ANALYZING BENCHMARKING DATA

Action Team 2: Data Quality and Analysis

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INTRODUCTION

As of May 2018, 24 U.S. cities, three states and one county had passed benchmarking and transparency laws that address the tracking and reporting of annual building performance data. This report focuses on the annual benchmarking reports that many jurisdictions publish to summarize 12 months of reported energy and/or water utility data. It includes discussions of the types of analysis that jurisdictions with benchmarking laws have used to extract valuable information from the benchmarking data and gives examples of how some jurisdictions have calculated and displayed their analytical findings.

This report draws from works published by jurisdictions that are currently implementing benchmarking ordinances, academic publications, as well as interviews and discussions with members of the Urban Sustainability Directors Network (USDN) Benchmarking and Energy Data Collective Action Group.

SECTION ONE:
DATA ANALYSIS AND ANNUAL BENCHMARKING REPORTS

A number of cities, including Boston, Chicago, the District of Columbia, New York City, Minneapolis, Philadelphia, San Francisco, and Seattle produce annual reports summarizing the benchmarking data collected over the course of the previous 12 months. These reports serve four critical purposes:

- Document the effectiveness of the implementation of the benchmarking requirement;
- Provide summary information about the jurisdiction's public and private buildings;
- Document trends in energy and water performance;
- Communicate insights taken from the data that could be of interest to policymakers, policy analysts, and real estate market stakeholders.

The following subsections describe data analyses that support these purposes. Each description explains why that analysis is important to include and how to calculate it. Additionally, for most analyses, an example of how one or more jurisdictions have displayed the results in their annual benchmarking reports is included.

Note: Accurate analysis of benchmarking data requires a high-quality dataset. Otherwise, the findings of the analysis could be skewed by incorrect underlying information. Those implementing a benchmarking policy or program are highly encouraged to read the IMT and USDN report on data quality, "Managing Benchmarking Data Quality," which proposes a framework for checking the quality of submitted benchmarking data and for handling suspected data errors.

CLIMATE PLANNING WITH BENCHMARKING DATA

To see how cities such as the District of Columbia, Philadelphia, and Seattle have used benchmarking data to inform climate planning, see Section 4 of the Institute for Market Transformation (IMT) report "Putting Data to Work: How Cities are Using Building Energy Data to Drive Efficiency," part of the IMT's Putting Data to Work project that examined how jurisdictions were deploying city-collected building benchmarking data. For a specific example of this, see the District of Columbia Department of Energy and Environment Clean Energy DC case study.

1.1 DOCUMENT EFFECTIVENESS OF IMPLEMENTATION

Jurisdictions should use their annual benchmarking reports to communicate their efforts to reduce the time and resources needed to comply with the ordinance. This information makes the case to local stakeholders that the jurisdiction is doing what it can to streamline the benchmarking submission and compliance process and ease the burden on covered property owners. Furthermore, information related to the implementation process can be useful to other jurisdictions across the U.S. seeking best practices for implementing an effective and streamlined benchmarking submission process. The following data points should be included in annual benchmarking reports to support the continued development of effective benchmarking implementation strategies:

- Compliance rates (by number of properties and by floor area). High compliance rates indicate that the ordinance is being implemented well and that building owners are taking the requirement seriously. When presenting compliance rates to the public in an annual benchmarking report, jurisdictions should give contextual information to help readers interpret the data. For example, compliance rates may drop significantly if a jurisdiction has extended its ordinance requirements to cover smaller buildings. Because smaller buildings are generally harder to reach with compliance support and often have fewer available resources than larger ones, they often struggle to comply with benchmarking ordinances in the first year or two of implementation.

- Number of benchmarking trainings and educational events the jurisdiction has hosted and number of attendees. Like compliance rates, the number of outreach and training events and the number of attendees indicate how well a jurisdiction is getting the word out about the benchmarking requirements. Again, jurisdictions should supply readers with contextual information to help them understand this metric.
- Statistics summarizing benchmarking help center interactions (number of phone calls, emails handled), if available. These data points help other jurisdictions estimate the level of support they should expect to provide for building owners.
- Where utilities offer electronic data transfer using Portfolio Manager Web Services, the number of building owners using that process as opposed to making data requests using other methods, if available.

1.2 PROVIDE SUMMARY INFORMATION ABOUT THE JURISDICTION'S BUILDINGS AND THEIR ENERGY PERFORMANCE

Annual benchmarking reports should summarize basic characteristics about the covered building stock in a jurisdiction. This information helps readers understand how energy is used in buildings, including which property sectors are most energy intensive, and the fuels used to power, heat, and cool different building types. This data can help jurisdictions plan future energy efficiency programs, by revealing the building types and property sectors that are most opportune for energy savings. Subsections 1.2.1–1.2.7 summarize some basic analyses that a jurisdiction should include in an annual benchmarking report to give readers a baseline understanding of the local building stock.

1.2.1 Analysis: Number of Buildings and Floor Area by Building Type

This analysis helps the reader understand the composition of property use types among covered buildings. By breaking the distribution of buildings down by floor area in addition to number of buildings, the jurisdiction can account for the effect that the size of buildings have on the distribution. A jurisdiction could contain a greater number of multifamily buildings than office buildings but if the office buildings have a significant amount of square footage, they could still represent a larger proportion of the jurisdiction's total built area.

This kind of information can be helpful in designing and directing outreach and engagement strategies and technical assistance for maximum effect in the most common building types. It could also be useful for estimating the potential scope of future markets for common energy efficiency measures that are particular to building type or size.

To do this analysis, categorize the covered buildings by general property use type (e.g., Office, Multifamily, Retail Store, Hospital, etc.) then add up the number of buildings and total square footage for each category. Divide each number by the corresponding total for the entire sample (all of the covered buildings left after data cleansing) to find the percentage of the total for number of buildings and square footage.

Example:
Figure 1. City of San Francisco. This figure allows the reader to easily compare each property use type as a percentage of the total number of buildings against its percentage of the total floor area.

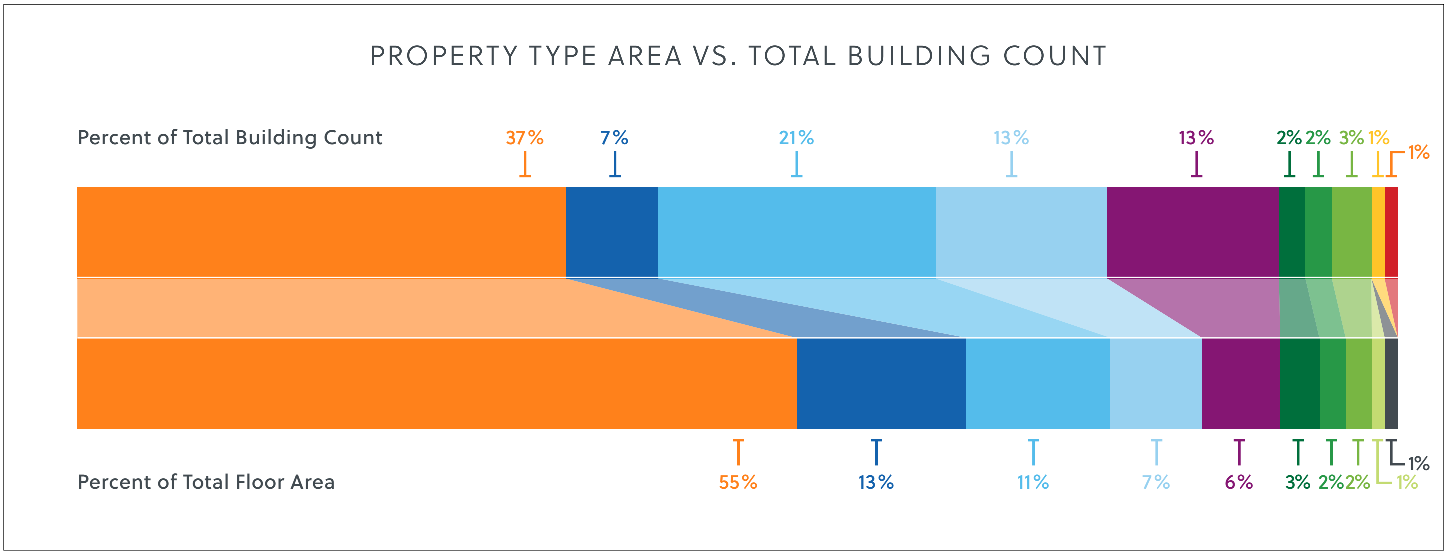


Figure 1. San Francisco Existing Commercial Buildings Performance Report 2010-2014*, San Francisco Department of the Environment and Urban Land Institute Greenprint Center.*

1.2.2 Analysis: Number of Buildings and Floor Area by Decade Constructed

This analysis shows when the jurisdiction's covered buildings were constructed and how old and new buildings are distributed. Buildings constructed during the same era tend to use similar designs, construction techniques, and energy-consuming technologies. They would also have been subject to similar building code requirements. Therefore, knowing when properties were built serves as a clue as to which energy efficiency measures may be most opportune in the local building stock and whether improvements to energy codes are achieving their expected impact.

To do this analysis, categorize each covered building into a decade of construction using the Year Built field in ENERGY STAR Portfolio Manager. This information can be displayed by property use type (Office, Multifamily, etc.), by building size category (≥ 50,000 square feet, ≥ 100,000 square feet, etc.) or by floor area.

Examples:
Figure 2. City of Boston. This figure indicates floor area and number of buildings for each decade of construction.
Figure 3. City of Minneapolis. This figure show the number of properties built in each decade, while separating buildings by size and by private or public ownership.

1.2.3 Analysis: Distribution of ENERGY STAR Scores for Eligible Properties

An ENERGY STAR score is the most recognizable and easily understood energy performance metric for buildings in the U.S. For this reason, it is important to provide summary information about the distribution of ENERGY STAR scores among covered buildings. Although some covered buildings are not eligible for ENERGY STAR scores, the buildings most familiar to the public generally are, e.g., Office, Multifamily, and Retail Store. Providing information about the

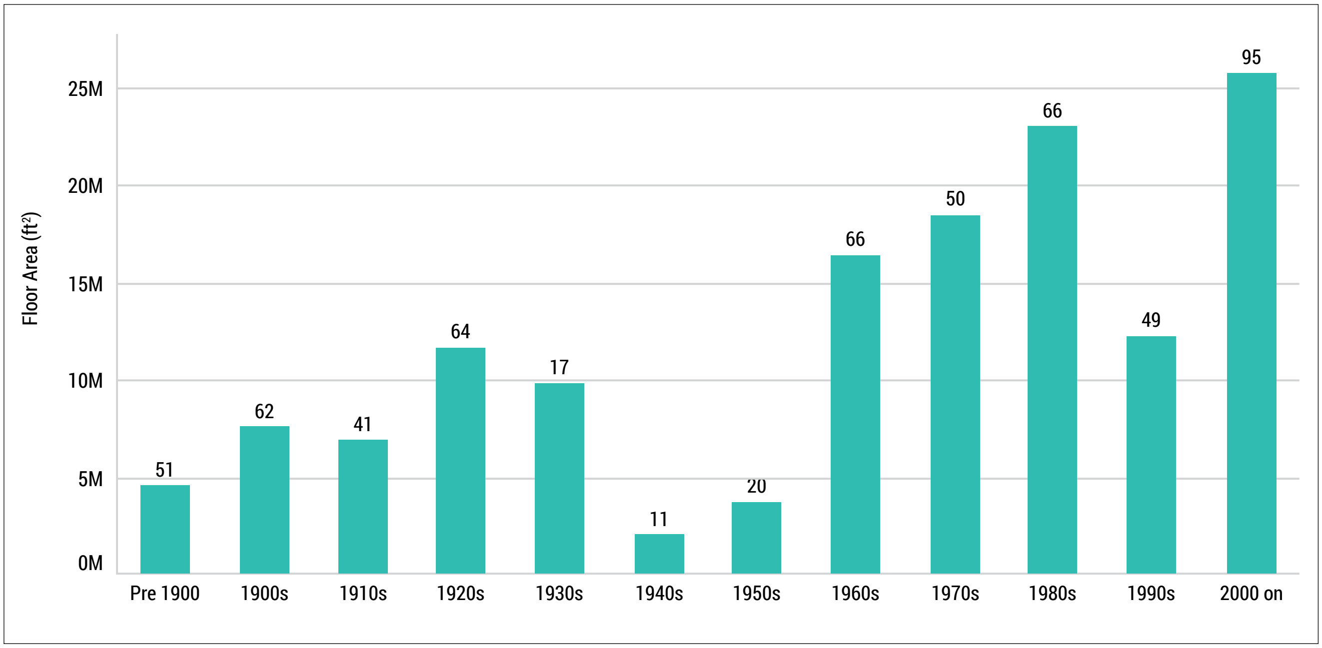


Figure 2. Energy and Water Use in Boston's Large Buildings, 2013, August 2015. City of Boston Environment Department.

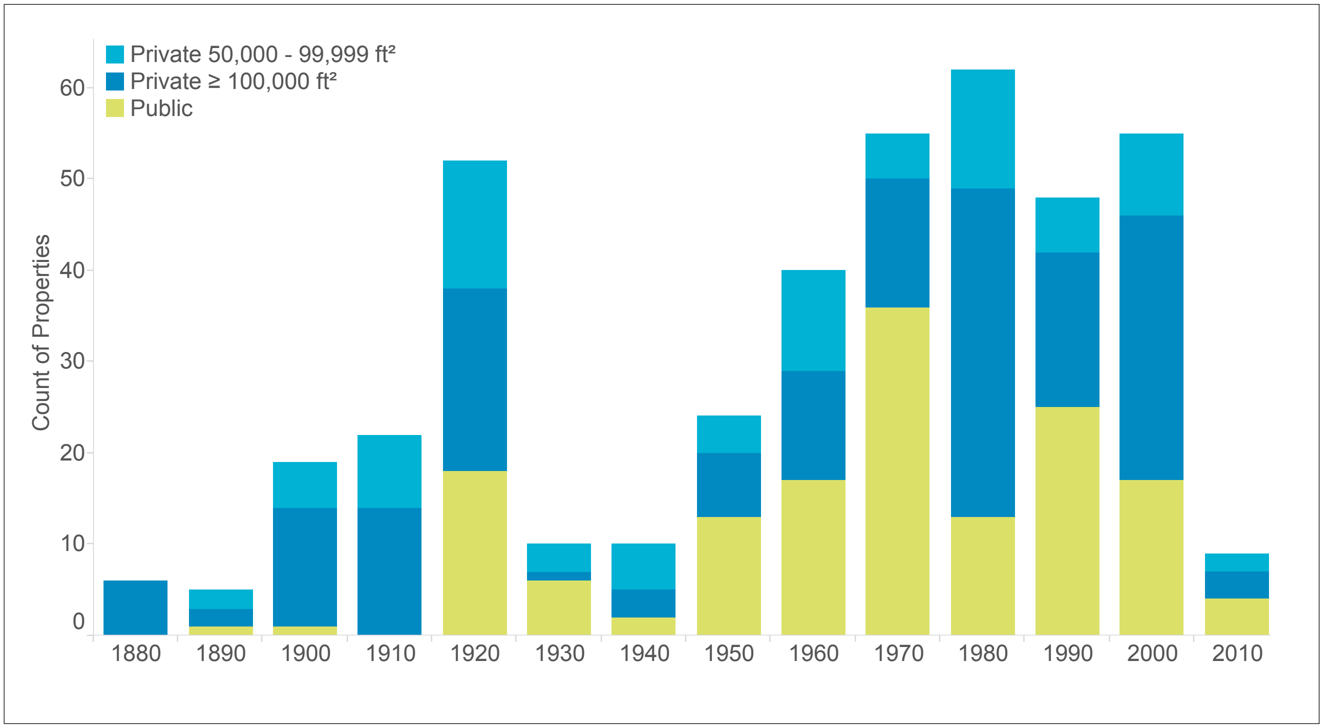


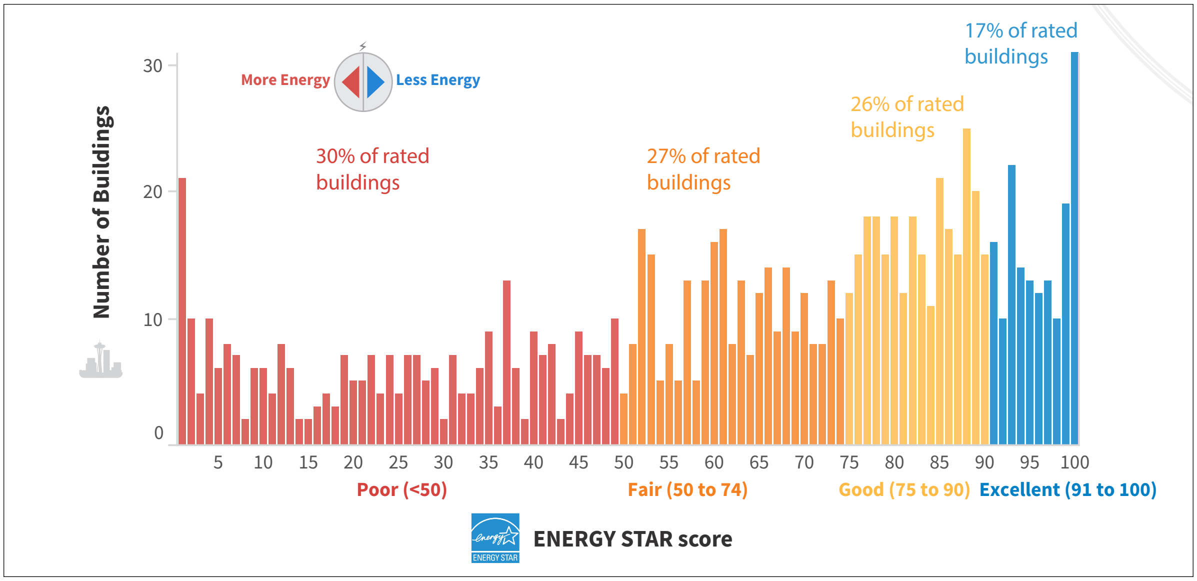
Figure 3. 2015 Energy Benchmarking Report, February 2017. City of Minneapolis

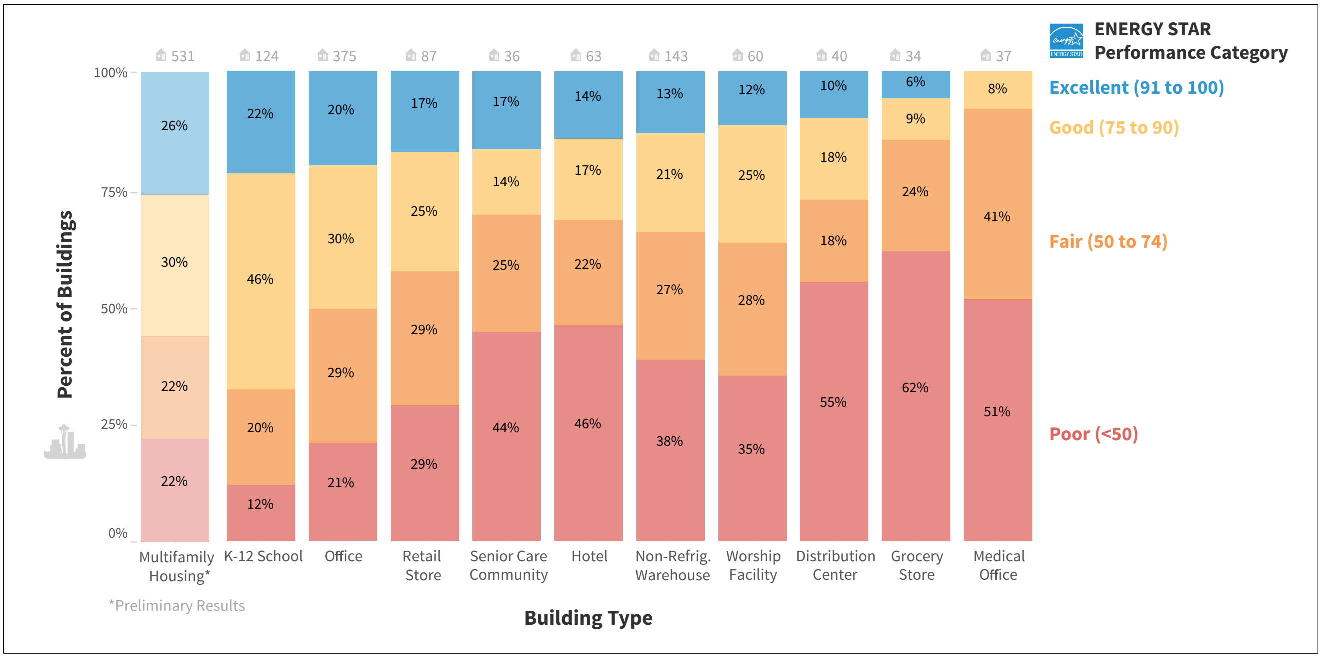
median and range of ENERGY STAR scores can be a quick indicator of how a city's building stock compares to the national average. Cities take different approaches to displaying ENERGY STAR score information, but a general best practice is to display the median score and the distribution of scores, either by percentage of or number of total ENERGY STAR-eligible buildings.

Figures 4 and 5. Building Energy Benchmarking Analysis Report 2013 Data*, September 2015. Office of Sustainability and Environment, City of Seattle.*

Examples:

Figure 4. City of Seattle. This figure shows the distribution of ENERGY STAR scores for non-residential buildings. The City color-codes the scores to denote their inclusion in one of four performance categories: Poor, Fair, Good, and Excellent.
Figure 5. City of Seattle. This figure shows the percentage of buildings in each of the four performance categories (Poor, Fair, Good, Excellent) by property use type.





1.2.4 Analysis: Distribution of EUI for Different Property Types (Average, Median, Quartiles)

City governments, utilities, and other organizations that conduct outreach and technical assistance to promote energy efficiency benefit from knowing which property types in a jurisdiction are the most energy intensive. This information can be used to customize programs and more efficiently deploy outreach efforts. Jurisdictions can provide this information by calculating metrics and producing graphics that represent the distribution of Energy Use Intensity (EUI) values for each property type of benchmarked buildings.

Calculating a single median EUI for each property type provides less value than showing the distribution of EUIs where it is easier to see savings opportunities. To show the distribution of EUIs for a property type, divide the distribution of each property type's EUIs into quartiles and display it in a chart (see Figure 6) or a box and whisker plot (see Figure 7).

Examples:

Figure 6. City of Seattle. This figure shows the distribution of EUIs for each property type divided into quartiles.

Figure 7. City of Boston. This figure shows the distribution of EUIs for each property type using box and whisker plots.

	2013 Annual Energy Use Intensity (Site EUI in kBtu/sf)								
Type of Building	**Median**	**Lowest Use** *(1st Quartile)*	**Medium-Low** *(2nd Quartile)*	**Medium-High** *(3rd Quartile)*	**Highest Use** *(4th Quartile)*	Number of Buildings	Year Built *(median)*	Size *(median sf)*	**EPA ENERGY STAR** *(median)*[1]
Low -Rise Multifamily[2]	30.3	≤24	25-30	31-38	≥39	918	1987	29,652	77*
Mid-Rise Multifamily[2]	34.3	≤27	28-34	35-45	≥46	445	1995	52,020	85*
High-Rise Multifamily[2]	49.0	≤42	43-49	50-63	≥64	88	1980	139,684	47*
Office	58.0	≤43	44-58	59-72	≥73	431	1970	55,632	75
Warehouse	24.9	≤14	15-25	26-48	≥49	187	1964	39,984	60
Distribution Center	30.6	≤20	21-31	32-43	≥44	54	1967	46,355	48
Self-Storage Facility	19.0	≤11	12-19	20-30	≥31	23	1956	38,959	NA
Refrigerated Warehouse	44.6	≤34	35-45	46-91	≥92	11	1955	27,200	57
K-12 School[3]	43.1	≤35	36-43	44-56	≥57	125	1960	54,986	83
Retail Store	60.4	≤43	44-60	61-93	≥94	99	1966	41,615	68
Hotel/Motel	85.8	≤55	56-86	87-106	≥107	67	1977	88,592	53
Worship Facility	38.9	≤26	27-39	40-52	≥53	65	1952	26,210	60
Medical Office	83.7	≤67	68-84	85-115	≥116	39	1984	63,909	49
Senior Care Community	72.4	≤51	52-72	73-111	≥112	39	1974	90,383	58
Hospital	205.3	≤170	171-205	206-229	≥230	9	1959	607,780	46
Supermarket	277.4	≤221	222-277	278-299	≥300	35	1996	41,447	41
Restaurant	156.2	≤88	89-156	157-186	≥187	11	1919	33,600	NA
Residence Hall	69.3	≤42	43-69	70-85	≥86	16	1958	31,622	63
University[4]	83.1	≤57	58-83	84-94	≥95	14	1958	58,706	74
Other	62.2	≤36	37-62	63-113	≥114	216	1962	42,750	NA

Figure 6. Building Energy Benchmarking Analysis Report 2013 Data, September 2015. Office of Sustainability and Environment, City of Seattle.

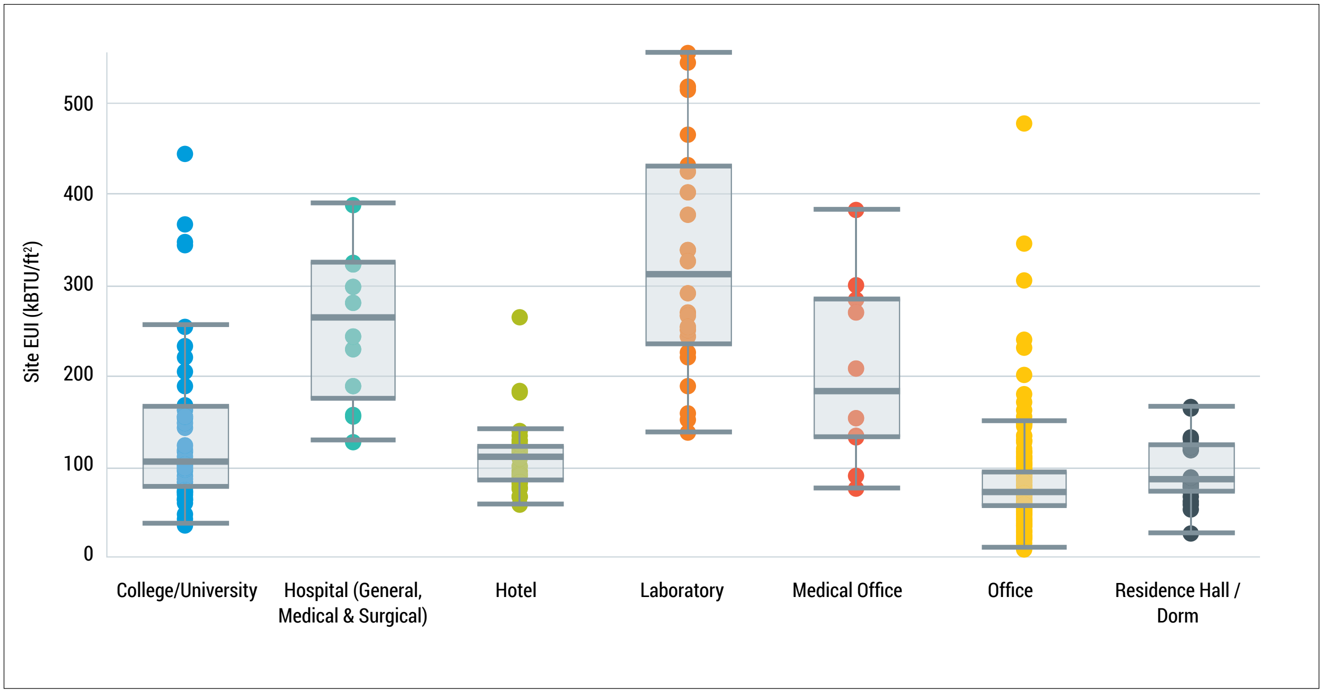


Figure 7. Energy and Water Use in Boston's Large Buildings, 2013, August 2015. City of Boston Environment Department.

SITE, SOURCE, AND WEATHER NORMALIZED: WHICH EUI METRIC SHOULD YOU USE?

Depending on the analysis, any one of the U.S. Environmental Protection Agency (EPA) Portfolio Manager's Energy Use Intensity (EUI) metrics might be most appropriate. Site energy use is the total amount of energy—whether from electricity, natural gas, or another fuel—that a building uses on site and is what building owners and managers are most familiar with and have the most direct control over. Therefore, site energy use and site EUI are the metrics that should be used to evaluate a building's change in energy performance over time. Source energy use includes the total energy that a building uses, including energy lost during production, transmission, and delivery.[1] As a result, source energy more fairly compares the energy performance of buildings that use different energy sources, since it fairly compares electricity with on-site-combustion. Source energy use and source EUI are the most appropriate metrics to use when trying to understand the total energy that is used in providing power and heat to a building, and thus when comparing buildings to one another within a single year. Because EPA uses one national site-to-source energy ratio, and periodically updates it, source energy may not be an appropriate metric in some locations or for some comparisons over time.

Weather-normalized site and source energy account for the weather in the year measured. Because weather in a region fluctuates from year to year with some years being significantly colder or hotter than average, Portfolio Manager calculates the energy a building would have used if it had experienced 30-year average temperatures. Weather-normalized energy use and energy use intensity values are important to use when comparing buildings' energy use over time, so that differences in weather do not skew the analysis.[2] It is important to note that weather-normalized energy is not appropriate for comparing buildings from different climates, as it does not take into account regional variations in average weather conditions. ENERGY STAR scores are the appropriate metrics for cross-regional comparisons.

1.2.5 Analysis: Year Built and Energy Use Intensity

This analysis is useful for investigating a potential relationship between the age of a building and its energy performance. A common misconception among building owners and the public is that older buildings are less efficient than newer ones; however, analyses from benchmarking data in Boston,[3] New York City,[4] Chicago,[5] and Washington, DC[6] have shown this not to be the case. In fact, New York City found that buildings constructed prior to 1910 tended to be the least energy intensive, whereas buildings constructed after the Second World War were increasingly energy intensive.[7] Most jurisdictions should include this analysis in their annual benchmarking reports to see if there is indeed a correlation between year built and energy consumption in the local building stock; while a building's age may not be correlated with greater energy consumption, certain decades of construction could be. As discussed in Section 1.3.2, buildings constructed during the same era tend to have similarities in their design, construction, and technologies. Seeing significant variation in energy use in buildings constructed in certain decades could give a clue as to technologies or design techniques that contribute to better or worse energy performance.

This calculation is only applicable if a city has enough of a given property type that they can be separated by vintage and still have a substantial number of buildings in each decade. Sort buildings of like property type by the Year Built field and group them by decade. For each decade, calculate the median EUI. By comparing the results for each decade, it is possible to detect a relationship between a building's date of construction and its energy use.

Example:

Figure 8. New York City. This figure shows the median weather-normalized source EUI for Office and Multifamily buildings constructed in each decade going back to the pre-1900s. The figure illustrates dramatic increases in median energy use intensity for offices built in the 1970s and 1990s.

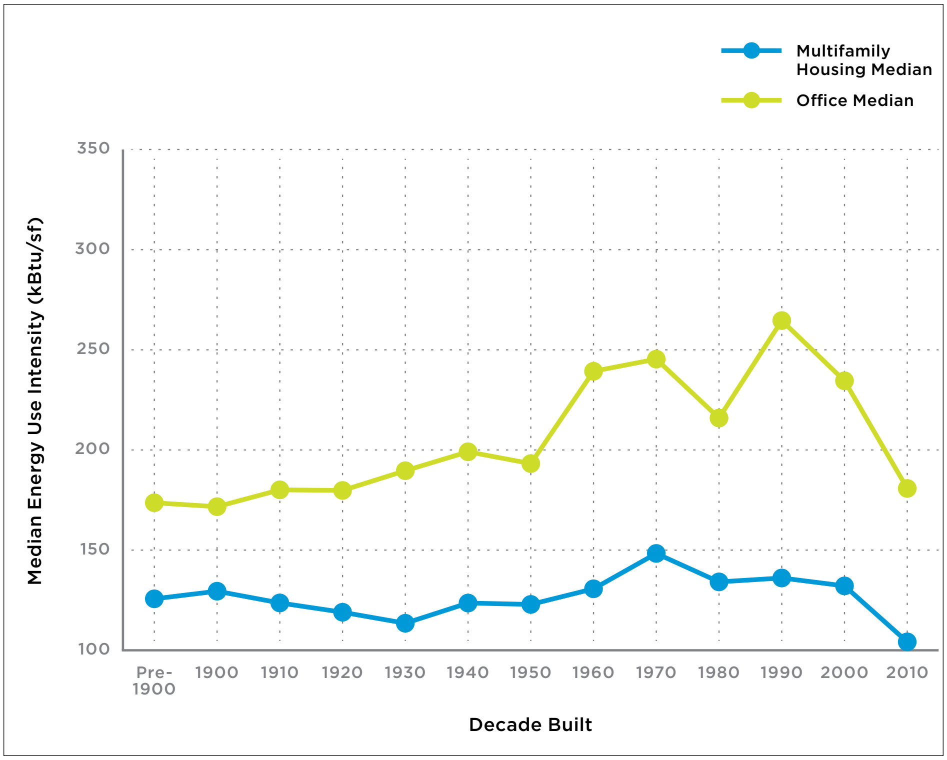


Figure 8. New York City's Energy and Water Use 2013 Report*, August 2016. Urban Green Council*

1.2.6 Analysis: Estimated Energy Costs

Estimating the amount of money spent on utilities helps readers understand energy consumption in a more familiar and salient unit of measure. By estimating the energy costs for each covered building, a jurisdiction can develop median energy cost estimates for each property use type. This enables building owners to compare their precise operating expenses against the typical expenses for their building type.

To calculate a rough estimate of the energy costs for a single building, take the site energy the building used for each fuel type and multiply it by the average cost of that fuel in the region. The U.S. Energy Information Administration (EIA) keeps estimates, drawn from reports by Electric Power Monthly and Natural Gas Monthly,[8] of average commercial retail prices in each state. Add up the building's energy cost for each fuel type it used to estimate its total annual energy costs.

The real estate industry commonly expresses its costs on a per square foot basis, so jurisdictions should consider expressing energy costs in the same manner.

1.2.7 Analysis: Fuel Mix for Different Building Types

Knowing the quantity and type of fuel that buildings use helps the city accurately account for emissions from direct combustion in buildings.[9] This information can be useful for developing decarbonization strategies, as it allows a jurisdiction to see how many of its buildings are moving to full electrification.[10] In some cases, it can also be useful for engaging utilities to expand or refine energy efficiency services, including rebates or fuel-switching incentives.

Examples:

In Figures 9 and 10, New York City and Washington, DC graph the fuel mix for multifamily and office buildings by decade built. These graphs allow the reader to see how buildings constructed in different eras are powered. The NYC graph shows that a significant percentage of buildings constructed before the 1990s use fuel oils and district steam for heating.

Figure 9. New York City's Energy and Water Use 2013 Report*, August 2016. Urban Green Council*

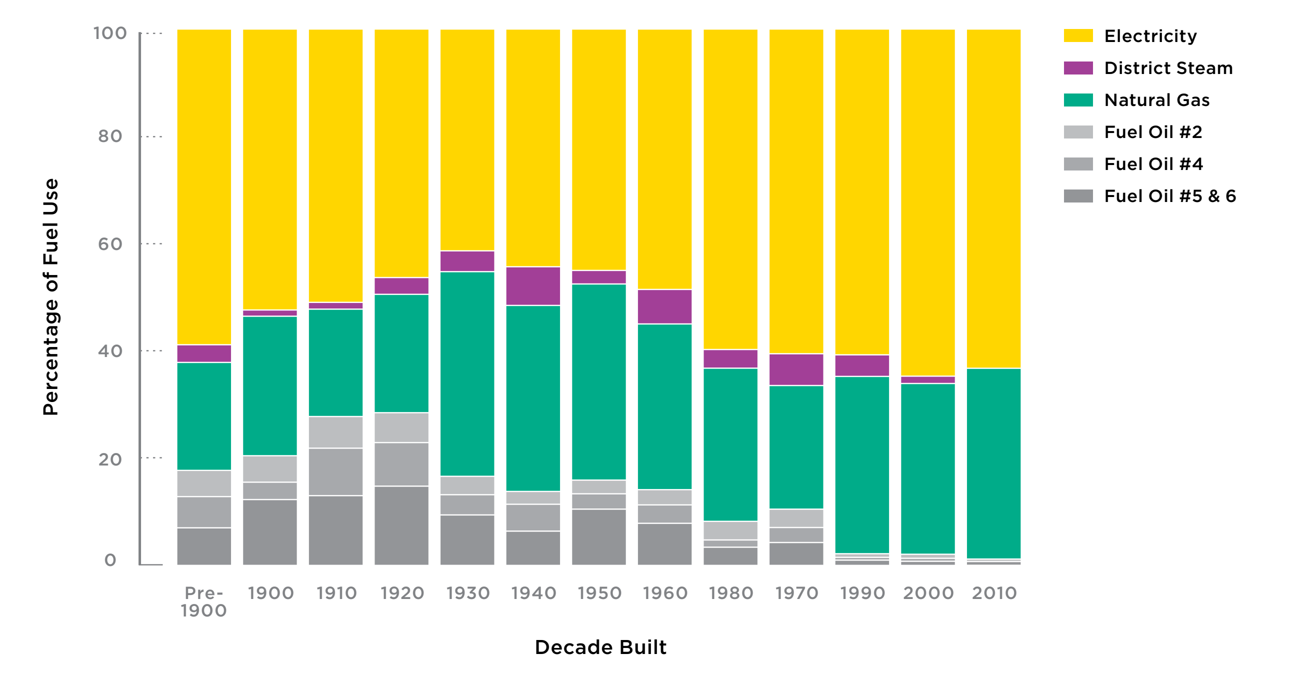


Figure 10. [Green Building Report For the District of Columbia](), *2013, Department of Energy and Environment*

1.3 DOCUMENT CHANGES IN ENERGY AND WATER PERFORMANCE

The essential question about benchmarking and transparency ordinances is whether they work. That is, do they lead building owners and property managers to manage their energy consumption more carefully, leading to energy consumption reductions? And do they cause real estate professionals to consider energy more during transactions? Unfortunately, answering these questions is outside of the scope of a jurisdiction's annual report. Attributing changes in energy use to any one factor, such as a benchmarking and transparency ordinance, is a challenge, as in most jurisdictions a mix of utility, state, and city energy programs and policies all factor into the energy performance of the local building stock, to say nothing of market transformation effects occurring naturally in the private real estate market. This type of analysis is best left to academic and professional researchers. A jurisdiction should, however, measure and publish the change in energy use for buildings that consistently comply with the benchmarking and transparency ordinance, as this analysis provides important information about whether the jurisdiction's buildings are making progress toward citywide energy reduction goals.

1.3.1 Analysis: Change in Energy Use from Consistently Complying Properties

Perhaps the most important calculation in an annual benchmarking report is the change in energy use of benchmarked properties over time. By tracking the change in energy use, the jurisdiction will know if building performance is improving, declining, or remaining constant. This is the best indicator a jurisdiction has for evaluating the aggregate impact of the various energy efficiency programs and policies affecting its local building stock.

Selecting the appropriate metric of comparison. To account for variations in weather between years, data analysts should use the weather-normalized site energy use as the metric of comparison. Weather normalization is important because it accounts for the different weather buildings would have experienced in each year of the analyzed period. Without it, the comparison would be meaningless. Weather-normalized site energy use is a more appropriate metric than weather-normalized source energy use because the fuel mix factors that Portfolio Manager uses to calculate source energy use are updated periodically and could distort year-over-year analysis.

Selecting the time period of analysis. It takes several years for buildings to go through the complete cycle of benchmarking, comparing to peers, identifying energy-saving opportunities and taking action. Because of this long cycle, jurisdictions need at least three and preferably 4–5 years of data for each property included in the analysis to document changes in energy use.[11] Jurisdictions should also consider the size of the dataset that will result when setting a time period, as jurisdictions with mandates that phased in over time will have much smaller datasets in the initial year(s).

Developing the dataset for analysis. Jurisdictions need to be careful about the universe of buildings they include in the dataset for this analysis. Buildings that failed to submit a compliant benchmarking submission during any year included in the analyzed period should generally be excluded from the analysis; however, this can lead to an ever-shrinking set of buildings to work with over time. To overcome this difficulty, New York City now allows for some gaps in its dataset, where they will interpolate data values for missing years.[12] Buildings with dramatic increases or decreases in their total site energy use should be flagged for follow-up or removed from the analysis, as dramatic changes indicate probable data quality issues.

Finding the percentage change in energy use: After finalizing the dataset for analysis, the jurisdiction adds up the total weather-normalized site energy use for all properties in the current year and does the same for the baseline year. Divide the difference in energy use between the current and baseline years by the baseline year's total weather-normalized site energy use to find the percentage change in energy use. Dividing by the total square footage will allow the creation of the change in average Energy Use Intensity.

For an in-depth discussion of how several U.S. cities calculate the change in energy use from consistently complying properties, see the IMT report, "Impact Assessment: A Guide for City Governments to Estimate the Savings from Energy Benchmarking and Energy Efficiency Programs."

CHANGE IN GHG EMISSIONS

Some jurisdictions may choose to calculate the change in greenhouse gas (GHG) emissions over time for consistently complying buildings. Because benchmarking and transparency ordinances are often passed as a tool to help jurisdictions reach their GHG reduction goals, it often makes sense to track how benchmarked buildings are performing with respect to GHGs; however, that can potentially create some complications. First, buildings can report green power purchases through Renewable Energy Certificates (RECs) which do not directly reduce the buildings' local GHG output. Therefore, RECs could create the impression that local GHGs are shrinking more than they really are. Second, the emissions & generation resource integrated database (eGRID) factors that Portfolio Manager uses for the carbon intensity of the energy supply in different regions of the country are regularly updated to reflect the ever-changing mix of fuels supplying the grid. This can give the appearance that consistently complying buildings are steadily reducing their GHG emissions due to energy efficiency when the real cause is grid decarbonization. Jurisdictions that wish to show the change in GHG emissions across the local building stock should clarify to the reader that observed changes may be due to a cleaner fuel mix supplying the grid.

Examples:
Figure 11. City of Chicago. This figure shows how the total weather-normalized site energy use has changed year over year for buildings with three years of benchmarking data and for buildings with two years of data.
Figure 12. Washington, DC. This figure shows the change in average weather-normalized site Energy Use Intensity (EUI) for all private buildings larger than 50,000 square feet.
Figure 13. New York City. This figure shows how the distribution of EUI scores has shifted for Office and Multifamily buildings between 2010–2013.
Figure 14. New York City. This figure shows the change in median EUI for Office and Multifamily buildings. A change in median EUI shows how the distribution of EUIs in a population of buildings has shifted; however, because it does not account for the total energy use of the population of buildings, the change in median EUI shown alone could mask the effect of high-consuming outlier buildings.

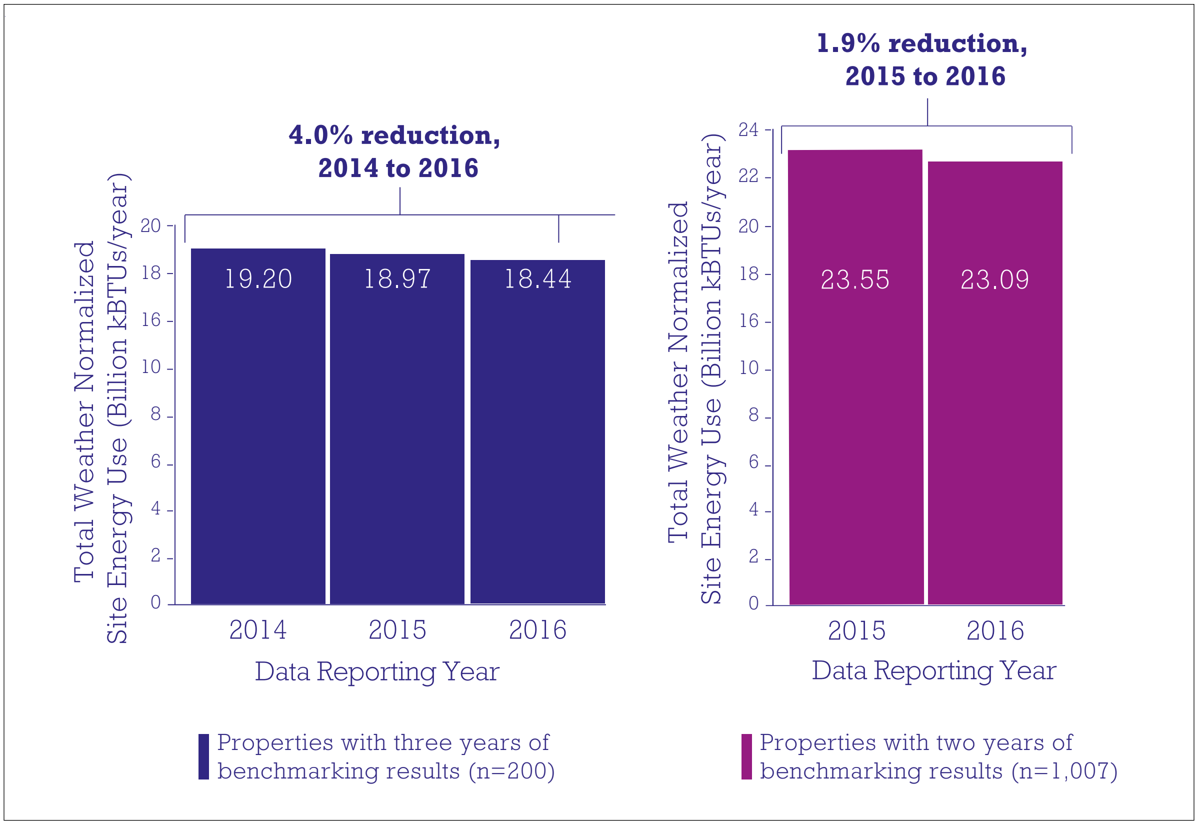


Figure 11. City of Chicago Energy Benchmarking Report

Figure 12. Green Building Report For the District of Columbia, 2014-2016, *District of Columbia Department of Energy and Environment*

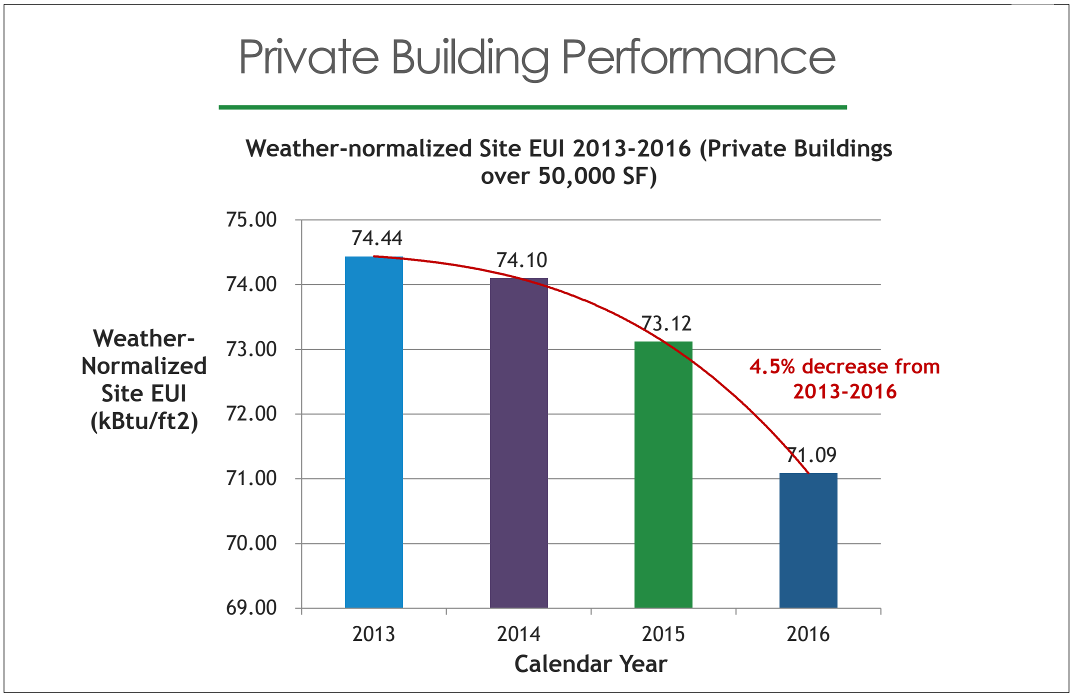
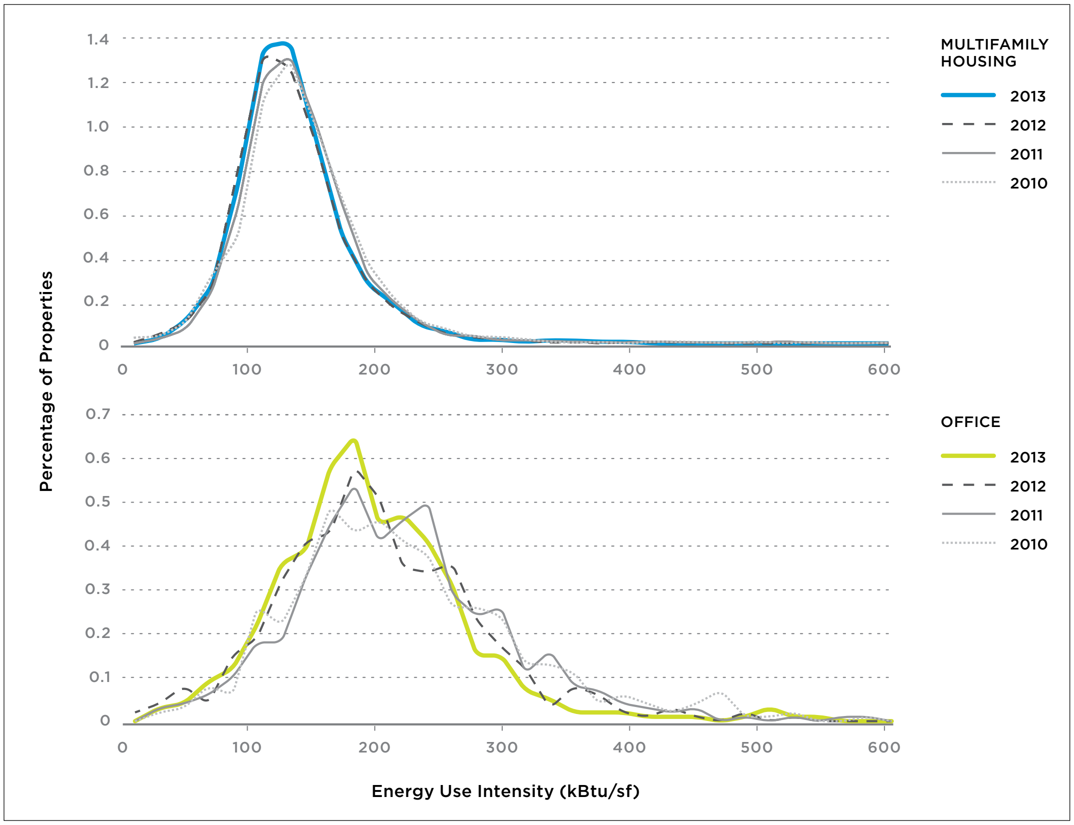


Figure 13. New York City's Energy and Water Use 2013 Report, *August 2016. Urban Green Council*



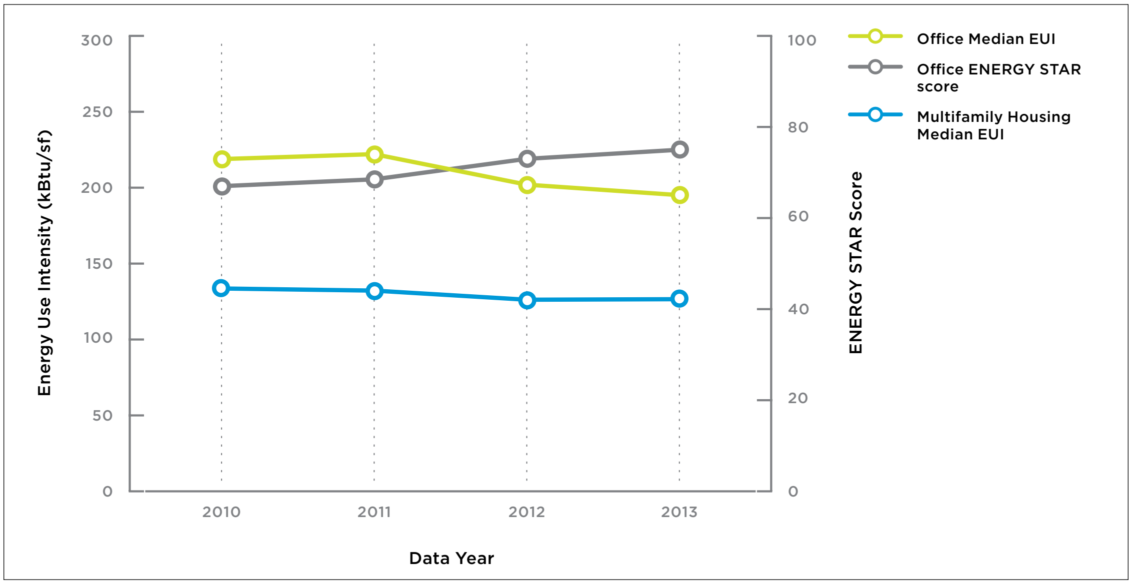


Figure 14. New York City's Energy and Water Use 2013 Report, *August 2016. Urban Green Council*

1.3.2 Analysis: Change in ENERGY STAR Score for Consistently Complying Eligible Properties

Calculating the change in median ENERGY STAR score shows the reader how consistently complying properties' energy performance has changed in relation to national peers, but it does not necessarily indicate a percentage increase or decrease in energy use.

To find the change in median ENERGY STAR score, simply find the median score in the baseline year and the current year. The difference between the two is the change in median ENERGY STAR score.

It is important to consider that updates to the ENERGY STAR score algorithm will have an effect on ENERGY STAR results. For example, when ENERGY STAR updates its score models based on the CBECS 2012 data in 2018, every building's ENERGY STAR score will be affected. Therefore, it is most appropriate to track the change in ENERGY STAR score against years in which the ENERGY STAR algorithm was the same.

Example:

Figure 15. City of Chicago. As a jurisdiction collects additional years of data, it can be helpful to show how median ENERGY STAR scores have changed for common building

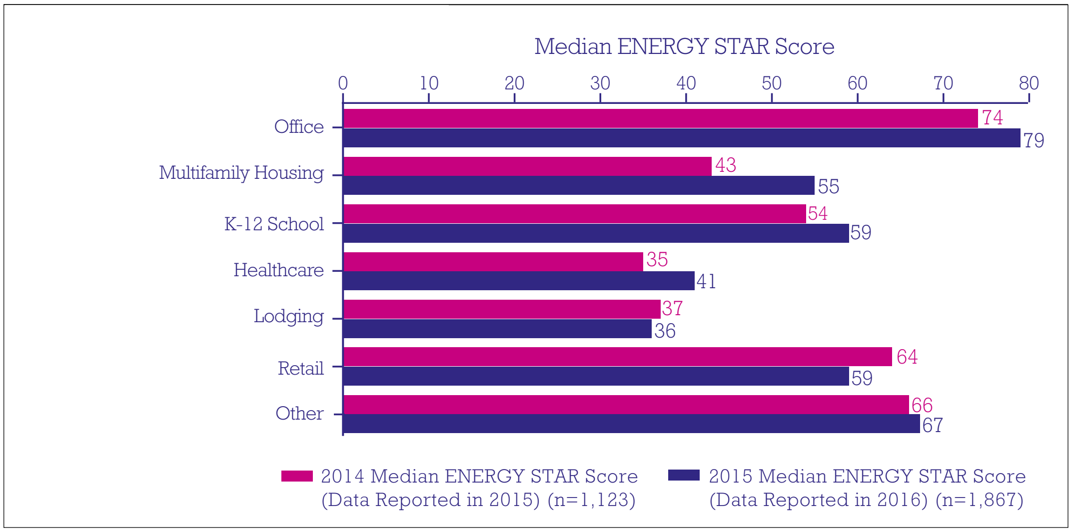


Figure 15. City of Chicago Energy Benchmarking Report

types over time. Chicago charts the change in median score between the current and previous years by building type. For information on how jurisdictions calculate change in ENERGY STAR scores, see subsection 2.3.3 "Change in ENERGY STAR Score for Consistently Complying Eligible Properties."

1.4 COMMUNICATING INSIGHTS TAKEN FROM THE DATA

The following subsections describe analyses that can be conducted with benchmarking data to show the benefits that could be realized from greater progress toward energy efficiency.

1.4.1 Analysis: Energy Savings Opportunity

By calculating the potential energy that could be saved if all benchmarked buildings met their achievable energy savings potential, jurisdictions can estimate the associated dollars that could be saved, greenhouse gases reduced, and jobs created.

The general approach to estimating energy savings potential is to calculate the energy that would be saved if lower performing buildings reduced their site Energy Use Intensity (EUI) to a performance target based on the site EUIs of better performing buildings of the same use type. Jurisdictions should use their discretion and the input of their implementation advisory groups to set performance targets.

The City of Chicago's method of calculating the potential energy savings from benchmarked buildings is to add up the energy reductions that would occur if all buildings that are below the 50th percentile in site EUI for their Portfolio Manager property use type improved to the median. They set this as the lower boundary for the savings opportunity range for that property type. To estimate the upper boundary, they add up the energy reductions that would occur if all buildings of the same property type with site EUIs below the 75th percentile improved their site EUI equivalent to the 75th percentile. Finally, for buildings at the 75th percentile or above, the energy reductions that would occur from a flat two percent reduction in their site EUI are added up. Separately, to reflect the total energy that could be saved, inclusive of generation and transmission losses, Chicago converts the potential site energy use reductions for each building type to source energy use.

1.4.2 Energy Cost Savings Opportunity

By converting potential energy savings to cost savings, jurisdictions can communicate savings potential in a metric that is more familiar and more salient to the vast majority of readers. To calculate potential annual energy cost savings for each building, multiply the potential annual site energy use reduction percentage in Analysis 1.4.1 by the electricity use and the natural gas (or other fuel) use of the property. This gives the potential reduction in annual electricity and natural gas consumption, which can then be multiplied by local energy rates to find the potential annual energy cost savings for each building. The savings for each building can be added up to arrive at a citywide potential annual cost savings number. Note: The U.S. Energy Information Administration (EIA) keeps estimates, drawn from reports by Electric Power Monthly and Natural Gas Monthly,[13] of average commercial retail prices in each state.

1.4.3 Investment Opportunity and Jobs Created by Achieving Potential Energy Savings

One of the major benefits of energy efficiency is the local economic activity it generates. Achieving the estimated energy savings potential would require building owners to invest in energy efficiency through capital projects and new energy management procedures. These investments create local jobs and support local businesses in energy efficiency-related industries and trades. To demonstrate this local economic impact, a jurisdiction can estimate the number of jobs that would be created if benchmarked buildings achieved their energy savings potential.

Investment Opportunity. The first step in this analysis is to estimate the investment in dollars needed to reach the potential energy cost savings calculated in Analysis 1.4.2. To do this, multiply the total estimated annual cost savings by an investment multiplier. This is a number that represents the average payback period for building owners to recoup the investment necessary to reach the potential energy cost savings. In other words, when multiplied by the potential annual cost savings for a building, the result is the investment opportunity, or the amount of money the building owner would have to invest to realize the annual cost savings calculated in Analysis 1.4.2.

Developing an appropriate multiplier can be difficult, and the assistance of a knowledgeable implementation advisory group can be valuable in determining what a reasonable multiplier would be. The City of Chicago used a multiplier of 3.5 to calculate the investment that would be needed to realize the city's potential energy cost savings.

Jobs Created. The investment opportunity can be used to derive an estimate of the number of jobs that would be created from that spending. To estimate job creation opportunity, the jurisdiction multiplies the total investment opportunity by assumptions that represent the share of investment spending that would go to pay for labor and an estimated annual salary for the labor used to implement the energy efficiency upgrades.

For example, the City of Chicago assumed that the share of investment spending going to labor would be 50 percent. To arrive at an estimated annual salary of $70,000 for the jobs created by that spending, Chicago used statistics from the U.S. Bureau of Labor Statistics' Occupational Employment Statistics. This number was based on the median salary for the construction industry but increased to hedge against overestimation of the number of jobs created. To arrive at an estimated number of jobs that would be created by the investment opportunity, Chicago divided the total investment opportunity by 50 percent and then divided the result by the estimated annual salary.

An alternative approach to estimating an average annual salary is to use a jobs multiplier developed by a third party. New York City uses the Bureau of Economic Analysis' Regional Input-Output Modeling System (RIMS II) to select a multiplier to represent direct and induced jobs created by achieving the potential savings potential. This number is multiplied by the total estimated installation and construction costs that would be incurred to reach the city's energy savings potential.

SECTION TWO:
COMPREHENSIVE VERSUS STREAMLINED ANNUAL REPORTS

In general, this paper recommends that early on in the implementation of their benchmarking and transparency ordinances, jurisdictions publish a more comprehensive initial benchmarking report that includes many if not all of the analyses described above. This sets a good baseline for the make-up of a jurisdiction's building stock, its performance, and its potential energy and economic savings. To see examples of more comprehensive benchmarking annual reports, see recent reports produced by New York City (2014–2015 data),[14] Chicago (2014–2016 data),[15] and San Francisco (2010–2014 data).[16]

In later years, however, such a comprehensive analysis may not be necessary, as many of the analyses will not change much from year to year. For this more streamlined report, jurisdictions should focus on the following analyses:

- The implementation analyses described in section 1.1 "Document Effective Implementation" are helpful to show how the jurisdiction's implementation efforts have paid off over time in terms of compliance rates.
- Analysis 1.2.1 "Number of Buildings and Floor Area by Building Type" is helpful to give readers a sense of the distribution of different building types among the covered buildings list.
- Analysis 1.2.3 "Distribution of ENERGY STAR Scores for Eligible Properties" and Analysis 1.2.4 "Distribution of EUI for Different Property Types" give readers a snapshot of how different building types perform.
- Analysis 1.3.1 "Change in Energy Use from Consistently Complying Properties" and Analysis 1.3.2 "Change in ENERGY STAR Score for Consistently Complying Properties" show readers how energy performance has changed since the previous year among consistently complying buildings.

Periodically, perhaps every five years, jurisdictions should consider issuing an updated comprehensive report that records changes in the results of the larger set of analyses included in the initial benchmarking report.

NOTES

1. "Portfolio Manager Technical Reference: Source Energy," U.S. Environmental Protection Agency ENERGY STAR, https://portfoliomanager.energystar.gov/pdf/reference/Source%20Energy.pdf
2. "Portfolio Manager Technical Reference: Climate and Weather," U.S. Environmental Protection Agency ENERGY STAR, last modified August 11, 2017, http://www.energystar.gov/buildings/tools-and-resources/portfolio-manager-technical-reference-climate-and-weather
3. City of Boston Environment Department, *Boston Building Energy Reporting and Disclosure Ordinance Data Analysis and Recommendations* (Feb 2015), https://www.cityofboston.gov/images_documents/Peregrine%20Report%20to%20City%20of%20Boston_2014-02-21_tcm3-52525.pdf
4. City of New York, New York City's Energy and Water Use 2013 Report (August 2016), http://www.nyc.gov/html/gbee/downloads/pdf/nyc_energy_water_use_2013_report_final.pdf
5. City of Chicago, *City of Chicago Energy Benchmarking Report 2016* (December 2016), https://www.cityofchicago.org/content/dam/city/progs/env/EnergyBenchmark/2016_Chicago_Energy_Benchmarking_Report.pdf.
6. District of Columbia Department of Energy and Environment, *Green Building Report For the District of Columbia, 2013* https://doee.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/Green%20Building%20Report%202013_WORKING%20DRAFT.pdf
7. City of New York, New York City's Energy and Water Use 2013 Report (August 2016), page 43 http://www.nyc.gov/html/gbee/downloads/pdf/nyc_energy_water_use_2013_report_final.pdf
8. ENERGY STAR Portfolio Manager Technical Reference, "Estimating Fuel Mix and Energy Cost," August 2017, https://portfoliomanager.energystar.gov/pdf/reference/FuelMixandCost.pdf
9. Erin Beddingfield, Zachary Hart, Julie Hughes, "Putting Data to Work: How Cities are Using Building Energy Data to Drive Efficiency," Institute for Market Transformation, February 2018, page 11. http://www.imt.org/puttingdatatowork/summaryreport
10. The District of Columbia found that more large office buildings were all-electric than they expected. The District also found that multifamily buildings built in the 1970s and later were much less dependent on natural gas than older ones. Page 30-32 https://doee.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/Green%20Building%20Report%202013_WORKING%20DRAFT.pdf
11. Jayson Antonoff, "Impact Assessment: A Guide for City Governments to Estimate the Savings from Energy Benchmarking and Energy Efficiency Programs," Institute for Market Transformation, February 2018, http://www.imt.org/puttingdatatowork/impactassessment
12. Ibid.
13. ENERGY STAR Portfolio Manager Technical Reference, "Estimating Fuel Mix and Energy Cost," August 2017, https://portfoliomanager.energystar.gov/pdf/reference/FuelMixandCost.pdf
14. Urban Green Council and New York University Center for Urban Science and Progress, *New York City's Energy and Water Use 2014 and 2015 Report* (October 2017), http://www.nyc.gov/html/gbee/downloads/pdf/UGC-Benchmarking-Report-101617-FINAL.pdf.
15. City of Chicago, *City of Chicago Energy Benchmarking Report 2016* (December 2016), https://www.cityofchicago.org/content/dam/city/progs/env/EnergyBenchmark/2016_Chicago_Energy_Benchmarking_Report.pdf.
16. SF Environment and ULI Greenprint Center for Building Performance, *San Francisco Existing Commercial Buildings Performance Report 2010-2014*, https://sfenvironment.org/sites/default/files/fliers/files/sfe_gb_ecb_performancereport.pdf.

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ABOUT IMT

The Institute for Market Transformation (IMT) is a national nonprofit organization focused on increasing energy efficiency in buildings to save money, drive economic growth and job creation, reduce harmful pollution, and tackle climate change. IMT ignites greater investment in energy-efficient buildings through hands-on expert guidance, technical and market research, policy and program development and deployment, and promotion of best practices and knowledge exchange. IMT's efforts lead to important new policy outcomes, widespread changes in practice, and ultimately, lasting market shifts toward greater energy efficiency, with substantial benefits for the economy and the environment. For more information, visit imt.org and follow us on Twitter at @IMT_speaks.

ABOUT USDN

The Urban Sustainability Directors Network (USDN), a project of Global Philanthropy Partnership, is a peer-to-peer network of local government professionals from cities and counties across the United States and Canada dedicated to creating a healthier environment, economic prosperity, and increased social equity. USDN's dynamic network enables sustainability directors and staff to share best practices and accelerate the application of good ideas both between North American cities, and between North America and the rest of the world. www.usdn.org.