weather-Normalized Site Energy Use Intensity Quartile Ranges by Sector

Property Category (Primary Use)	Weather Normalized Site EUI				
	4th Quartile High Energy Intensity	*3rd Quartile Medium-high Intensity*	*Median*	*2nd Quartile Medium-low Intensity*	*1st Quartile Low Energy Intensity*
Office N=152	>= 95.9	78.1 - 95.8	78.0	64.9 - 77.9	<= 64.8
Healthcare N=20	>= 281.4	243.8 - 281.3	243.7	215.5 - 243.6	<= 215.4
K-12 School N=41	>= 94.9	81.7 - 94.8	81.6	68.5 - 81.5	<= 68.4
University N=14	>= 125.2	83.6 - 125.1	83.5	59.7 - 83.4	<= 59.6
Other N=21	>= 178.5	96.7 - 178.4	96.6	65.8 - 96.5	<= 65.7
TOTAL (ALL TYPES) N=248	**>= 106.5**	**83.3 - 106.4**	**83.2**	**66.4 - 83.1**	**<= 66.3**

Weather-normalized source energy use intensity (EUI) reflects the energy intensity of a building's site energy use, as well as the energy needed for generation, transmission, and distribution of the site energy use. Table 4 shows the median weather-normalized source EUI and quartile ranges for each building sector and for all reporting buildings.

Table 4: Weather-Normalized Source Energy Use Intensity Quartile Ranges by Sector

Property Category (Primary Use)	Weather Normalized Source EUI				
	4th Quartile High Energy Intensity	*3rd Quartile Medium-high Intensity*	*Median*	*2nd Quartile Medium-low Intensity*	*1st Quartile Low Energy Intensity*
Office N=152	>= 230.6	202.5 - 230.5	202.4	177.8 - 202.3	<= 177.7
Healthcare N=20	>= 545.1	459.5 - 545.0	459.4	405.7 - 459.3	<= 405.6
K-12 School N=41	>= 200.0	138.9 - 199.9	138.8	119.9 - 138.7	<= 119.8
University N=14	>= 261.1	205.1 - 261.0	205.0	158.5 - 204.9	<= 158.4
Other N=21	>= 359.9	242.4 - 359.8	242.3	140.5 - 242.2	<= 140.4
TOTAL (ALL TYPES) N=248	**>= 254.1**	**202.5 - 254.0**	**202.4**	**165.5 - 202.3**	**<= 165.4**

MUSEUM OF SCIENCE AND INDUSTRY

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Neighborhood: **Hyde Park**
Constructed: **1893**
Architect: **Charles B. Atwood for D.H. Burnham & Company**
Building Size: **1,200,000 square feet**

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MSI's investments and improvements include the creation of a 1.75 MW cogeneration system providing up to 80 percent of the Museum's heat, hot water and electricity; retrofitting garage lighting, saving 900,000 kwh/year; solar panels; and a building automation system. Benchmarking is a key tool enabling us to track the impact of these efforts, which allows the Museum to save money and provide for an exceptional guest experience."

– Museum of Science and Industry

Ed McDonald - Director of Facilities

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