CITY OF BOSTON

BUILDING ENERGY REPORTING AND DISCLOSURE ORDINANCE

ENERGY AND WATER USE IN BOSTON'S LARGE BUILDINGS, 2013

AUGUST 2015

GREENOVATE BOSTON

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ACKNOWLEDGMENTS

The success of the first year of private-sector energy reporting in Boston was supported in large part by strong partnerships between the City and organizations in the public, non-profit, and private sectors.

The development of the ordinance and regulations would not have been possible without the input of the many stakeholders and constituents that provided comment. The members of the Building Energy Reporting and Disclosure Ordinance (BERDO) Advisory Committee and the sectors they represent provided especially valuable feedback in developing regulations.

The utilities Eversource (formerly NSTAR), National Grid, and Veolia created services that make whole-building energy data available to building owners, and their efforts made the reporting process much easier. The collaboration with Eversource and National Grid built on the existing relationships between the utilities and the City of Boston, particularly through its Renew Boston program. In addition, coordination with Boston Water and Sewer Commission ensured that owners had access to water data.

Several organizations supported outreach to building owners and managers to ensure that they had the information and resources they needed. A Better City and the Green Ribbon Commission's working groups on healthcare and higher education worked with their members extensively on reporting. A Better City also provided training on Portfolio Manager to many large building owners in Boston. In addition to A Better City, the organizations NAIOP Massachusetts, Greater Boston Real Estate Board, Community Associations Institute, Boston Bar Association, and Healthcare Without Harm hosted informational sessions and distributed updates to their members.

The reporting process was also supported by Boston's partners at the U.S. Environmental Protection Agency (EPA) and the Department of Energy (DOE). The ENERGY STAR® team at EPA provided extensive support in enabling their Portfolio Manager® platform and resources to facilitate BERDO reporting. EPA Region 1 helped train and provided one-on-one support to building managers in Boston. The DOE has also supported Boston's ongoing efforts to improve data management and streamline utility data access.

The City of Boston was fortunate to have valuable support and advice from staff in other cities with benchmarking and disclosure ordinances, including New York, Washington, D.C., Seattle, and San Francisco. Formal collaboration was also made possible through the generous support of the Urban Sustainability Directors Network and the Institute for Market Transformation.

Finally, Peregrine Energy Group, and their partners, Empower Efficiency, OptiMiser, and Harvey Michaels at MIT, conducted the extensive data organization and data cleaning and the many analyses presented in this report. Their report to the City of Boston is available on our website.

Implementation of the Building Energy Reporting and Disclosure Ordinance, including this report, is the responsibility of the City of Boston Environment Department and the Air Pollution Control Commission. Comments on this report are welcome at energyreporting@boston.gov. For more information about BERDO, please visit boston.gov/eeos/reporting.

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SUMMARY

In 2014, the first year of private-sector energy reporting in Boston, over 175 million square feet of floor area began tracking and reporting energy use and greenhouse gas emissions, for a first-year compliance rate of 84 percent. The City continued reporting on its 321 municipal facilities for a second year. Combined, more than 26 percent of all built floor space in Boston reported its energy use, water use, and greenhouse gas emissions.

Reports were submitted by approximately 820 buildings, including 101 that were not required to but chose to do so voluntarily. The reporting process spurred several building owners to investigate their least efficient buildings and to contact the City to learn more about utility programs for efficiency. The data submitted provides better insight on how energy is being used by Boston's buildings and the first broad, building-specific understanding of greenhouse gas emissions.

BACKGROUND

In 2013, Boston enacted the Building Energy Reporting and Disclosure Ordinance (BERDO), which requires large buildings in Boston to report their annual energy and water use and requires the City to make this information public. By providing better information on the energy use of buildings, the ordinance will enable owners, tenants, residents, and other stakeholders to become more aware of energy use, energy costs, and greenhouse gas (GHG) emissions and of opportunities to reduce all three.

Energy reporting and disclosure builds on Boston's work over the past decade to reduce citywide GHG emissions 25 percent by 2020 and 80 percent by 2050. Since large buildings and institutions are responsible for approximately half of Boston's GHG emissions, increased energy efficiency in this sector will be critical to achieve these reduction targets. Connecting reporting buildings to city, state, and utility efficiency programs and incentives is an important part of Boston's Climate Action Plan.

IMPLEMENTATION IN 2014

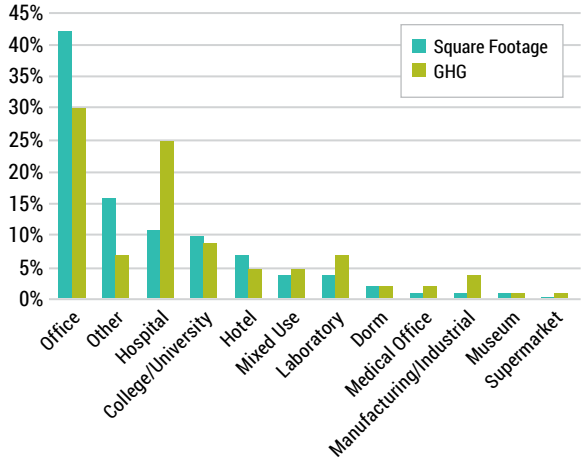
In 2013, the City of Boston began reporting the energy and water use of municipal facilities. 2014 was the first year of required reporting for private-sector buildings in Boston, starting with all non-residential buildings over 50,000 square feet. To help building owners, the City provided multiple reminders, training sessions, step-by-step guidance, weekly office hours, and helpdesk services. The region's utilities provided services that allowed building owners to obtain whole-building energy use data, and partners at EPA and business organizations supported the outreach and training.

ANALYSIS AND FINDINGS

Building owners were required to report on their 2013 calendar year energy and water use. Key findings from this data include:

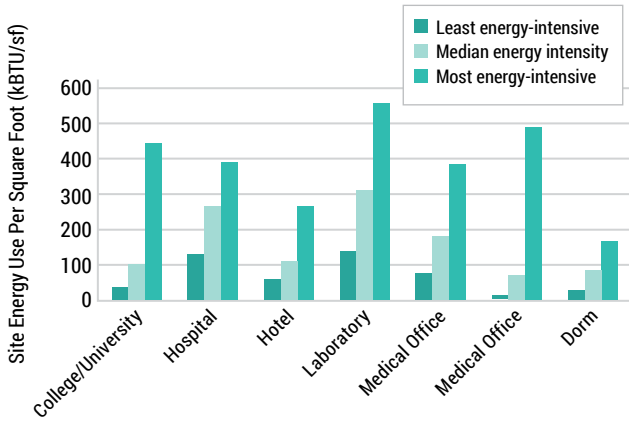
- **The buildings reporting in 2014 represent approximately 45 percent of the energy used by all commercial, industrial, and institutional buildings in Boston.** This is also equal to 31 percent of total building energy use in Boston[1] (p. 14).
- **Three property types account for approximately two-thirds of the reported GHG emissions and floor area.** Office buildings were the most prevalent type of building, accounting for 42 percent of the floor area, followed by hospitals and higher education buildings, accounting for approximately 10 percent each (Figure S-1). These three types of properties were collectively responsible for approximately two-thirds of all reported GHG emissions (p. 12 and p. 15).

FIGURE S-1: Square footage and GHG emissions by property type in 2014, as a percentage share of the total square footage and GHGs reported



[1] Estimate based on a comparison with Boston's community greenhouse gas inventory. The methodologies used by EPA Portfolio Manager and the City's own greenhouse gas inventory may differ slightly.

FIGURE S-2: Site EUI, or energy used per square foot. This graph shows the lowest values and the highest values for each type of property. For some types of buildings, the most energy-intensive buildings reported 10 times as much energy per square foot as the least energy-intensive.



Solar panels on the roof of the Haynes House Apartments in Roxbury

- **Buildings of the same type can vary greatly in energy use intensity.** Site energy use intensity (the energy used per square foot) varied greatly even among buildings of the same type (Figure S-2). Among Boston's large office buildings, for example, the most energy-intensive buildings reported ten times more energy per square foot than the least energy-intensive buildings (p. 18).
- **On average, older buildings perform well.** Office buildings built before 1950 used significantly less energy per square foot on average than those built after 1950 (p. 19).
- **Many of Boston's buildings score highly on the current national scorecard.** Many of Boston's large non-residential buildings earn high ENERGY STAR scores, which are based on a 2003 nationwide building survey. Offices, university dormitories, and Boston's public schools have median scores that are significantly higher than the national median (p. 20).
- **Lessons from the first year of implementation are helping outreach and resources.** The City has expanded outreach to buildings between 50,000 and 100,000 square feet, which typically had lower compliance rates than larger buildings, and is working to identify the appropriate points of contact within complex ownership entities. The City has increased staff resources for help services and continues to improve its guidance documents (p. 26).

LOOKING AHEAD

In May 2015, large residential buildings submitted their first year of data, and, in 2016 and 2017, buildings between 35,000 and 50,000 square feet will begin to report, completing full implementation of the reporting requirements. At that time, over 40 percent of floor space in Boston will be tracking and reporting its energy use and GHG emissions, though this comprises less than 4 percent of Boston's buildings.

As buildings continue their yearly reporting, the additional data will enable owners to track their year-over-year changes. A 2012 EPA study showed that buildings consistently tracking their energy use achieved a 7 percent reduction in energy use on average over three years.[2]

The ordinance requires that, beginning in October 2015, the City publicly disclose metrics on individual building energy use, water use, and GHG emissions to expand upon the benefits of BERDO. For building owners and managers, this increased access to information will help foster a better understanding of how buildings compare in energy use with their peers. This understanding can support peer-to-peer learning between building managers and owners on reducing energy use and costs. Existing networks in the commercial, industrial, and institutional sectors can help spur such learning and share lessons learned from efficiency projects.

[2] U.S. EPA. 2012. "Benchmarking and Energy Savings." Available at http://www.energystar.gov/sites/default/files/buildings/tools/DataTrends_Savings_20121002.pdf. October.

For residents and tenants, expanded access to energy information will enable a greater understanding of the energy use and GHG emissions of large buildings. Later this year, Bostonians will be able to visit the City's website and easily look up the energy use, water use, or GHG emissions of the large buildings in which they live or work and understand how they compare with similar buildings. This increased awareness can foster conversations between residents, commercial tenants, and building owners about ways to reduce energy use and costs.

Ultimately, understanding building energy use through better information will promote greater engagement in actions to reduce energy use and GHG emissions. In particular, it will encourage all stakeholders to take better advantage of the resources and incentives offered by the City, Commonwealth, and utilities for energy efficiency and clean energy.

I. INTRODUCTION

ENERGY AND GREENHOUSE GAS REDUCTIONS IN LARGE BUILDINGS

Boston's Climate Action Plan, first adopted in 2007 and updated twice since, lays out the strategies necessary to reduce greenhouse gas (GHG) emissions 25 percent by 2020 and 80 percent by 2050. Large buildings and institutions are collectively responsible for about half of citywide GHG emissions. Given the importance of reductions in this sector, the Climate Action Plan establishes a comprehensive set of efficiency and clean energy strategies for large buildings and institutions. As a key component of understanding building energy performance, energy reporting and disclosure was one of the strategies laid out in the 2011 Climate Action Plan Update.

The Building Energy Reporting and Disclosure Ordinance (BERDO), enacted in 2013, requires Boston's large buildings to annually report their energy and water use and requires the City to make this data publicly available. In 2014, non-residential buildings over 50,000 square feet were required to begin reporting. At full implementation in 2017, approximately 2,000 buildings will be reporting — just 2.4 percent of the private-sector buildings in Boston. Yet, because of the size of these properties, more than 40 percent of the private-sector floor area will be tracking and reporting its energy use and GHG emissions.

FIRST-YEAR ANALYSIS

This report presents an analysis of data submitted in 2014, including findings on compliance, patterns in energy use and GHG emissions, and municipal energy use, and it concludes with a look at potential improvements to the program.

As explained in the following sections, some analyses pertain to *buildings* and *tax parcels*, while other analyses apply to properties as reported by the owner, which may consist of multiple buildings. Each section explains the approach presented; however, care should be taken when comparing numbers, charts, and tables.

The data analyzed in this report are the energy and water use during 2013 as reported by building owners. Data cleaning and error-checking helped to remove the clearly erroneous values from further analysis, but less discernible errors may remain. Buildings submit their data using ENERGY STAR Portfolio Manager, a free energy tracking tool developed by the U.S. Environmental Protection Agency. Portfolio Manager uses the raw data entered by property owners to calculate energy and GHG metrics, and the analysis presented in this report relies on those calculations. The approach of Portfolio Manager may differ slightly from the methodology and emission factors used in the City's own GHG inventories or other Boston-specific energy and climate studies.

UNDERSTANDING THE METRICS

Using data entered by building owners, Portfolio Manager calculates a number of metrics for each building, displaying them in a dashboard for the user. Building owners can also generate reports on their portfolio to compare metrics across their buildings.

First, all users receive a *site EUI*, or energy use intensity — the building's total energy use divided by the gross square footage of the building (in units of thousand BTU per square foot). All users also see a *source EUI*, which includes the losses that take place during generation, transmission, and distribution of energy to represent the raw energy required per square foot. Users additionally see the *weather-normalized source EUI*, which adjusts for weather to allow for comparisons over time and across different locations. Many buildings also receive an *ENERGY STAR* Score, on a 1-to-100 scale. To calculate scores, Portfolio Manager accounts for the location and use details of a building, such as workers, equipment in the building, and operating hours, and, using a national building dataset of similar buildings, gives the building a 1-to-100 percentile score based on its source EUI. The score thus provides a metric that is somewhat adjusted for how the building is used. Nearly all major property types can receive a score, including offices, schools, grocery stores, multifamily buildings, hotels, dorms, hospitals, and warehouses. Due to limitations in the national dataset, some other property types, such as fire stations, food service buildings, and parking structures, do not receive a score. A mixed-use building can receive a score if at least three-quarters of the floor area is a score-eligible property use.

The national dataset primarily uses energy use information from the Commercial Buildings Energy Consumption Survey (CBECS), which is conducted by the U.S. Energy Information Administration. The current CBECS dataset dates to 2003; the EIA is expected to release an update to CBECS by the end of this year.[3]

Portfolio Manager also enables building owners to track water use and calculates water use intensity. However, it does not provide any water-use scores or comparisons with peer buildings.

Finally, Portfolio Manager provides users with metrics on greenhouse gas emissions by calculating both the direct emissions from onsite combustion of natural gas, oil, and diesel and the indirect emissions from the use of electricity and steam. GHG emissions can be lower if a building owner buys green power and enters the information into Portfolio Manager or has onsite renewable energy.

[3] Multifamily buildings were added to the ENERGY STAR scoring dataset independently of CBECS in 2014.

II. COMPLIANCE IN 2014

In the 2014 reporting year, all non-residential buildings over 50,000 square feet were required to report their energy and water usage for calendar year 2013; in addition, any set of non-residential buildings on one tax parcel totaling over 100,000 square feet was required to report. This included buildings in the office, real estate, non-profit, education, health-care, and industrial sectors.

A total of 819 buildings, encompassing 175 million square feet, reported. As shown in Table 1, 562 — or 71 percent — of the 790 parcels required to report submitted their energy reports (as of February 6, 2015).[4] Because many parcels have multiple buildings, the parcels that reported encompass 718 (or 73 percent) of the 984 buildings required to comply.[5] These 718 buildings represent more than 84 percent of the total square footage covered by parcels required to report.

Another 101 parcels (representing 101 buildings) that were not required to report did so voluntarily.

In December 2014, the City disclosed which buildings had complied and which had not, as specified by the ordinance. This list is available at www.boston.gov/eeos/reporting.

The City of Boston's own reporting on 321 municipal facilities is covered separately and in detail in Section VI; the numbers presented above do not include municipal buildings. The City has published annual energy and water data on municipal facilities each May, starting in 2013.

TABLE 1: Compliance by number of buildings, parcels, and square footage

	Required to report	Submitted Reports	Compliance Rate
Total tax parcels	790	562	71%
Total buildings	984	718	73%
Total square footage (based on tax assessing data)[6]	189,191,367	159,225,789	84%

Mayor Walsh announcing the release of the Greenovate Boston 2014 Climate Action Plan Update, which identifies strategies for energy efficiency and climate action across all sectors.

[4] Reports received after the legal deadline were still considered in compliance for the purposes of this analysis.

[5] To calculate compliance by buildings, this analysis uses the numbers of buildings on each parcel as recorded in the City's tax assessing records. Portfolio Manager users also self-report the number of buildings that their property consists of, and this may differ from the building count recorded in tax assessing data. For example, the property assessing records for a hospital campus might show three buildings that are required to report, but the hospital may submit a report that refers to eight buildings, either because they included smaller buildings in their energy report or because the hospital identifies its buildings and their wings differently than is shown in tax records. Per the building count in Portfolio Manager reports, 791 buildings were identified in the 562 submissions received for parcels required to report. This self-reported count of buildings is not used for compliance analysis.

[6] From City of Boston's 2013 Tax Assessing Database, not the self-reported square footage in Portfolio Manager. Gross square footage was not available in tax data for commercial condo buildings and so was estimated in GIS for the purpose of analysis using building footprint and number of floors. The gross square footage for two additional parcels required to report without readily available area information was pulled from their Portfolio Manager submissions.

TABLE 2: Compliance by parcel size groups (100,000 ft² intervals)

Gross Square Footage[7]	Parcels Required to Report	Parcels Submitted Reports	Compliance Rate
50,000 to 100,000	351	215	61%
100,001 to 200,000	210	155	74%
200,001 to 300,000	71	49	69%
300,001 to 400,000	39	32	82%
400,001 to 500,000	22	18	82%
500,001 to 600,000	19	19	100%
600,001 to 700,000	18	16	89%
700,001 and Greater	60	58	97%
TOTAL	**790**	**562**	**71%**

COMPLIANCE BY PROPERTY SIZE

In general, larger properties had higher rates of reporting than smaller ones. As Table 2 shows, properties over 700,000 square feet had a compliance rate of 97 percent, and the next two smaller size categories had compliance rates of 100 percent and 89 percent, respectively. For parcels between 50,000 and 300,000 square feet, on the other hand, 66 percent of properties complied, and the smallest size category in that group, 50,000 to 100,000 square feet, had a compliance rate of only 61 percent. Parcels between 50,000 and 300,000 square feet made up three-quarters of the properties required to report in 2014 and approximately 43 percent of the square footage required to report.

COMPLIANCE BY PROPERTY TYPE

Tax assessing records identify each parcel in Boston with a property type. Table 3 shows the breakdown of the 984 buildings that were required to report and the compliance rates of each type of property.

TABLE 3: Compliance by property type

Property Type[8]	Buildings Required to Report	Buildings That Submitted Reports	Compliance Rate
Office	260	207	80%
Higher Ed	162	153	94%
Healthcare	113	97	86%
Storage	64	33	52%
Manufacturing/ Industrial	57	34	60%
Retail	45	20	44%
Hotel	40	26	65%
Nonresidential Condo	28	19	68%
Laboratory	25	25	100%
Nonprofit	24	18	75%
Parking	21	17	81%
Priv. K-12 Education	17	7	41%
Sports/ Entertainment	15	10	67%
Supermarket	12	7	59%
Mixed Use Property	11	6	55%
Other	90	39	43%
TOTAL	**984**	**718**	**73%**

Buildings identified as Office, Higher Ed, Healthcare, Storage, Manufacturing/Industrial, and Other encompassed 76 percent of the total buildings required to report in 2014. The top three property types by building count—Office, Higher Ed, and Healthcare—had some of the highest compliance rates, at 80 percent, 94 percent, and 86 percent, respectively. Only Laboratories were higher, with 25 of 25 buildings reporting. In contrast, Private K-12 Education had the lowest rate of compliance, at 41 percent, with only seven of 17 buildings reporting.

[7] From City of Boston's 2013 Tax Assessor Database. Gross square footage for commercial condo buildings was estimated in GIS for the purpose of analysis using building footprint and number of floors. The gross square footage was pulled from Portfolio Manager submissions for two additional parcels without GROSS_AREA available in tax assessor data.

[8] Property types were determined by each parcel's P-Type, or property type code, as identified in the City of Boston's Tax Assessing Database, and then grouped by sector.

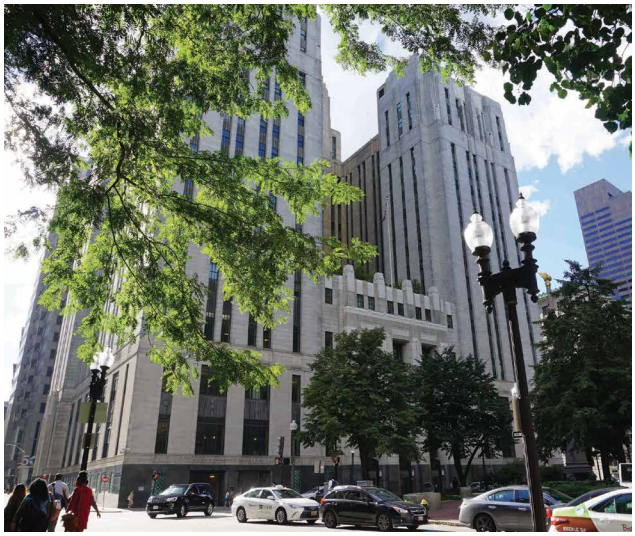
VOLUNTARY REPORTING

In addition to the properties that were required to report, an additional 101 parcels reported voluntarily (encompassing 101 buildings). For example, some owners of large portfolios included buildings under 50,000 square feet in their reporting. A number of residential buildings chose to report as well, although reporting on residential buildings was not required until May 2015.

Table 4 presents the breakdown of voluntarily reported buildings by property type. Higher Education accounts for 38 of the buildings.

TABLE 4: Voluntary reporting by property type[9]

Property Type	Number of Buildings That Voluntarily Submitted Reports
Higher Ed	38
Mixed-use Property	7
Nonprofit	6
Nonresidential Condo	6
Office	6
Supermarket	5
Retail	5
Hotel	3
Storage	3
Restaurant	2
Sports/Entertainment	2
Hospital	1
Parking	1
Healthcare	1
Residential	1
Other	14
TOTAL	**101**



The J.W. McCormack Post Office and Courthouse was built in 1933 and was remodeled in 2007 to include a green roof and other energy-efficient features. The building has earned an ENERGY STAR score of 90 and ENERGY STAR certification.

The East Boston Branch of the Boston Public Library opened in 2013 and earned LEED Gold certification. The innovative building design incorporates high-performance glass, underfloor ventilation, and daylight-responsive dimming.

[9] Property types were determined by each parcel's P-Type, or property type code, as identified in the City of Boston's Tax Assessing Database, and then grouped by sector. The sectors identified for voluntary reporting are identical to the categorization of required reports in Table 3, except for the addition of 'Restaurant.'

III. CHARACTERISTICS OF REPORTING PROPERTIES

The analysis of first-year energy and water data used the reports received through mid-November 2014. The analysis included buildings that were required to report and voluntary reporters (Table 5).

A property can be set up in Portfolio Manager to include one or more buildings in order to reflect how energy is metered and used. For a typical commercial building, the property manager will likely set it up as one property consisting of one building. In contrast, a campus that has three buildings sharing a single electricity meter and central heating plant will often be set up and reported as one property consisting of three buildings.[10] In that case, Portfolio Manager reports energy metrics for the property, not for any individual building within that property.

The analysis presented here examined reports for 642 properties. A property may span multiple tax parcels (e.g., a small campus spanning two parcels and on one central meter), and hence the analysis uses the count of reporting properties, not the count of parcels.

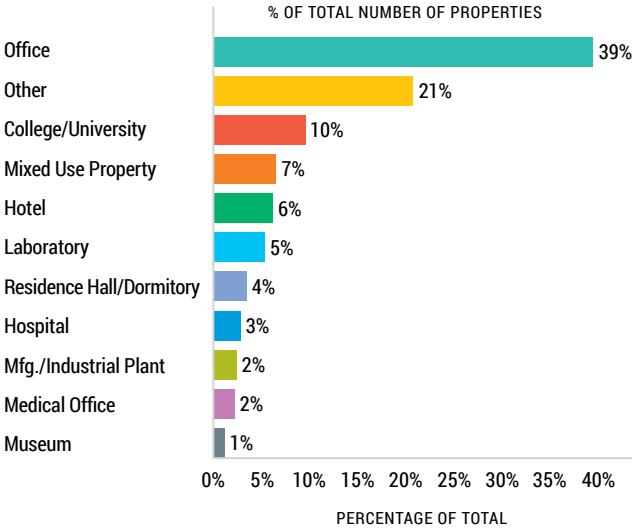
Portfolio Manager classifies properties by primary type, based on user-entered information about how the buildings are used. Figure 1 shows the distribution of reporting properties by property type.[11] Office buildings are the most prevalent type, accounting for 39 percent of all properties. College/university buildings (non-dormitory)[12] make up 10 percent of properties, followed by mixed use at 7 percent.

Thirty of the less prevalent property types—including recreational facilities, storage facilities, malls, and houses of worship—are grouped together into the "Other" category and make up 21 percent of properties.

TABLE 5: Summary of reporting counts

	Reported based on requirement	Reported voluntarily
Parcels reporting	562	101
Buildings encompassed by these reports	718	101
Total number of Portfolio Manager reports (i.e., properties) for these buildings	655	
Properties reported in time for analysis (through mid-November)	642	
Properties with adequate energy data for analysis	520	

FIGURE 1: Distribution of reporting property types, by count of properties



[10] Under Boston's reporting regulations, individually metered buildings must be reported as individual properties; a complex of buildings that shares a single meter can be set up as one reporting property with multiple buildings or, if the buildings are similar in use, as individual properties with apportioned energy use.

[11] This analysis of submitted reports uses the property types identified by Portfolio Manager. The compliance analysis in the preceding pages categorized buildings based on the property codes in the Assessing Database, as it examined all parcels that were required to report.

[12] Portfolio Manager has a property type for dorms, allowing them to be split out from general higher-ed buildings in this analysis.

Figure 2 shows the share of total floor area of each category of reporting properties. Offices accounted for 42 percent of the floor area and 39 percent of the property count, indicating that offices were close to the average size among the reporting population. In contrast, hospitals were only 3 percent of the number of properties but 11 percent of the floor area, indicating that they tended to be much larger than the average property that reported in 2014.

Boston's large non-residential buildings span a wide range of ages, not surprising given Boston's long history. The oldest property that reported dates back to 1811, and the newest were buildings constructed in 2013. Figure 3 shows the distribution of square footage and the number of properties by decade of construction. Over two-thirds of the square footage has been constructed since the 1950s, with over 25 million square feet of reported area having been built in the last 15 years alone.

FIGURE 2: Reported floor area by property type

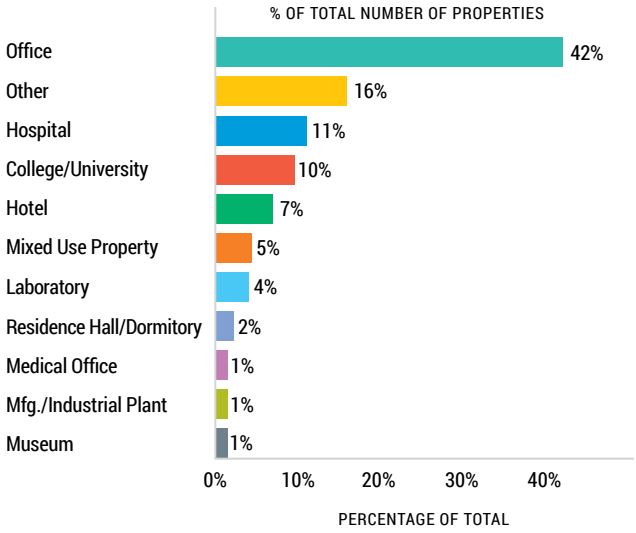
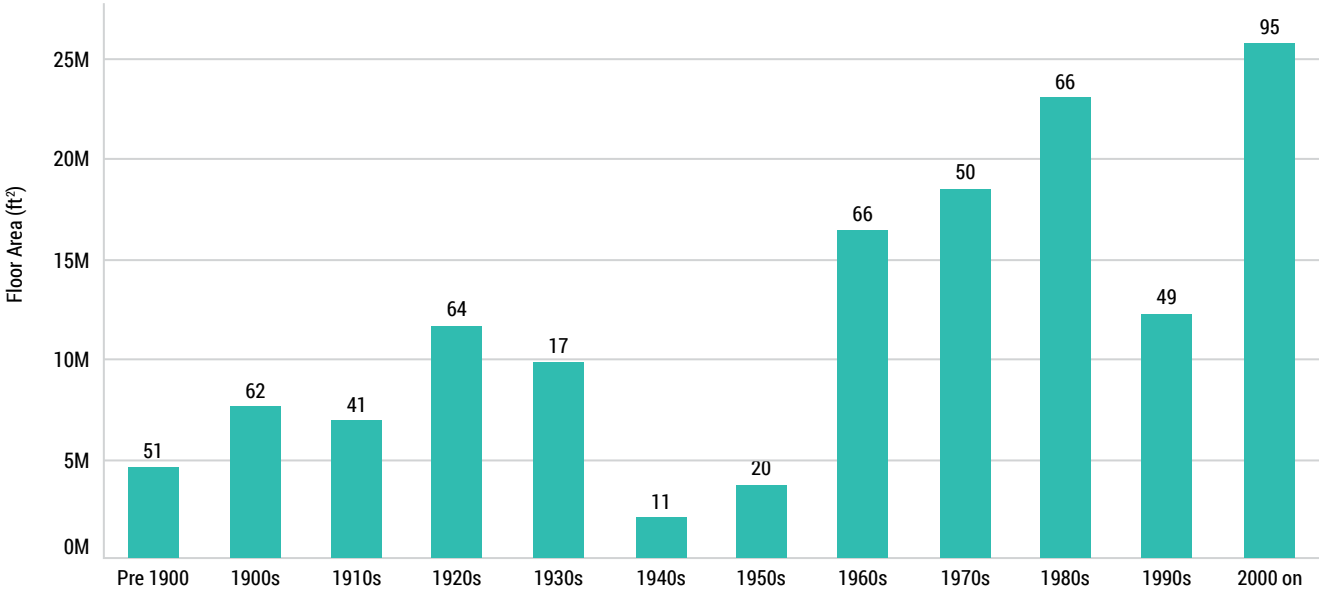


FIGURE 3: Floor area by decade of construction. The numbers at the top of each bar indicate the property count.



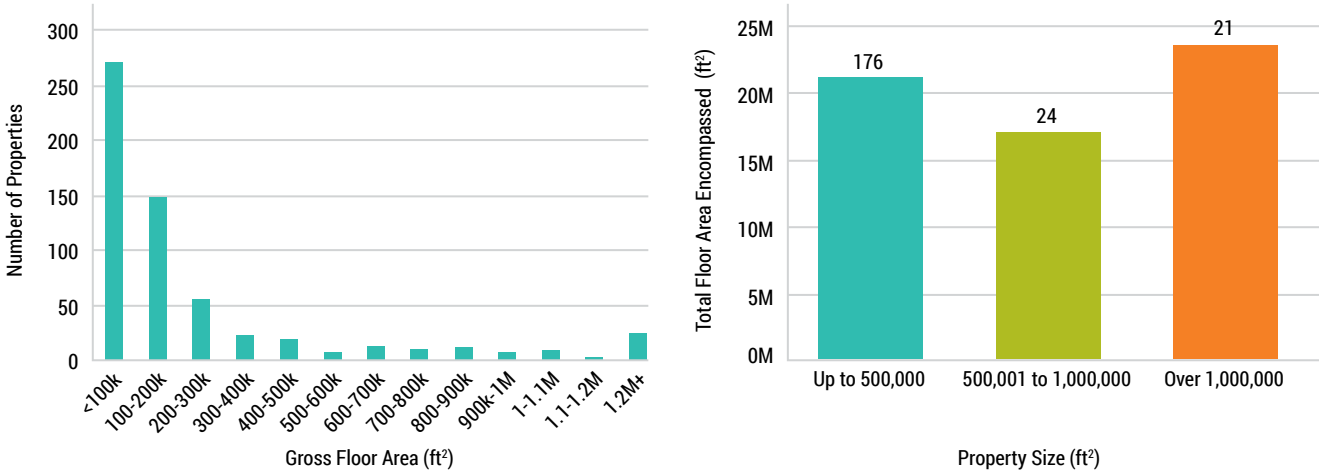
The properties that reported in 2014 span a wide range of sizes. Figure 4 shows the distribution of property sizes (top) and the amount of square footage contained within different groups of property sizes (bottom).

Properties under 200,000 square feet in size make up approximately two-thirds of all reports. As noted before, some properties may consist of multiple buildings aggregated on one meter or one central plant, and the distribution may skew slightly toward larger property sizes as a result. This may explain why the count of properties over 1.2 million square feet is greater than those between 1 and 1.2 million square feet.

When the amount of square footage in these properties is added together, as shown in the bottom graph of Figure 4, approximately the same amount of floor area was collectively reported by properties under 500,000 square feet as was encompassed by properties over 1,000,000 square feet.

The Mayor's Carbon Cup recognizes large properties that have committed to a 35% reduction in GHG emissions by 2020. Over 19 million square feet have enrolled as of 2015.

FIGURE 4: Reported properties by size (left) and the amount of square footage encompassed in each larger category (right). Some properties consist of multiple buildings, such as those aggregated on one meter or one central plant.



IV. ENERGY USE AND GREENHOUSE GAS EMISSIONS

The total energy use reported by non-municipal buildings in 2014 represent approximately 45 percent (19.5 billion kBTU) of the energy used in Boston's commercial, industrial, and institutional (C&I) buildings. The reported energy use is also equal to 31 percent of the energy used by all of Boston's buildings.

Similarly, the GHG emissions reported by non-municipal buildings represent about 50 percent of C&I greenhouse gas emissions, or approximately 35 percent of Boston's total building GHG emissions.[13] Reporting by the City on 321 municipal facilities is explored in further detail in Section VI.

The following sections provide a look at how the energy use and GHG emissions of buildings are distributed by fuel type, sector, and property type. Prior to analysis, the reported data was cleaned to remove outliers, incomplete data, and other inadvertent errors, removing some reports from the analysis. Data cleaning is described further in Section VII.

ENERGY USE AND GHG EMISSIONS

The 2014 reports include energy from electricity, natural gas, district steam, district chilled water, and oil, in addition to very small amounts of diesel and district hot water. Table 6 shows the number of properties that used each type of energy.

Figure 5 shows the breakdown in the sources of energy used, in units of MMBTU. Electricity was the most prevalent form of energy used, followed by natural gas. Fuel oil made up only 1 percent of the energy used by reporting properties.

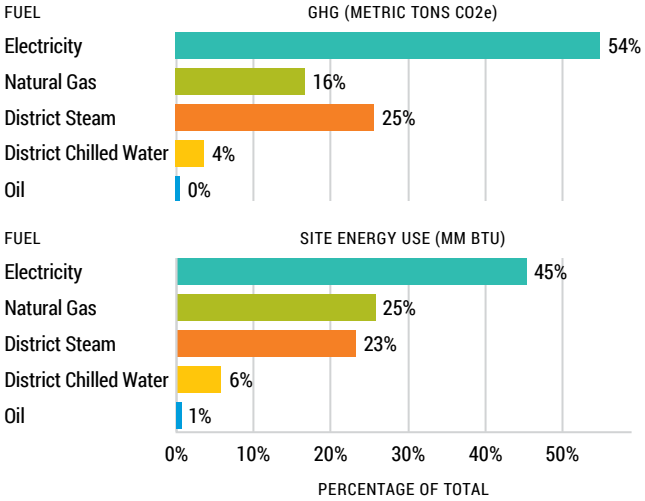
Figure 6 shows the contribution of each of these energy sources to GHG emissions from reporting properties. Electricity use represents the largest source of GHGs. Notably, natural gas accounts for 25 percent of energy use but only 16 percent of GHGs due to its relatively low emissions intensity.

Six properties also reported using onsite solar power, totaling 665 megawatt-hours of generation.

TABLE 6: Count of properties reporting different types of energy use

	Number of Properties Reporting Use
Electricity	570
Natural Gas	397
District Steam	119
District Chilled Water	32
Oil	62
Diesel	6
District Hot Water	1

FIGURES 5 AND 6: Site energy use and GHG emissions from each fuel type



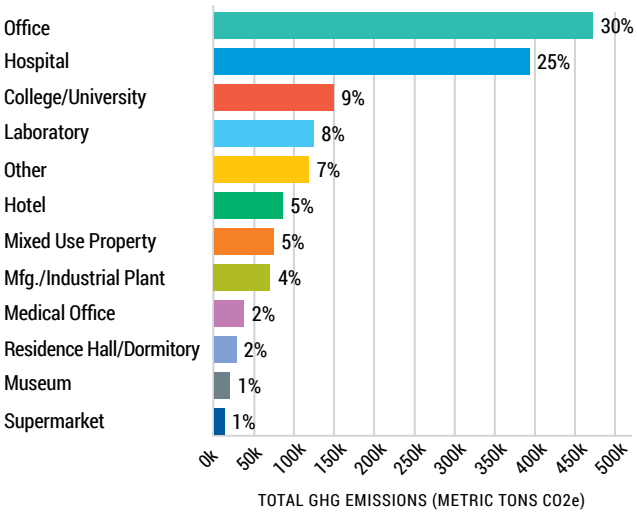
[13] These percentages are based on comparison to Boston's 2013 Community Greenhouse Gas Inventory. The methodologies and emission factors used by EPA's Portfolio Manager differ slightly from those used in the inventory, and these percentages should be regarded as an estimate.

ENERGY AND GHG EMISSIONS BY PROPERTY TYPE

Figure 7 shows the distribution of reported GHG emissions by type of building. Offices and hospitals were the primary contributors to GHG emissions at 30 percent and 25 percent, respectively, of the total, followed by university buildings at 9 percent. As Section III showed, these are the most prevalent types of properties in the 2014 reporting population. Labs accounted for only 4 percent of reported floor area but with their energy-intensive functions are responsible for 8 percent of reported GHGs.

A collection of less frequent property types are grouped together as "Other" and collectively account for 7 percent of reported emissions. This category includes sports arenas, distribution centers, retail stores, parking garages, and other building types. Hotels, mixed-use properties, manufacturing/industrial plants, medical offices, residence halls/dormitories, museums, and supermarkets all emit less than 5 percent each.

FIGURE 7: GHG emissions by property type. Shown as a percentage of the total GHG emissions of reporting properties.

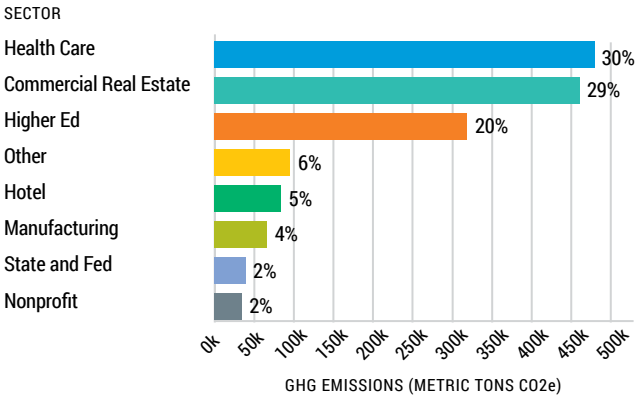


ENERGY USE AND GHG EMISSIONS BY SECTOR

Property type relates to the uses of the building and is helpful for comparing similar buildings to each other. Sector, on the other hand, relates to the ownership entity.[14] For example, a college stadium will have a property type in Portfolio Manager of "outdoor arena," and would be compared with a professional open-air arena. From the perspective of sector, however, the college stadium is part of the higher education sector and would be grouped with other university-owned buildings, such as dormitories, classrooms, and laboratories. Sectors are useful for assessing the overall contribution of different types of ownership entities to energy use and emissions. Many of Boston's climate action strategies focus on engaging specific sectors to identify their needs and solutions.

Figure 8 shows the contributions of each sector to the reported GHG emissions. Healthcare and commercial real estate are the two leading sectors, responsible for approximately 30 percent and 29 percent, respectively, of the total GHG emissions. Higher education is third in GHG emissions, at 20 percent, followed by hotels (5 percent), manufacturing (4 percent), state

FIGURE 8: GHG emissions by sector. Shown as a percentage of the GHG emissions of reporting properties



[14] Sector assignments were made primarily on the name of the property owner. Where the owner's name did not indicate the sector, the property type was used to make the sector assignment.

and federal government (2 percent), and non-profits (2 percent). "Other," including supermarkets, distribution centers, and other entities, collectively emits 6 percent of the GHG total.

Commercial real estate and higher education have the greatest variety of property types among sectors. Figures 9 and 10 show the GHG emissions of different building types within these two sectors. The size of the boxes represents the percentage of emissions that are attributable to the property type, and the numbers indicate the count of buildings.

A BREAKDOWN BY QUARTILE

Table 7 and Figure 11 present a quartile analysis of GHG emissions from reporting properties. Properties are ranked by emissions then divided into four equal groups, each of which collectively accounts for 25 percent of reported emissions. Quartile 1 contains the largest emitters and Quartile 4 the smallest.

Table 7 shows the count of properties in each sector. Just six properties constitute the top quartile — responsible for 25 percent of all emissions reported. Another 26 properties make up Quartile 2. In contrast, 481 properties collectively emit the same amount of GHGs in the fourth quartile.

Figure 11 illustrates the size and sector constituents of each quartile. Each box indicates a reporting property; its color indicates the sector, and its size represents its relative GHG emissions. Four healthcare properties, one industrial/warehouse facility, and one higher-ed institution make up Quartile 1. These six properties account for the same amount of emissions as the 481 properties in Quartile 4.

Commercial real estate properties account for a significant share of the second quartile — 12 of the 26 properties in the quartile. Hotels appear only in Quartile 3 and Quartile 4. There are healthcare and higher education properties in all four quartiles, indicating a range of GHG emissions in each of those sectors.

TABLE 7: GHG emissions quartiles

	Number of Properties
Quartile 1	6
Quartile 2	26
Quartile 3	69
Quartile 4	481

FIGURE 9: Commercial real estate sector GHG emissions by property type

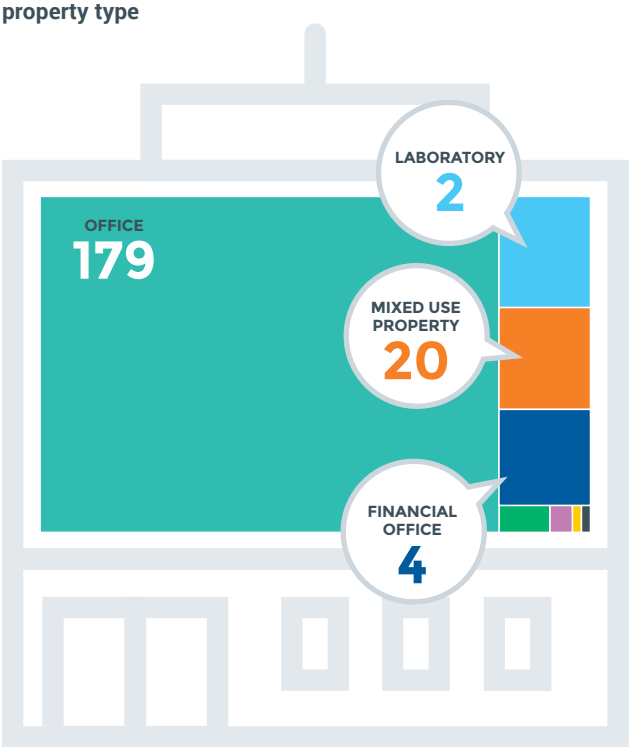


FIGURE 10: Higher education sector GHG emissions by property type

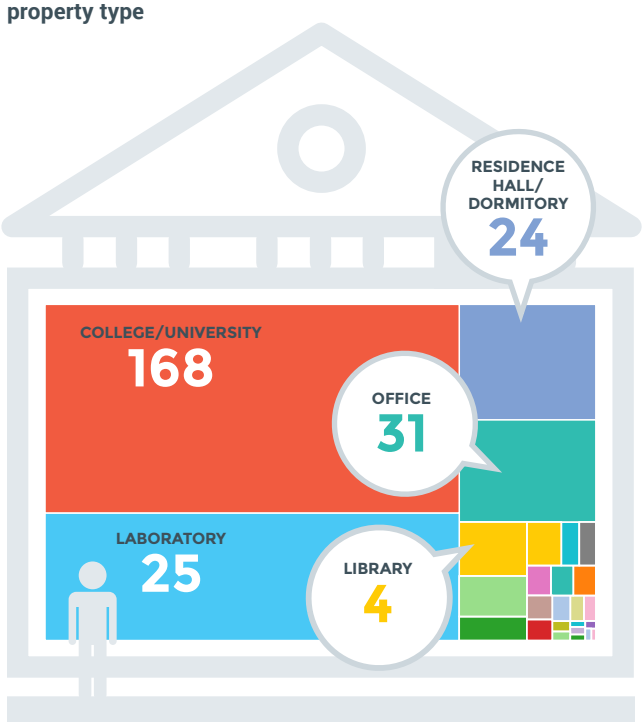
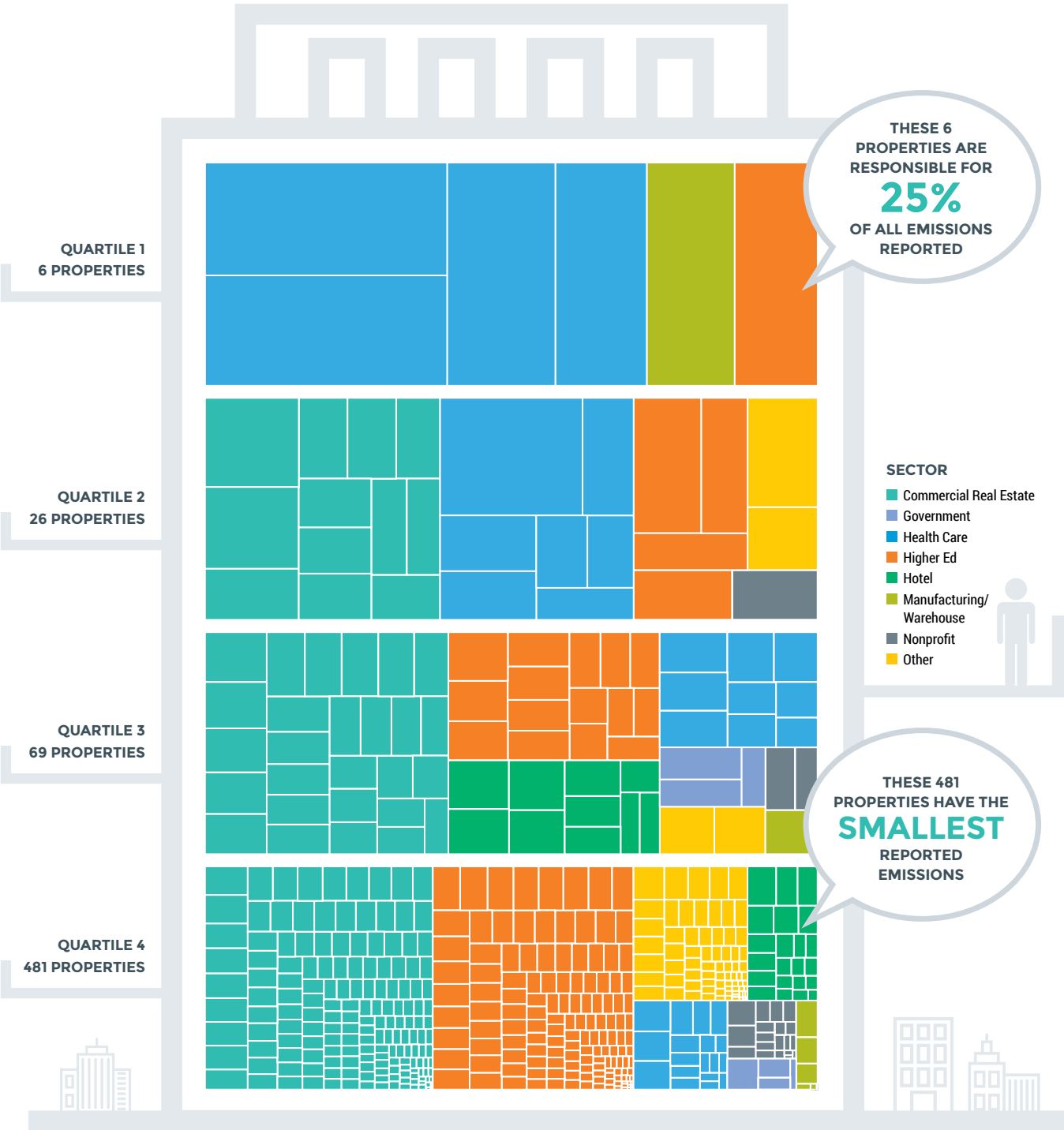


FIGURE 11: GHG quartiles by sector. Each section represents 25 percent of the GHG emissions reported.



V. BUILDING METRICS

ENERGY USE INTENSITY (EUI) BY PROPERTY TYPE

Portfolio Manager provides users with a number of metrics that can help with comparing and better understanding a building's energy use. Site energy use intensity (EUI), the sum of all energy used by the building divided by gross floor area, provides a metric of energy use per square foot.

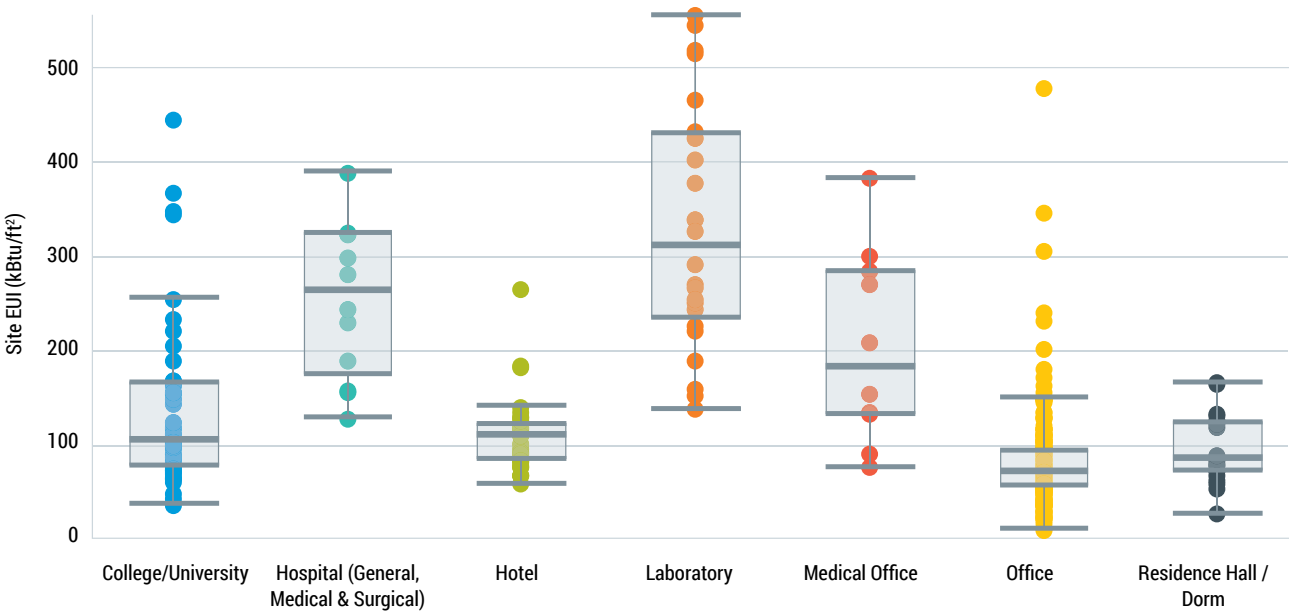
This is a metric that is not adjusted for property types or characteristics. Different building types, given the nature of their use, are likely to have higher site EUIs than others: for example, a 24-hour hospital with medical equipment is going to have a much higher EUI than an elementary school, typically open five days a week with far less electronic equipment. As a result, comparisons of EUI across sectors are far less useful than EUI comparisons within a sector.

Figure 12 presents the site EUIs for Boston's major property types, with the median values and quartile boundaries for each type. Laboratories, hospitals, and medical office buildings have the highest median EUIs.

The range of EUI values within each category indicates how widely spread EUIs are within any one type of building. Laboratories, for example, have a wide range of site EUIs, ranging from 140 to over 550 kBTU/sf. Office buildings also have a wide range of EUIs and have the most outliers , and the most energy-intensive office buildings use over ten times as much energy use per square foot as the least energy-intensive.

Buildings with high site EUIs for their property type may offer the best opportunities for energy efficiency improvements — after all, they far exceed the energy intensity for buildings of similar use types. However, there may be many valid reasons

FIGURE 12: Site Energy Use Intensity (EUI) by property type, in kBTU per square foot. Each dot represents an individual property. The solid bars in the center of the boxes are the median, and the top and bottom of the boxes are the 25% quartile and 75% quartile. The outlying whiskers mark the nearest data point within 1.5 the interquartile range (IQR) of the quartile value; points outside these whiskers are typically considered outliers.



[15] Defined as being more than 1.5 the interquartile range (IQR) above the third quartile or 1.5 IQR below the first quartile.

for a relatively high EUI. For example, the relatively high EUIs for some laboratories may be attributed to more energy-intensive research work, with more equipment and ventilation necessary than the low-EUI labs. Among hotels, a high EUI might be attributed to multiple commercial kitchens or a heated pool. As a result, a high EUI is not a definitive indicator of an inefficient building.

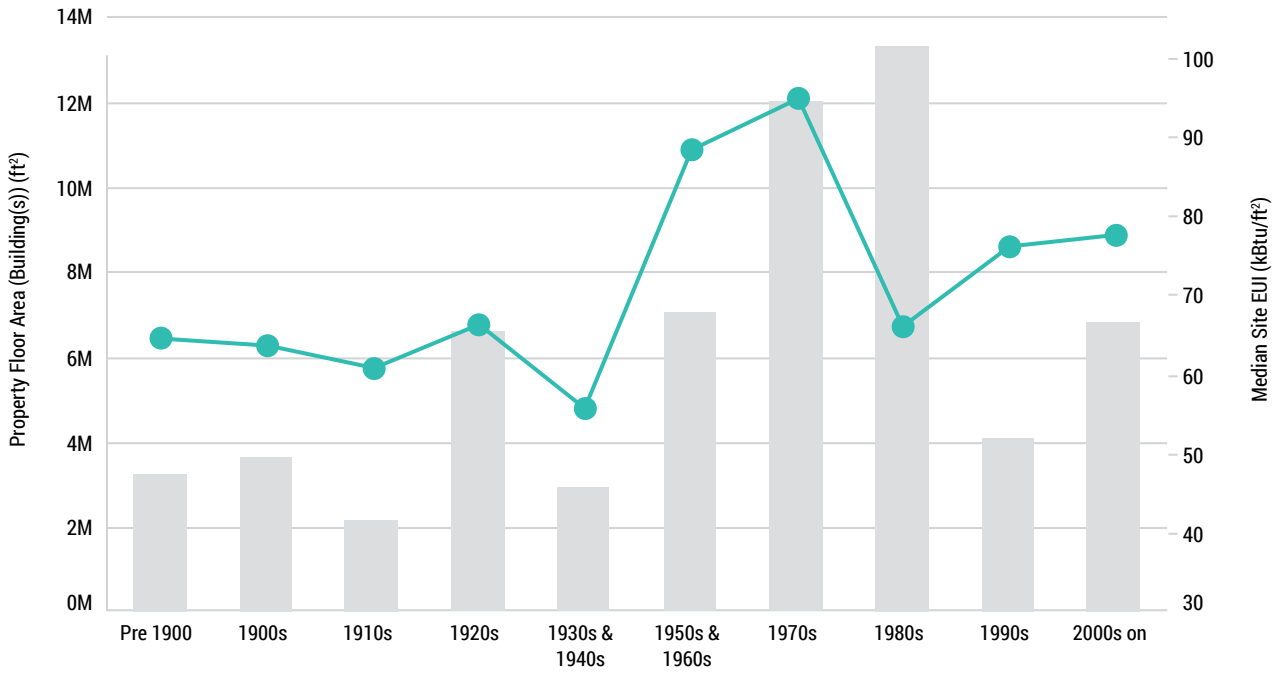
EUI BY YEAR OF CONSTRUCTION

Portfolio Manager also asks users to enter the year of construction. Since including multiple property types can introduce disparate ranges of EUI, the analysis of EUI by year of construction focuses on offices, the most common property type reported in 2014. Figure 13 shows median site EUI for Boston's office buildings by decade of construction. Office buildings constructed in the 1950s through 1970s are the most energy intensive, while buildings over 70 years old — those constructed in the 1940s and earlier — have the lowest energy use per floor area. Buildings constructed in the last twenty years have a median EUI that falls between these two extremes.

In analyzing their reported energy data, New York[16] and Seattle[17] found similar patterns of EUI by building age. Much of this variation is due to changes over time in construction materials and building systems: pre-WWII buildings tended to use masonry construction, for example, compared to glass-curtain wall construction in the 1960s and 1970s.

The pattern of EUI by year of construction may create opportunities for targeted energy efficiency initiatives. For example, buildings of similar age have similar materials and systems and may present common opportunities for energy efficiency upgrades.

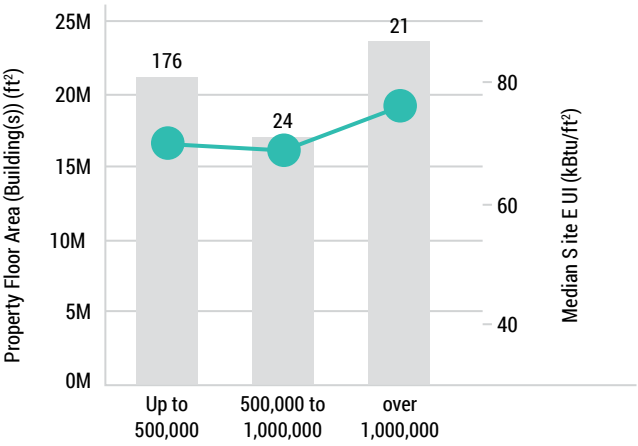
FIGURE 13: Energy Use Intensity (EUI) of office buildings by year built. The gray bars indicate the amount of floor area by decade of construction, and the green circles indicate the median site EUI.



EUI BY BUILDING SIZE

Figure 14 looks at the median site EUI of office buildings by property size. (As in the previous section, this analysis focuses on offices so as to not aggregate the disparate EUIs of different property types.) Office properties over 1,000,000 square feet have a slightly higher median EUI than smaller buildings.

FIGURE 14: Site Energy Use Intensity (EUI) of office buildings by property size. The gray bars indicate floor area and the green circles indicate the median site EUI. The numbers above the bars show the number of properties.



ENERGY STAR SCORES BY PROPERTY TYPE

ENERGY STAR Portfolio Manager generates a 1-to-100 percentile score for many building types, using details about the building and its location to adjust for how the building is used. As a result, the ENERGY STAR score provides some measure of how a building performs relative to similar buildings across the country. A score of 50 represents median energy performance relative to the 2003 CBECS dataset; a score of 75 or above means that the building may be eligible for ENERGY STAR certification. Not all buildings types receive a score due to the limitations in the CBECS dataset, and the age of the dataset means that it may not accurately reflect relative building performance today.

In Boston, the median ENERGY STAR scores for several property types are well above the national median: office buildings, financial offices, and dormitories in Boston had median scores of 78, 78, and 73, respectively (Figure 15). Boston's hotels have a broad range of scores, while Boston's hospitals and medical office buildings generally score below the national medians for hospitals and medical offices, respectively. Although there are several possible explanations, the cause of such sectoral differences from ENERGY STAR medians is not yet fully understood. The City will continue to examine differences between the national dataset and Boston buildings that may contribute to these patterns.

Other cities have also observed high median scores. In 2014, Chicago reported a median score of 76 across all of its score-eligible buildings,[18] New York observed a median of 70,[19] and Seattle, a median of 68.[20] This may be due to several reasons. Buildings in Boston, New York, Chicago, and Seattle may be more attuned to energy efficiency and efficient operations than the national average, thus resulting in high percentile scores. It may also indicate that buildings across the country have become more efficient since the last CBECS update in 2003, with many buildings scoring well compared to the 2003 average.

The Tip O'Neill Federal Building on Causeway Street is over 770,000 square feet in size and has earned ENERGY STAR certification for three of the last four years, with scores of 93 and higher.

[18] City of Chicago. 2014. "Building Energy Benchmarking Report."

[19] City of New York. 2014. "New York City Local Law 84 Benchmarking Report." September.

[20] Seattle Office of Sustainability and Environment. 2014. "2011/2012 Seattle Building Energy Benchmarking Analysis Report." January.

FIGURE 15: ENERGY STAR score by property type. As in Figure 12, each dot represents a property, and the bars indicate the median, quartile, and outlier values for each sector.

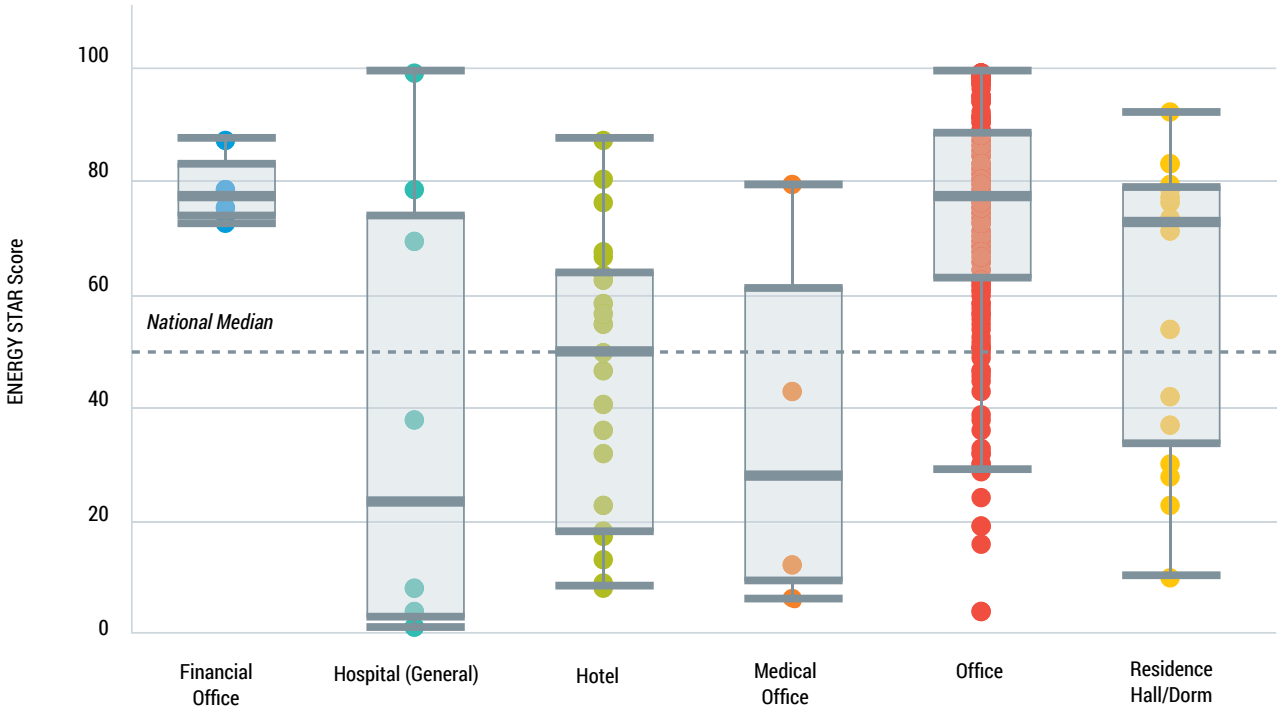
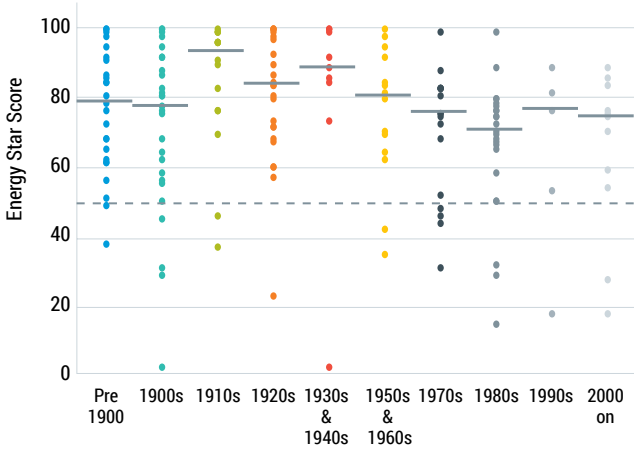


Figure 15 also shows the distribution of ENERGY STAR scores in each sector. Boston's buildings show a wide range of scores, with office buildings showing an especially broad range. Outliers in this distribution indicate properties that, even after Portfolio Manager adjusts for building operations and uses, are performing far above or far below similar buildings. Thus, low ENERGY STAR scores may provide a better indicator of efficiency opportunities than simply looking at EUI outliers and can inform outreach strategy for Boston's energy efficiency programs. However, some buildings with lower scores may have specific equipment or ventilation needs that are not adjusted for within Portfolio Manager.

ENERGY STAR SCORES BY YEAR OF CONSTRUCTION

Figure 16 presents a closer look at the ENERGY STAR scores of office buildings in Boston, showing the range and the median of score for each decade of construction. In every decade, the majority of Boston's office buildings have scores above the ENERGY STAR median of 50. Given that pre-WWII buildings typically have lower EUI values than more recently built peers, it follows that those buildings — especially those built between 1910 and 1940 — also have some of the highest ENERGY STAR scores.

FIGURE 16: Office buildings' ENERGY STAR scores by decade built. The gray lines indicate the median for Boston office buildings in each decade.



ENERGY STAR CERTIFICATION

Buildings with an ENERGY STAR score above 75 are eligible to pursue ENERGY STAR certification. To do so, building owners must have the energy information verified by a building professional, replace any estimates for energy use, water use, or building information with actual data, and apply to EPA to be certified. Among Boston's 655 reporting properties, 65 properties have earned ENERGY STAR certification within the past seven years. Office buildings form the majority of this group, along with a few dorms and one hotel.

An additional 110 properties earned scores at or above 75, making them potentially eligible for ENERGY STAR certification. The City will encourage these buildings to pursue certification to raise the profile of energy-efficient buildings in Boston. EPA research indicates[21] that ENERGY STAR-certified buildings typically see significantly lower operating costs compared to similar buildings and have approximately 4 percent higher occupancy rates.

WATER USE BY PROPERTY TYPE AND SECTOR

Buildings are required to report water use in addition to energy use. Figure 17 shows each property type's water use and GHG emissions and the share of total reported water use and emissions. The property types that are responsible for a significant part of energy use and GHG emissions are also responsible for a large part of reported water use. However, property types that include residential or lodging space are responsible for a larger fraction of water use than GHGs. For example, hotels account for just 5 percent of GHG emissions but 15 percent of water use.

Similarly, water use by ownership sector shows clear parallels to the sectoral share of GHG emissions (Figure 18). The top three sectors were collectively responsible for 80 percent of reported GHG emissions and 75 percent of reported water use.

FIGURE 17: GHG emissions (left) and water use (right) by property type. The numbers indicate the percentage contribution to total reported GHG emissions and water use.

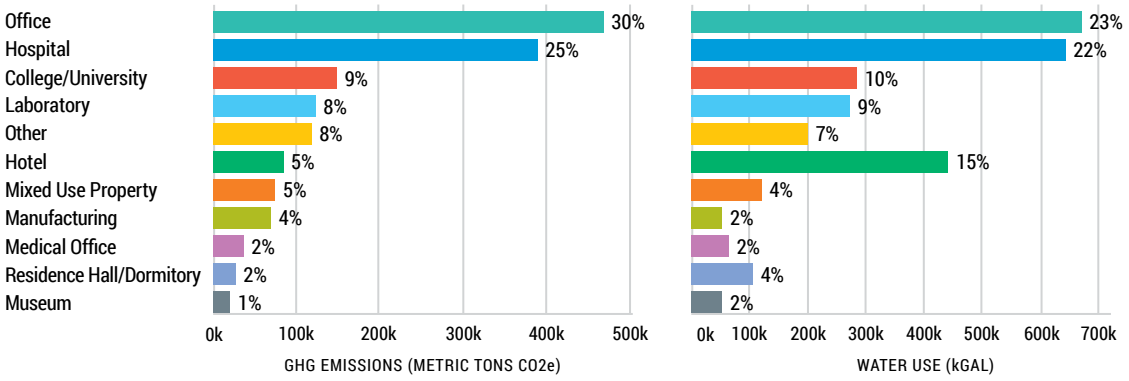
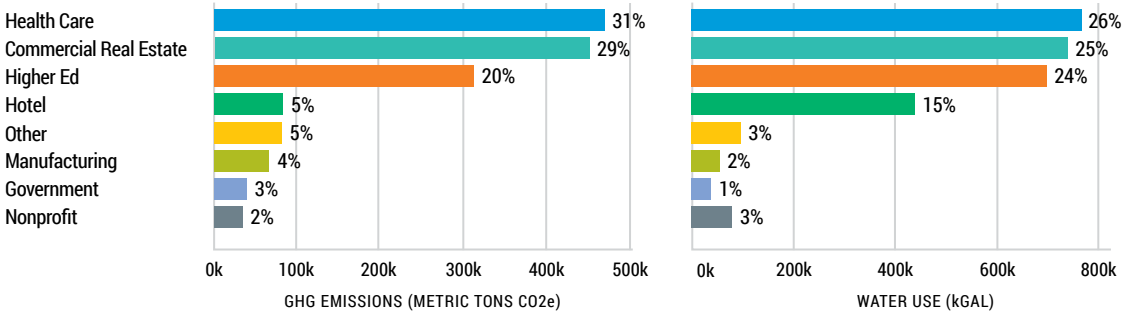


FIGURE 18: GHG emissions (left) and water use (right) by sector. The numbers indicate the percentage of total reported GHG emissions and water use.



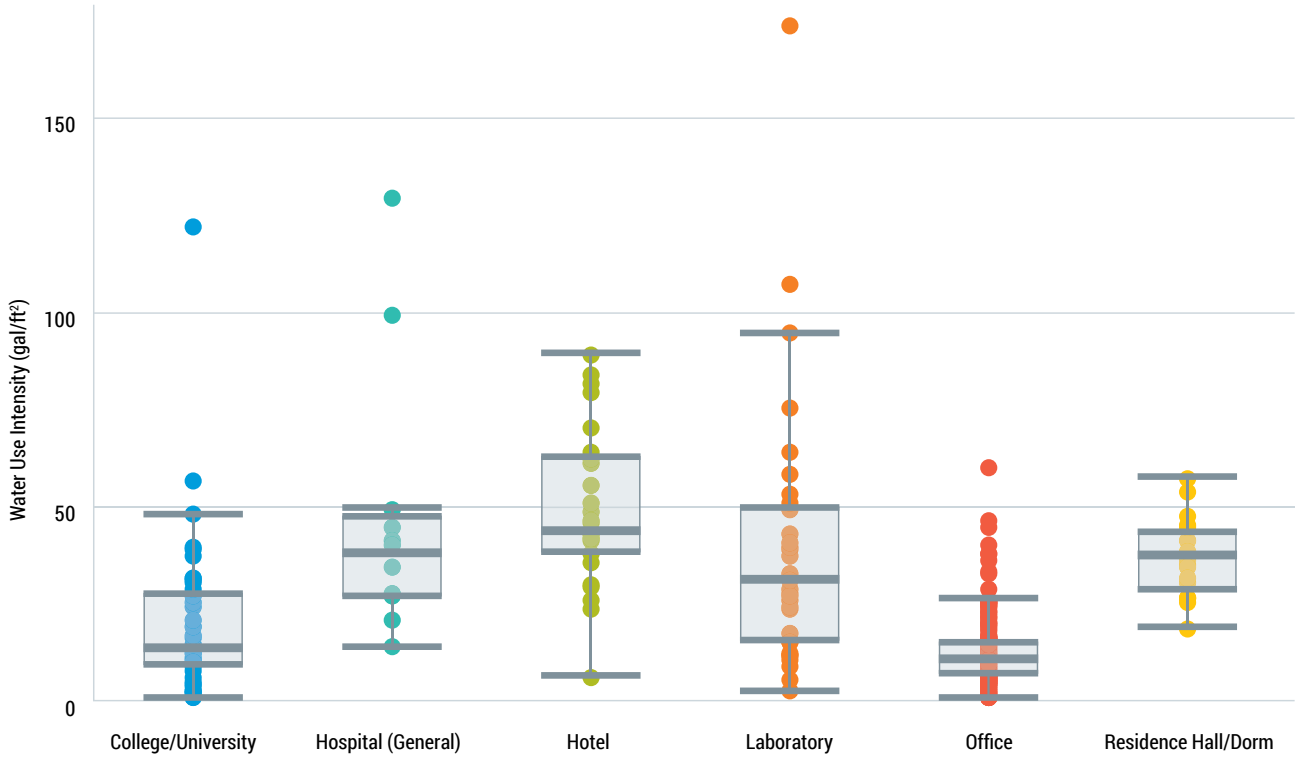
[21] U.S. EPA. "Ten reasons to pursue ENERGY STAR certification." Available at www.energystar.gov/buildings/about-us/how-can-we-help-you/build-energy-program/business-case/10-reasons-pursue-energy-star

WATER USE INTENSITY

Water use intensity, like EUI, measures water use divided by gross square footage. Figure 19 shows water use intensity (WUI) by sector. Hotels and university dormitories have the highest median WUIs of the property types reporting. This is to be expected for residential buildings given their use of water for showers and bathing. Office buildings and non-residential college and university buildings have the lowest WUIs. Laboratories have the greatest range of WUIs, just as they do with EUIs; this reflects the wide range of uses found within laboratories.

The B-2 Police Station in Dudley Square earned LEED Silver certification with extensive daylighting and a vegetated roof.

FIGURE 19: Water Use Intensity by property type. As in earlier figures, each dot represents a property, and the bars indicate the median, quartile, and outlier values for each sector.



VI. BOSTON'S MUNICIPAL BUILDINGS

In May 2013, the City of Boston first reported the individual energy use, water use, and greenhouse gas emissions for 321 municipal facilities, and has reported its annual usage and emissions every May thereafter. The analysis presented here examines the data reported in 2014. The City's reporting on municipal facilities encompasses nearly 17 million square feet.

PROPERTY TYPES AND GHG EMISSIONS

Schools are by far the dominant property type for municipal buildings, accounting for 67 percent of the square footage (Figure 20). Offices and libraries were the next most prevalent property types, accounting for 6 percent and 5 percent of floor area, respectively. The "Other" category includes pools, recreation centers, storage facilities, and other uses.

Figure 21 shows the distribution of GHG emissions from the City's buildings. Schools make up 58 percent of the City of Boston's GHG emissions from buildings, not surprising given the percentage of municipal square footage they account for.

In 2012, the City of Boston installed solar panel arrays on the roof of the Public Works Central Maintenance Facility at 400 Frontage Road. The solar panels power the emergency operation of traffic control systems at eighteen intersections along key evacuation routes.

FIGURES 20 AND 21: Floor area and GHG emissions of municipal buildings

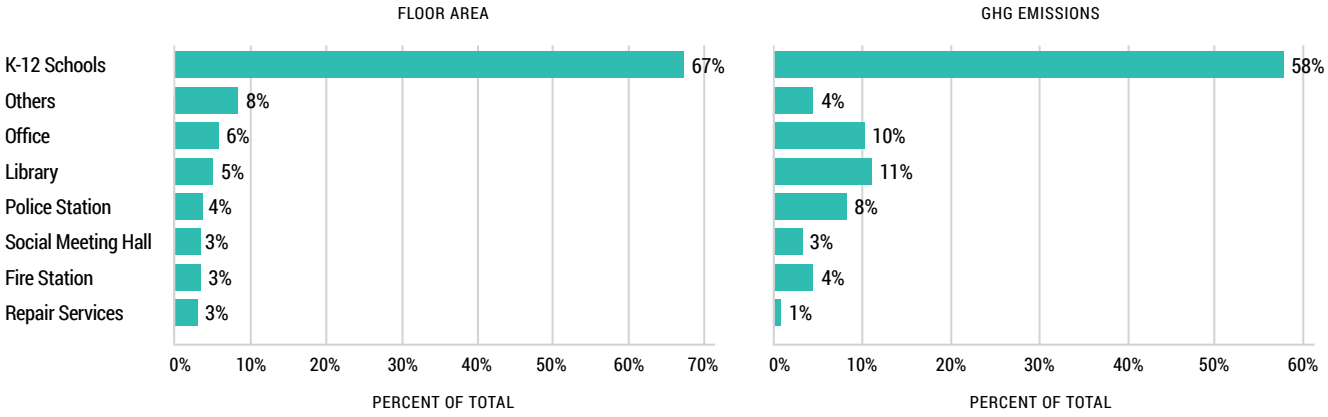
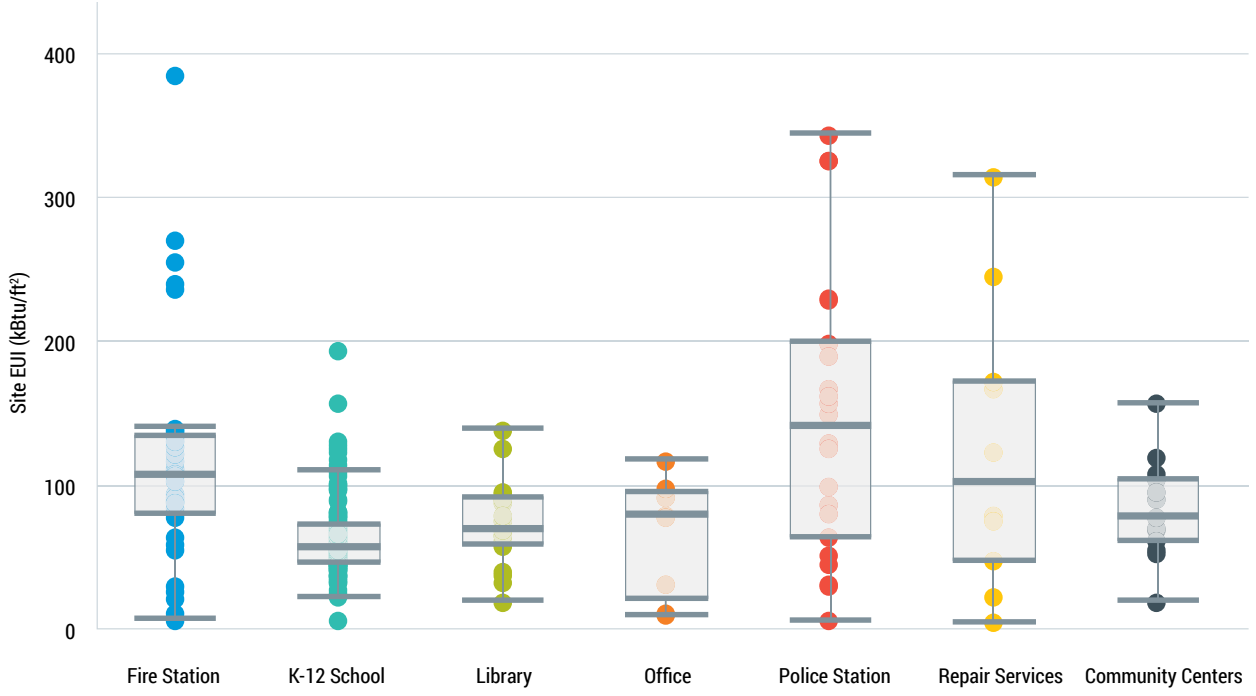


FIGURE 22: Site energy use intensities of municipal buildings. As in previous figures, each dot represents a property, and the bars indicate median, quartile, and outlier values for each property type.



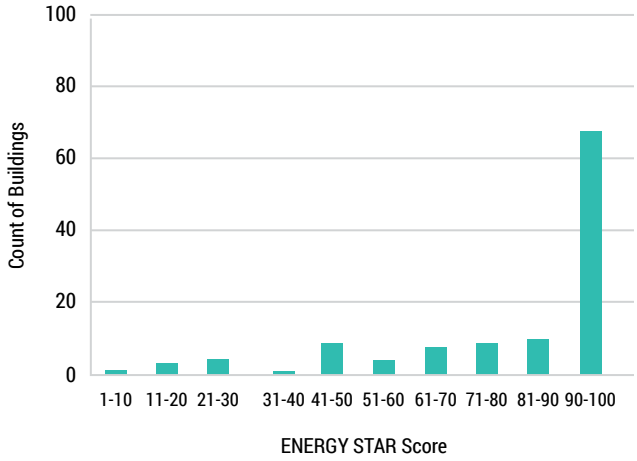
EUI BY PROPERTY TYPE

Figure 22 shows EUIs for different types of municipal buildings in Boston. Police and fire stations have both the highest median site EUIs and the widest range of EUIs. Police and fire stations are both 24-hour facilities, contributing to higher energy use.

ENERGY STAR SCORES

Due to limited data in the CBECS dataset for municipal building types, the only City properties that receive ENERGY STAR scores are schools, storage facilities, and offices, of which schools are by far the most common. Figure 23 shows the distribution of ENERGY STAR scores among Boston Public Schools. Many schools score far above the ENERGY STAR median, with a Boston median of 93. Although the City has implemented many efficiency measures in its schools to help them earn high scores, the City will continue to investigate the reasons for each school's score. Future projects will work to further capture efficiency opportunities in school heating and lighting.

FIGURE 23: Distribution of ENERGY STAR scores for Boston's public school buildings



VII. OBSERVATIONS ON IMPLEMENTATION

The City intends to keep improving outreach, providing more resources, and facilitating improvements to energy reporting. City staff met with business organizations, stakeholder groups, building owners, the Advisory Committee, utilities, Peregrine staff, and EPA to discuss lessons learned in the first year of reporting. In addition, the City examined data quality, patterns in compliance, and utilization of its help center. These lessons were used to improve the reporting process in 2015 and will continue to inform implementation in future years.

OVERVIEW OF DATA QUALITY AND CLEANING

Spurred by the ordinance, many building managers began to use Portfolio Manager for the first time. As a result, some reports included inadvertent errors and incomplete data. Data cleaning of the received reports helped us produce a dataset that would be reliable for further analysis and also identify patterns of common errors. (In the first year, we accepted reports with errors as compliant, and reached out to property managers with information on how they could correct inadvertent errors.)

A detailed description of the data cleaning process, common errors, and recommendations for better data quality are available in Peregrine Energy Group's report to the City.

As Table 8 shows, the data cleaning process flagged a number of reports for four types of common errors, leaving a smaller number of reports used for analysis:

- **Wrong units for steam use.** Eight properties entered steam use in incorrect units, resulting in the property appearing to have energy use 1,000 times higher than it should have been. This is likely due to the fact that steam billing and Portfolio Manager use different abbreviations for units.
- **Zero greenhouse gas emissions and zero energy use intensity.** Portfolio Manager requires a full calendar year of data for calculating annual energy use intensity and GHG emissions. Eighty-nine reports had gaps or incomplete data, resulting in their exclusion from further analysis.
- **Zero square footage.** Since square footage is necessary to calculate a building's energy use intensity (energy use per square foot), the 25 properties lacking this information were excluded.
- **Site energy use intensity outside common-sense range.** The site EUI for 13 properties was either under 5 or above 1,000 kBTU per square foot. Some of these reports had errors in square footage values (e.g., 125 square feet when the building is actually 125,000 square feet).

The errors that lead to zero EUI or zero GHG emissions were prevalent across all building sizes and not just limited to small properties.

The cleaning of errors in water data was conducted separately, and properties with water data errors were removed only for the purposes of the water use analysis. The data cleaning flagged a similar set of issues with the water data, as some buildings neglected to report water use in Portfolio Manager, or their data resulted in zero or very high water use intensity (Table 9).

TABLE 8: Errors flagged during data cleaning

	Removed	Properties Remaining for Analysis	Percentage of Initial Total
Properties submitting reports		642	100%
District steam use > 750,000,000	8	634	99%
No GHG emissions reported	81	553	86%
No square footage	25	528	82%
No EUI	8	520	81%
Site EUI < 5 or > 1,000 kBtu per ft^2	13	507	79%

TABLE 9: Errors identified in water data

	Removed	Properties Remaining	Percentage of Initial Total
Properties submitting reports		642	100%
No water use reported	135	507	79%
No water intensity	24	483	75%
Water intensity > 400 gal per ft^2	10	473	74%

The State Transportation Building uses solar collectors and heat recovered from electrical equipment to supply the building's heating and hot water needs.

To address these data errors, the City intends to provide feedback on errors soon after each report is received, which would allow users to correct any mistakes while the process is still fresh in their minds. Since last fall, EPA launched a newly developed data check in Portfolio Manager that will catch less than a full year of energy data, zero square footage, and similar errors that lead to zero GHG emissions or zero EUI. This check is run when a user generates a report to send to the City.

REVIEWING COMPLIANCE

A few key patterns emerged in the compliance review (see Section II). First, larger buildings were very likely to comply, with 97 percent of buildings over 700,000 square feet in compliance, while the relatively smaller buildings were much less likely to comply — only 61 percent of the non-residential buildings between 50,000 and 100,000 square feet reported.

Second, the property types with the lowest compliance rates were private K-12 schools, storage facilities, and retail buildings. These are the types of buildings that are less likely to have staff dedicated to energy management or sustainability and that are likely to need the most support on using Portfolio Manager and understanding the reporting requirements.

The City continues to offer the training sessions and office hours it began providing in 2014 and will expand outreach to small properties, private schools, and other low-compliance property types through sector associations.

INSIGHTS FROM CONSTITUENT SUPPORT

The City of Boston answered approximately 700 calls and emails regarding the reporting process over the course of 2014, through the Environment Department phone number and energyreporting@boston.gov. Calls and emails were most frequent right before the deadline and soon after past due notices were sent to non-compliant buildings.

The questions encompassed a broad range of issues, but five types of inquiry formed the most common questions:

- How do I get started and get utility data?
- Can my building be exempted, either based on property type or size?
- I am returning to Portfolio Manager after completing some steps. How do I find my place?
- The building was recently sold. Who is required to comply?
- How do I submit the report from Portfolio Manager to the City?

Analysis conducted by the City of Seattle on their helpdesk services[22] showed that buildings continue to need support on reporting after the first year. Furthermore, in 2015, large multifamily buildings begin reporting. With this in mind, the City has increased its staff resources to help constituents with their questions on energy reporting. The City will also continue to update its guidance to address common questions. Finally, the City will continue to work closely with EPA's ENERGY STAR team on improvements to Portfolio Manager.

[22] Slope, Deborah and Gregory Heller, Resource Media. "Seattle Building Energy Benchmarking Ordinance: 2013 Technical Support Evaluation." June 13, 2014.

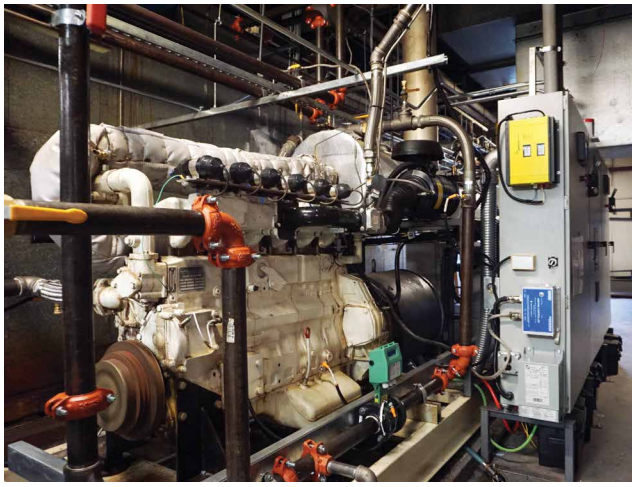
ADDITIONAL FEEDBACK

Feedback from stakeholders and partners also provided insights into potential improvements. First, many elements of the reporting program worked well for users, including:

- **Whole-building data services.** Building owners found the utility services to be very valuable, providing them with information on building-level energy use for the first time. Utilities reported being able to turn around most requests within one business day, with over 800 requests for electricity or gas data. Established points-of-contact at each utility allowed constituent questions to be easily referred to the right person.
- **Outreach and resources.** The informational sessions provided jointly by the City, utilities, and EPA were attended by approximately 240 property managers and owners, allowing them to understand the process and get their questions answered. Property managers also heavily utilized the guidance provided by the City: the Energy Reporting How-To Guide was downloaded or viewed approximately 1,400 times in 2014, and many said they used it step-by-step to comply with the ordinance. EPA also provided support to many buildings through its helpdesk email, and EPA's Region 1 staff in Boston provided one-on-one help to approximately 25 property managers.
- **Insight into portfolio-wide performance.** Several owners of large portfolios reported that the reporting process helped them identify their poor performers and motivated them to look into the causes of poor performance and ways to improve it.

A few areas emerged as issues that required additional attention:

- **Turnover and point-of-contact.** As buildings are sold throughout the year, some notification letters did not reach the current building owner. In addition, the structure of some ownership entities meant that it took weeks for a letter sent to the owner of record to make it to the actual staff responsible for compliance. To address this issue, the City began conducting more direct outreach to property managers in 2015, and not just to owners, and will continue to improve notification channels.



The combined heat-and-power plant at West Roxbury Education Center was upgraded in the summer of 2015. It provides the school with highly efficient heating and power, as well as cooling through the use of absorption chillers. It is configured to be load-following, to further increase system efficiency.

- **Challenges with parcel-based identification.** Some building owners reported that it was difficult to understand which buildings were required to report when the City notified owners based on tax parcel. Campuses and large institutions, in particular, have buildings that do not always align with underlying parcel boundaries, making it complicated to track compliance for these parcels as well. We are examining ways to transition to a different system for tracking and notifying buildings.
- **Learning to use Portfolio Manager.** For property managers that were new to tracking energy use, and new to Portfolio Manager in particular, there were occasional challenges in learning how to use the software for the first time. The City of Boston continues to share feedback with EPA, and improvements such as online video tutorials and help resources in Portfolio Manager have been deployed since last fall. The City will continue to offer training sessions targeted at new users.

VIII. CONCLUSIONS

OUTCOMES IN 2014

After the first year of private-sector energy reporting, over 175 million square feet of floor area in Boston began tracking its energy use and greenhouse gas emissions, with a compliance rate of 84 percent. Even in the first year, the reporting process spurred several building owners to investigate their least efficient buildings and to contact the City to learn more about utility programs for efficiency.

Smaller buildings were less likely to comply, and understanding their needs will be important to ensure successful implementation when buildings between 35,000 and 50,000 square feet will begin reporting. Ensuring quality and accuracy of data is a priority as well. Despite these limitations, the data submitted provides better insight on how energy is being used by Boston's buildings and the first broad, building-specific understanding of greenhouse gas emissions.

NEXT STEPS

In May 2015, large residential buildings began reporting, and large commercial, industrial, and institutional buildings reported a second year of data. This annual tracking and reporting will enable building owners to monitor their year-over-year changes. With buildings between 35,000 and 50,000 square feet beginning to report in 2016 and 2017, even more of Boston's built space will be tracking and understanding patterns in energy use in the near future.

Starting this October, the City will disclose metrics on energy use, water use, and GHGs for individual buildings. Disclosure will enable building owners, residents, and others to compare the energy consumption of similar buildings.

This increased access to energy information will be useful in several ways:

- For building owners and managers, this information will enable a better understanding of the range of energy performance across similar buildings. This can spur peer-to-peer learning, possibly through existing business and institutional networks, in order to share success stories of efficiency projects and lessons learned. A common reporting tool enables more in-depth sharing of building metrics between managers. Finally, building owners will also benefit from the ability to identify and highlight high-performing buildings, increasing the visibility of their investments in efficiency. More buildings may choose to voluntarily report in the future to better communicate information to stakeholders and peers and highlight progress on energy efficiency.
- For residents and commercial tenants, this access to energy information will allow Bostonians to look up the energy use, water use, and GHGs of the large buildings they live or work in. Increased awareness of energy use and costs will spur conversations between owners and tenants about reducing energy use, and will enable stakeholders to consider this information in their decision making.
- For utilities, efficiency programs, and service providers, this information will enable broader engagement of buildings and the better design of efficiency programs, incentives, and business models. Massachusetts and Boston have each been ranked by the American Council for an Energy-Efficient Economy as having the best-in-the-nation programs for energy efficiency,[23] and engagement between reporting buildings and these programs will be vital to achieving reductions in energy use and GHGs.

BROADER ENGAGEMENT ON ENERGY EFFICIENCY

Greater energy efficiency offers significant benefits to Boston: the economic benefits of reducing our collective energy costs, the improved livability of high-performing buildings, and the reduction of our GHG emissions. Yet the most persistent market barrier to energy efficiency is its lack of transparency and the abstraction of efficiency. By providing better information of the energy use of buildings, reporting and disclosure will enable a greater awareness of energy use and broader engagement on efficiency opportunities.

This awareness can spur residents, owners, and property managers alike to examine efficiency measures, the financial savings possible, the potential improvements to building comfort, and the next steps to implementation. Indeed, a well-informed, better-engaged community is essential for Boston to reach its energy and climate goals for 2020 and beyond.

[23] American Council for an Energy Efficient Economy. 2014. "The City Energy Efficiency Scorecard" and "The State Energy Efficiency Scorecard". Available at aceee.org.

APPENDIX: BACKGROUND AND IMPLEMENTATION

BACKGROUND

In 2007, Boston released its first Climate Action Plan. The plan identified energy efficiency as not only a vital component of reducing greenhouse gas (GHG) emissions but also a strategy with extensive economic and human health benefits. Boston added Article 37 Green Building to its zoning code that same year, which requires LEED certifiability in new large buildings or renovations. In 2009, Boston launched the first Renew Boston program, a partnership between the City, utilities, and retrofit contractors to pursue residential energy efficiency at scale. In recent years, the City has successfully implemented energy efficiency retrofits and energy management systems in Boston's municipal buildings. Citing these and other innovative approaches to building and transportation efficiency, the American Council for an Energy-Efficient Economy ranked Boston as the #1 city in the country for policies and programs that drive energy efficiency.

Energy reporting and disclosure is an important component of this commitment to pursuing energy efficiency. In May 2013, the City of Boston enacted the Building Energy Reporting and Disclosure Ordinance (BERDO). The ordinance requires large buildings in Boston to annually report their energy use, water use, and GHG emissions. Beginning this fall, the City will make the information publicly available. The ordinance is designed to help building owners and tenants become more aware of opportunities for reducing energy costs and GHG emissions. Reporting and disclosure will enable tenants, financial institutions, and other stakeholders in the market to utilize information about building energy use when making decisions on renting, buying, and financing a property.

The ordinance has its origins in the recommendations of Boston's Climate Action Leadership Committee and Community Advisory Committee. In their 2010 report, "Sparking Boston's Climate Revolution," the Committees recommended that Boston adopt a reporting and disclosure policy to help reduce GHG emissions 25 percent by 2020. The strategy was then incorporated in Boston's Climate Action Plan 2011 Update. In 2013, an ordinance was proposed to the City Council, and the final ordinance was passed and signed in May. Within a month, the City of Boston led by example and publicly disclosed energy and water use for municipal facilities.

In the fall of 2013, the Air Pollution Control Commission (APCC), which oversees implementation, released draft regulations that specify how building owners can comply with the requirements of the ordinance. The APCC held hearings to solicit public comment and received extensive written comment. The City held further meetings with stakeholders, and, in particular, with the BERDO Advisory Committee, appointed to represent Boston's various real-estate sectors. The APCC promulgated final regulations in December 2013.

Boston was the eighth U.S. city to adopt energy reporting requirements. Today, thirteen cities, two states, and one county have such policies (Figure 24).

THE COMPONENTS OF THE ORDINANCE

Boston's Building Energy Reporting and Disclosure Ordinance has three major components.

First, large buildings in Boston are required to annually report their building's energy use, water use, and greenhouse gas emissions. The ordinance phases in the reporting requirements over several years, with buildings required to begin their annual reporting as listed below:

- **2013:** All municipal facilities
- **2014:** All non-residential buildings over 50,000 square feet, or multiple buildings on one tax parcel totaling 100,000 square feet
- **2015:** Residential buildings over 50,000 square feet or 50 units
- **2016:** Non-residential buildings over 35,000 square feet
- **2017:** Residential buildings over 35,000 square feet or 35 units.

The reporting deadline is May 15 each year, except in the first year, 2014, in which the deadline was extended to September 15. Buildings complete their reporting using ENERGY STAR Portfolio Manager, a free energy tracking tool developed by the U.S. Environmental Protection Agency (EPA).

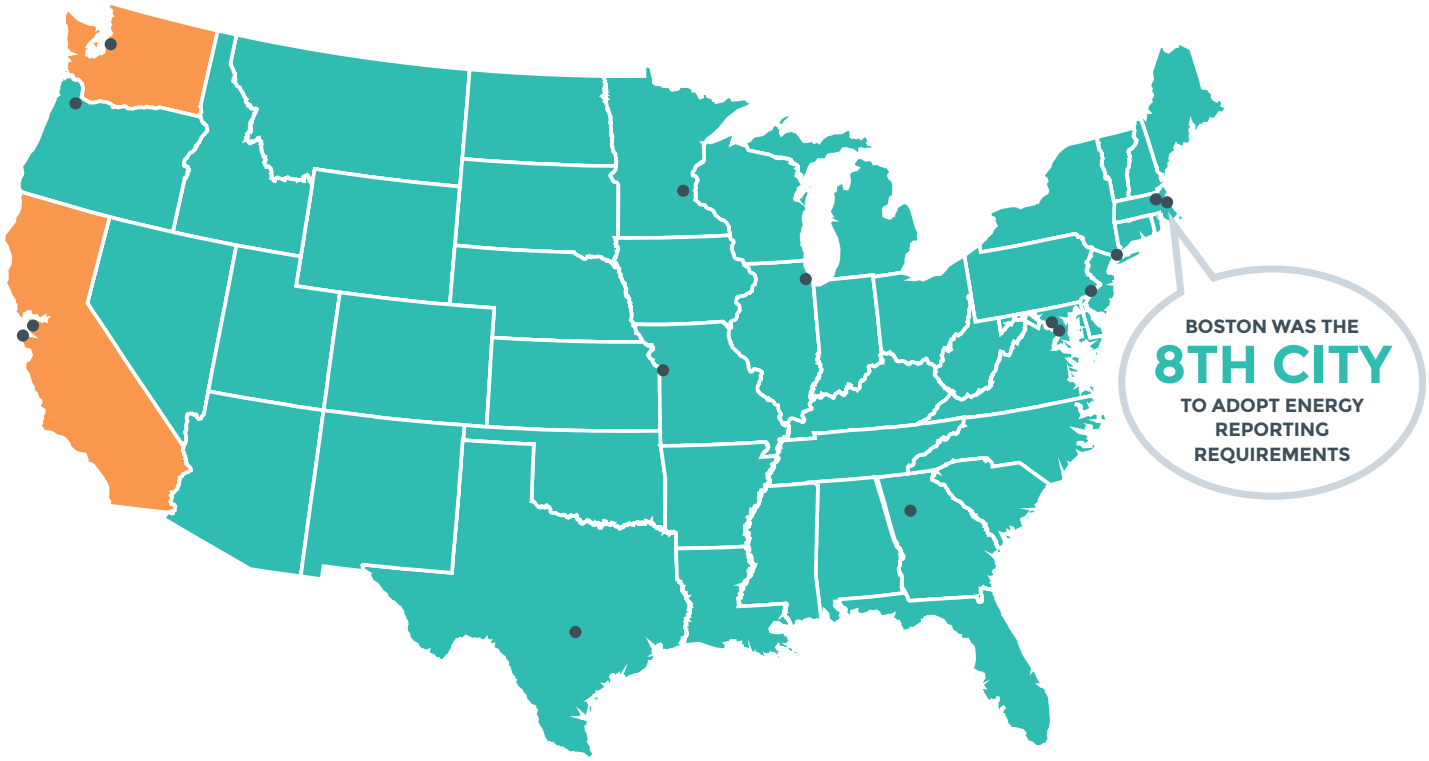
The second component of the ordinance is an assessment or action requirement: Buildings are required to conduct an energy assessment or qualifying energy action every five years. The assessments, which must be conducted by a qualified professional, must identify opportunities for energy

savings and the associated costs and benefits. Owners have no obligation to complete any of the recommendations. Alternatively, building owners can complete a qualifying energy action — any project that cuts building energy use or GHG emissions by 15 percent, through building retrofits, green power use, behavioral efficiency, or similar strategies. Buildings that are already highly efficient or making significant progress on efficiency are exempt from this five-year requirement — the exemption criteria include ENERGY STAR certification and LEED Silver certification for Existing Buildings, among others.[24]

Buildings that do not qualify for exemptions must complete their first action or assessment within five years of their first reporting deadline — thus, the buildings that began reporting last year will need to complete their first assessments or actions by 2019.

Third, starting this fall, the City will publicly disclose the energy performance and greenhouse gas emissions of individual buildings. In 2014, however, public disclosure was limited to whether buildings complied with the reporting requirement.

FIGURE 24: Reporting and disclosure ordinances in the U.S.



Energy reporting and disclosure ordinances have been enacted by the cities of Atlanta, Austin, Berkeley, Boston, Cambridge, Chicago, Kansas City, Minneapolis, New York, Philadelphia, Portland, San Francisco, Seattle, and Washington, DC. In addition, equivalent laws have been passed by California and Washington state, and at the county level by Montgomery County, MD.

[24] For additional details, please see the BERDO regulations at www.boston.gov/eeos/reporting.

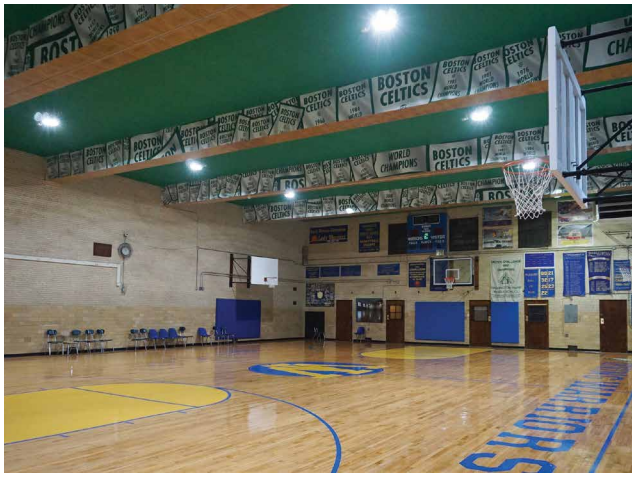
RESOURCES AND OUTREACH IN 2014

2014 was the first year of required reporting for private-sector buildings. Coordinating with utility and institutional partners, the City began extensive outreach in January with a mailing to all large buildings, informing them of the reporting requirements and the resources available on the City's website. The City also posted online a list of buildings required to report.

Since building owners need to report whole-building energy data, Boston's partners at NSTAR, National Grid, and Veolia began offering whole-building data services in February 2014. These services allow building owners to obtain aggregated whole-building energy consumption data without having to ask tenants for their billing information. While the ordinance requires non-residential tenants to provide data if the owner requests it, the utility data services allowed building owners to obtain data more easily. Only buildings with three or fewer tenants, or buildings where one tenant used more than half of the energy consumed, were required to get tenant permission to access whole-building data. NSTAR and National Grid developed a joint form to handle these authorizations. Since the ordinance requires reporting for the previous calendar year, the utility data services provided monthly totals for the 2013 calendar year.

Over the course of the year, NSTAR fulfilled more than 500 electricity data requests. National Grid fulfilled over 300 gas data requests and processed authorizations from 180 tenants. In three cases, the building owner asked the City to inform tenants of their obligations, and the tenants in all three cases complied. No building reported being unable to get whole-building data. NSTAR's data portal inadvertently flagged several buildings that had two or three electric meters paid for by the owner as having two or three tenants and thus asked for tenant authorization. NSTAR resolved this ambiguity by reaching out to these buildings and asking building owners to provide account and meter numbers to verify that the meters were owner-paid.

The City provided several resources to help building managers through the reporting process. For anyone who was new to Portfolio Manager, the City published a step-by-step "How-To Guide" on its website, and mailed a condensed list of the steps to all building owners. Links to resources, including EPA's webinars and helpdesk on Portfolio Manager, and the list of buildings required to comply, were posted on the City's website as well. The City also provided a helpdesk email (energyreporting@boston.gov) and phone number to answer questions[25] and held weekly office hours for property managers who wanted additional assistance.



Washington Irving Middle School in Roslindale has recently installed LED lighting in its gym, with occupancy sensors to better manage energy use.

The City, utilities, and EPA's Region 1 office in Boston also held six in-person informational sessions to train property managers on how to comply with the ordinance. Typically an hour-and-a-half in length, these sessions covered the requirements of the ordinance, how to use the utility data services, a demonstration and walkthrough of Portfolio Manager, and how to find resources during the reporting process. Several business organizations hosted sessions for their members, and the City also held one at City Hall. In total, approximately 240 people attended the sessions. Finally, EPA's Region 1 office provided one-on-one support on Portfolio Manager to several dozen property managers.

The City sent several reminder mailings over the spring and summer to building owners and property management firms. By the September 15 deadline, buildings had received five mailings — letters and postcards — with information on the available resources. Email updates were also sent to constituents

[25] Section VII provides additional information on common questions that property managers had.

that signed up for them, and updates were shared through the Greenovate Boston newsletter. In addition, the City partnered with business and non-profit membership organizations to conduct outreach to their members. After the deadline, the City sent out warning letters to non-reported buildings and conducted further targeted outreach, spurring additional compliance.

TRACKING AND REPORTING ENERGY USE WITH ENERGY STAR PORTFOLIO MANAGER

Portfolio Manager, first launched in 1999, enables building owners to track and understand building energy use and is now used by approximately 400,000 buildings across the country. In the last five years, it has become the tool used by all jurisdictions with reporting and disclosure policies for sharing building energy reports with city governments.

For a building owner who is getting started, Portfolio Manager asks first for building information: square footage and the types of uses within the building, such as office space, restaurant, warehouse, and so on. Based on the uses, Portfolio Manager asks for use details, such as the number of workers in the office space, or the presence of commercial kitchens in a hotel, and these details are used to benchmark the building against similar properties. Over 80 property use types are available to describe a building.

After setting up the property, a building owner needs to enter monthly energy and water use data for one full calendar year. Building owners can enter bills one at a time or upload a whole set of data. NSTAR and National Grid provided their whole-building data in a format that could be directly uploaded into Portfolio Manager.

The final step in the reporting process involves sending a report to the City of Boston. With EPA's assistance, the City created a Boston-specific reporting link and distributed it by email and online. By clicking on this link, users generate reports in their accounts and send them to the City through Portfolio Manager. The reporting link created by Boston pulls data from approximately 240 different fields, encompassing building uses, energy use, and various metrics related to energy and GHG emissions.

A chiller control panel at West Roxbury Education Center allows for the chiller's operation to be monitored in detail and fine-tuned.

CREDITS

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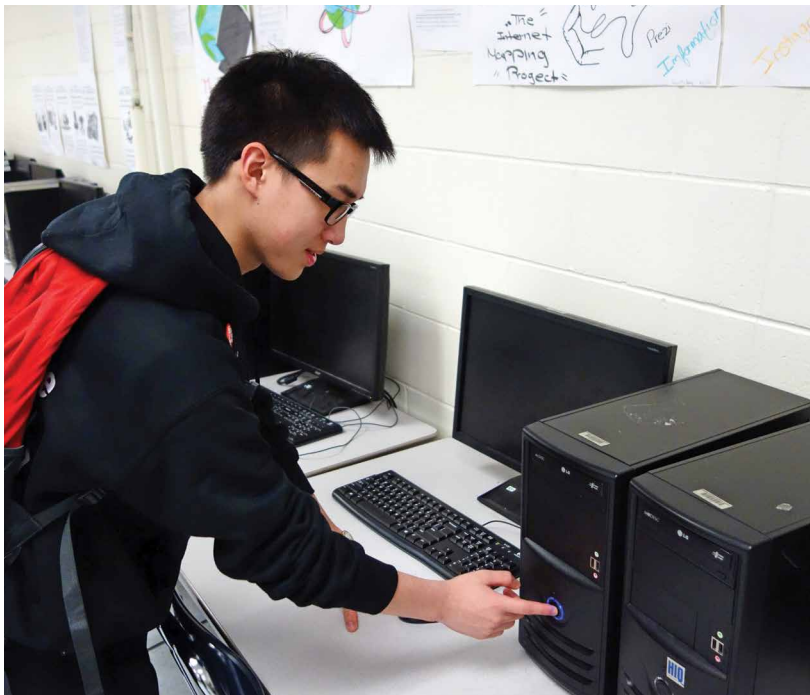
The Bruce C. Bolling Municipal Building, home of the Boston Public Schools central offices, opened in April 2015 and is designed to achieve LEED Silver certification.

Boston Water and Sewer Commission installed 240 kilowatts of solar panels on the roof of its headquarters building in 2010.

GREENOVATE BOSTON is the City's initiative to reduce greenhouse gas emissions 25% by 2020 and 80% by 2050 and prepare for the impacts of climate change. It is a community-wide movement that seeks to engage all Bostonians in achieving these goals, while continuing to make Boston a thriving, healthy, and innovative city.

GREENOVATE BOSTON

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