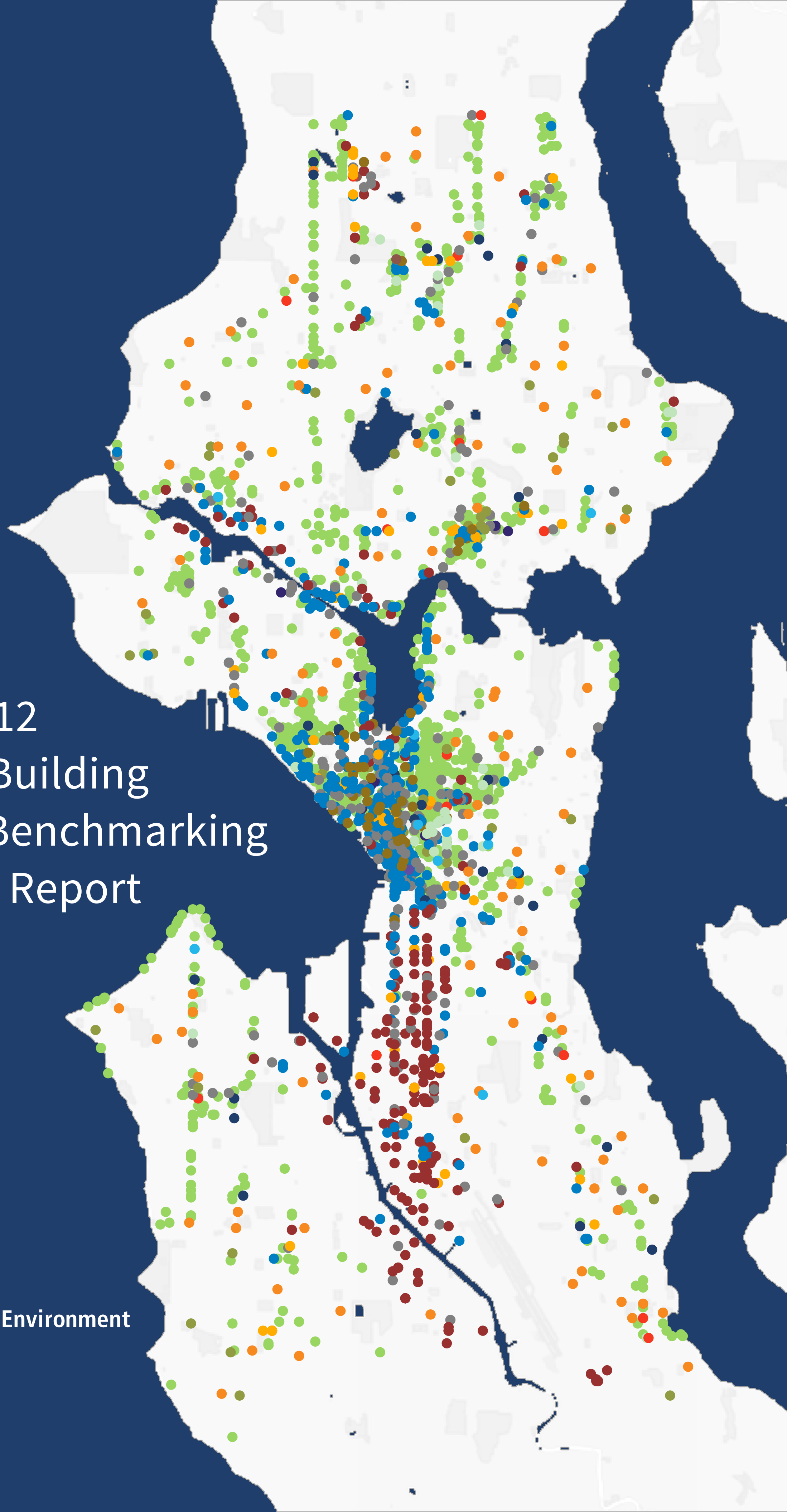
SEATTLE ENERGY BENCHMARKING & REPORTING



2011/2012 Seattle Building Energy Benchmarking Analysis Report

Prepared by

SEATTLE OFFICE OF
Sustainability & Environment

January 2014

Acknowledgements

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Executive Summary

Seattle is currently one of nine cities and two states in the nation that have enacted energy benchmarking disclosure policies aimed at increasing energy efficiency in the existing building stock through data access and transparency. In 2013, Seattle completed the Energy Benchmarking and Reporting program ramp-up phase by collecting whole-building annual energy use for commercial and multifamily buildings 20,000 square feet or larger. This first report summarizes program outcomes, building characteristics, trends, and recommendations.

Key Findings

HIGH COMPLIANCE RATES

Seattle boasts the highest compliance rates in the nation—as of January 1, 2014 nearly 3,000 (93%) of required buildings had 2012 energy use reported. The dataset used for establishing the 2012 baseline EUIs in this report represents 80% of the buildings required to report 2012 data (87% of the applicable gross square footage). The development of an energy performance baseline will help inform next steps in the City's progress toward reaching building energy reduction goals in Seattle.

BENCHMARKING DATASET VALID

Seattle's reported building performance data, on the whole, are within a reasonable accuracy range. The dataset resembled statistically validated datasets, including the Northwest Commercial Building Stock Assessment. No widespread errors or systematic biases were identified. However, large datasets are always subject to improvement. This report details recommendations for continued accuracy improvements.

INFORMING BUILDING OWNERS & MANAGERS

For the first time ever, Seattle building owners can see how their investments stack up to the local competition. By comparing their building's performance to the summary data in this report, owners and managers can identify if they are leading the pack or potentially ripe for energy efficiency upgrades.

INFORMING THE MARKETPLACE

The dataset also provides useful information never before accessible to policymakers or the market. This report highlights general trends and energy savings opportunities that can be identified through the data. Further analysis could yield targeted and actionable recommendations for energy efficiency improvements in specific sectors.

SEATTLE'S BUILDINGS HAVE ENERGY SAVINGS POTENTIAL

If the worst performing buildings improved energy performance to median performance levels, total annual bill savings would surpass $55 million and annual energy use would decline 25%. One-quarter of the buildings receiving an ENERGY STAR rating were performing below national averages.

PROVEN PERFORMANCE... AND POTENTIAL

While 18% of Seattle's buildings have already earned ENERGY STAR-certification, 41% reported a score of 75 or greater, making them eligible to apply for certification. This suggests an untapped market of buildings that could use the ENERGY STAR label to their advantage in the marketplace.

OLDER BUILDINGS CAN PERFORM WELL

Seattle's oldest buildings (pre-1950) are not necessarily high energy users. Office building energy performance was worst for mid-century buildings built between the 1960s and 1980s, but better for those constructed earlier and for those built since 2000.

Opportunities Ahead

The data presented in this report will help Seattle track its progress toward 2030 Climate Action Plan goals. Successfully meeting these goals will depend on multiple factors including supporting City policies, utility incentive programs, available financing mechanisms and changes in the marketplace.

Most importantly, building owners must continue to track energy use, recognize the potential for efficiency improvements and take action. This report includes profiles of several buildings that have started with benchmarking—and achieved significant energy and cost savings. Members of the Seattle 2030 District, formed in anticipation of the benchmarking ordinance and profiled on page 42, share their energy data, learn from their peers and strive to meet aggressive building performance targets. The benchmarking program will work to inspire all building owners through a focused outreach program to help them understand building energy use and take advantage of incentive and funding programs.

Also critical to success is a market response that rewards more efficient buildings. While full public disclosure of building results is not a part of the benchmarking ordinance, disclosure by owners to existing or potential buyers, tenants and lenders is. The benchmarking program will work to make summary data available to all and will encourage more tenants, buyers and lenders to request building energy data from owners when making rental and investment decisions.

Contents

1. Introduction

The Seattle Building Energy Benchmarking and Reporting Program requires building owners to annually benchmark and report the energy use of non-residential and multifamily buildings 20,000 square feet or larger by April 1st. As of January 2014, 93% of Seattle building owners complied with this regulation by reporting 2012 building energy performance data to the City of Seattle. This robust localized dataset creates unprecedented transparency into the energy use of Seattle's buildings and supplies the necessary information to help achieve the City's Climate Action Plan building energy efficiency goals.

Seattle was an early adopter, enacting the disclosure law in 2010. Seattle is now one of nine cities with benchmarking policies, which include San Francisco, New York, Washington, D.C., Austin, Philadelphia, Minneapolis, Boston, and Chicago. Energy disclosure ordinances are intended to make building performance information accessible to building owners, industry professionals and policymakers across some of the largest metropolitan areas in the country. This wave of policies signals a new era of transparency and data-driven decision-making for building energy management.[1]

Energy efficiency represents the lowest cost energy resource for Seattle and is a cornerstone to achieving reductions in greenhouse gas emissions.

The City of Seattle annually collects and analyzes benchmarking data to understand how local buildings are performing. Traditionally, national building performance datasets have a limited number of regional buildings and thus less relevance as a means to guide performance standards. The Seattle benchmarking program relies on actual performance data, providing a valuable and previously unavailable data source.

The results of this analysis will help Seattle building owners and the building industry learn where energy efficient market opportunities exist. Building owners will have relevant comparisons and can identify if they are wasting energy and money. Local utilities will better understand what building segments have efficiency needs or could benefit from additional targeted incentive programs.

Even though energy is a substantial cost for an organization, most organizations—tenants and owners alike—do not know how efficiently their building is performing.

[1] *For more information see: www.buildingrating.org/content/us-policy-briefs.*

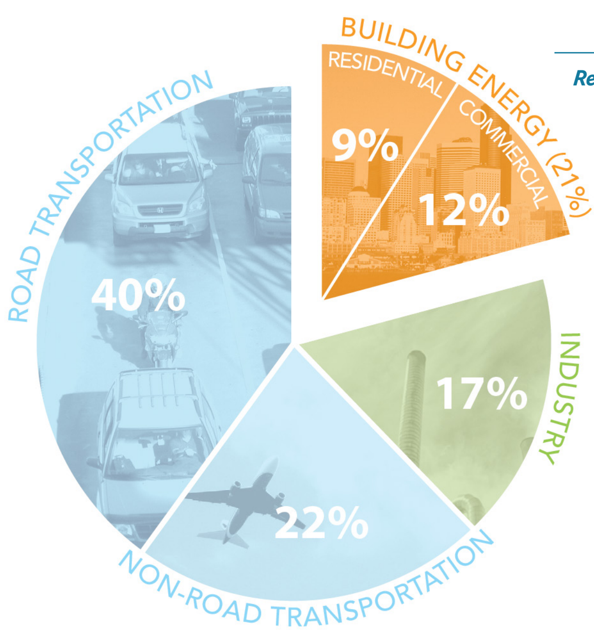
This report shares an in-depth analysis of the 2011/2012 Seattle building benchmarking data. It includes:

- Background on the Energy Benchmarking and Reporting Program
- Compliance rates
- A description of the analyzed dataset
- An assessment of dataset accuracy
- An overview of citywide building characteristics
- 2012 energy performance results by building type
- Highlights of dataset trends, including baseline 2012 Energy Use Intensities (EUI)
- Recommendations to improve accuracy and further study objectives
- An appendix detailing analysis methodology and results of data accuracy tests

2. Seattle's Benchmarking and Disclosure Policy

The City of Seattle Energy Benchmarking and Reporting Program was enacted into law in 2010 through Ordinance 123226 (updated in 2012 via Ordinance 123993). Non-residential and multifamily building owners of facilities 20,000 square feet or larger are required to track building energy performance (benchmarking) through the U.S. EPA's ENERGY STAR Portfolio Manager and report the results annually by April 1st to the City of Seattle. In addition, upon request, building owners must provide energy performance information to any current or prospective tenant, buyer, or lender involved with a real estate or financing transaction.

The benchmarking policy was developed with guidance from local industry leaders and is one of the policies enacted as part of the 2009 2013 Climate Action Plan aimed at reducing energy consumption in Seattle's existing building portfolio. The 2013 Climate Action Plan established a 2030 goal to reduce energy use in commercial buildings by 10% and residential buildings (including multifamily) by 20%, and reduce the Greenhouse Gas (GHG) intensity of all fuels by 25%.



Recognizing that energy use in buildings accounts for more than 20% of Seattle's carbon footprint; energy benchmarking is an important step toward managing energy use, saving money and lowering carbon emissions.

The three components of Seattle's law: benchmarking, reporting and disclosure, collectively aim to help building owners manage resources, reduce energy costs and lower carbon emissions from existing buildings.

BENCHMARKING establishes a baseline of energy performance for each property and provides information to guide energy efficiency investment decisions.

ANNUAL REPORTING of whole-building energy performance to the City provides a means to monitor progress toward achieving citywide energy efficiency targets, identify market sectors with the greatest opportunities, and guide future policies and incentive programs.

DISCLOSURE of building energy performance helps qualified parties, such as buyers, lenders and tenants, compare energy use (and future operating costs) between similar properties and guide purchasing, leasing and financing decisions.

Seattle's policy builds on Washington State Law (RCW 19.27A.170) that requires state and commercial buildings owners and operators to disclose benchmarking data and ENERGY STAR scores to potential buyers, renters or lenders prior to the closing of a transaction.[1]

Implementation

Seattle's benchmarking policy was phased in across three years, allowing the industry time to respond to this new regulation. Commercial buildings 50,000 square feet or larger were required to report 2011 benchmarking data for the first time by April 1, 2012. Multifamily buildings 50,000 square feet or larger were due October 1, 2012 and lastly buildings 20,000–49,999 square feet were required to report 2012 data by April 1, 2013.

To help building owners meet the regulation, Seattle has provided a free help desk with staff available each weekday during business hours (8am–5pm, M–F) for telephone and email questions. Support has also included weekly drop-in sessions, free workshops, and step-by-step instructions online and in print. To learn more, click on How to Comply at www.seattle.gov/energybenchmarking.

[1] *For more information see: www.buildingrating.org/content/policy-brief-washington-state.*

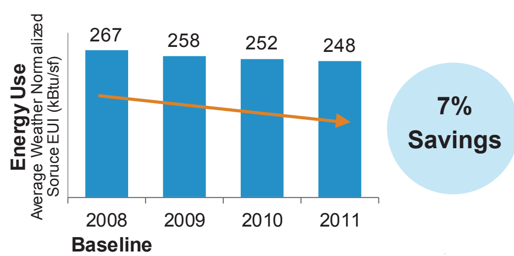
Benchmarking Energy Performance

Since the late 1990s, the Environmental Protection Agency (EPA) in collaboration with the Department of Energy has offered a free, secure, online benchmarking tool called ENERGY STAR Portfolio Manager (www.energystar.gov/benchmark). This energy performance tracking tool has become the industry standard and the common platform required by energy disclosure policies in the United States. Benchmarking a building using Portfolio Manager allows a building owner to understand the relative energy efficiency of a building and compare its performance to similar buildings nationwide.

35,000 buildings using the U.S. EPA's ENERGY STAR Portfolio Manager between 2008 and 2011 saved an average of 7% in energy.

ENERGY STAR® PortfolioManager®

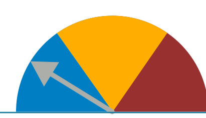
Energy Savings in Portfolio Manager



Source: U.S. Environmental Protection Agency

ENERGY USE INTENSITY

Energy Use Intensity (EUI) is a building's energy use per square foot per year. EUIs are calculated by totaling the annual energy used by all utilities serving the building, such as electric and natural gas, divided by the building's gross floor area. It is typically measured in kBtu/sf (one thousand British thermal units per square foot). EUIs normalize for building size, which allows buildings of various sizes to be compared to each other. Building EUI is an important output from Portfolio Manager and the focus of many of the analyses in this report. Higher EUIs show greater energy use, whereas lower EUIs indicate more energy efficient buildings.



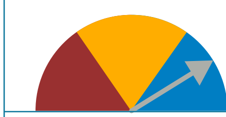
Lower EUI indicates better performance

WHAT IS AN EUI?

total annual energy use (kBtu) ÷ total square feet (sf) = Energy Use Intensity (kBtu/sf/year)

ENERGY STAR SCORES

Portfolio Manager is a powerful tool for calculating EUIs for all types of buildings, and for calculating a more robust metric—the ENERGY STAR score—for about fifteen building types, such as offices, schools and warehouses. The 1-100 ENERGY STAR score compares the building to national averages. A score of 50 represents the national median, and a score over 75 indicates the building is in the top 25% of performers and may be eligible to be nationally recognized as an ENERGY STAR certified building. Some buildings, such as multifamily buildings and many mixed-use buildings, are not eligible for an ENERGY STAR score. In contrast to EUIs, higher ENERGY STAR scores represent better energy efficiency.



Higher ENERGY STAR score indicates better performance

Seattle's benchmarking and reporting ordinance provides value to building owners and property managers who can use energy performance data to assess their building operations and compare their individual performance to similar buildings nationwide via the ENERGY STAR score. Additionally, this report provides them with a means of comparing their building to similar buildings within Seattle. Building benchmarking is the first step in establishing or maintaining improved energy management within a building or portfolio of buildings. Such improvements can result in lower operating costs and increases in building asset value.

BENCHMARKING
Greening a Community & Saving Money

Horizon House Retirement Community
1,024,950 sf

In 2012, energy, water and waste conservation efforts at Horizon House saved the community more than $50,000 on utility bills. Energy saving projects include:

- Heating and cooling upgrades in common areas
- Over 300 lighting fixture upgrades
- Occupancy sensors in stairwells, parking garages and community spaces

The energy saved from these building improvements is enough to power 22 homes for a year.

"Thanks to the City's benchmarking program, we are now regularly tracking our energy use and finding new ways to save energy and money."

— Bob Anderson, CEO of Horizon House

3. Compliance Rates

Seattle's benchmarking ordinance has achieved high compliance rates over time. As of this report's publication date, about 3,250 buildings 20,000 square feet or larger (a total of 281.2 million square feet) are required to report. This includes approximately 1,600 multifamily buildings and 1,650 non-residential buildings.

	2011 Data 50,000 SF + *AS OF JUNE 24, 2013*		2012 Data 20,000 SF + *AS OF JANUARY 1, 2014*	
	NUMBER	AREA *(MILLION SF)*	NUMBER	AREA *(MILLION SF)*
Non-Residential	629 (89%)	129.1 (93%)	1,469 (90%)	159.0 (93%)
Multifamily	567 (97%)	76.6 (97%)	1,523 (96%)	108.2 (98%)
Total	**1,196 (93%)**	**205.7 (94%)**	**2,992 (93%)**	**267.2 (95%)**

Table 1: **2011 and 2012 Annual Benchmarking Reporting Compliance Rates**

As of January 1, 2014, 93% of these buildings—90% of non-residential and 96% of multifamily buildings 20,000 sf or larger—have successfully reported their 2012 energy performance data to the City. This represents 95% of the total square footage subject to the requirement.

Buildings 50,000 square feet or larger were also required to report 2011 data, as the ordinance was phased in by building size. For 2011 data, 93% of buildings had reported by June 24, 2013—89% of non-residential and 97% of multifamily buildings. High compliance rates suggests that the City's outreach and communication strategies and technical support system were effective in communicating requirements and providing instructions for benchmarking in Portfolio Manager.

4. Seattle Benchmarking Dataset

This analysis report summarizes the dataset of buildings reported to the City on or before June 24, 2013—the date that EPA Portfolio Manager was taken offline for its major upgrade. Seattle initiated analysis in June with 93% of the buildings required to report 2011 data and 80% of the buildings required to report 2012 data (87% of the square footage). Analysis of the collected dataset was funded by The Department of Energy Better Buildings Energy Efficiency and Conservation Block Grant.

The final dataset consisted of 2,686 buildings, totaling 228 million sf, which reported complete energy usage for either 2011 or 2012. Fifty-four buildings in the top and bottom 1% of EUIs were considered outliers and removed to reduce the potential for skewing the data. Outlier reports will be reviewed by the helpdesk to identify errors and owners will be contacted as warranted to improve overall data accuracy. Compliance rates for the 2012 data were also reviewed geographically and participation was found to be proportionally distributed throughout the city.

Chapter 6 of this report, which focuses on non-energy characteristics of the benchmarked buildings, such as size, number of uses and building age, used data from buildings reported in either 2011 or 2012. The most recently reported building energy performance data from 2012 was used to summarize energy use intensity (EUI), ENERGY STAR scores and other energy-related trends in chapters 7 and 8.

ESTABLISHING THE BENCHMARKING BUILDING DATABASE

The City of Seattle developed a database of buildings subject to the benchmarking ordinance based on building details imported from the King County Assessor Property database such as building name, gross floor area, number of floors number of units (for multifamily), year built and address. Each building was assigned a unique numerical "Seattle Reporting Building ID". This data was combined with ownership information from the Assessor, other databases such as CoStar, and program outreach. Property owners and managers (if known) were notified about the ordinance, deadlines and told how to benchmark and report using the unique Building ID assigned to their property. Updates and corrections were made to the City's building benchmarking database using feedback from building contacts.

Exemptions

Established by Director's Rule 6-2011, some building owners can claim exemptions from reporting. The most typical is an exemption for buildings with 50% or more industrial and manufacturing uses. Campuses, defined as a group of buildings on a shared meter or central plant (not including

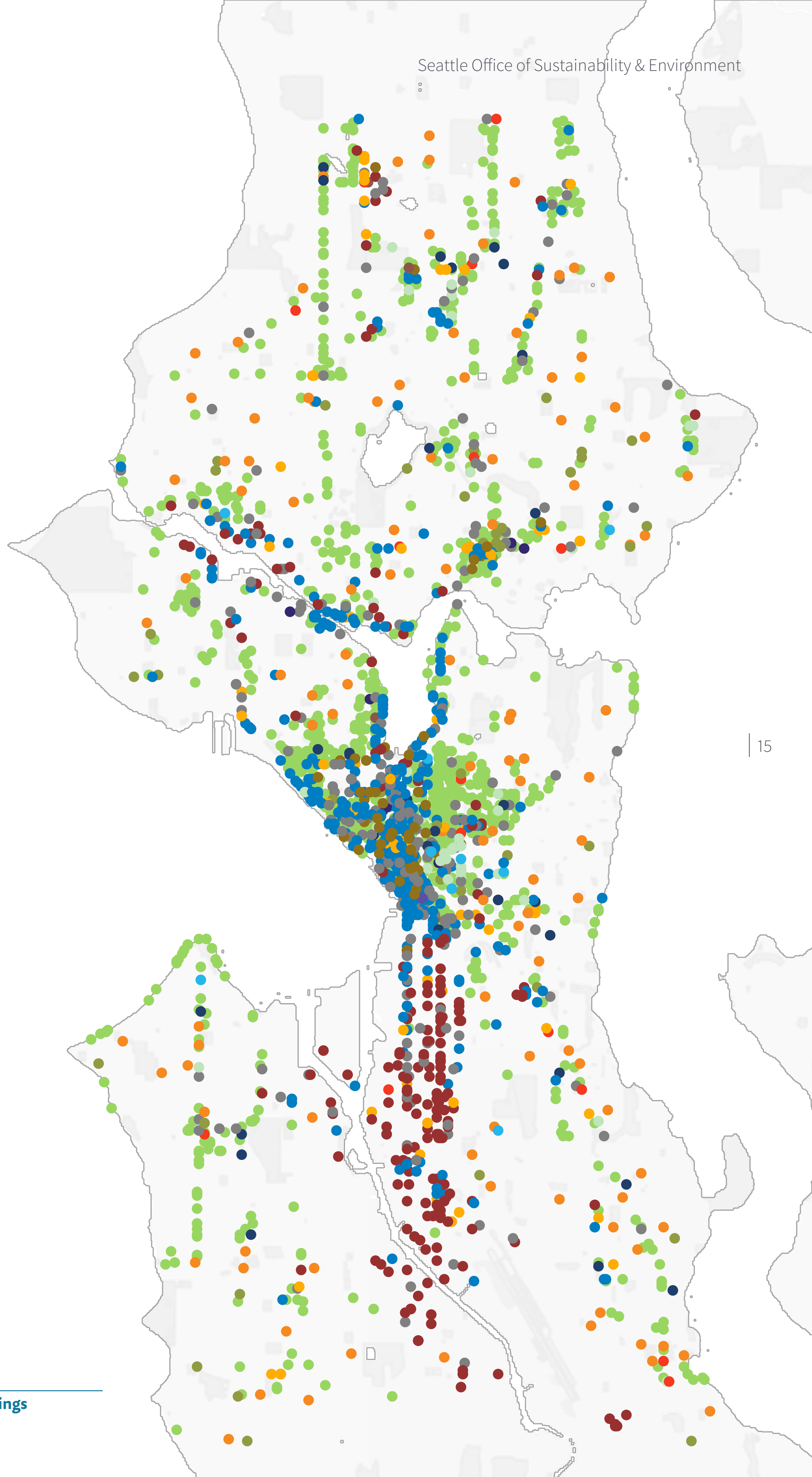


Figure 1: **Location of Benchmarked Buildings by Building Type**

hospitals, senior care or K-12 schools) were exempt from reporting 2011 and 2012 data because campus data could not be downloaded from Portfolio Manager prior to July 2013. Campus building benchmarking reports will be required for 2013 data reporting. Other exemptions included demolished buildings, vacant buildings with no meters, and those under major renovation.

Reporting Process

To comply with Seattle's energy benchmarking policy, building owners set up a Portfolio Manager account and authorize the City of Seattle to annually download building performance data for the previous calendar year. The City uses Portfolio Manager's "data exchange" (called automated benchmarking services or ABS by EPA before July 2013) to establish a secure, web-based connection. Building owners can also use "data exchange" to receive automated uploads of utility consumption data to their Portfolio Manager account from Seattle City Light, Puget Sound Energy, and Seattle Steam.

The data collected by the City on each building is a subset of the information in Portfolio Manager. It includes the following fields:

- Building Name
- Building Address
- Total Gross Floor Area
- Year Built
- Total Gross Floor Area for Each Space Use in the Building
- ENERGY STAR Rating (if available)
- Normalized[1] Total Site Annual Energy Consumption
- Non-normalized Total Site Annual Energy Consumption
- Normalized Site EUI (total annual energy consumption per sf)
- Non-normalized Site EUI[2] (total annual energy consumption per sf)
- Estimated CO2 Generation

NOTE: The July 2013 upgrade of Portfolio Manager will allow the City to download energy consumption and EUI data and by electric and gas, which was not available for 2012.

The data collected from Portfolio Manager is matched to the City benchmarking database through the unique "Seattle Reporting Building ID." This allows the City to track compliance, update contacts, compare reported data to King County information, and analyze the energy data.

[1] *"Normalized" is the energy the building would have used under average weather conditions in the building's geographic location. Since weather in a given year can be hotter or colder than average, weather-normalized energy is used to account for yearly variations from average. Portfolio Manager uses weather data from Seattle's Boeing Field weather station to inform its normalization.*

[2] *This report uses the "Site EUI" metric, which represents the total on-site energy use—the most relevant metric for facility managers and owners. Site EUI, however, does not account for the environmental impacts of energy sources. Seattle also uses site EUI because the metrics used by the US EPA to calculate source EUI do not take into account Seattle City Light's carbon-neutrality.*

5. Dataset Accuracy

The accuracy of the Seattle benchmarking dataset is foundational to understanding energy use in Seattle's existing building stock, and to the City's efforts to meet its long-term carbon and energy reduction goals. Before the data could be analyzed for trends, data accuracy tests were conducted to ensure there were no widespread or systematic errors. The assessment confirmed the accuracy of the overall dataset and identified no major issues that would prevent establishing EUI baselines, restrict comparisons to national and regional values, or invalidate trend analyses.

Data accuracy tests included the following:

1. A comparison of square footage reported in all Portfolio Manager records to the City's benchmarking database (based on King County Assessor property information) to look for systematic errors, such as over-reporting or under-reporting of square footage.
2. A review of EUIs by building type classifications.
3. A comparison of office building EUIs in the dataset to a Seattle-specific subset of the Northwest Energy Efficiency Alliance's (NEEA) 2009 Northwest Commercial Buildings Stock Assessment (NCBSA).
4. A simple random sample of buildings (n=75) to review the accuracy of usage data by fuel type, use of automated benchmarking services (ABS) for electricity, and building type and space characteristics such as occupancy. Since annual total energy usage and building square footage are used to calculate EUI, these metrics were the focus of the data accuracy assessment. ENERGY STAR scores and other trend analyses require accurate building characteristic data, so these metrics were also investigated.

BENCHMARKING
Banking on Energy Efficiency

Verity Credit Union
38,000 sf

Since 2008, Verity Credit Union has reduced its annual energy use by 20%—enough energy savings to power 12 Seattle homes for a year. Energy saving projects include:

- Installed lighting motion sensors in offices and conference rooms
- Installed high-efficiency light in garage
- Replaced old servers with high-efficiency models
- Rebalanced air conditioning and heating systems

In just five years, Verity's ENERGY STAR score increased from 48 to 74.

"Energy bills only tell you so much. Benchmarking lets you see trends and how your building compares with others."

— Stephen Chandler, Verity Facilities Manager

Data Accuracy Assessment Results

Building square footage reported in Portfolio Manager is reasonably valid. Since square footage is an important variable for generating an accurate EUI, it was reviewed for systematic errors towards over- or under-reporting. As part of its notification process, the City of Seattle provided property owners with the King County Assessor record of their building's gross square footage as a guideline, but asked owners to use the most accurate value known when benchmarking. King County gross floor area typically includes the building uses (rentable and non-rentable), basement area, and parking area. Although some square footage errors have been found in the King County data, it was considered a good source for obtaining reasonably accurate square footage for benchmarking. Parking area, however, should be excluded for Portfolio Manager benchmarking when separately metered.

The analysis found that about half (50.4%) of the Portfolio Manager reports used a square footage that fell within 1% of King County records. To investigate whether using square footage in Portfolio Manager "matched" the King County value was a reasonably accurate choice, the two records were compared to look for a known potential error—over-reporting square footage by inappropriately including parking area. The vast majority of the buildings (87%) with "matching" square footage did not have any parking listed in the King County record, thus using the provided "matching" value was reasonable.

The other half of reported buildings that had "non-matching" values were also compared to the originally provided King County value. Of those buildings, the majority (71.5%) reported a smaller value than the King County value. This percentage appeared to be reasonable as more than half of these buildings had parking listed in the King County record, suggesting that parking square footage was correctly omitted when benchmarking in Portfolio Manager, and square footage was not under-reported. This finding also suggests there was no systemic inflation of square footage values to manipulate EUIs downward.

While these findings suggest that the use of King County square footage does not substantially bias the summary analyses in this report, individual building owners could increase accuracy by calculating square footage based on building plans or actual measurements.

Building use types are accurately defined in Portfolio Manager, as indicated by clustered EUIs for building type. Scatter plots of energy to square footage (Figures A2–A11 in Appendix) show clear clusters by building type, which is expected when classification types are accurate. This is because EUIs typically remain in fairly consistent ranges across building type regardless of size. Multifamily buildings show more "scattering" which may be a result of more mixed uses as discussed in Chapter 8.

Benchmarked office building EUIs are consistent with local validated dataset. A comparison of office buildings in the Seattle-specific subset of the Northwest Commercial Building Stock Assessment (NCBSA) and the

Seattle Benchmarking dataset showed an extremely similar distribution of EUIs (Figure A12 in Appendix). The NCBSA included audits of square footage and accessed billing records to collect energy consumption data and is a statistically valid dataset. This similarity in distributions suggests that the energy and square footage data in the Seattle Benchmarking dataset for office buildings are reasonably accurate. Comparisons to other datasets and reports from vendors are detailed in the Appendix.

Majority of building owners use automated benchmarking (ABS) to obtain electric utility usage data. Based on a statistical sample (n=75), an estimated 78% of buildings reported used direct data uploads for obtaining whole building electric energy consumption from Seattle City Light. ABS minimizes data entry errors and omissions and ensures consistency with utility records.[1] See Appendix for more details.

Building type error rate is very low. Based on a statistical sample (n=75), comparisons of building type classifications in the King County Assessor's database and the Seattle Benchmarking dataset suggests a low error rate of less than 5% for building type classifications in the Seattle Benchmarking dataset. See Appendix for more details.

Potential Sources of Data Inaccuracies

Although the analysis supports using the dataset for summary statistics, improvements could likely be made for some individual building reports. Many building owners may still be learning best practices when benchmarking. A building-specific review of energy records and building characteristics was not conducted for this study, but could provide additional insights into data quality for individual buildings. Five potential sources of data inaccuracies are noted below:

Inclusion of all meters not verified. Buildings using utility automated benchmarking for aggregating multiple tenant meters into one upload could be missing electric, steam or gas meters if the meters were not correctly verified by the owner or manager. Assessing this would require comparing billing records and on-site meter verification with summarized utility meter uploads.

Use of unverified property square footage. Although the data accuracy assessment determined that the use of King County square footage does not appear to substantially bias results, building owners could increase accuracy by calculating square footage based on building plans or actual measurements.

[1] *Automated data exchange usage rate for natural gas reporting was not assessed because the Puget Sound Energy (PSE) ABS system was taken offline for a major redesign during the benchmarking period.*

Data centers, cell phone towers and electric vehicle charging stations. These three loads may substantially affect a building's energy use if they are not separately metered. Portfolio Manager requires building owners to separately document data centers. It is possible that the 44 out of 429 offices (10%) recording a data center space represents an underreporting of data centers. Cell phone towers and electric vehicle charging stations are not documented in Portfolio Manager, and could be included in building EUIs if not separately metered and excluded.

Outliers. The data cleaning process conservatively removed only the top and bottom 1% of EUIs in the entire dataset, leaving some unlikely values in the dataset that could represent benchmarking errors. Additionally, the assessment found some variability in EUI for buildings with two years of data, with 5% of buildings reporting a change in EUI of 50% or greater. These cases along with extreme values could be reviewed on a case by case basis by technical assistance staff to identify and resolve any issues. It is also likely that reporting practices will improve over time, resulting in fewer outliers.

Building occupancy not frequently updated. In the statistical sample (n=75), 15% of commercial buildings 50,000 square feet or larger updated occupancy information between 2011 and 2012. This rate may reflect that some owners are not reporting occupancy changes (Chapter 6, Figure 7). Occupancy information is taken into account in ENERGY STAR scores for buildings that require it to be documented.

BENCHMARKING
First Step to Energy Savings

Bank of America 5th Avenue Plaza
1,200,000 sf

Since 2008, Bank of America Fifth Avenue Plaza has lowered its energy use by 15%, saving nearly $240,000 in utility bills annually. The building has an ENERGY STAR rating of 100 — the highest score possible. Energy saving projects include:

- Garage fan retrofit
- Restroom lighting retrofit
- Stairwell and garage lighting replacement
- Chiller compressor retrofit

These improvements paid themselves back in less than three years.

"Using ENERGY STAR Portfolio Manager is a great way to learn how your building's energy performance compares to similar buildings, and can serve as a catalyst for making upgrades that improve energy efficiency and lower energy costs."

— Anthony Brusco, Hines Engineering Manager

6. Characteristics of Benchmarked Buildings

The high rate of compliance with the Seattle benchmarking ordinance enabled the collection of building characteristics for Seattle commercial and multifamily buildings 20,000 square feet or larger. In order to best understand non-energy characteristics of Seattle's buildings, 2,686 buildings (228 million sf) that either reported 2011 or 2012 data were reviewed.

Building Type

Building types were defined based on the space use of the majority of square footage (at least 50%) of the building—buildings with no majority space use were classified as "Other." This protocol is consistent with Portfolio Manager's building type classification. Although multifamily housing made up nearly half of the dataset by number of buildings, their smaller square footage on average relative to office buildings results in these buildings comprising only 37% of the total square footage (Figure 2). Similarly, offices comprise only 16% of the buildings, but 28% of square footage. Warehouses, K-12 Schools, Hotels, Retail, and Hospitals combined make up the highest percentage of square footage outside of Multifamily and Office (Figure 2).

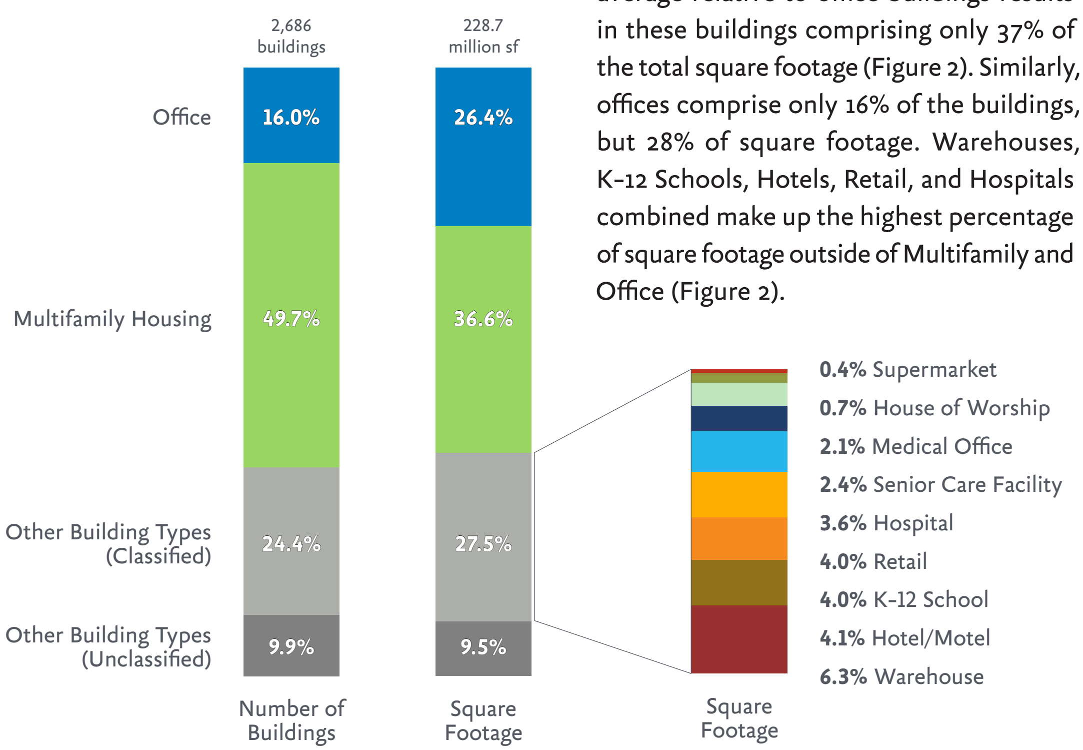


Figure 2: **Percentage of Buildings and Square Footage by Building Type**

Building Age

Seattle's buildings are relatively young, with the majority constructed after 1960 and slightly less than a quarter built before 1946 (Figure 3). The city's largest building boom occurred in the 2000s. Peaks in multifamily housing growth occurred in the 1960s and after 1980. Most office buildings were constructed before 1920, in the 1980s, and post 2000. Warehouse construction peaked in the 1960s. The dataset contains 34 buildings constructed 2010 or later.

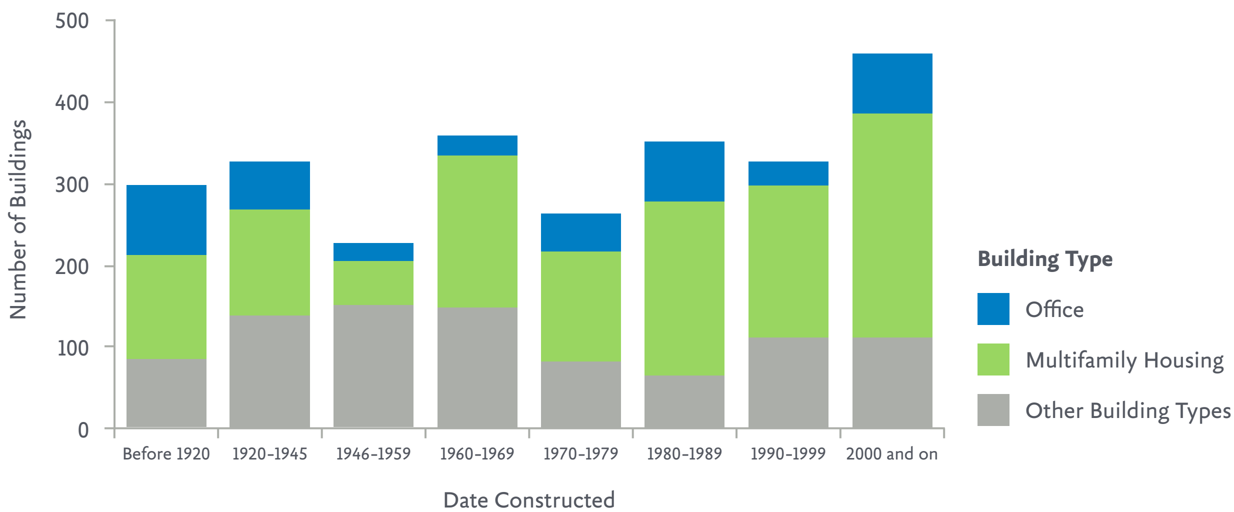


Figure 3: **Building Construction by Time Period**

Square Footage Distribution

Buildings less than 100,000 square feet make up the large majority of the total building population by number (2,137) and buildings 100,000 square feet or larger comprise the majority (60%) of total square footage (Figure 4). Buildings 100,000 square feet or larger also make up the majority of the total energy consumption (65%), underscoring the importance of energy management in large buildings. The largest benchmarked building was 1.85 million square feet, 92 times larger than 20,000 square feet, the threshold required for benchmarking.

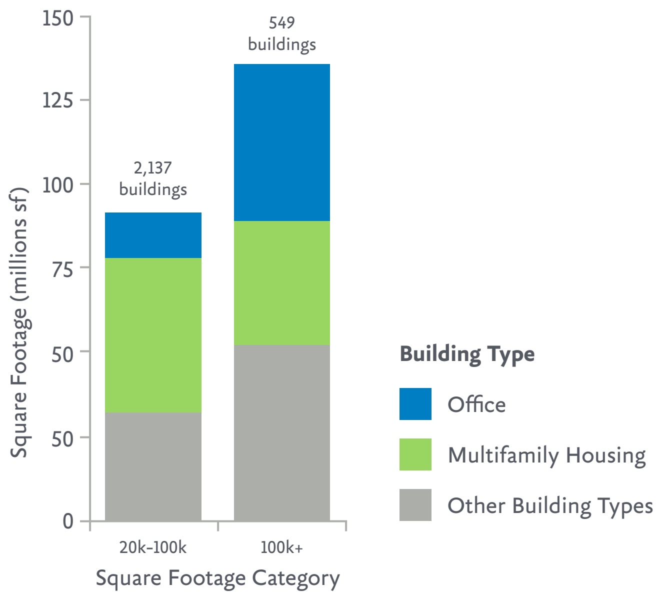


Figure 4: **Square Footage Distribution**

Size and Number of Floors

Seattle's multifamily and office buildings have been generally increasing in median size[1] over time (Figure 5). Multifamily buildings constructed in 2000 and later are larger (in terms of number of floors, units, and square footage) than those constructed in other years. Newly constructed office buildings have become larger since 2000; however, the median number of floors has remained consistent, indicating an increase in square footage per floor. The result may reflect the fact that many new office buildings are located on larger parcels in areas such as South Lake Union. Additional research is needed to best understand energy intensity implications relative to building size.

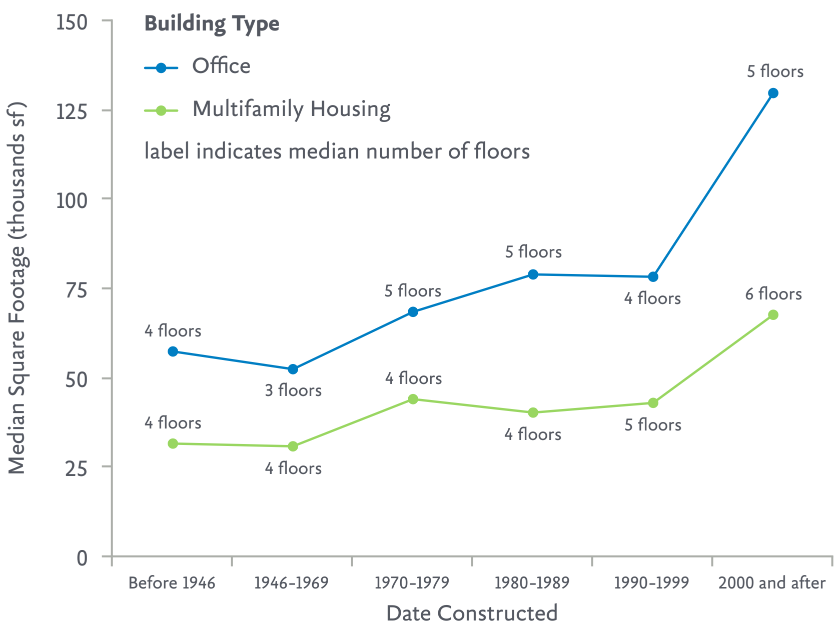


Figure 5: **Median Office and Multifamily Building Size and Number of Floors by Time Period Constructed**

[1] *The median represents a typical building constructed in that time period, and does not reflect, for example, that highest percentage of office buildings over 10 floors were constructed in the 1980s.*

Mixed-use Buildings

Most multifamily buildings (60%) are exclusively housing with no other uses (excluding parking), but only 33% of office buildings are solely used as offices. Secondary uses often include retail, supermarkets, restaurants, and other high-energy intensity uses, which can lead to higher EUIs. These "mixed-use" buildings contribute to some of the trends noted later in Chapter 8.

Since 1970, mixed-use buildings have become increasingly common in Seattle (Figure 6). Multifamily housing constructed in 2000 or later has an average of 2.1 types of uses per building, compared to an average of 1.3 for those constructed from 1946 to 1969. Similarly, office buildings built in 2000 or later have an average of 2.6 use types, up from 2.1 uses or less before 1980. Buildings classified as "other"—which include mixed-use buildings with no majority space types—follow a similar upward trend since 2000 for number of uses in the building.

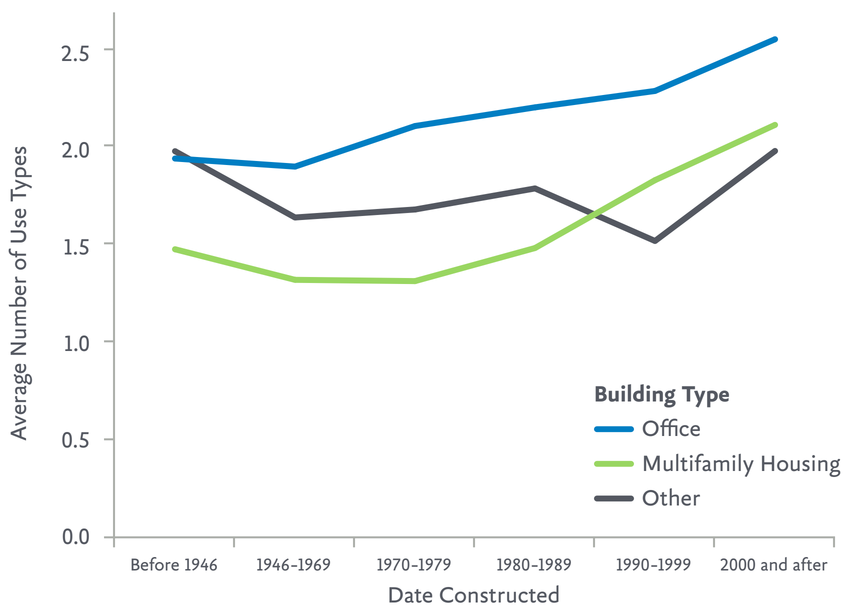


Figure 6: **Number of Uses in Buildings by Time Period**

Common secondary space uses in multifamily are retail (2.5% of total square footage), office (2.0%), other (1.9%), hotel (1.4%), and grocery (0.6%). For office buildings, the most common secondary space uses are other (3.0%), retail (2.7%), warehouse (1.2%), and data center (0.7%).

Occupancy Levels

Building occupancy can impact building EUI, as vacant and low-occupancy spaces typically have low energy usage. While occupancy data were not available in the dataset, regional occupancy levels for the reporting period were collected from other sources for the multifamily, retail, and office building sectors. Since 2011, vacancy rates have fallen—and occupancy rates have risen—in the multifamily, office and retail sectors in the Puget Sound Region (Figure 7). The decrease in office space vacancy has been particularly notable, falling by more than 3% from a high of 18.8% in the second quarter 2011 to 15.5% in the first quarter 2013.[1]

Occupancy and hours of use are considered in the office building 1-100 ENERGY STAR score calculation and should be updated annually in Portfolio Manager. If not, a building's score will become worse as the increased energy use will not be correctly attributed to increased activity in the building. Future research may be warranted to investigate the extent to which increases or decreases in regional building occupancy impacts overall EUI.

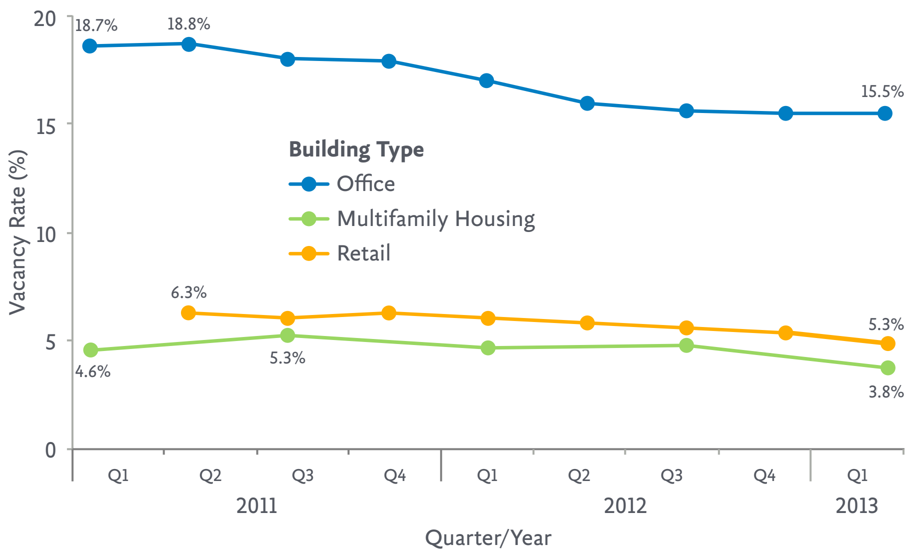


Figure 7: **Occupancy Levels by Year for the Reporting Period, Puget Sound Region**
Sources: Offices – CBRE, Retail – CBRE, Multifamily – Dupre & Scott

[1] *CBRE, "Puget Sound Office Historical," 2013*

Fuel Mix

In aggregate, all reporting buildings recorded 13.39 trillion Btus of 2012 energy consumption[1] across electricity, gas, and steam.

At the time this analysis was conducted, building energy use by fuel source was not available from Portfolio Manager for download. (EPA made this breakdown for gas and electric available for download as part of the 2013 Portfolio Manager upgrade.) Based on a statistical sample (see Appendix), an estimated 57% of Seattle large commercial and multifamily buildings (50,000 sf or larger) received gas service[2] and 5% of buildings received steam service.[3] All buildings in the sample had electric service. In terms of energy consumption by fuel type, an estimated 82% of energy consumed was electricity, 17% was gas, and less than 1% was steam.[4] These numbers excluded fuel oil and on-site electric generation.

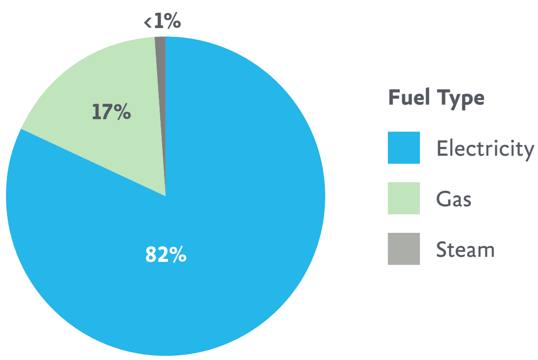


Figure 8: **Fuel Mix Based on Building Sample**

[1] *Non-normalized total site annual energy consumption*
[2] *90% confidence interval for gas customers: 56.8% ± 9.5%*
[3] *90% confidence interval for steam customers: 5.4% ± 4.3%*
[4] *90% confidence intervals: electricity 82.74% ± 4.24%, gas 17.19% ± 4.25%, steam 0.07% ± 0.03%.*

7. Benchmarking Results

The site Energy Use Intensity (EUI) and the ENERGY STAR scores, where available, are presented in this chapter by building type for those that reported 2012 annual energy performance data. Also discussed are estimates of energy savings potential in two scenarios. Another metric, "Source EUI", that includes energy source impacts, is also available through Portfolio Manager.

2012 EUIs by Building Type

There is a large variation in 2012 median site EUI[1] (not weather-normalized) by building types (Figure 9). A range of median EUIs by building type is expected, as some, such as grocery stores and hospitals, have lots of energy-intensive equipment, while others do not. Building owners can compare the 2012 median EUIs shown here to the EUI of their own buildings.

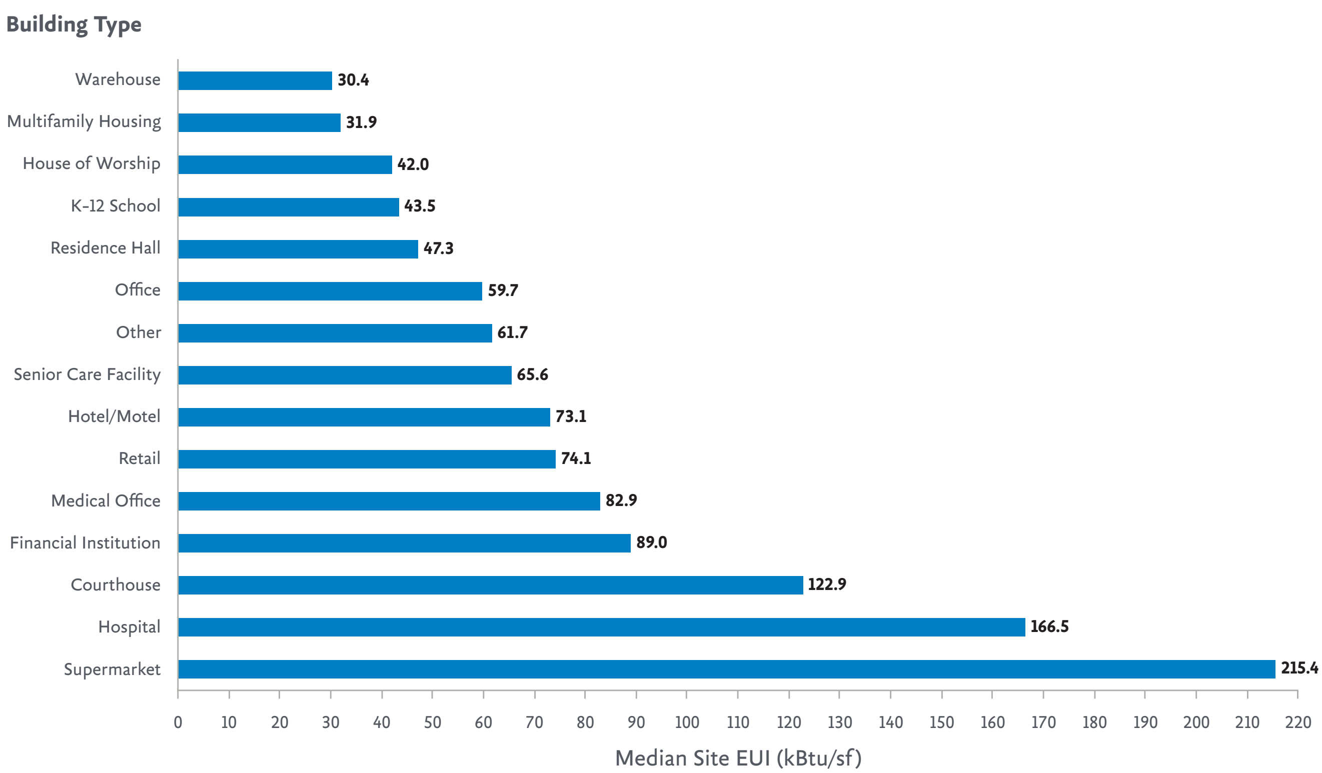


Figure 9: **Median Seattle 2012 Site EUI by Building Type**

[1] *The median, or middle value, is used in lieu of the mean (average), which is higher due to individual building outliers. The median therefore gives a better representation of the energy use of a typical building in Seattle.*

The importance of classifying energy use by building type is further illustrated in figure 10. Buildings such as hospitals use a large amount (1.3 billion kBtu) of the total annual energy consumed by Seattle's benchmarked buildings despite being few in number, as shown by the size of the circle. Although multifamily buildings consumed a total of 3.1 billion kBtus annually, this is less than office buildings (3.7 billion kBtus) even though there are three times as many multifamily (1,309) than office (419) buildings in this analysis.

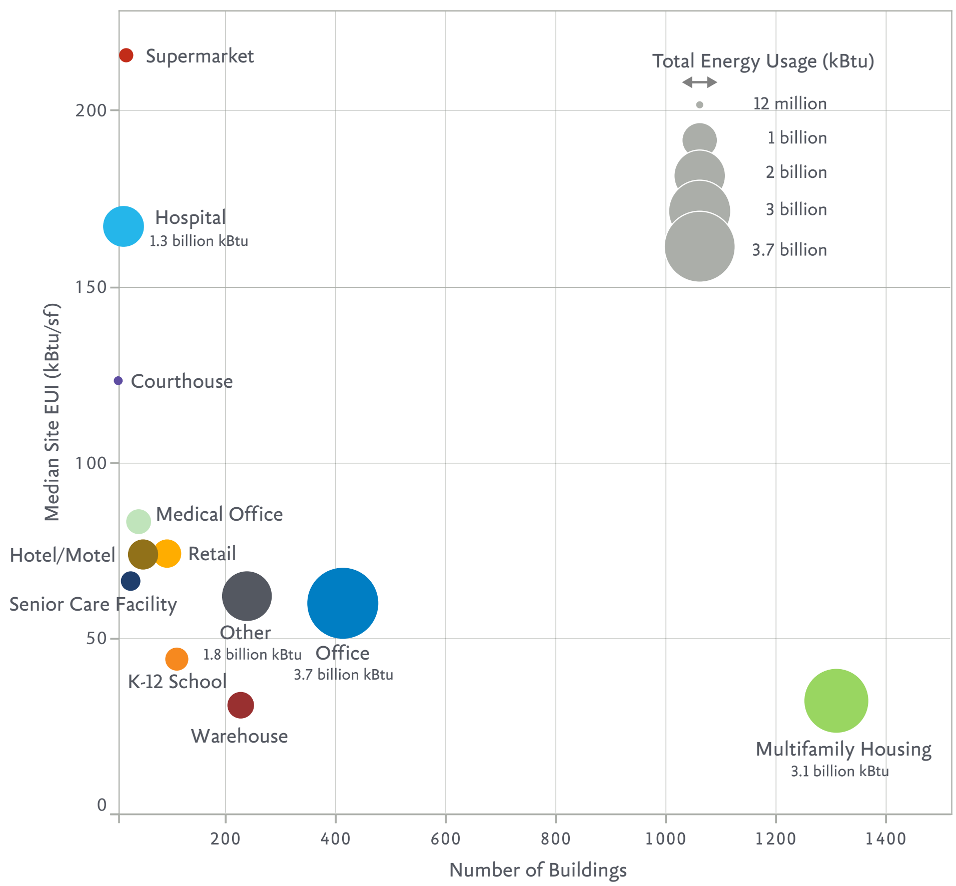


Figure 10: **Median 2012 Site EUI by Number of Buildings**

To facilitate this comparison, EUIs for each building type were broken into four performance ranges: low, low-medium, medium-high, and high energy use intensity (Table 2). These categories represent the four "quartiles" within the data. The 1st quartile represents the range of EUIs among the 25% of buildings with the lowest EUIs. The 2nd quartile represents the range of EUIs for the next 25% of buildings with respect to EUI, and so on. A Seattle multifamily building with an EUI of 44, for example, would place it in the highest energy use intensity quartiles, with 75% of buildings performing better. This high EUI, relative to others in the city, likely indicates there are opportunities for reducing energy use and operating costs. This information can also be used as a decision point when leasing, buying or financing a property.

Another valuable tool for owners of multiple buildings is the ability to compare building performance within the same building portfolio, locally and nationally. Seattle's benchmarking ordinance encourages owners to track individual use across their entire portfolio of properties.

	2012 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)*
Multifamily Housing	31.9	≤25	26-32	33-43	≥44	1309	1981	39,212	NA
Office	59.8	≤42	43-60	61-80	≥81	419	1972	64,858	75
Other	61.7	≤33	34-62	63-115	≥116	240	1960	40,854	NA
Warehouse	30.4	≤16	17-30	31-52	≥53	228	1962	43,080	56
K-12 School	43.5	≤36	37-43	44-55	≥56	114	1962	55,427	72
Retail	74.1	≤42	43-74	75-106	≥107	94	1967	53,500	68
Hotel/Motel	73.1	≤53	53-73	74-97	≥98	52	1988	107,117	68
House of Worship	42.0	≤26	27-42	43-54	≥55	45	1952	26,374	63
Medical Office	82.9	≤62	63-83	84-112	≥113	41	1984	66,588	47
Senior Care Facility	65.6	≤48	48-66	67-104	≥105	29	1995	94,370	51
Supermarket	215.4	≤202	203-215	216-269	≥270	17	1996	46,280	59
Residence Hall	47.3	≤33	34-47	48-82	≥83	11	1960	34,560	77
Hospital	166.5	≤122	123-167	168-206	≥207	9	1961	879,000	67

**Number of buildings in the dataset*

Table 2: **2012 EUI Performance Ranges for Seattle Buildings by Type**

A finer-grained look at EUIs in Figure 11 shows each building represented by a dot and the full range of performance for each building type. Although most building EUIs fall within a reasonable range, as indicated by the distribution of 10th to 90th percentiles, extremely high and low EUIs also occur in the dataset, as shown by the dots that fall outside the blue and gold bars. While some of these more extreme EUIs may represent a legitimate intense use, such as an office with a very large data center, other high EUIs may indicate extremely poor building performance, which would be worthy of investigation by the building owner or manager.

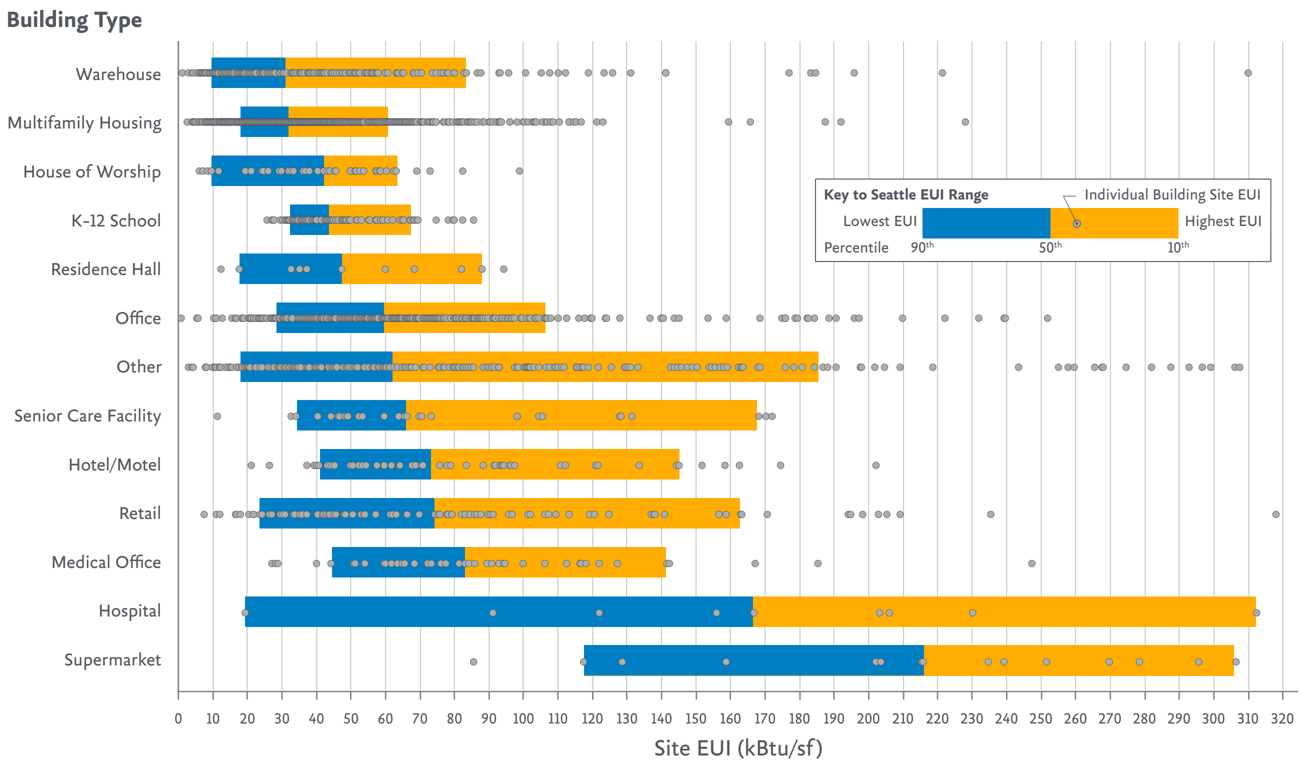


Figure 11: **2012 EUI Performance Range and Distributions by Building Type**

ENERGY STAR Scores

Of the 1,102 non-residential buildings included in this analysis, 890 (80%) qualified for 2012 ENERGY STAR scores, by being a ratable building type, such as office or warehouse, and having all required usage information entered into Portfolio Manager, such as occupancy and hours of operation. Multifamily housing and "other" buildings are not currently eligible for ENERGY STAR scores.

While the EUI performance categories shown in Table 2 and Figure 11 provide an indication of a building's performance relative to other Seattle buildings of its type, ENERGY STAR scores and performance categories compare a building's performance to national distributions.[1]

Seattle buildings with scores from 60 to 99 are distributed relatively evenly, as shown by Figure 12. The peaks at 0 and 100 suggest there may be a number of very poor and high performing buildings, but these peaks may also be partially explained by outliers in the data as noted in the data accuracy chapter.

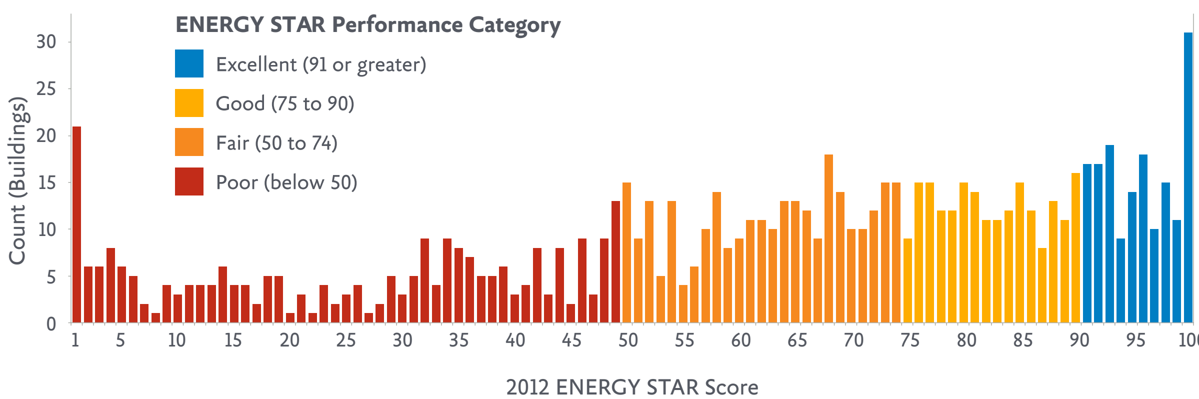


Figure 12: **Number of Buildings that Achieved Each ENERGY STAR Score from 1 to 100 (2012)**

Seattle buildings generally performed better than the national median ENERGY STAR score, with 74% of buildings receiving a score of 50 or above. Forty-one percent of buildings received a score of 75 or above, and 18% received a score of 91 or above. The median ENERGY STAR score in Seattle was 68.

Office buildings comprise 39% of the rated buildings, followed by warehouses at 21%. The majority of buildings of every type except medical office received a rating of 50 or above as shown by the percentages in Figure 13. Residence halls/dormitories had the highest median rating (77), followed by offices (75), and K-12 schools (72). These three building types, in addition to

[1] *ENERGY STAR scores provide a comparison of the building's EUI to national distributions, so a building with an ENERGY STAR score of 50 is equivalent to the national median, while a building with score above 50 is better (i.e. it uses energy more efficiently) than the national median. Note that ENERGY STAR scores account for monthly weather variations and building characteristics, such as operating hours, occupancy, and size.*

hospitals and retail, also had the highest percentage of buildings classified as Excellent or Good. Medical offices had the lowest median rating (47), followed by senior care facilities (51) and warehouses (56). These represent building types that may need additional focus or tailored incentive programs to improve energy performance.

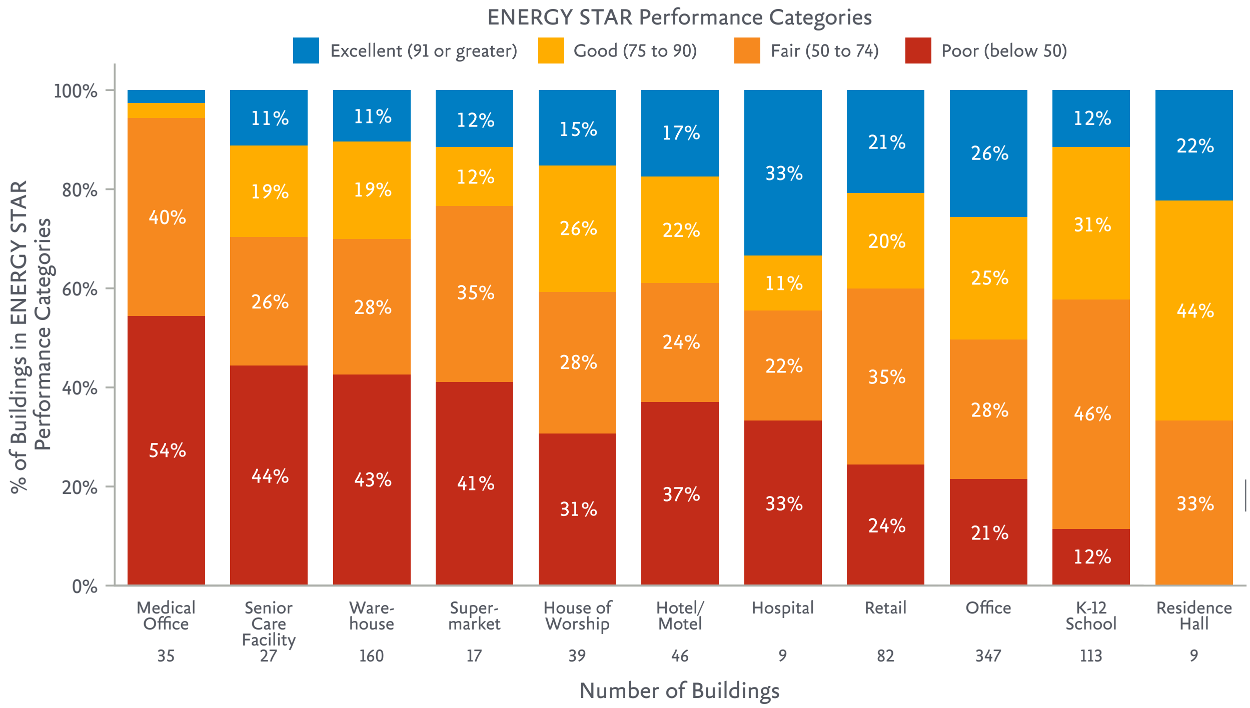


Figure 13: **Percent of Buildings in each ENERGY STAR Score Performance Category by Building Type (2012)**

Buildings receiving a score of 75 or above (shaded yellow and blue in Figures 12 and 13) are eligible to apply for ENERGY STAR certification (EPA requires that a professional engineer or registered architect verify the accuracy of the information contained within the certification application). Of the 362 buildings receiving a score of 75 or higher, only 69 (19%) have been ENERGYSTAR-certified and only 52 (14%) have re-certified since 2010.

This finding demonstrates a need for increased marketing of the value of ENERGY STAR ratings and assistance in pursuing certification. The ENERGY STAR rating is well known in the Class A commercial real estate market as an important indicator of a building's energy efficiency. The greater the number of owners seeking and advertising an ENERGY STAR certification, the more energy efficiency will be considered as a competitive value in the market.

The difference one building can make

Compared with their peers, an ENERGY STAR certified office building, on average:

- *Uses 35% less energy*
- *Generates 35% fewer greenhouse gas emissions*
- *Costs $0.54 less per square foot to operate*
- *Has higher rental and occupancy rates*

Source: U.S. Environmental Protection Agency

Energy Savings Potential

Although most high-performing buildings can typically be made more energy efficient, this analysis demonstrates that Seattle has many low-performing buildings, which likely have easily recognizable opportunities for efficiency improvements and cost savings. One-quarter (26%) of the ENERGY STAR-rated buildings in this analysis were ranked below the national average of 50. EPA research has shown that buildings that began with ENERGY STAR scores under 50 saved twice as much energy as those starting with above average energy efficiency.[1]

The Seattle buildings with EUIs worse than the median for their type (Table 2) represent potential opportunities for energy savings. If all buildings with EUIs worse than the Seattle medians reduced their energy consumption to the median, total annual energy consumption would decrease by 3,363 mmBtu or 25%. The annual bill savings for building owners would amount to $56.1 million.[2] If all buildings reached the top performance quartile, total energy consumption would decrease by 5,609 mmBtu or 42%. In this scenario, the annual bill savings would reach $93.5 million.

[1] *ENERGY STAR DataTrends, October 2012. www.energystar.gov/buildings/tools-and-resources/datatrends-benchmarking-and-energy-savings*

[2] *Assuming $0.0167 per kBtu and 83/17 distribution between electric and gas energy savings based on reported buildings.*

BENCHMARKING
Key to Staying Competitive

Dexter Horton Building
379,000 sf

Since 2007, tenant energy use at the historic Dexter Horton building has dropped by 34% and the building's energy rating has increased from 60 to 97. The building is both ENERGY STAR and LEED-EBOM Gold certified. Energy saving projects include:

- Stairwell lighting retrofit
- Elevator lobby retrofit
- Cooling tower variable frequency drive installation

These energy-saving improvements paid themselves back in just two years.

"By benchmarking the Dexter Horton building and making energy efficiency improvements, we are able to compete with buildings that are 60 years younger."

— CB Richard Ellis Seattle

8. Trends

General trends in the reported dataset can help identify potential reasons for low or high energy usage or point to areas that should be further explored in future research. This chapter discusses trends in the 2012 energy performance data, including trends by building age, size, and location. The trend analysis focuses on two buildings types, office and multifamily housing buildings, as they make up nearly two-thirds of the benchmarked building square footage and about half of the total energy consumption.

Establishing an EUI Baseline

One objective of this analysis is to set an overall energy performance (median EUI) baseline for 2012—the first year that all buildings subject to the ordinance were required to comply. This baseline will help inform progress toward existing building energy reduction goals in the city. As part of the program phase-in, buildings 50,000 square feet or larger were required to report 2011 data. This allowed a preliminary review of changes in the dataset for overall EUI between 2011 and 2012.

For all buildings 50,000 square feet or greater reporting in both 2011 and 2012 (n=1,955), the overall weather-normalized median EUI held nearly steady at 65 kBtu/sf annually across the two years. Although further investigation is warranted to determine any causality, given that building occupancy likely increased between 2011 and 2012, this "flat" EUI can be viewed positively because greater overall occupancy would theoretically increase overall EUI.

Some variability in EUI was found for individual buildings with two years of data, with 5% of buildings reporting an increase or decrease of EUI that was 50% or greater. These cases will be reviewed to determine if this variability is the result of occupancy changes, reporting errors or corrections, or actual increases or decreases in energy use. The program's goal is to improve reporting practices over time to reduce individual building errors and improve overall accuracy.

Given that implementing efficiency upgrades in buildings can take up to five years, it is likely that actual decreases in annual building EUI may take years to show up in individual or overall building energy performance results. As such, program progress will be monitored yearly and EUI impact relative to the 2012 baseline will be measured periodically.

Mixed-use Buildings and EUI Trend

An important characteristic of Seattle's buildings noted in Chapter 6 is the relatively recent increase in the percentage of mixed-use buildings. Newer office and multifamily buildings often contain more energy-intensive secondary uses such as restaurants, retail, and data centers, resulting in slightly higher EUIs for these buildings than those which operate exclusively as office or multifamily housing. In both office and multifamily buildings, as the number of building uses increase from one to four or more, EUIs increase (Figure 14). It is notable, however, that multifamily buildings with two use types are only slightly more energy intensive than those with one.

This finding shows the importance of accurately accounting building uses when benchmarking buildings currently eligible for ENERGY STAR scores, such as offices, and the need for future ENERGY STAR scores for multifamily and mixed-use buildings. Such accounting could allow for better energy use comparison between single use and multi-use buildings. This trend towards increasingly more mixed-use buildings will be considered when reviewing long-term trends in median building type EUI.

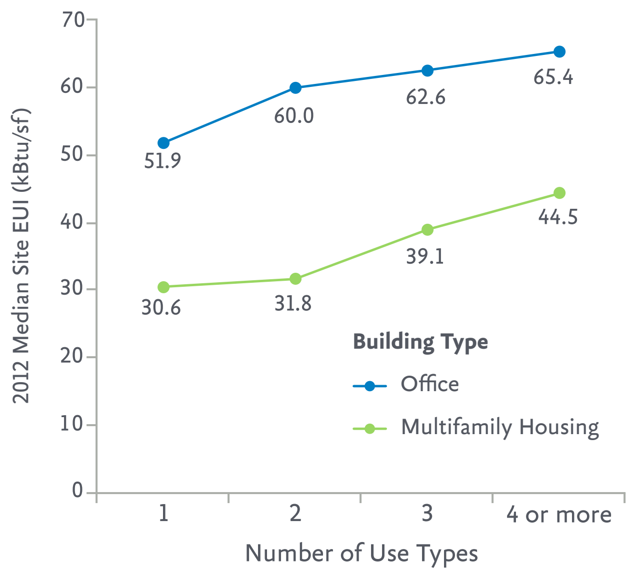


Figure 14: **2012 Median EUI by Number of Uses**

Building Age and EUI Trend

Office and multifamily buildings demonstrated different trends in EUI based on date of construction.[1] Older office buildings—particularly those constructed before 1945—generally have lower EUIs than newer buildings (Figure 15). Office buildings constructed in the 1980s have the lowest median EUI in the post-war era. While median EUI increases for buildings constructed in the 1990s, median EUI declines again for those constructed in 2000 or later.

In contrast to office buildings, the oldest multifamily buildings (constructed 1887 to 1945) have the highest EUI (Figure 15). Median EUI for buildings constructed from 1946 to 1989 were stable at around 30 kBtu/sf, but median EUI for multifamily buildings from the 1990s and 2000s have increased by about 5 kBtu/sf. The trend for single use type buildings (multifamily-only) is less pronounced, with only a 1.4 kBtu/sf difference between the 1980s and 2000s, suggesting the trend may be related to the rise in mixed-use buildings (Figure 14).

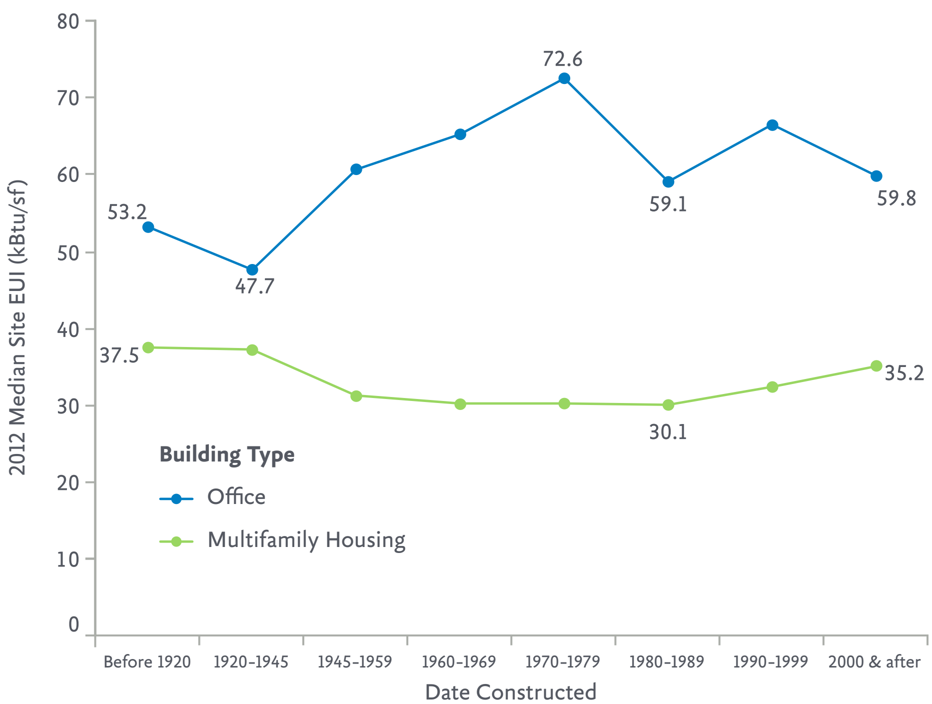


Figure 15: **2012 Median EUI and Total Energy Use by Date Constructed for Office and Multifamily Buildings**

[1] *Building construction eras are those used in the Commercial Building Energy Consumption Surveys (CBECS) database.*

Number of Multifamily Housing Units and EUI Trend

EUI in multifamily buildings tends to increase as the number of units increases, regardless of construction time period (Figure 16). Multifamily buildings with up to 100 units per building and constructed before 1946 have higher EUIs than new buildings. For buildings with 101 units or more, those built after 1946, except those built from 1980-1989, have higher EUIs than pre-1946 buildings.

As discussed previously, larger multifamily buildings—especially those built post 1990—are more likely to include mixed uses, which may pronounce the trend towards higher EUI. Multifamily buildings constructed post 2000 have higher EUIs at small sizes (50 units or less), but have similar or lower EUIs at larger sizes (more than 50 units). Thus, greater unit numbers are potentially contributing to an increase in median EUI for newer buildings.

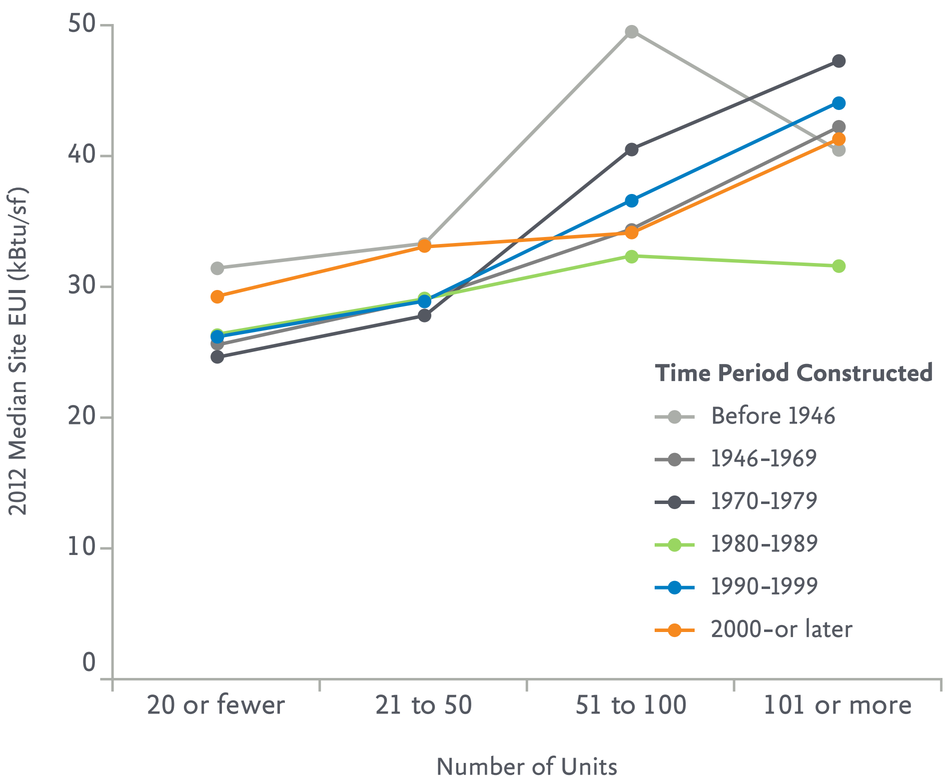


Figure 16: **Median 2012 Site EUI by the Number of Units for Multifamily Buildings by Time Period**

Low-Income/Affordable Multifamily Housing Trends

Low-income and affordable housing properties operated by public and non-profit housing providers were studied as a subset of the reported multifamily buildings and were found to have higher average EUIs at each building capacity, defined by number of units (Figure 17). These buildings are also smaller by square footage at some unit capacities, suggesting that they have smaller units and more occupants per square foot (greater density) than other multifamily housing, on average. This finding coincides with anecdotal information about building density learned from representatives of this sector.

Although occupancy is currently not required when benchmarking multifamily buildings in Portfolio Manager, such data will be an important building characteristic for a multifamily ENERGY STAR score. This detail would allow Seattle multifamily buildings to be normalized for occupancy when considering the energy efficiency of a property and provide a more in-depth understanding of actual building performance. Occupant density likely explains some of the higher EUIs, but there are potentially other contributors, such as more senior housing in the low-income sector, whose occupants are likely at home—using energy—more often than persons in the workforce.

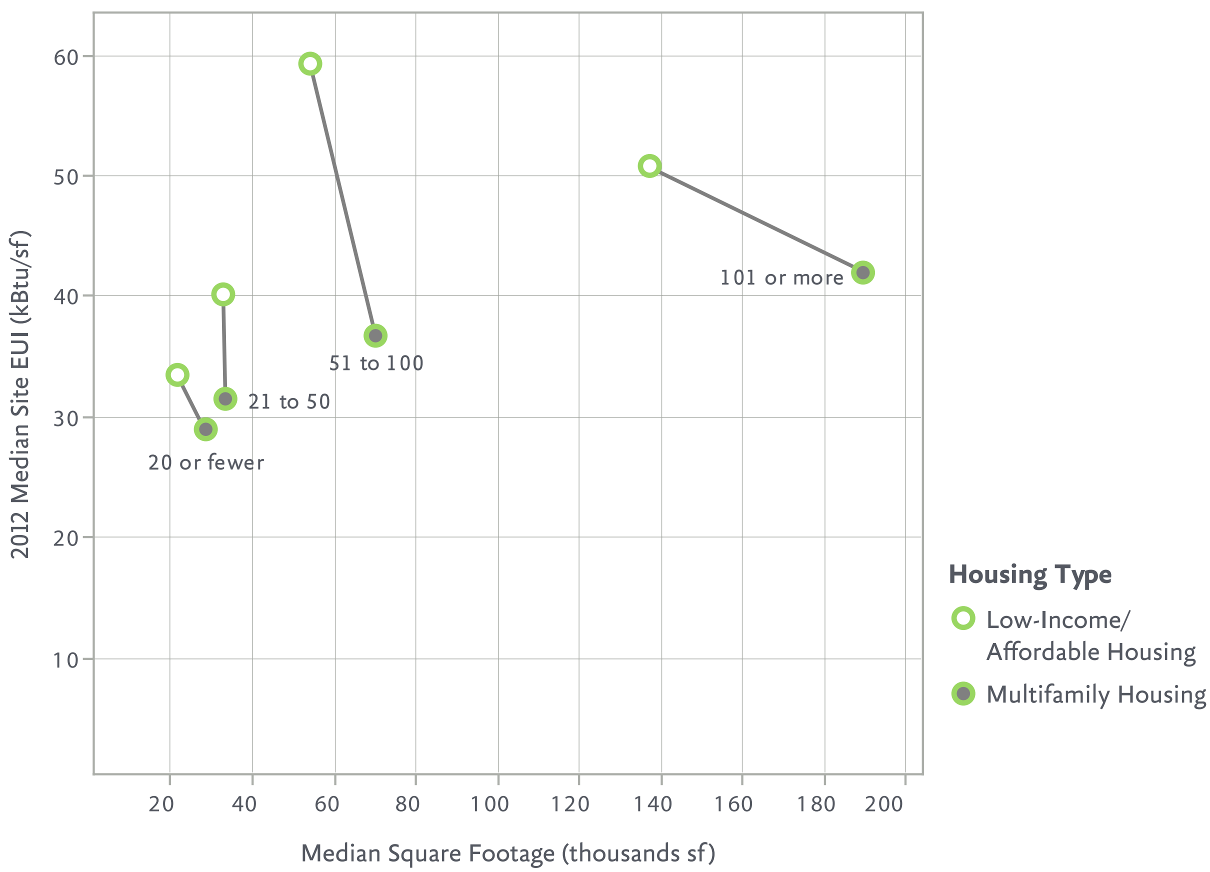
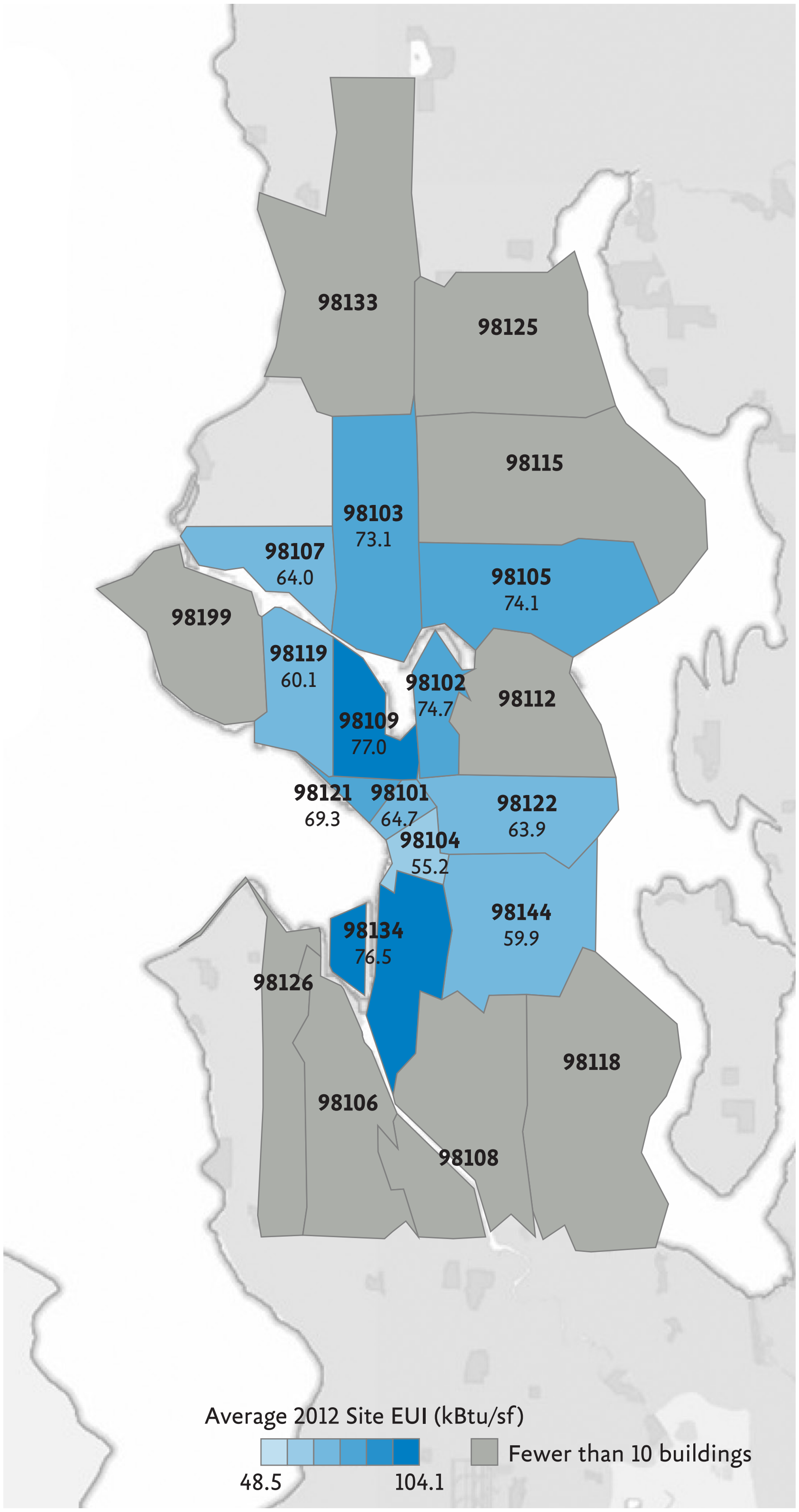


Figure 17: **2012 Median EUIs of Low-Income/Affordable Housing and Multifamily Buildings by Number of Units**

Building Location and EUI Trend

Average EUI for office and multifamily buildings were analyzed by ZIP code to look for geographic trends. ZIP codes with fewer than 10 reporting buildings are shaded grey and are excluded (Figure 18).



The three downtown ZIP codes (98121, 98101, 98104) tend to have lower average EUI than 98109 (South Lake Union and Westlake), which had the highest average EUI among ZIP codes with more than 10 office buildings. There is likely a relationship between building uses in this area (such as energy intense functions of the high tech and research industries) and average EUI.

Figure 18: **Average 2012 EUI by Zip Code for Offices**

In contrast to offices, the highest average EUI for multifamily housing—by a large margin—was found downtown (98101) (Figure 19). Average EUIs in ZIP codes near downtown (98121, 98104) are also slightly higher than other ZIP codes. These ZIP codes roughly correspond to the neighborhoods of Belltown, First Hill and those south of downtown. These neighborhoods also have the greatest housing density often represented by "high rise" buildings.

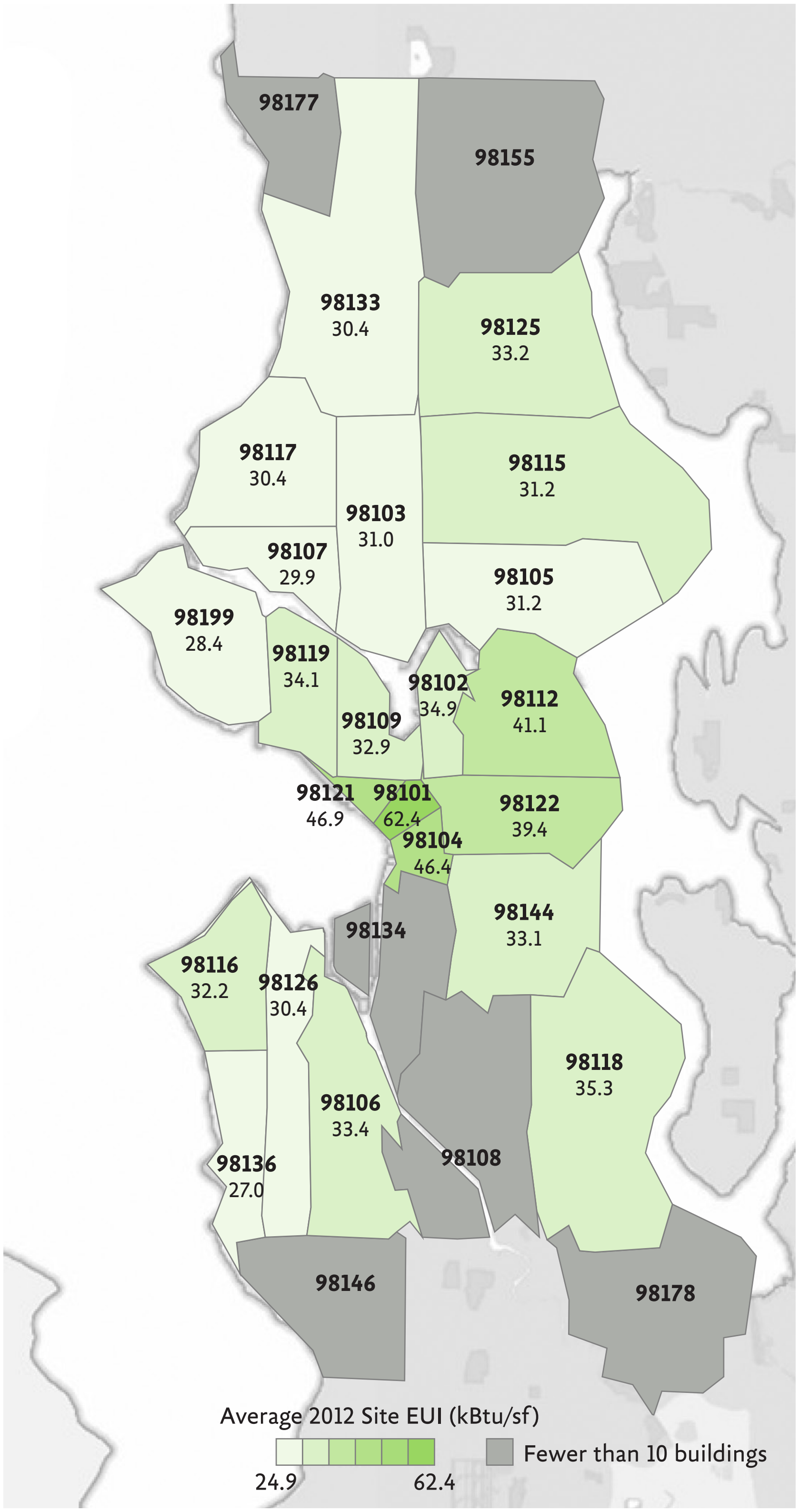
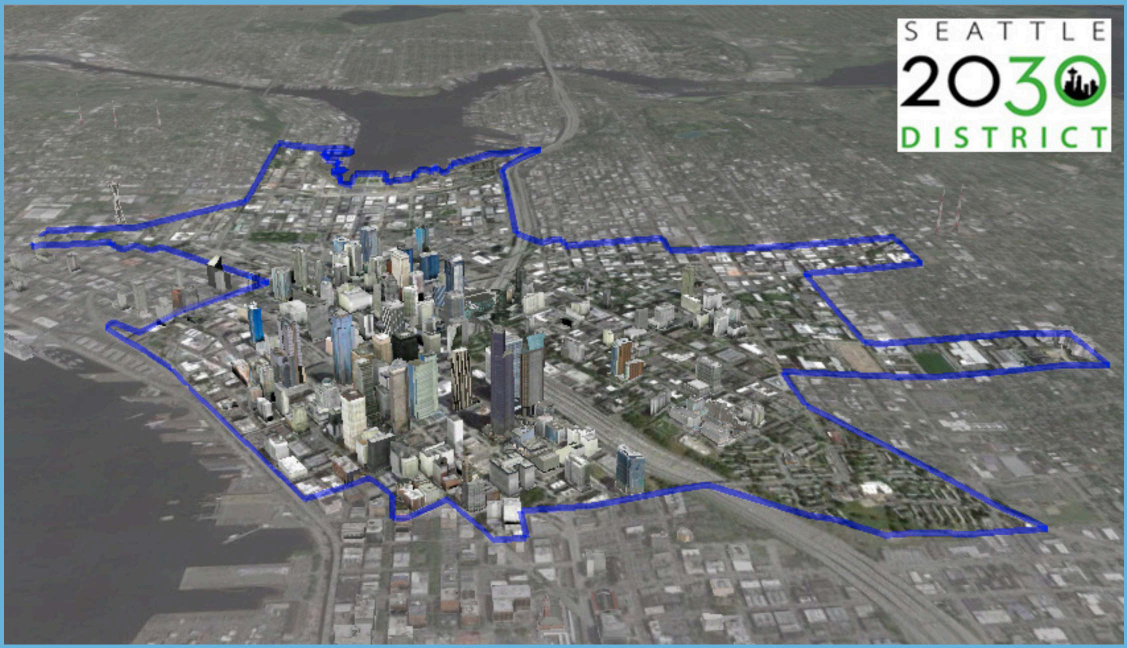


Figure 19: **Average 2012 EUI by Zip Code for Multifamily Buildings**

Seattle 2030 District Breaking New Ground with Benchmarking



The Seattle 2030 District is proving just how powerful benchmarking can be for setting and achieving ambitious energy-saving goals.

The high-performance building district made up of more than 80 downtown property owners, managers, engineers, architects and others is already well on its way to meeting its goal of reducing energy use in member buildings 50% below the national median by 2030.

Benchmarking and sharing building energy use information among members has helped the District measure progress toward energy-saving goals, compare results, share best practices and make buildings perform at higher levels of efficiency.

"The City's benchmarking ordinance is serving as a catalyst for Seattle 2030 District members to continue to push the envelope of what is possible for energy savings in buildings. Increasing building energy efficiency benefits the entire city by boosting property values, lowering energy costs, reducing carbon emissions and making Seattle an even more attractive place to live and work."

— Brian Geller, Executive Director
Seattle 2030 District

The Seattle 2030 District encompasses dozens of properties downtown, including the 1201 3rd Avenue tower, Russell Investments Center and Joseph Vance Building, and also public and residential buildings like the Seattle Central Library, Horizon House retirement community and Bellwether's Mercer Court apartments. Many of these buildings are saving tens of thousands of dollars each year thanks to energy-saving actions.

9. Recommendations

Benchmarking is a foundational program aimed at reducing energy consumption in Seattle's existing buildings through data access and transparency. Summarizing and communicating benchmarking data in meaningful and usable formats to building owners, managers and industry professionals is an essential part of increasing the transparency of Seattle's building performance and ultimately, market transformation. The benchmarking data will be evaluated annually to better understand building energy performance and identify trends in Seattle's building stock. The results of these analyses will influence future benchmarking program implementation and inform additional program and policy development to ensure Seattle is on track to reach the 2013 Climate Action Plan goals.

The following recommendations are based on the energy benchmarking analysis summarized in this report. Recommendations focus on improving the quality of self-reported data, identifying opportunities to better understand energy performance and most importantly, how to inspire building owners to take action to lower their energy costs and improve building performance.

MAINTAIN HIGH COMPLIANCE RATES AND A ROBUST DATASET THROUGH CONTINUED OUTREACH

Seattle's high compliance rates are the result of a comprehensive communication plan coupled with ample training, technical assistance and enforcement. Without adequate compliance, Seattle will not have a robust, long-term dataset that is representative of Seattle's building stock. Continuous outreach will ensure building participation is maintained, even as ownership changes overtime—many commercial and multifamily real estate buildings are sold every 3–5 years. Proactive, on-going communication will help keep Seattle's building contact database up-to-date and inform new owners and management about benchmarking requirements. Continued direct communication with owners and managers also facilitates opportunities to improve individual building report accuracy, encourage energy efficiency upgrades and link building owners with utility incentive programs.

MAINTAIN AND EXPAND TECHNICAL ASSISTANCE

This benchmarking analysis showed a reasonable level of accuracy with respect to reported building square footage, building type classification and energy use per square foot ranges. The analysis notes, however, that individual building reports may contain errors. Continuing and expanding the role of technical assistance will maintain high compliance rates, improve

Seattle's benchmarking dataset accuracy, and improve the data for individual building energy management. Seattle should take a more proactive data quality assessment approach by reviewing building benchmark reports to identify common errors and when warranted, correct the reports.

CREATE A FEEDBACK LOOP FOR UNDERSTANDING AND USING BENCHMARKING REPORTS

The energy benchmarking program should be positioned as a "bridge" to help building owners and managers understand and act on their building's energy performance data. In fact, many owners initially seeking technical assistance to comply with the requirement are now asking how to use the data to manage energy use. Such requests move the benchmarking program from merely a regulatory requirement to a useful tool that provides value, especially for those owners new to benchmarking. The results of this analysis should be used as part of a feedback loop to show owners how their building's EUI or ENERGY STAR scores faired relative to other Seattle buildings. Utility incentive programs and other "next steps" should be included in communications to connect owners to existing programs. Owners with ENERGY STAR scores near or above 75 should be targeted as candidates for ENERGY STAR certification. In future years, the benchmarking feedback loop can show changes over time, helping building owners understand if their building's energy performance is improving or declining.

ENCOURAGE ENERGY PERFORMANCE DISCLOSURE REQUESTS THROUGH TARGETED OUTREACH

The results of this analysis should be shared with building, real estate, investment, and lending communities to increase the demand for disclosure reports. Increases in disclosure requests support the value of benchmarking and may reward owners with efficient buildings. Briefings to organizations such as the Building Owners and Managers Association (BOMA), the Rental Housing Association (RHA) and the International Facility Managers Association (IFMA) will help encourage more use of the data. An awareness campaign targeted at existing and potential tenants in both the multifamily and commercial sectors will help renters understand how their building's energy performance fares relative to others in Seattle.

MONITOR PROGRAM PROGRESS AND CHANGES IN BUILDING PERFORMANCE OVER TIME

The 2012 energy benchmarking dataset can serve as a baseline from which changes can be tracked over time. Annual or biennial analysis of benchmarking data is recommended to monitor changes in overall building performance and to evaluate program impacts and identify opportunities for improving energy efficiency. A select number of key metrics should be annually reported to assist building owners and industry professionals with tracking individual and overall performance trends.

SEEK OPPORTUNITIES TO APPLY THE ANALYSIS RESULTS

The data analysis includes useful summary metrics, such as median and quartile EUIs for 2012 by building types and highlights emerging trends in Seattle's building stock. The analysis results and dataset should be used in partnership with utilities to inform incentive programs and identify building sectors that could benefit from more in-depth analysis. Additionally, industry partners should be sought out to conduct additional research. Participation in national building energy data programs operated through the U.S. Department of Energy and others will help further the analysis of Seattle's benchmarking dataset and work to establish standard analysis metrics among the growing number of municipalities and states with benchmarking ordinances.

EXPLORE POTENTIAL COMPANION POLICIES AND PROGRAMS

The 2013 Climate Action Plan includes a strong focus on reducing carbon emissions from Seattle's building stock. The benchmarking and reporting program is a foundational policy aimed at improving building efficiency and helping to reach the goals established in the Plan. Continued policy and program development can capitalize on the established benchmarking program and information gained from analysis of benchmarking data can inform direction and priorities.

The benchmarking program contact database should be used to engage stakeholders in the development of future building energy efficiency policy and program design. For example, the 2013 Climate Action Plan highlights specific actions to be implemented by 2015. These include development of an energy audit policy for the largest and least efficient commercial and multifamily buildings to identify cost-effective improvements. Making information from energy benchmarking reports publicly accessible is another policy to consider implementing in the near or long term to increase market transparency and improve building efficiency. Lastly, the program should consider and recommend best approaches for increasing energy efficiency in buildings smaller than 20,000 square feet that are not currently covered by the benchmarking policy.

APPENDIX

A. Data Accuracy Analysis

B. Glossary

Data Accuracy Analysis

This appendix details the data accuracy assessments included in this study. The assessment was based on an in-depth review of the dataset and comparisons to other datasets, including those retained by the Office of Sustainability and Environment (OSE) from the King County Assessor property records and the Northwest Energy Efficiency Alliance (NEEA) Northwest Commercial Buildings Stock Assessment (NCBSA).

APPROACH

The assessment of data accuracy focused on the review of summary statistics of the data. The primary method used to assess data accuracy was to look for systematic biases that could lead to consistent over- or under-reporting of energy use or square footage. No systematic biases were identified at the aggregate level. Comparisons with the NCBSA and King County Assessor datasets reinforced the positive assessment of accuracy and precision of summary statistics.

However, this assessment is less certain at the individual building level. The dataset contains observed variability, or noise, within some building types and high and low outliers. Analysis of trends primarily used medians, rather than means, to mute the effects of outliers.

To refine records at the individual building-level, some potential next steps include audits and comparisons with billing records and building plans. Nonetheless, the assessment of data accuracy at the aggregate level means that summary statistics—such as medians and quartiles—are reasonably accurate and can be used as a baseline for future comparisons.

METHODS

1. REVIEW OF DATASET SQUARE FOOTAGE

Figure A1 shows a visual comparison between the square footage reported in Portfolio Manager and that provided by the City of Seattle (based on King County data) for each building. These findings are discussed in detail on page 18. About half (50.4%) of the square footage values from Portfolio Manager buildings reports fell within 1% of the provided King County value. These buildings form a nearly 1:1 trend line on the figure. The "non-matching" values (49.6%) fall mostly below the line, indicating that most of these (71.5%) reported a Portfolio Manager square footage smaller than the King County value.

These findings suggest that the usage of the King County Assessors property record square footage value is not introducing a large systematic bias into square footage values and EUIs. However, there may be potential improvements to the precision of square footage values if building owners base their square footage inputs on building plans or measurements.

Figure A1: **Square Footage Comparison between Portfolio Manager and King County Assessor**

2. BUILDING TYPE CLASSIFICATION AND EUI

The ratio of 2012 energy usage to square footage (i.e., EUI) appeared to be consistent for specific building types. In scatter plots of energy to square footage, buildings appear to be clustered together. This indicates that building type classifications are generally accurate. The linear nature of most of the clusters suggests that EUIs remain consistent across building sizes for many building types—although this was not the case for multifamily buildings. Other trends noted in the report that affect EUI (such as mixed uses, occupancy, vintage, etc.) may explain the variability in multifamily EUIs. The variability in warehouse EUIs likely reflects the two kinds of warehouses included in this classification. The EUI variability in the classification "other" reflects the diversity of building uses in this classification. Figures A2 to A11 are examples of the scatter plots demonstrating the clustering.

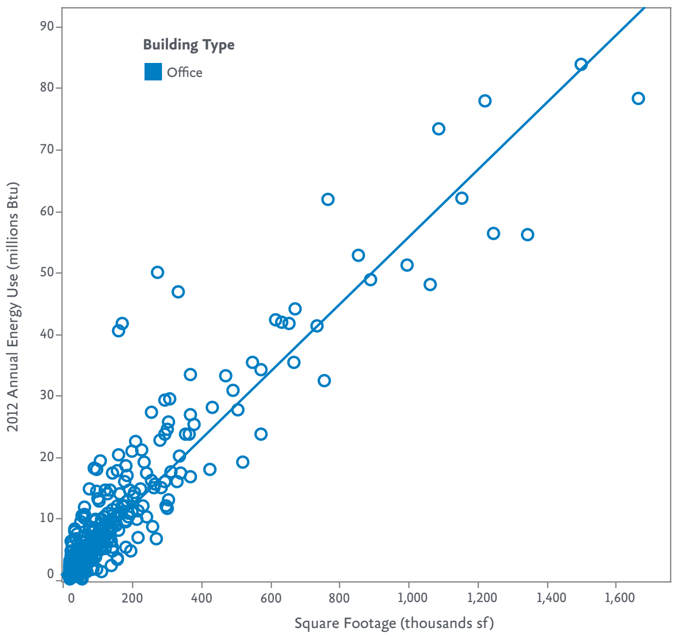


Figure A2: **Trend of Annual Energy Use by Square Footage for Office**

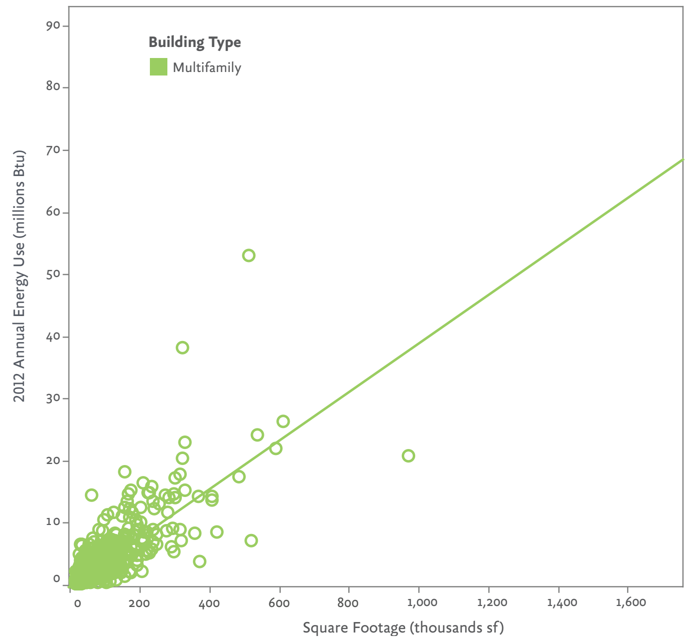


Figure A3: **Trend of Annual Energy Use by Square Footage for Multifamily**

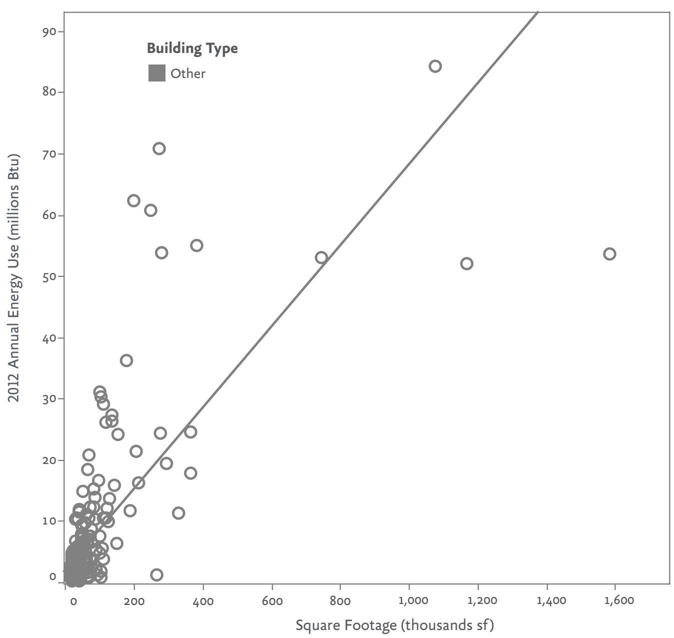


Figure A4: **Trend of Annual Energy Use by Square Footage for Other**

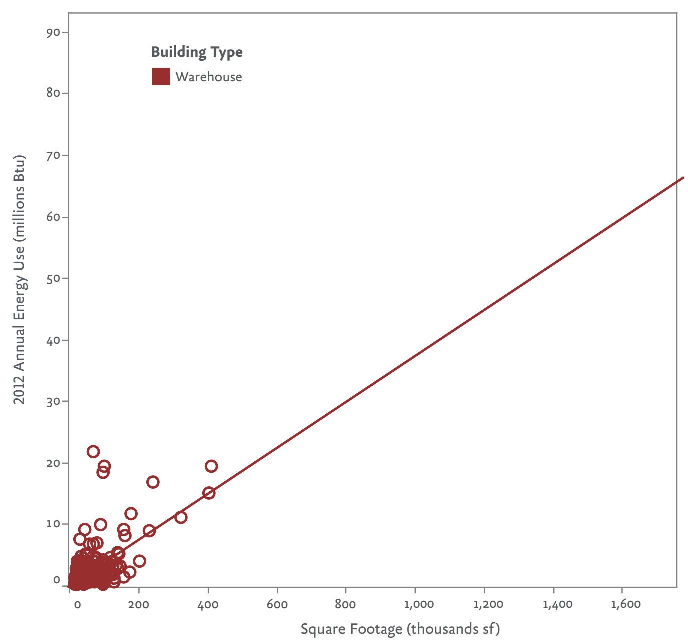


Figure A5: **Trend of Annual Energy Use by Square Footage for Warehouses**

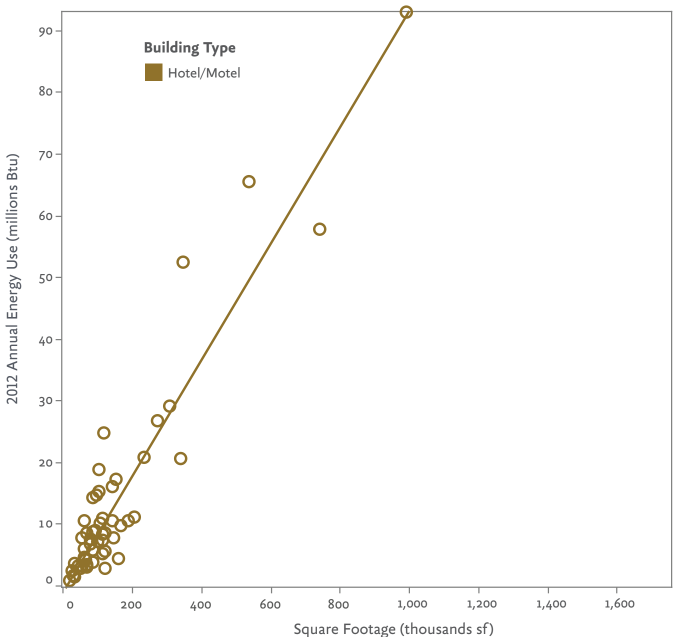


Figure A6: **Trend of Annual Energy Use by Square Footage for Hotel/Motel**

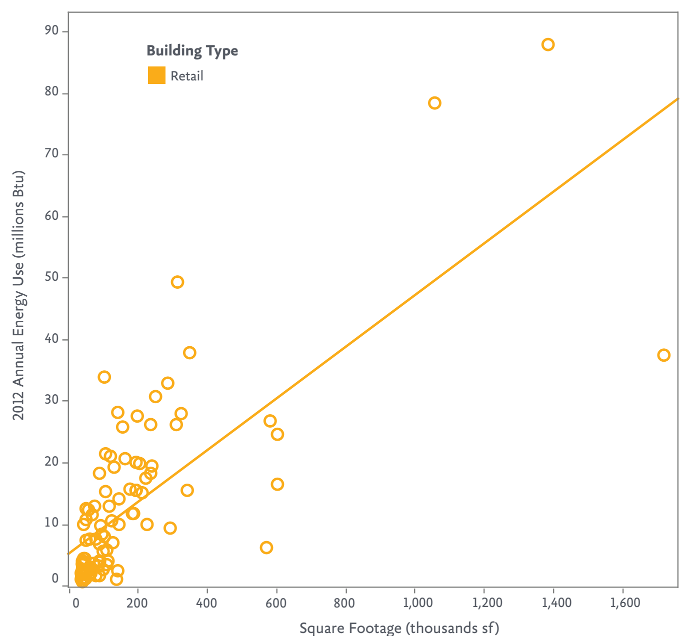


Figure A7: **Trend of Annual Energy Use by Square Footage for Retail**

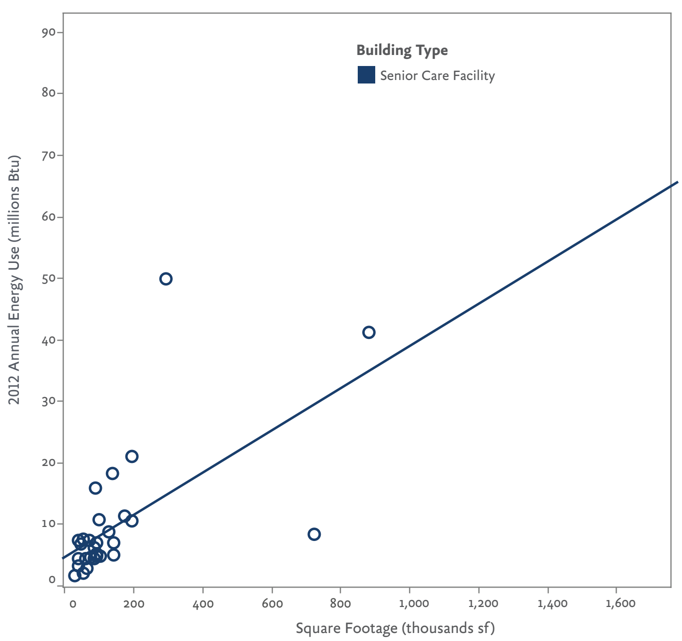


Figure A8: **Trend of Annual Energy Use by Square Footage for Senior Care Facility**

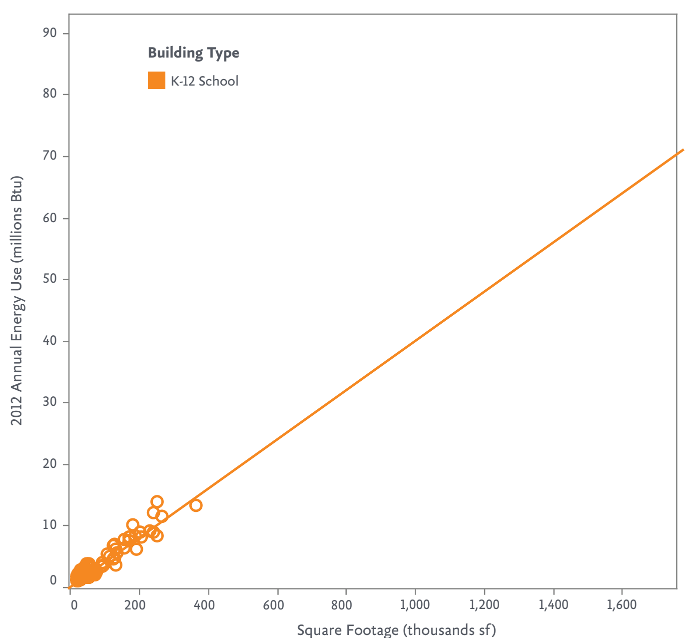


Figure A9: **Trend of Annual Energy Use by Square Footage for K-12 School**

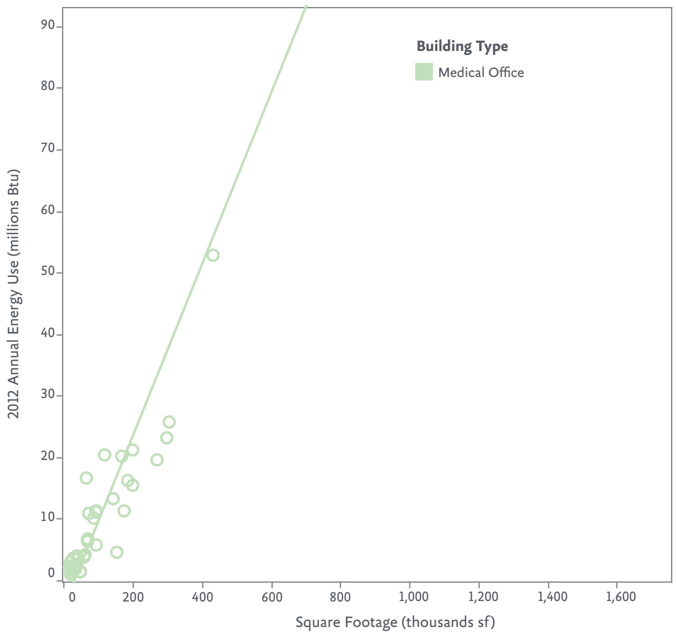


Figure A10: **Trend of Annual Energy Use by Square Footage for Medical Office**

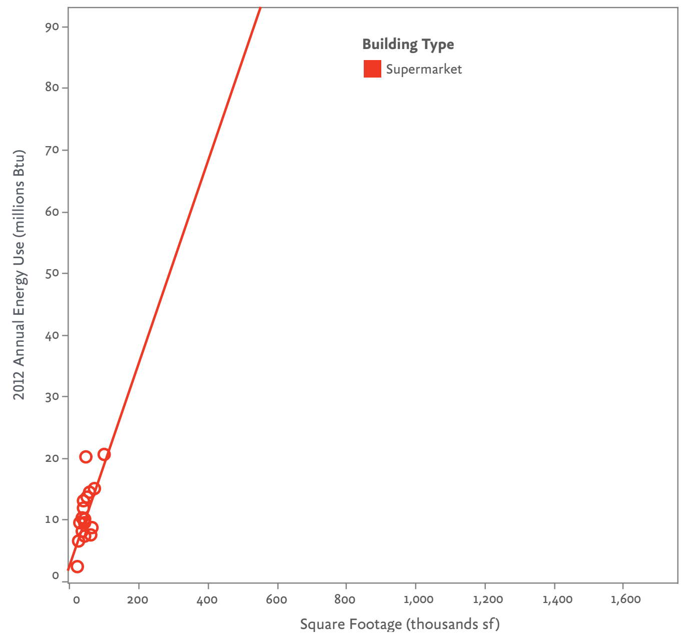


Figure A11: **Trend of Annual Energy Use by Square Footage for Supermarket**

3. DATASET COMPARISONS

NCBSA The Northwest Energy Efficiency Alliance (NEEA) and Seattle City Light provided a Seattle-specific subset of the Northwest Commercial Building Stock Assessment (NCBSA) dataset. Due to the stratification used in NCBSA sampling, a comparison between the NCBSA and Seattle benchmarking dataset for all buildings types was not advisable. Office buildings were the only building type defined in a similar manner with a sufficient number of buildings in the NCBSA to make an instructive comparison.

The office building comparison showed an extremely similar distribution of EUIs. As shown in Figure A12, the median EUI (the middle line of the box portion) is nearly identical, differing only by tenths of a unit. This suggests that the energy and square footage data in the Seattle Benchmarking dataset are reasonably accurate. Further extrapolations are inappropriate given the sampling strati¬fication in the NCBSA. The boxes in Figure A12 depict the interquartile range (between the 25th and 75th percentiles), with the median represented by the middle line. The whiskers extend to 1.5 times the interquartile range, and the circles beyond the whiskers are defined as outliers. The interquartile range for the Seattle benchmarking dataset is larger due to the much larger size of the dataset.

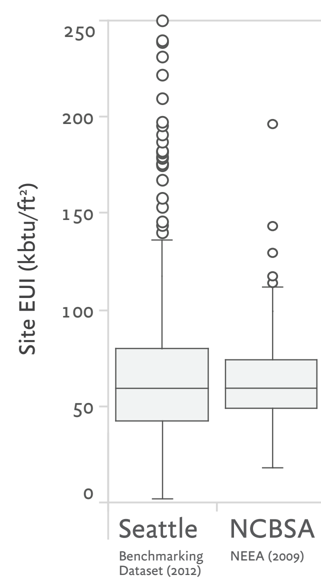


Figure A12: **Comparison of Seattle Benchmarking and NCBSA Office Building EUIs**

CBECS The 2003 Commercial Building Energy Consumption Survey (CBECS) is the national dataset upon which ENERGY STAR scores are modeled. A comparison of overall EUIs by building type (total energy consumption/ total square footage) between CBECS and the Seattle benchmarking dataset was conducted to ensure that Seattle building type EUIs were reasonably relative to CBECS overall EUIs. This was indeed the case and no further comparisons were made due to redundancy with ENERGY STAR scores and possible differences in building type definitions.

RECS As ENERGY STAR scores were unavailable for multifamily housing, the U.S. EIA's Residential Energy Consumption Survey (RECS) provided the best available means of comparison of Seattle multifamily building performance to national and regional averages. The overall EUI for Seattle multifamily housing was 37.8, comparing favorably to the overall EUI for the RECS West Region at 41.7 and the national gross EUI of 54.5. Seattle appears to be outperforming the West region, but this comparison does not account for climate differences or mixed uses[1].

VENDORS Many building owners employed a vendor or consultant to conduct their building benchmarking. A subset of the dataset submitted by known vendors (n=193 for multifamily, n=46 for offices) was compared to the rest of the population. The two subsets again showed very similar distributions with almost identical medians (Figure A12). This could indicate that vendors are just as inaccurate as building owners, or that building owners are just as accurate as vendors. The consistency seen between the groups is more likely to be a positive indicator for data accuracy, but further analysis is required.

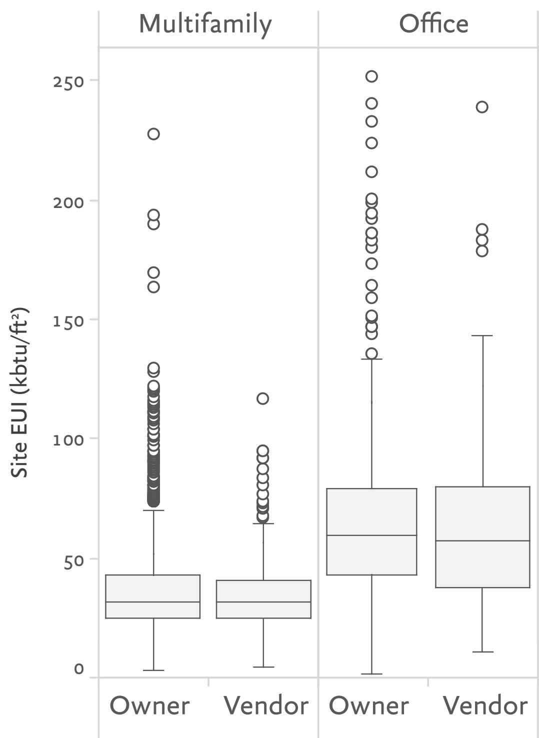


Figure A13: **Comparison of Owner and Vendor-Benchmarked EUIs**

[1] *The RECS measures occupied housing units only, excluding common spaces and unoccupied units. National and regional whole building EUIs generally can be assumed to be higher than the RECS values due to common spaces and mixed uses. The RECS values cited are for multifamily apartments with five or more units.*

4. SAMPLE OF BUILDINGS

Due to limitations of the Portfolio Manager software, some data could only be accessed through the Portfolio Manager web portal. These fields included usage data by fuel type, use of automated benchmarking services (ABS) for electricity, and building and space characteristics such as occupancy. In order to assess the accuracy of these fields, a simple random sample was drawn (n=75) to meet 90% confidence and 10% precision targets. This sample was limited to buildings 50,000 square feet or greater since they were in the second year of reporting and assumed to have more accurate data. For estimates of fuel mix, additional buildings were sampled to replace K-12 Schools (subject to an academic year reporting period) and cases with unreadable meter data. For the sample, building type data were also collected through the King County Parcel Viewer.

AUTOMATED BENCHMARKING Seattle building owners used automated benchmarking services (ABS) or data uploading at a high rate for electricity use, with an estimated 78% of reporting buildings using Seattle City Light's whole building monthly consumption data for electric reporting. Direct data upload between the utility and Portfolio Manager minimizes data entry errors, missing data and ensures consistency with utility records. This finding also suggests that electric data are precise, although it is possible that meters could get excluded as it is incumbent on the building owner to verify the list of meters supplying the whole building consumption report. Natural gas data exchange usage rates were not assessed due to changes in the Puget Sound Energy (PSE) system that occurred during the benchmarking period. There were insufficient steam customers in the sample to make any inferences about steam data uploading usage.

BUILDING TYPE Comparisons of building type classifications in the King County Assessor's database use and the Seattle Benchmarking dataset revealed a low error rate of less than 5% for building type classifications in the reported dataset. Note that the King County Assessor building types were not considered to be a more accurate data source, but rather a means of comparison. In cases where building type did not match (15% of buildings), publicly available building information was used to determine that the building type used was likely correct.

BUILDING OCCUPANCY Of the buildings in the sample with required occupancy information, 15% recorded updates to occupancy information in 2011 or 2012. This rate could reflect an underreporting of occupancy changes given the rapidly evolving real estate market in Seattle, as noted in Chapter 6, Figure 8. Occupancy information is taken into account in ENERGY STAR scores for these buildings. If a building has increased occupancy but has not documented it, then its score could be lower than it should be.

DATA CENTERS, CELL PHONE TOWERS AND ELECTRIC VEHICLE CHARGING STATIONS These three loads could substantially affect a building's energy use if they are not separately metered. Portfolio Manager does allow building owners to separately document data centers, but many data centers are relatively small and not separately metered, and Portfolio Manager's qualification criteria for data center spaces can be complex. Thus it is possible that the 44 out of 429 offices (10%) recording a data center space represents an underreporting of data centers. Electric vehicle charging stations are not documented in Portfolio Manager, and could be included in building EUIs if not separately metered and excluded.

OUTLIERS Data cleaning is often conducted prior to analysis of large datasets as some degree of error is assumed. Outliers also can skew summary statistics, particularly means. The data cleaning process for the Seattle dataset conservatively removed only the top and bottom 1% of EUI values in the entire dataset, since there was insufficient knowledge about outlier cases to justify removal of a more substantial percentage of buildings. This left many extreme values in the dataset that could represent errors. The assessment did not review these cases individually and it is also possible that they are accurate values.

DATA NOT ASSESSED

BUILDING VINTAGE The data accuracy assessment did not investigate building vintage due to the lack of a reputable data source—vintage values are defined differently in the King County Assessor's database than by Portfolio Manager.

SPACE TYPES The assessment did not assess the accuracy of secondary uses or space types. While relatively few buildings appeared to be incorrectly assigned to majority use type, secondary uses could not be verified. It was unknown whether building owners were conscientious in documenting secondary spaces. Neglecting to record secondary space types can result in inaccurate ENERGY STAR scores, but not EUIs, since EUIs are based only on square footage and energy use.

Furthermore, a large number of buildings could only be classified as "other" in the dataset. The Portfolio Manager upgrade released in July 2013 now includes 18 broad building categories and 80 primary types that may help better categorize these buildings for future analysis.

Glossary

ENERGY USE INTENSITY (EUI) A building's Energy Use Intensity is equal to the amount of annual energy used per square foot of building space. The value includes all utility energy inputs—electricity, gas, and steam—standardized into a single energy unit, often kBtu/sf (thousands of British thermal units per square foot). EUIs are a simple and transparent way to capture energy performance and efficiency and allow for comparisons across building types and sizes. A higher EUI indicates greater energy use and lower performance or efficiency, while a lower EUI indicates less energy use and higher performance or efficiency.

ENERGY STAR SCORE A building's ENERGY STAR score ranges from 1 to 100 and compares the building's energy performance to other nationwide buildings of its type. Unlike EUI values, ENERGY STAR scores take into account building characteristics such as number of occupants and operating hours. Higher ENERGY STAR scores indicate less energy use and higher performance or efficiency, while lower scores indicate more energy use and lower performance or efficiency.

The score corresponds to a percentile such that a score of 50 represents the national median (i.e., a typical building), and a score of 75 or over indicates the building is in the top 25% of performers and may be eligible to be nationally recognized as an ENERGY STAR certified building (also known as the ENERGY STAR label). ENERGY STAR scores are available for 20 building types but are not yet available for multifamily housing buildings. ENERGY STAR scores are based on the 2003 Commercial Building Energy Consumption Surveys (CBECS).

PORTFOLIO MANAGER The U.S. EPA's Energy Star Portfolio Manager is a free, online tool developed and administered by the U.S. Environmental Protection Agency (EPA) for commercial, industrial, multifamily, public and institutional building owners and managers to track and access energy use across their entire portfolio of buildings. Using Portfolio Manager, the energy performance of buildings can be benchmarked and rated through comparisons to similar buildings nationwide.

BUILDING TYPE & SPACE TYPE In Portfolio Manager, building type is defined by the space type making up the majority (50% or more) of a building's area. Space types (also referred to as use types) are defined by the type of commercial, governmental, or residential activities occurring within that area. Portfolio Manager includes more than 80 specific space types.