PUTTING DATA TO WORK

How Cities are Using Building Energy Data to Drive Efficiency

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REPORT

IMT
INSTITUTE
FOR MARKET
TRANSFORMATION

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ABOUT IMT

The Institute for Market Transformation (IMT) is a national nonprofit organization focused on increasing energy efficiency in buildings to save money, drive economic growth and job creation, reduce harmful pollution, and tackle climate change. IMT ignites greater investment in energy-efficient buildings through hands-on expert guidance, technical and market research, policy and program development and deployment, and promotion of best practices and knowledge exchange. For more information, visit imt.org.

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EXECUTIVE SUMMARY

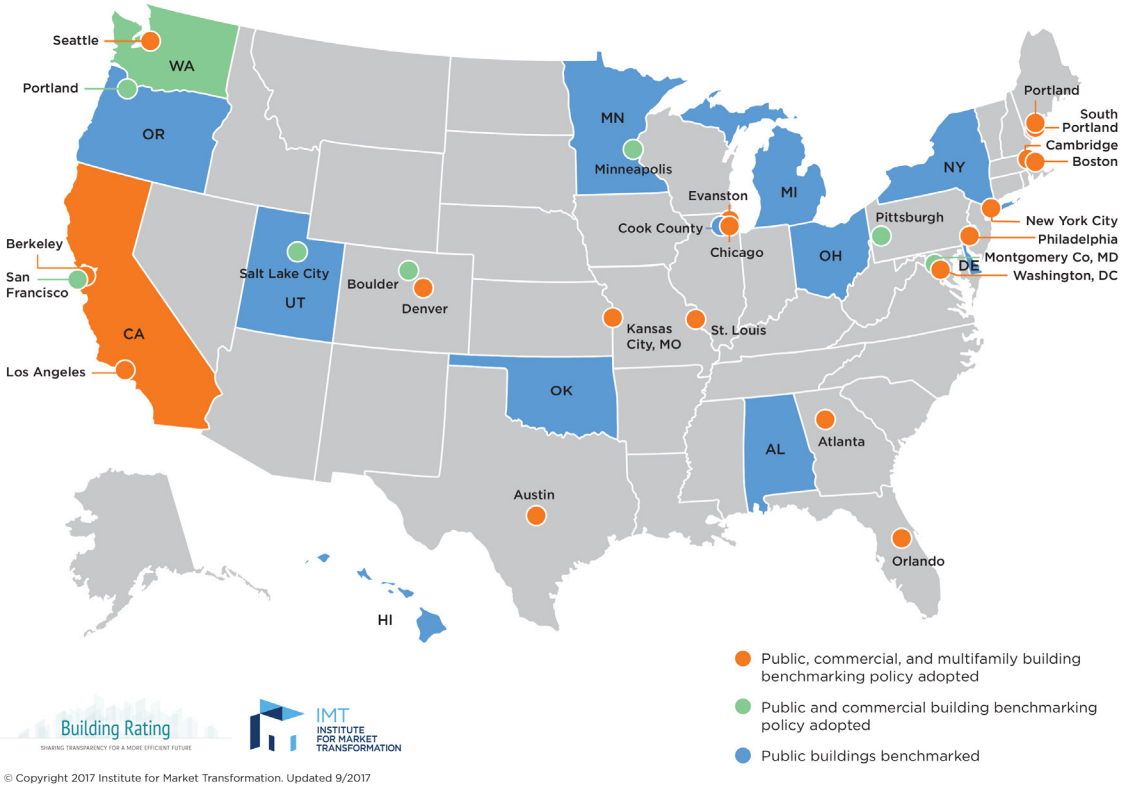
The United Nations Framework Convention on Climate Change agrees that significant reductions in greenhouse gas (GHG) emissions—specifically, 80 percent reductions in emissions below 2005 levels from developed countries such as the United States, by 2050—are necessary in order to mitigate the worst impacts of climate change. In large urban areas, the energy required to power commercial buildings results in up to 75 percent of GHG emissions. Reducing the energy consumption of the commercial buildings sector thereby represents one of the most significant opportunities to decrease GHG emissions and achieve climate-related goals.

Across the U.S., an increasing number of state and local jurisdictions are implementing building performance reporting laws regarding building energy and water use in the commercial and multifamily building sectors, as shown in Figure 1, on page 2.[1] These programs generate large quantities of useful data on the characteristics and resource consumption of a region's building stock. However, the data is only valuable if it is used to drive smarter business decisions and savings, and the wealth of information being collected by an ever-growing number of cities nationwide is not yet being deployed to its full potential.

Reducing the energy consumption of the commercial buildings sector represents one of the most significant opportunities to decrease GHG emissions and achieve climate-related goals.

1 "U.S. Building Benchmarking Policy Landscape." Institute for Market Transformation. 2017. Accessed January 2018. http://buildingrating.org/graphic/us-building-benchmarking-policy-landscape.

Figure 1: U.S. Building Benchmarking and Transparency Policies



The need to dramatically reduce GHG emissions over a relatively short timeline is too urgent for the current market uptake timeline of benchmarking policies alone—to be most effective, the data generated by these policies must be used to its maximum potential, coupled with parallel efforts in cities, states and the private sector, to drive energy efficiency. *Putting Data to Work*, a three-year project led by the Institute for Market Transformation (IMT), examines how, exactly, this data can and is being deployed to reap an array of benefits for cities, energy efficiency service providers, utilities, and building owners. Under this project, IMT partnered with the District of Columbia Department of Energy and Environment (DOEE) and the New York City Mayor's Office of Sustainability, as well as their respective partners, the District of Columbia Sustainable Energy Utility (DCSEU) and the NYC Energy Efficiency Corporation (NYCEEC), to examine pioneering efforts underway in each jurisdiction, both of which have been frontrunners in adopting and implementing building benchmarking and performance policies.

The resulting toolkit—of which this report is one element—and associated resources aim to enable other local governments, utilities, and program implementers to learn from the District and New York City's experiences and replicate their success, to maximize energy and GHG savings from their built environments.

Cities with building performance policies can use this report to understand how other jurisdictions are using the data collected through these ordinances. The report is divided into sections that provide strategies for improving data quality, communicating the data's availability and use, and aiding building owners in making energy-efficient decisions.

- **Communicating Benchmarking Data to Motivate Action** details the various ways that cities publicize their benchmarking data, including public websites and visualization platforms, and how they direct building owner communication through energy scorecards.

- **Marketing and Outreach Strategies Using Benchmarking Data** discusses various strategies for using benchmarking data in outreach to building owners, both through targeting building owners with the highest potential for energy savings and through continued engagement using data.

- **Other Applications of Benchmarking Data** addresses additional uses for benchmarking data, including direct support of building decision makers, and use of benchmarking data in city energy and infrastructure planning.

- **Reducing Error in Benchmarking Datasets** provides strategies for improving the quality of benchmarking datasets, including activities that cities can undertake during policy and program design, during the reporting period, and after data collection.

- **What's Next?** discusses how cities can continue to improve energy efficiency by building off their benchmarking efforts.

ABOUT PUTTING DATA TO WORK

Putting Data to Work is a three-year pilot project aimed at using building performance data and asset information to help efficiency program implementers better target their outreach to building owners and increase the number of projects executed within these programs. The project used building performance data to improve energy efficiency program design and delivery in the District of Columbia and New York City, and developed a toolkit of resources to enable local governments, utilities, and program implementers to learn from activities to replicate successes.

Cities with building performance policies can use this report to understand how other jurisdictions are using the data collected through these ordinances. This includes strategies for improving data quality, communicating the data to motivate action, using the data to directly drive efficiency retrofits, using the data in city climate and energy planning.

For jurisdictions with building performance policies such as benchmarking and audits requirements, the hands-on experience collected in the District and New York City provides a guide for identifying efficiency opportunities using City-collected data. For utilities and program implementers, these resources bring to light ways in which publicly available policy data can assist in better customer targeting, ideally leading to higher participation rates at lower participant acquisition costs.

Various toolkit components are referenced throughout this report with clickable, embedded URLs. In addition, the full toolkit is available at [imt.org/puttingdatatowork.](imt.org/puttingdatatowork)

INTRODUCTION

The purpose of energy benchmarking is to establish demand for energy efficiency that in turn drives investment in energy upgrades, resulting in a highly energy-efficient building stock and a self-sustaining retrofit market. Benchmarking establishes the mechanics for this by allowing for the comparison of a building's performance to its own historical energy and water consumption, and comparison with the performance of similar buildings in its peer group. Benchmarking policies require the owners of certain types of buildings, most often large commercial and multifamily structures, to report on the buildings' characteristics and energy and water performance to the governing jurisdiction. Those jurisdictions then typically publish information relating to whole-building energy consumption, greenhouse gas (GHG) emissions, and an ENERGY STAR for Commercial Buildings score.[2] Some jurisdictions have adopted additional requirements on top of benchmarking and transparency that require additional energy assessments such as periodic energy audits or retrocommissioning. Beyond tracking the energy performance of a building, these policies require the building owners to take action, either by contracting an auditor to review the systems and operation of the building against a certain standard, or by requiring upgrades to systems that do not meet certain criteria.

All of these policies collect valuable information about the performance of a city's large building stock. This information can inform many actions that cities, efficiency implementers, and the real estate community can take to improve the energy efficiency of buildings, however to do so, all of them require that the data actually be used.

Operating on this premise, the District of Columbia (DC) and New York City (NYC) local governments are "putting data to work"—using it to inform building owners of cost-saving efficiency opportunities and to identify ways to target customer outreach for specific

2 ENERGY STAR scores for commercial buildings control for key variables affecting a building's energy performance, including climate, hours of operation, and building size. These are on a scale of 1-100, where 1 is the worst performing building and 100 is the best performing building.

government and utility efficiency programs. In these cities, local government is working as a market catalyst, jumpstarting the establishment of a thriving retrofit industry, through which private demand for energy-efficient buildings is pervasive and buildings are upgraded as a matter of routine business. The *Putting Data to Work* project has tested and defined replicable methods for local governments and utilities nationwide to use, so that they can motivate building owners to invest in energy efficiency upgrades and more economically recruit participants for government and utility energy efficiency programs. The toolkit of resources associated with *Putting Data to Work* goes into greater depth and explanation, to more fully enable replication of successful DC and NYC strategies, and resources from that toolkit are linked throughout this document.

DATASETS AT WORK

Benchmarking data is useful as a directional indicator of buildings' energy performance and can be used to identify the least efficient buildings across a portfolio, but it does not provide information about a building's systems that is necessary for identifying targeted upgrades. Audit data provides system-level information—as well as an auditor's energy efficiency recommendations—that enables more informed and accurate targeting of energy-saving opportunities. Data from a retro-commissioning policy, which requires periodic assessments of a building's performance relative to its modeled performance, provides even deeper and more frequent information from which to identify improvement opportunities.

Local Governments as Market Catalysts

Across the world, cities large and small are setting and undertaking ambitious climate goals to reduce energy consumption and resulting GHG emissions. Through energy and climate modeling, New York City (hereafter NYC) and Washington, D.C. (hereafter DC or the District) have found that ambitious policies and programs targeted at the built environment will be enablers in meeting their ambitious emissions reductions targets. Many other cities are following the lead of these larger cities, pursuing similar policies and programs as they look to the leaders for lessons and guidance.

City governments are actively embracing their role as market transformation catalysts. However, they are keenly aware that a benchmarking or audit policy—along with the data that such a policy brings forth to local government and the market—is not enough to build a robust retrofit market, unless the collected data is actively deployed. Demand for efficiency needs to rise to a point where building owners upgrade the efficiency of their buildings as business as usual and can easily access skilled, qualified service providers to identify optimal efficiency opportunities and implement the retrofits. There is work to be done and, at this point in the development of the market, city governments are the entities with the incentive and motivation to take it on.

Using Policy Data to Drive Efficiency Retrofits

In an ideal market—one in which both buyers and tenants of commercial buildings value and demand energy-efficient spaces—building owners would be compelled purely by economic motivations to make their buildings efficient. They would make efficiency investments in the same business-as-usual fashion as they currently do for upgrading lobbies and restrooms. The process for reaching such an ideal market—one in which energy efficiency is appropriately and consistently valued—can be accelerated through local governments' and utilities' proactive transformation of the data gathered through such policies into actionable information that building owners and related agents can use to make investment decisions.

Mechanisms for translating policy-gathered data into actionable information for the private sector are varied; numerous strategies and tactics are discussed in greater detail throughout this report. At the highest level, the ways governments and utilities can use the reported information are:

- Make building-specific efficiency data publicly available, so that tenants, investors, lenders, appraisers, brokers, providers of energy-efficient products and services, and other market actors can discern the difference in efficiency among buildings that may otherwise appear identical (discussed in Chapter 1 of this report);

- Present data in actionable formats through communications such as "scorecards" sent to building owners (discussed in Chapter 1 of this report);

- Analyze and act upon the data themselves to target outreach to specific building owners that appear to be the best candidates for upgrades (discussed in Chapter 2 of this report);

- Provide guidance to building owners and property managers to identify priority buildings for energy efficiency upgrades, and provide guidance on next steps to undertake those actions (discussed in Chapter 3 of this report); and

- Use data in long-term city energy and infrastructure planning to take advantage of localized data in making energy models as accurate as possible (discussed in Chapter 3 of this report).

This report also includes detailed guidance on enhancing the quality of reported data to ensure that datasets are accurate and complete, in Chapter 4, so that decisions made based on the data result in their intended outcomes of improved energy efficiency. These include actions that the city can take during policy development, during the policy compliance cycle, and after data have been collected.

In addition, Appendix B contains a list of data tools from the U.S. Department of Energy that are available to cities managing building energy performance databases.

CHAPTER 1: COMMUNICATING BENCHMARKING DATA TO MOTIVATE ACTION

Whole-building energy consumption data provides better information for transactional real estate decisions such as purchasing and leasing space; allows buildings to compare their energy use with peers; creates a historical record of building performance over time; and in cases where laws include audit and retrocomissioning, helps to identify opportunities for efficiency improvements. Having this data available in the market is only useful if market actors understand the information and how it can be incorporated into their activities. Barriers that prevent this optimal use of benchmarking data, including awareness of data and understanding of how it can be used, are discussed in Table 1, below.

Table 1: Common Communication Barriers and Solutions for Using Benchmarking Data

CATEGORY	BARRIER	CITY GOVERNMENT SOLUTION
Awareness	Market decision makers, including building owners and tenants, investors, brokers, and energy service providers, may not know that datasets of reported benchmarking data are publicly available.	• Building owner benchmarking (a primary mechanism for increasing awareness of building energy consumption) • Data published and searchable on a City website • Visualization platforms that enable easy identification of a building's efficiency
Understanding	Market decision makers, including building owners and tenants, may not understand how benchmarking data can be used in their operations to increase energy efficiency.	• Direct one-on-one outreach from the City to building owners and property managers • Energy scorecards sent to building owners • Annual benchmarking reports summarizing impact of all compliant buildings • City-hosted educational events and workshops to review data and identify energy-saving actions • Dissemination of information through local partners with real estate industry relationships

The following sections summarize ways that jurisdictions have surmounted the awareness and understanding barriers by supplying building performance information to the market and providing the context in which that information can be used to increase energy efficiency. These solutions include publication, through spreadsheets and data visualization platforms, as well as individualized insights for building owners to compare their performance with their peers through energy scorecards, and broader context of the citywide building stock's progress by tracking performance over time in annual reports.

Spreadsheets and Data Visualization Platforms

Most cities with benchmarking data transparency policies in place disclose their data by publishing, at a minimum, a spreadsheet of certain pieces of data on a City-hosted website. Notably, not all fields that the reporting entities disclose to City government are made publicly available, whether because of privacy concerns or because a jurisdiction may not find publishing certain fields to be useful for its policy's goals. Most jurisdictions publish the fields outlined in Table 2, below, though the total number of published fields varies significantly by jurisdiction.

Table 2: Common Data Fields Published by Jurisdictions with Benchmarking Policies

DATA FIELD	DESCRIPTION	HOW DATA ARE USED
Property Name, Address, Size	Basic property information includes the property name, address, gross floor area, and Property IDs.	Address information allows for geographic comparison across streets, neighborhoods, and zip codes in order to understand energy consumption within various geographic constraints.
ENERGY STAR Score	ENERGY STAR scores for commercial buildings are based on data from national building energy consumption surveys (e.g., EIA Commercial Buildings Energy Consumption Survey) and control for key variables affecting a building's energy performance including climate, hours of operation, and building size. These are on a scale of 1–100, where 1 is the worst performing building and 100 is the best performing building.	The ENERGY STAR score normalizes for climate and operational characteristics, which allows the energy performance of buildings to be compared to one another in a standardized way.
Site EUI or Source EUI (kBtu/sq. ft.)	Energy Use Intensity (EUI) is the energy use per square foot at a property. Site EUI is the annual amount of energy the property consumes per square foot on-site, as reported on utility bills. Source EUI is the total annual amount of raw fuel per square foot that is required to operate a property, which includes losses from generation, transmission, and distribution.	These metrics allow for energy use (site or source) to be compared across buildings, normalizing for the size of the building.
Weather Normalized Site or Source EUI (kBtu/sq. ft)	These are site and source EUI (as defined above), but normalized against the energy use the property would have consumed during 30-year average weather conditions.	These are site and source EUI (as defined above), but normalized against the energy use the property would have consumed during 30-year average weather conditions.
Total GHG Emissions (mt CO_2e) or Total GHG Emissions Intensity (kg CO_2e/sq. ft.)	GHG emissions include gases released into the atmosphere as a result of energy consumption at the property. GHG emissions are expressed in carbon dioxide equivalent (CO_2e), a universal unit of measure that combines the quantity and global warming potential of each greenhouse gas. GHG intensity measures the emissions of GHGs per square foot at a property.	These metrics allow for the relative GHG emissions impact of a building's operation to be compared with other buildings.

The stakeholders who are best positioned to make their buildings more energy efficient are highly unlikely to seek out, download, and manipulate a spreadsheet for the purposes of comparing their buildings to peers and identifying opportunities for improvements. City governments then assume the important role of making the data interesting and engaging so that market actors begin to understand and use it.

While publishing the benchmarking data in a spreadsheet accomplishes the goal of releasing the information publicly, it may not accomplish the underlying objective of having the information be incorporated into market decisions. This is because large, data-heavy spreadsheets are often complex and not easily understood, and this is typically not of interest to those outside the building energy efficiency community. The stakeholders who are best positioned to make their buildings more energy efficient are highly unlikely to seek out, download, and manipulate a spreadsheet for the purposes of comparing their buildings to peers and identifying opportunities for improvements. City governments then assume the important role of making the data interesting and engaging so that market actors begin to understand and use it.

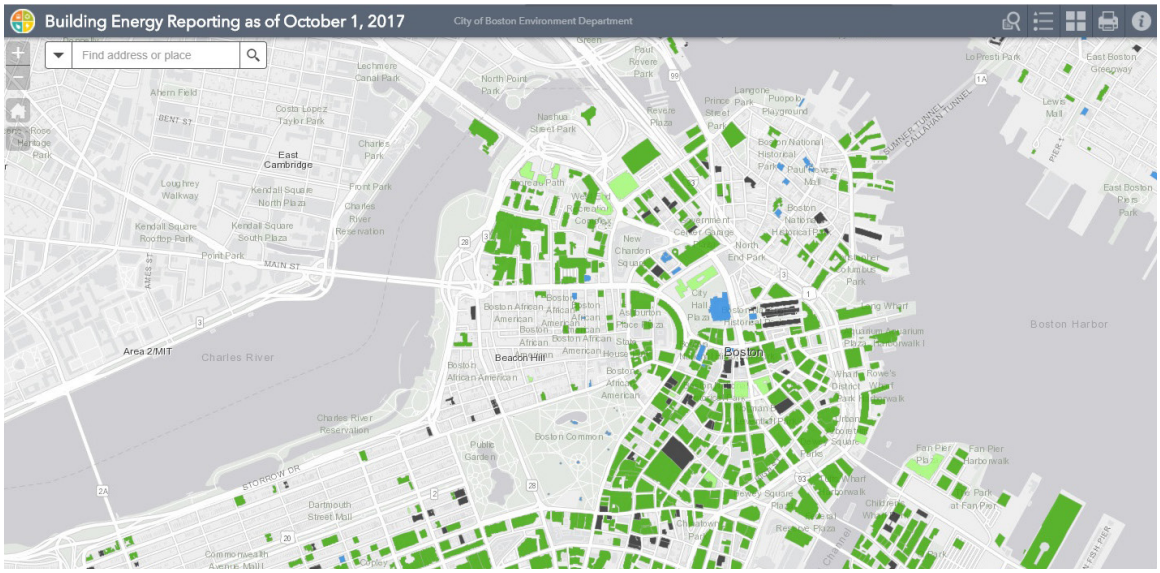
To make the data more interesting, cities are sharing this information in creative ways to allow decision makers to better understand and interact with the datasets. Boston,[3] Chicago,[4] New York,[5] and Philadelphia[6] provide map-based visualization platforms that allow the public to view covered buildings' performance and geography, interacting with the published dataset in a more engaging way than with spreadsheets alone. The idea behind these visualizations is that users are able to see, in context to their local geography and neighborhood, how specific buildings are performing relative to other comparable buildings. Much more compelling than a spreadsheet, visualization maps place energy consumption in the context of subjects that building decision makers are used to dealing with: neighborhood streets, neighboring buildings, and easy-to-understand categorization (such as red coloring for a poor performer and green coloring for a high performer).

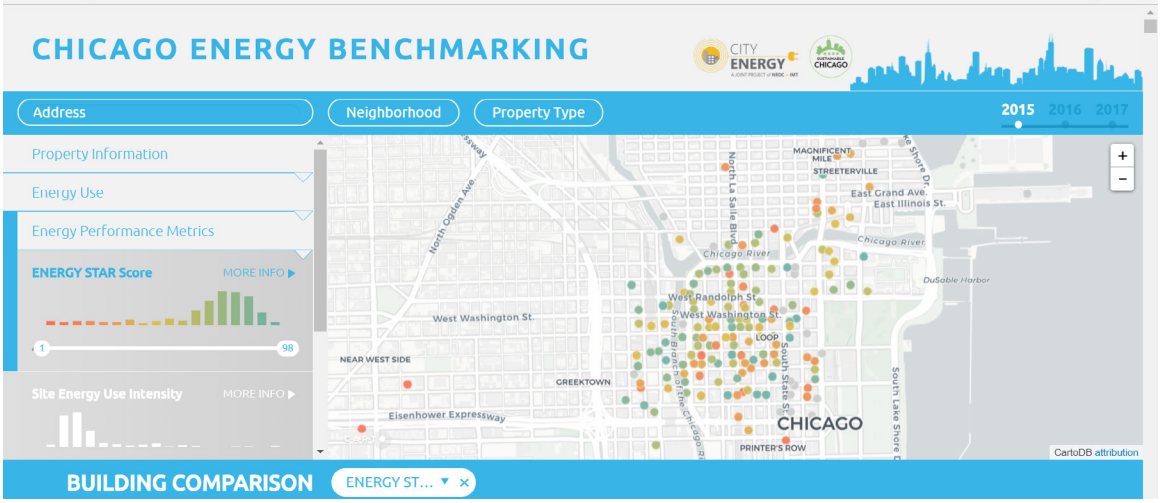
3 "Boston Maps," City of Boston, http://boston.maps.arcgis.com/home/index.html

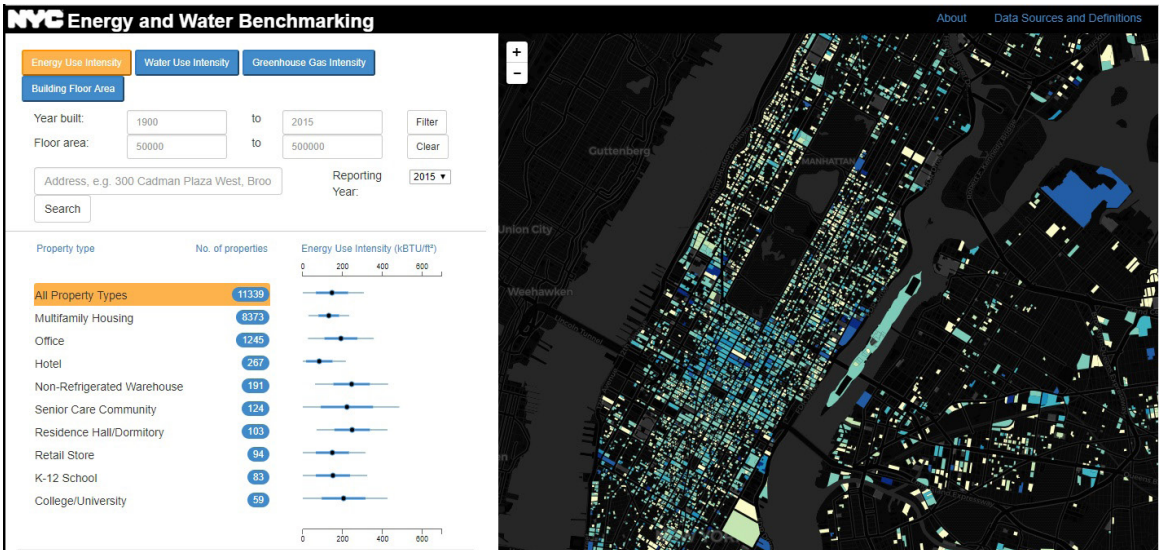
4 "Chicago Energy Benchmarking," City Energy Project and Sustainable Chicago, http://cityenergyproject.github.io/chicago/#chicago/2015?layer=energy_star_score&metrics[]=energy_star_score&sort=energy_star_score&order=desc&lat=41.8843&lng=-87.6325&zoom=11

5 "NYC Energy Energy & Water Performance Map," NYC Center for Urban Science + Progress, https://serv.cusp.nyu.edu/projects/evt/

6 "2017 Building Energy Benchmarking," The City of Philadelphia Office of Sustainability, http://visualization.phillybuildingbenchmarking.com/#!/


Building Energy Reporting as of October 1, 2017
City of Boston Environment Department
Find address or place
Boston
Beacon Hill
Charles River
Boston Harbor
East Cambridge
Area 2/MIT


CHICAGO ENERGY BENCHMARKING
Address
Neighborhood
Property Type
2015
2016
2017
Property Information
Energy Use
Energy Performance Metrics
ENERGY STAR Score
MORE INFO
Site Energy Use Intensity
MORE INFO
BUILDING COMPARISON
ENERGY ST...
CHICAGO
CartoDB attribution


NYC Energy and Water Benchmarking
About
Data Sources and Definitions
Energy Use Intensity
Water Use Intensity
Greenhouse Gas Intensity
Building Floor Area
Year built:
1900
to
2015
Filter
Floor area:
50000
to
500000
Clear
Address, e.g. 300 Cadman Plaza West, Broo
Reporting Year:
2015
Search
Property type
No. of properties
Energy Use Intensity (kBTU/ft²)
All Property Types 11339
Multifamily Housing 8373
Office 1245
Hotel 267
Non-Refrigerated Warehouse 191
Senior Care Community 124
Residence Hall/Dormitory 103
Retail Store 94
K-12 School 83
College/University 59

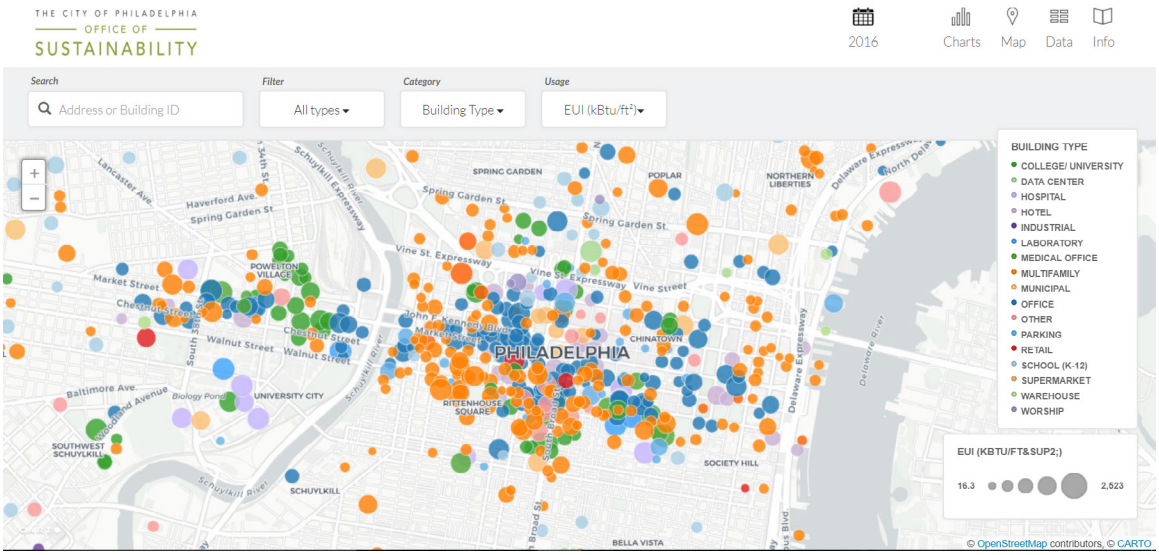


Figure 2: Benchmarking Visualization Platforms (from top: Boston, Chicago, New York, and Philadelphia)

In addition to the geographic maps, some cities, such as Philadelphia, include comparison charts which allow the user to evaluate key metrics (such as building count, emissions, ENERGY STAR score, and energy consumption) by building type. This allows the user to interact with the data by inputting their desired parameters, allowing them to understand how buildings within those parameters compare with one another.

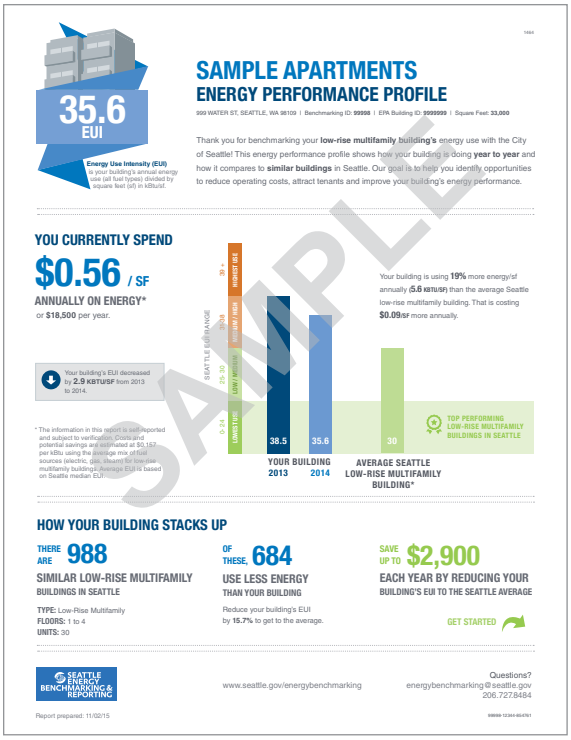
Energy Scorecards

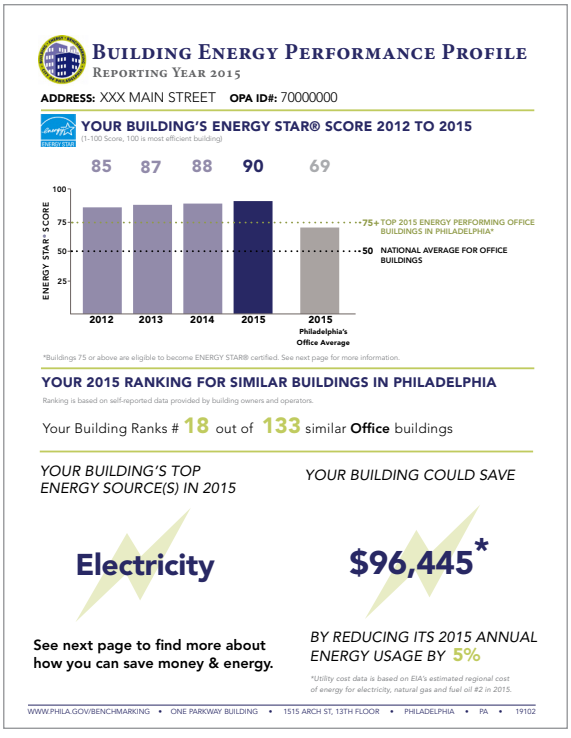
Beyond public visualizations, some cities are reaching out to individual building decision makers with building-specific visualizations that show their relative performance and outline next steps to improve performance. Chicago, Philadelphia, and Seattle provide energy scorecards directly to building owners, which offer specific information about the owners' buildings compared with peers and, in some cases, identify opportunities for improvement and expected savings. These scorecards often include graphics that show a building's ENERGY STAR score or EUI compared with similar buildings (of the same use type and size). Scorecards may also include energy cost information, such as estimated energy cost per square foot, or estimated annual energy spend for a building. Some also include estimated potential energy savings and provide simple, actionable next steps to pursue those savings.

The benefit of scorecards is that they compel action by identifying an issue (energy performance could be improved in a building), explaining to the recipient why they should care (money is being wasted on energy unnecessarily, thereby decreasing net operating income), and identifying clear next steps for the building owner to take action for improvement. Those next steps may include contact information for a local utility efficiency program, reference material for building operator training, or information about local challenge and recognition programs.

Other forms of active outreach by cities and efficiency implementers are discussed in Chapter 2 below.

Figure 3: Example Building Scorecards, Seattle (top) and Philadelphia (bottom)





Communicating Progress

Annual reporting on benchmarking data and progress toward those city goals is often done through formal benchmarking reports, as seen in cities such as Boston,[7] Chicago,[8] Minneapolis,[9] New York,[10] and San Francisco.[11] These reports include the aggregate data reported to cities, which shows the amount of energy that cities' large buildings are consuming, and progress over time for cities with multiple years of benchmarking data available. When communicated to city stakeholders, these metrics allow building owners to see how their reported energy benchmarking data is being used by the city, and how their actions to improve the efficiency of their buildings are contributing to a city's progress toward broad climate and sustainability goals.

Cities that have reported estimated savings from benchmarking in their annual reports have found measurable improvement in energy performance of reporting buildings, with specific annual improvement varying by year and jurisdiction. For additional information on calculating energy savings from benchmarking, including methods used by cities that currently publish benchmarking reports, reference the *Putting Data to Work* tool "Impact Assessment: A Guide for City Governments to Estimate the Savings from Energy Benchmarking and Energy Efficiency Programs."

7 "Energy and Water Use in Boston's Large Buildings, 2013." City of Boston Building Energy Reporting and Disclosure Ordinance (August 2015). Accessed January 2018. https://www.boston.gov/sites/default/files/document-file-05-2017/berdo_rprt_webfinal_tcm3-52025.pdf

8 "Chicago Energy Benchmarking Results, Analysis, & Building Data." City of Chicago (2017). Accessed January 2018. https://www.cityofchicago.org/city/en/depts/mayor/supp_info/chicago-energy-benchmarking/Chicago_Energy_Benchmarking_Reports_Data.html

9 "Energy Benchmarking Results for Public and Large Commercial Buildings." Minneapolis Health Department (2017). Accessed January 2018. http://www.minneapolismn.gov/environment/energy/benchmarking

10 "The New York City Energy & Water Use 2016 Report." Urban Green Council (2017). Accessed January 2018. https://urbangreencouncil.org/content/projects/new-york-city-energy-and-water-use-2017-report

11 "San Francisco Existing Commercial Buildings Performance Report 2010-2014." SF Environment, ULI Greenprint Center for Building Performance. Accessed January 2018. https://sfenvironment.org/sites/default/files/fliers/files/sfe_gb_ecb_performancereport.pdf

CHAPTER 2: MARKETING AND OUTREACH STRATEGIES USING BENCHMARKING DATA

Communicating the availability of benchmarking data, as discussed in Chapter 1 is critical. However, additional interventions are needed in order to identify specific opportunities and encourage building owners to undertake energy-efficient improvements. Energy (and resulting emissions) savings are only achieved when actions (which may include capital investments or operational changes to the building) are taken at the building level to improve performance. Strategic outreach can connect building owners and property managers to training and guidance, resources to obtain incentives for energy-efficient upgrades, resources to obtain financing for energy-efficient capital improvements, and information and references for operational energy management platforms. This section discusses ways that DC and NYC incorporate energy benchmarking data (and in the case of NYC, audit information) into their strategic outreach and engagement.

Directly Engaging Building Owners to Increase Efficiency

The DCSEU is a third-party, demand-side management program administrator that services electric and natural gas customers in the District of Columbia. Success in DCSEU programs is measured though energy reductions, among other targets, giving the organization a keen motivation to use building-specific energy consumption information to increase uptake in its programs. Annual benchmarking data helps the DCSEU to understand and prioritize prospective customers based on several factors that apply broadly to any efficiency implementer that may have access to annual, whole-building data. Specific analyses include:

- **Peer-building comparisons.** Benchmarking data allows for comparison of buildings of similar size and use type to one another to identify the highest priority energy users for outreach and engagement.

- **Change in energy use over time.** The benchmarking data is used to show changes in energy and resource consumption over time, as well as differential changes in energy efficiency and energy utilization by fuel type.

- **Market trends.** The data provides a mid-level picture of trends within market types and sectors, and is useful for targeting specific sectors or geographic areas for outreach.

- **Customized interaction with customers.** The data allows for more intensive and custom work with an owner or manager's portfolio of buildings or a single building. The data shows portfolio-level trends, improvements over time, comparisons to direct peer competitors, and identification of the best opportunities within a portfolio or between portfolios. The data can also show which buildings have data centers or other energy-intensive uses, allowing account managers to initiate conversations with potential customers with valuable existing knowledge, increasing the likelihood of a successful engagement.

In addition to the DCSEU's efforts, the District government uses energy benchmarking data to enhance targeting and outreach for several programs in similar ways. The District's Commercial Property-Assessed Clean Energy (DC PACE) program, which is managed by the District's PACE administrator Urban Ingenuity, coordinates closely with the DCSEU and uses the benchmarking data to target its own loan programs at buildings that stand to benefit from deeper energy efficiency incentives than can be financed purely through DCSEU incentives.[12] The Power Down DC Competition, a multifamily building utility-reduction competition operated by Steven Winter Associates, Inc. and funded by DOEE, also uses benchmarking data to identify potential participants and compare savings.[13]

New York City has the benefit of additional building performance-related legislation that requires building owners to perform an energy audit and submit the findings to the City every 10 years. The NYC Retrofit Accelerator, run out of the Mayor's Office of Sustainability, uses energy benchmarking and audit data to compare buildings to their peers to determine which buildings have the greatest energy- and water-saving opportunities and identify specific projects to recommend during conversations with building decision makers. The Retrofit Accelerator's team of Efficiency Advisers conduct outreach and provide free help to building owners and decision makers to explain energy and water efficiency opportunities in their buildings, select projects, identify available financing and incentives, choose contractors, and provide ongoing support through project completion. The Efficiency Advisers use benchmarking and energy audit information to determine which buildings are highest priority for assistance. Once Efficiency Advisers are working with a building decision maker, they also use the data to help select projects that improve the energy efficiency of the buildings, and prioritize buildings for upgrades within portfolios. For additional information on the NYC Retrofit Accelerator, reference the *Putting Data to Work* case study, "Successful Partnerships to Accelerate Efficiency: NYC Retrofit Accelerator."

INCREASING CUSTOMER ENGAGEMENT WITH DATA

As part of the *Putting Data to Work* project, the DCSEU undertook a pilot program to use benchmarking data in strategic outreach to potential customers. After prioritizing buildings for strategic engagement, the DCSEU developed a standard script for engagement (see the *Putting Data to Work* tool "Outreach Strategies for Cities and Efficiency Administrators"), with an initial call to broadly explain the energy-savings opportunity, and a follow-up, in-person meeting to talk through specific activities and next steps. Additional detail on the DCSEU's engagement program under the pilot project is available in the *Putting Data to Work* case study, "Increasing Customer Engagement with Data: District of Columbia Sustainable Energy Utility".

12 "Property Assessed Clean Energy." District Department of Energy & Environment (2017). Accessed January 2018. https://doee.dc.gov/service/dcpace

13 "Power Down DC: A Multifamily Energy & Water Challenge." District Department of Energy & Environment (2017). Accessed January 2018. https://doee.dc.gov/service/power-down-dc

In addition to work done by the cities directly, organizations such as NYCEEC use benchmarking data in their own offerings, which complement those of the City. NYCEEC uses benchmarking data to extend offers for low-cost financing, and has developed a tool called efficienSEE™, which provides building owners and property managers with a high-quality, rapid estimate of energy and water savings, and, where applicable, cogeneration potential to help make the business case for efficiency improvements. For additional detail on the development of the efficienSEE™ tool, reference the *Putting Data to Work* case study, "Making the Financial Case for Energy Efficiency Upgrades: NYCEEC efficienSEE™ Tool"

Challenge Programs

Voluntary "challenge" programs ask private-sector building owners, property managers, or other decision makers to make public commitments to reduce the energy waste of their buildings. While not legally binding, the public nature of these commitments, along with the need to measure and report annual energy or emissions progress, is both supportive of and enhanced by energy benchmarking data. Challenge programs are administered by the city government, partner NGOs, or as part of a broader network of jurisdictions, such as the U.S. Department of Energy-administered Better Buildings Challenge.

Participation in challenge programs provides real-world, local case studies, giving the regional building community examples of the benefits their neighbors realize by tracking and reducing their energy consumption. These programs can leverage existing reporting platforms, such as Portfolio Manager, to either lay the groundwork for reporting under a benchmarking ordinance, or to build off of existing reporting structures where implementation of an ordinance has already begun. Challenge programs may include benefits such as training, informational workshops, and technical assistance, and may also include financial rewards and public recognition as benefits for participating.

The element of public recognition in challenge programs benefits participants' public image, as well as the jurisdictions administering the programs in several ways, including:

- **Underscoring active participation** from the real estate sector in progress toward the jurisdiction's sustainability goals;

- **Highlighting the business case for benchmarking,** which emphasizes the non-energy benefits of tracking resource consumption, including financial benefits such as improved net operating income;

- **Creating private-sector engagement** around shared goals and providing an opportunity for ongoing stakeholder input from the real estate sector; and

- **Educating the real estate sector about benchmarking** and enhancing their familiarity of Portfolio Manager. Many jurisdictions have stated that voluntary challenges help get real estate stakeholders more comfortable with the concept of benchmarking, building support for the passage of mandatory programs.

Voluntary challenge programs can continue after a benchmarking and transparency ordinance is in effect, as was demonstrated in the Better Buildings Challenge program in Atlanta. These stakeholder groups provide highly valuable market perspective to cities in crafting new programs and policies to reduce energy waste, and should be engaged in an ongoing basis.

Another leading voluntary challenge program is the Retrofit Chicago Commercial Buildings Initiative, which was launched in 2012. The Initiative is run by the Chief Sustainability Officer with support from the Chicago City Director of the C40 Cities Climate Leadership Group, and the Initiative's partners also provide support in the coordination and implementation of the program. During the first two years of the Initiative, 48 buildings participated, representing 37 million square feet of commercial, institutional, and multifamily real estate. Collectively, 27 of the buildings (those for which data are available) reduced energy use by seven percent in the first two years, and participating buildings took advantage of over $2 million in utility incentives and are collectively saving 21 million kWh and over $1.5 million annually from implemented projects.[14]

Challenge programs provide an opportunity for engagement with the real estate sector before benchmarking policies are passed, but also an opportunity for continual engagement and monitoring progress over time using benchmarking data.

14 "Retrofit Chicago Commercial Buildings Initiative: Best Practices Report." Natural Resources Defense Council (July 2014): Page 4. Accessed January 2018. http://www.retrofitchicago.net/images/NRDC_Retrofit_report_productionREV_071714%202.pdf

CHAPTER 3: OTHER APPLICATIONS OF BENCHMARKING DATA

Benchmarking data can support additional activities for cities and efficiency program implementers, including strategies for assisting individual building owners in using benchmarking data and leveraging that data to take the next steps in improving the energy performance of their buildings (see this chapter's Providing Guidance and Support to Building Owners and Property Managers section), as well as using data in city energy and infrastructure planning (see this chapter's Using Benchmarking Data in City Energy Planning section). Implementers of benchmarking ordinances are uniquely positioned to engage with building owners through their help desk communications to improve the quality of reported data, and therein also improve building owners' understanding of the characteristics and energy performance of their buildings, as discussed in Chapter 4 of this report.

Providing Guidance and Support to Building Owners and Property Managers

A brief guide describing next steps that building owners can take after benchmarking their buildings is available in the *Putting Data to Work* tool, "Efficiency and Beyond: Guidance for Energy Efficiency Program Administrators to Aid Building Owners." These next steps are summarized in Table 3 below, along with how benchmarking data can inform those actions and ways that City or efficiency program staff can assist building owners in taking those next steps. In each case, benchmarking data can be used to initiate the action or to identify buildings with high potential for energy savings in order to prioritize focus for improving energy efficiency. In some cases, benchmarking data can be used to track savings over time to inform reporting or validation requirements.

The benefits of benchmarking to local governments lie in understanding the energy and resource consumption of the building stock in aggregate, and in analyzing and prioritizing neighborhoods, building types, or specific buildings for outreach or action to improve energy performance. To the individual building owner, benchmarking data provides the following benefits:[15]

- Establishes a baseline and ongoing understanding of buildings' characteristics and energy use;

- Provides metrics for building owners with multiple buildings in a jurisdiction in order to rank buildings within their own portfolio, allowing prioritization of energy efficiency investments;

- Supports better understanding of how buildings' energy performance compares with peer competitors (by size, neighborhood, and sector); and

- Establishes the basis of an energy management plan that can be used to drive continuous improvement in energy performance.

15 Zachary Hart, "The Benefits of Benchmarking Building Performance" Institute for Market Transformation (December 2015): adapted from page 6. http://www.imt.org/uploads/resources/files/PCC_Benefits_of_Benchmarking.pdf

Once a building has reported benchmarking data and the data is accurate and complete, the City or efficiency implementer role should be in supporting building owners in identifying buildings to prioritize for efficiency improvements, and in serving as an objective advisor and resource in helping decide what the next steps for the building owner should be (e.g., operational improvements, specific physical retrofits, etc.). This is exemplified through the NYC Retrofit Accelerator program—a detailed summary of the operations, benefits, and lessons learned from the Retrofit Accelerator is available in the *Putting Data to Work* case study, "Successful Partnerships to Accelerate Efficiency: NYC Retrofit Accelerator."

Table 3: Efficiency Improvement Opportunities for Building Owners

BUILDING OWNER'S DESIRED OUTCOME	BUILDING OWNER'S ACTION	USE OF BENCHMARKING DATA TO INFORM THE ACTION	CITY OR EFFICIENCY IMPLEMENTER SUPPORT
Improve operational energy performance	• Virtual audit • Onsite audit • Use of energy management information systems (EMIS)	• Virtual audits often use monthly energy data, along with other building characteristics, to identify basic recommendations for energy upgrades. This information should be readily available, as building owners collect monthly data for input into Portfolio Manager. • Benchmarking data can provide high-level energy performance as background information for an onsite audit. • Depending on the EMIS chosen, benchmarking data may be the primary input, or a building owner may choose to obtain more frequent, granular data to better understand operational energy consumption of their buildings.	• Contact building owners with high potential for energy savings and educate them about opportunities to save • Assist building owners in prioritizing buildings in an owner's portfolio that have the highest potential energy savings • Reference an approved vendor list of service providers that can deliver audit services, or a list of approved or vetted EMIS providers, if available
Improve systems/ Capital planning	• Financing for efficiency upgrades • Incentive for efficiency projects • High-performance "green" leasing	• Benchmarking data can be used to estimate potential savings for loan underwriting, and can be used to track savings over time. • Depending on the project receiving an incentive, benchmarking data may be used to track savings over time. • Benchmarking data could be used to inform tenants of whole-building energy performance, and can be used to encourage buy-in for building-wide savings to encourage high-performance leasing.	• Contact building owners with high potential for energy savings and educate them about opportunities to save • Maintain resource lists of available financing and incentive programs to guide building owners • Provide reference to high-performance leasing language

BUILDING OWNER'S DESIRED OUTCOME	BUILDING OWNER'S ACTION	USE OF BENCHMARKING DATA TO INFORM THE ACTION	CITY OR EFFICIENCY IMPLEMENTER SUPPORT
Receive recognition for high performance	• Certification and reporting	• Benchmarking data can be used to validate energy performance for certification or reporting requirements.	• Contact building owners with high-performing buildings and educate them about opportunities for certification • Facilitate a local recognition program for high-performing buildings

Using Benchmarking Data in City Energy Planning

Benchmarking data provides insight into the energy consumption of large buildings in a jurisdiction, which represent the largest contributors to GHG emissions in dense urban areas. So far in this report, benchmarking data has been discussed in terms of its value for providing an energy baseline; offering a means for comparison of peer buildings to identify potential energy-savings opportunities; use in outreach and engagement with building owners; and in tracking energy performance over time. Benchmarking data can also provide value in long-term City energy and infrastructure planning, as it provides a highly localized dataset of building characteristics and resource consumption. This section discusses that use for benchmarking data.

Cross-Agency and Stakeholder Collaboration

City government agencies that are not directly involved in energy benchmarking may not be aware of the existence of this data, nor of its potential use in planning energy-related programs in the city. The process of developing a city-level climate plan should include all relevant departments, as well as pertinent internal and external stakeholders (as categorized in Table 4, below) where applicable so that all pertinent stakeholders are aware of the existence of the data and understand its value in their own planning and operations.

Table 4: Key Stakeholder Groups to Engage in Energy Efficiency Planning

STAKEHOLDERS WITHIN CITY GOVERNMENT	NON-GOVERNMENT STAKEHOLDERS WHO WORK WITH ENERGY EFFICIENCY IN BUILDINGS	
• Buildings department/ Permitting office • Finance and procurement • General services/real estate management • Transportation department • Environment department • Energy department • Housing authority • Tax department • Economic development agency	• Utilities • Implementers of energy efficiency programs (e.g., utility program administrators) • Public Utility Commissions • Business Improvement Districts (BID) and related local business groups • Property Assessed Clean Energy (PACE) administrators	• Real Estate Community • Financial Community • Environmental Advocates • Equity Advocates • Trade Associations • Energy Service Companies (ESCOs) and Energy Service Providers • Chambers of Commerce

City Energy and Infrastructure Planning

Reported benchmarking data provides valuable information to the city that can be used in energy planning. As discussed in Chapter 1 not all data that cities collect is published; in some cases, both public and unpublished datasets collected under benchmarking ordinances can be valuable in city energy and infrastructure planning. The data provides highly localized, real data on the built environment in a jurisdiction, such as:

- **Building location.** Geographic information about a building, along with its energy use, can be valuable in energy infrastructure planning. For additional information on the benefits of benchmarking to utilities, reference the *Putting Data to Work* report, "Emerging Uses for Building Energy Data for Utilities."

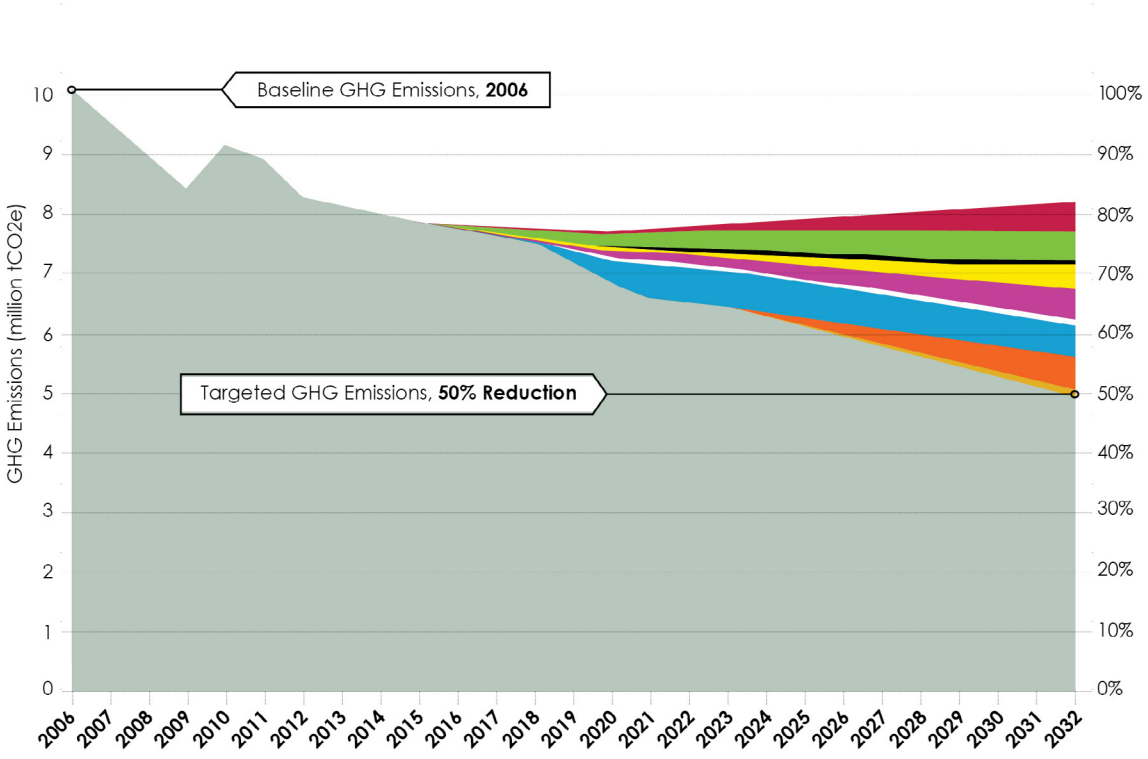
- **Building size.** In addition to understanding the size of the current building stock, information on the size of buildings can be used to develop average energy intensity factors (energy use per square foot) to model the energy use of new construction.

- **Building type.** Understanding the building use type allows for modeling and planning to address specific sectors, such as multifamily or commercial office space.
- **Energy use.** Understanding the amount of energy used gives a locally accurate estimation of a baseline, allows for forecasting future reductions, and can be used to track progress toward goals over time.
- **Fuel use.** Understanding the quantity and type of fuel used in the building stock helps accurately account for emissions from direct combustion in buildings.

There are several examples where cities have conducted in-depth strategic planning exercises across multiple types of infrastructure, and refined program and policy design accordingly. The examples from the District, Philadelphia, and Seattle below show how these exercises can incorporate building performance data collected through benchmarking policies.

Clean Energy DC,[16] the District of Columbia's recently released climate and energy plan, provides a vision for creating a cross-sector sustainable energy future in the District and incorporates District-collected benchmarking data into its energy modeling. As part of the Clean Energy DC process, the District's consultant team conducted visioning workshops and interviews with District stakeholders (both internally and externally) and combined the results of those sessions with global best practices and the team's novel ideas to identify over 90 actions that the District could undertake to reduce emissions. The team then created a community energy model using the best available data for each action. For the actions that related to existing buildings, the District's energy benchmarking data provided a localized dataset on the characteristics of the building stock (size, age, use type) with which to model expected savings. Figure 4, page 24, shows the output of the emissions modeling conducted, whereby the District is able to achieve 6.6 percent savings from existing buildings and a 5.2 percent savings from new construction.

16 "Clean Energy DC The District of Columbia Climate and Energy Plan (DRAFT)." District of Columbia Department of Energy & Environment (October 2016). Accessed January 2018. http://doee.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/Clean_Energy_DC_2016_final_print_single_pages_102616_print.pdf



Notes: All figures use GHG intensity factors that account for losses from generation. To maintain consistency with the 2006 GHG inventory, which provides the baseline for the 2032 GHG reduction target, the GHG intensity factors do not include transmission and distribution losses for electricity nor fugitive emissions from natural gas. See section A1.2.2.1 in Appendix A1 for more detail.

CAFE Standard = Corporate Average Fuel Economy Standard
PPA = power purchase agreement
RPS = Renewable Portfolio Standard.

GHG Reduction Wedge	GHGs Reduced from 2032 BAU (tCO_2e)	Percent GHGs Reduced from Total 2032 BAU*
CAFE Standard	473,000	**5.8%**
Mode Share Change	528,000	**6.4%**
Electric Vehicle Adoption	34,000	**0.4%**
New Construction Actions	430,000	**5.2%**
Existing Building Actions	544,000	**6.6%**
Neighborhood-Scale Energy	44,000	**0.5%**
PPA for Standard Offer Service	543,000	**6.6%**
Renewable Portfolio Standard	581,000**	**7.1%****
RPS Local Solar Requirement	87,000**	**1.2%****
Total GHGs Avoided vs. 2032 BAU	3,277,000	**39.8%**
Total GHGs Reduced vs. 2006 Baseline	5,664,000	**51%**

Figure 4: Clean Energy DC Modeled Emissions Savings

Rather than national averages or national datasets, benchmarking data collected through the District's ordinance provided localized data, allowing for more accurate modeling. The availability of annual updates to the building consumption information through the benchmarking reporting will also allow progress in energy and emissions reductions to be tracked over time. Additional detail on the Clean Energy DC plan and modeling process is available in the *Putting Data to Work* case study, "Deploying Building Performance Data in Climate Strategy: Clean Energy DC"

The City of Philadelphia produced an Energy Planning tool that incorporates utility data, nationally available grid information (eGrid factors and grid projections), transportation and waste emissions data, and energy benchmarking data to produce estimated energy and emissions savings and air quality metrics for various energy-reduction strategies. The tool is spreadsheet-based, and being used to inform the City's Municipal Energy Master Plan (City-owned buildings) and Citywide Energy Vision (all buildings in Philadelphia).[17] The measures analyzed include energy efficiency for homes and businesses (expansion of requirements under benchmarking, and encouraging the use of existing utility programs), cleaning the electricity grid (increasing renewables), increasing rooftop solar, and promoting low-carbon thermal energy (studying district energy systems, and promoting efficient technologies for residents and businesses).

The City of Seattle provides another example of using benchmarking data in climate planning. In order to track progress toward building sector targets laid out in the City's Climate Action Plan, Seattle developed a model with EcoTop, building off of work previously done under a Conservation Potential Assessment for its municipal utility, Seattle City Light[18]. Benchmarking data has allowed the City to calibrate its savings estimation tool, allowing it to evaluate different combinations of policy and incentive options relating to various building types, and to understand the associated energy and emissions savings those different policy approaches could garner.

Benchmarking data provides city government sustainability leaders the opportunity to engage with and assist building owners in taking next steps beyond simply benchmarking their performance, and also provides the foundation for long-term city-level climate and sustainability planning. Without baseline information about energy consumption of buildings that benchmarking data provides, these activities would be based on assumptions and averages of more aggregated dataset, and would provide less specific and accurate information.

17 Rich Freeh. "Greenworks: A Vision for a Sustainable Philadelphia." Powerpoint presentation to C40 PBE: Using Data for Policy. September 6, 2017.

18 Benjamin Hannas, et. al. "Reaching Seattle's Climate Goals in the Building Sector: Quantifying Targets and Tracking Progress." ACEEE Summer Study on Energy Efficiency in Buildings (2016). Accessed January 2018. http://aceee.org/files/proceedings/2016/data/papers/9_629.pdf

CHAPTER 4: REDUCING ERROR IN BENCHMARKING DATASETS[19]

Benchmarking and transparency policies provide building performance data that real estate market decision makers need to properly value buildings' resource efficiency. In order for market transactions to efficiently factor in this efficiency, the performance data must be accurate and reliable. This means that cities must ensure that the datasets generated from their building energy benchmarking policies are of the highest possible quality.

An ideal market scenario, where resource efficiency is factored into transactional decisions, assumes that publicly available benchmarking information is accurate. Inaccurate information could result in suboptimal investments by real estate stakeholders; lead governments, utilities, and researchers to draw incorrect conclusions about the state of the local building stock; and ultimately, if the quality of the information is especially poor, could undermine the benchmarking and transparency policy's credibility. This section defines high-quality benchmarking data, identifies common issues contributing to data reporting errors, and outlines best practices in policy and program design, data collection, building owner engagement, and post-collection analysis for reducing error and identifying inaccurate records within benchmarking data.

Defining High-Quality Benchmarking Data

A high-quality dataset is both complete and accurate. Complete datasets are those in which a high percentage of the records are complete, with information entered into each data field. Accurate datasets are those in which repeated data fields contain the same information in each instance, the data recorded in each field is correctly formatted using the correct units, and the data accurately reflects the characteristics and performance of the buildings being reported.[20]

Common Sources of Data Inaccuracies

The risk for error in benchmarking data is considerable because the data is self-reported, often manually entered by individuals lacking building energy efficiency expertise. To comply with benchmarking requirements, building owners or their designees must collect and enter into ENERGY STAR Portfolio Manager their building's monthly energy usage for the past calendar year, as well as specific information about the building's physical characteristics. The specific data collected vary by jurisdiction, but often include the property use types in the building, square footage, weekly operating hours, computer density, and occupancy, among other fields. These figures allow Portfolio Manager to calculate the building's energy use intensity (EUI) and its ENERGY STAR score, if one is available for its space type. Table 5, on page 27, includes a discussion of common factors that contribute to data quality issues in reported data.

19 Portions of this chapter were developed with funding under another grant and repurposed for this project. That funding was provided in part by the Office of Energy Efficiency and Renewable Energy (EERE), U.S. Department of Energy, under Award Number DE-EE0006890.

20 David Hsu, "Improving Energy Benchmarking with Self-Reported Data." Building Research & Information 42, no. 5 (February 21, 2014): 641-656. Accessed January 2018. http://www.tandfonline.com/doi/full/10.1080/09613218.2014.887612

Table 5: Common Factors Contributing to Errors in Reported Data

CATEGORY	ISSUE	DESCRIPTION
Data collection and reporting	Manual collection and input	It is unlikely that every owner will collect accurate information, representing their entire building, for all benchmarking data fields and correctly enter it into Portfolio Manager without any typographical errors. The problem of human error tainting self-reported data is so common that the U.S. DOE throws out 20 percent of the contributions to the Building Performance Database.
Education	Reporter inexperience	Benchmarking policy administrators should expect data quality issues to be most common in the first years of the benchmarking program. This will be especially true for owners of smaller buildings, who are less likely to be familiar with Portfolio Manager and building operations. Inexperienced owners or their designated agents will be more likely to misinterpret utility bills, mix up units, or report inaccurate, estimated, or default building characteristics in Portfolio Manager.
	Lack of familiarity with Portfolio Manager fields	Owners, facility managers, and their designated benchmarking compliance representatives may not be familiar with Portfolio Manager's output metrics and the relative importance of the input data fields used to calculate them. Building owners may not be aware of the gross area of their building, as they frequently think instead in terms of their net leasable area or the number of apartment units. Fields such as number of occupants and number of computers, which Portfolio Manager depends on to calculate the ENERGY STAR score, are particularly susceptible to being filled in with default or estimated values, since obtaining actual measurements can be time-consuming, and owners and building managers are less likely to understand the purpose of these factors in ENERGY STAR calculations.
Communication	Lack of interest in benchmarking	There is an imbalance between the degree of interest and enthusiasm displayed by the policy implementer and the building owners that must comply with the ordinance. Even within the real estate industry, some owners will be oblivious to the benchmarking requirements and uninterested in the policy's rationale. This can lead them to not comply or to be less attentive when carrying out their benchmarking. This issue can be mitigated by providing ample and clear communication and training, which will be discussed later in this report.

Beyond broad factors that contribute to the data quality issues discussed in Table 5, there are specific errors that may cause reported data to be inaccurate or to not fully reflect the circumstances of the subject building. These common errors are discussed in Table 6, on page 28.

Table 6: Common Sources of Errors in Reported Data

CATEGORY	ISSUE	DESCRIPTION
Incorrect or default data	Data entry errors	Whether they occur because of data transcription errors, incorrect units, or lack of understanding of the reporting requirements, errors in data entry undermine the quality of the resulting dataset.
	Estimated energy data values	Owners of multi-tenant buildings can use the energy consumption data of a sample of their tenants to extrapolate a figure for whole-building energy consumption. While estimated energy data may be acceptable in certain circumstances for compliance purposes, it should not be considered sufficiently high quality for data analysis.
	Temporary energy data values	Some building owners receive estimated energy bills from their utility. Owners should indicate that their energy consumption values are only temporary and update the fields when they learn the actual consumption values.
	Default property characteristic values	ENERGY STAR can generate default values for the characteristics within its Property Use Details section. These values allow owners to generate a quick ENERGY STAR score that gives them a ballpark idea of how well their facility performs. Jurisdictions should not accept records that use default values as compliant, because they are not adequate for generating an accurate ENERGY STAR score. The ENERGY STAR data quality checker will alert the user to the presence of default values, and jurisdictions should consider any benchmarking report containing these alerts to be non-compliant.
Partial data	Misreported utility billing periods	Often, utility billing cycles do not line up exactly with the calendar month. If an owner fails to adjust the dates of coverage in Portfolio Manager when reporting their energy consumption data, they may report monthly data for a time period of more or less than a full calendar month. When aggregated, this may result in over or undercounting consumption (because of overlapping values or gaps), and may result in an incorrect assessment of that buildings' resources use.
	Failure to report energy consumption for the whole building	For benchmarking data to be accurate, the reported consumption must include all energy sources for the entire building. This may be challenging for some building owners. The building may have multiple utility meters servicing different spaces, including cases where meters may directly service tenants. In those cases, the building owner would need tenant permission to access their energy consumption, absent a utility providing whole-building aggregated information directly to the owner.
	Missing meters	Even where the utility provides whole-building energy use data, the potential remains for having an incomplete picture of the building's total energy use. Although utilities charge for energy use on a per-meter basis, they have not historically been set up to track the relationship between each meter and the physical space it serves. Accurately mapping the entire universe of meters that are associated with a specific building can be a challenging up-front activity for some utilities, but failure to do so correctly will lead to errors in capturing total energy use.
	Omission of an energy source	The EUI and ENERGY STAR score for a building rely on an accurate, full picture of energy consumption at a building, including all applicable fuel sources (electricity, natural gas, fuel oil, district steam, etc.)

CATEGORY	ISSUE	DESCRIPTION
Unusual circumstances	Atypical building/ meter configuration	Situations in which the energy use of more than one building is included in a single benchmarking report present difficulties from a data quality perspective.
Intentional manipulation	Misleading data entered to alter score	Cities have not reported finding unfair manipulation of benchmarking results with any regularity, so it is not a large cause for concern; however, it could become an issue as more jurisdictions move toward comprehensive building performance policies that include mandatory improvements for poor-performing buildings.

Methods for Improving the Quality of Reported Data

Jurisdictions have instituted a number of effective methods for reducing errors in the benchmarking data they collect. Some of them are embedded in the process of policy and program design, others are used in the months and weeks leading up to the benchmarking reporting deadline, while still others are deployed after the initial data collection effort. Jurisdictions implementing benchmarking policies have deployed the following strategies to improve data quality. Recommended strategies below are organized by sections that correspond with the benchmarking timeline. The section labeled Policy and Program Design addresses actions that can be taken in the program or policy design process, the Prior to Reporting Deadlines section addresses actions that can be taken prior to reporting deadlines, and the Cleansing Reporting Benchmarking Data for Analysis section addresses cleansing that can be done after data are received.

Policy and Program Design

Require Benchmarking to be Completed by a Qualified Benchmarker. By including language in the jurisdiction's benchmarking and transparency law that requires benchmarking reports to be prepared by a qualified benchmarker, jurisdictions can reduce the frequency of errors in the reported data. The jurisdiction should define a qualified benchmarker as a professional holding a license or certification as specified in the ordinance itself or in rules and regulations. Qualified benchmarkers should hold one of the following certifications:

- Registered Architect
- Professional Engineer
- Certified Energy Manager (CEM)
- Certified Facilities Manager (CFM)

- Building Energy Assessment Professional (BEAP)
- LEED AP

Require Verification of Benchmarking Reports. A similar approach to the qualified benchmarker requirement is to allow anyone to perform the benchmarking, but require a certificate holder to verify that the benchmarking data is correct, which is used in the City of Chicago's benchmarking ordinance. Requiring data verification by a credentialed professional raises the cost of compliance for a benchmarking policy, so it is reasonable to expect significant opposition to such a legislative provision. Chicago was able to reduce this opposition by providing cost-lowering options for meeting the data verification requirement. In Chicago, building owners do not need to hire a third-party verifier if a member of their staff holds one of the recognized credentials; that person can then verify the data in-house.

Require Owner to Run Portfolio Manager Data Quality Alerts. Portfolio Manager includes its own automated checks for improving data quality. The system's built-in alerts detect common data entry errors and missing or unusual values in the energy use and property use data fields. Where errors prevent the calculation of metrics such as ENERGY STAR score or EUI, Portfolio Manager will display "N/A" and link the user back to the data input field that is the source of the problem. This data quality checker gives benchmarkers a chance to fix data issues in their reports before submitting them to the jurisdiction. Portfolio Manager does not require a user to correct data fields that have generated an alert. Thus, it is still possible for a user to submit a benchmarking report with data alerts and missing energy performance metrics. Jurisdictions should require building owners to address Portfolio Manager's data quality alerts before submitting benchmarking reports and this requirement should be emphasized in compliance resources and training.[21]

21 "How to Comply with Benchmarking in San Francisco." SF Environment (Step 5). Accessed January 2018. https://sfenvironment.org/energy-benchmarking-compliance-san-francisco#Step 5

Work with Utilities to Improve Provision of Energy Data: There are three ways to enter energy data into Portfolio Manager. The information can be entered manually through the Portfolio Manager web interface, it can be uploaded via spreadsheet, or it can be digitally imported into a user's account through Portfolio Manager's web services. Many utilities provide energy consumption data in formats that require the customer to enter the data manually, such as PDF or paper bills, which creates opportunities for data entry errors. Other utilities provide data by request, manually compiling the information into a spreadsheet and sending it to the customer. This is costly and time-consuming for the utility and is impractical for meeting the demands of owners of covered buildings in a jurisdiction with a benchmarking requirement.

The preferred method for providing utility data is through automated upload from the utility directly to the customer's Portfolio Manager account using Portfolio Manager's data exchange web services.[22] This removes the need for the customer to enter any utility consumption data by hand, essentially removing the risk of data entry error on the customer side. Ideally, the customer would only have to request the automatic upload once and the utility would continue to provide the data on a monthly basis. Errors originating from the utility are still possible using this method if the data supplied by the utility are not accurate or complete, though less likely.

22 There are significant challenges associated with having utilities provide whole-building data, especially through automatic upload. To aid utilities in understanding the value of this data, reference *Putting Data to Work's* Emerging Uses for Building Energy Data for Utilities and the Implementation Guide for Energy Efficiency Program Administrators

To reduce the chance of building owners forgetting to enter information from a meter (for example, entering data for the electric meter but neglecting to do the same for the gas meter), utilities could collaborate with other regional energy and water providers to create a single portal where building owners can request and receive automatic uploads of energy consumption information for all of the energy and water sources supplying their buildings.

Prior to Reporting Deadlines

Provide Compliance Resources. Benchmarking implementers can reduce the chance of benchmarking errors by providing a strong support system to help building owners comply with regulations. This is especially important during the early years of the policy's implementation when building owners will be submitting benchmarking reports for the first time.

The jurisdiction's website should host a collection of easy-to-access information about how to acquire building characteristic and energy consumption data, enter it into Portfolio Manager, and report it to the jurisdiction. For the purposes of improving data quality, the site should include:

- A benchmarking how-to guide: A detailed walk-through of the benchmarking process that addresses common sources of error, complete with screenshots from Portfolio Manager.
  - › Example: City of Chicago 2017 Energy Benchmarking Compliance Guide[23]
- A compliance checklist: A one to two-page document that describes the main actions an owner needs to take to comply with the ordinance.
  - › Example: District of Columbia Energy Benchmarking Flyer and Checklist[24]
- A compilation of frequently encountered problems: A short document that shows users how to solve common errors in Portfolio Manager, including missing EUI output, missing space use details, extreme ENERGY STAR score, and missing meters.
  - › Example: Philadelphia 2017 Benchmarking Troubleshooting Guide[25]
- A sample utility bill: In jurisdictions where one or more of the utilities does not provide energy consumption data in a digitally transferable format, the jurisdiction should provide a sample bill with instructions on how to find and interpret the information needed for Portfolio Manager. The sample bill should alert the user to the location of the utility billing period so that consumption over that period can be reported accurately. If users need to make unit conversions, the guidance should alert them to this and show them how to execute the conversion.

23 "Benchmarking Guide," Chicago Energy Benchmarking (March 2017). Accessed January 2018. https://www.cityofchicago.org/content/dam/city/progs/env/EnergyBenchmark/2017_Chicago_Benchmarking_Guide.pdf

24 "Energy Benchmarking for Buildings in the District." District Department of Energy & Environment (2017). Accessed January 2018. https://doee.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/Benchmarking%20Informational%20Flyer.pdf

25 "Benchmarking Troubleshooting Guide," City of Philadelphia Office of Sustainability. Accessed January 2018. http://www.phillybuildingbenchmarking.com/wp-content/uploads/2017/03/2017-Troubleshooting-Guide.pdf

Provide Benchmarking Training. The jurisdiction should work with partner organizations to offer and publicize live training events and workshops where owners, building managers, and building energy consultants can learn more about the ordinance requirements, as well as ways to act upon the data being gathered and reported. Trainings should walk attendees through entering information into Portfolio Manager and running the program's data quality alerts.

Set up a Benchmarking Help Center. A benchmarking help center is an important tool for improving the quality of reported benchmarking data. Well-trained help center staff can boost the accuracy of submitted benchmarking reports by helping owners understand the requirements they are subject to under the benchmarking law, connecting them with resources for compliance, and assisting them with Portfolio Manager.

As owners submit their benchmarking reports, the help center can contact owners whose benchmarking reports may contain errors. By using Portfolio Manager's alerts system and performing additional high-level data quality checks, the help center can send owners customized follow-up messages with instructions on how to review and correct their specific errors. Owners submitting reports with no error alerts should receive a simple confirmation message. The City of Chicago used such a system, and half the users that received error alert messages resubmitted corrected benchmarking reports. An analysis by the Consortium for Building Energy Innovation (CBEI) of 2013 benchmarking data from Philadelphia underscores the importance of a well-developed feedback system. CBEI found that one of the factors in the data's unexpectedly low quality was that there was little feedback flowing to the building owners and managers about how to improve the quality of their reports.[26]

KEY HELP CENTER ACTIVITIES

- Offer access to a person via phone and email to respond to benchmarkers' inquiries
- Offer guidance on submitting questions or requests for information to the help center to aid help center staff in streamlining their process and prioritizing requests
- Provide informational and training resources detailing specifics about the jurisdiction's reporting process
- Provide links to technical support resources of associated programs, including potential opportunities for incentives
- Offer guidance and next steps beyond benchmarking compliance. For guidance on next steps that building owners can take after benchmarking, reference the *Putting Data to Work* tool, "Efficiency and Beyond: Guidance for Energy Efficiency Program Administrators to Aid Building Owners."

26 Scott Wagner, "CBEI – Improving Benchmarking Data Quality," 2015 Building Technologies Office Peer Review (2015). Accessed January 2018. http://energy.gov/sites/prod/files/2015/05/f22/cbi72_Wagner_041515.pdf.

Cleansing Reported Benchmarking Data for Analysis

Once benchmarking data has been collected, a jurisdiction can reduce errors in its dataset through a well-developed and standardized data cleansing process. Data cleansing is the systematic process of reviewing data, identifying likely errors, and correcting or removing them.

Recognizing the importance of ensuring the quality of the benchmarking data they collect and publish, many of the cities that have established benchmarking requirements have since developed systemized approaches for verifying that acceptable quality standards are achieved. In 2017, the Institute for Market Transformation compiled the published data cleansing processes used by seven cities to identify the commonalities and differences in their approaches. The following is a summary of those procedures.

Initial Data Validation

Most cities described a first round of data cleansing in which they identified and removed duplicate records and records missing key values. Some cities reported attempts to correct these issues or validate unusual data values before removing them from the dataset. The following are common data issues cities addressed in the first round of data cleansing:

- duplicate benchmarking records, in which owners submitted more than one benchmarking report for the same property or building;
- records that misreported identifying information such as their City-assigned Building ID;
- records in which the building address was outside of the jurisdiction; and
- records with missing values for key data fields, such as gross floor area, EUI, water use intensity, GHG intensity, and meter data.

Data Cleansing

All of the published data cleansing procedures described a procedure for identifying outlier records. Outlier records contain extreme values in key data fields that are unlikely to be correct. To define outliers, cities set upper and lower limits for those data fields, representing the range of reasonable values for each field. Cities differ considerably in their approach to defining these limits. Some examples of city approaches to these fields are as follows:

Gross Floor Area

- In the benchmarking report for the City of San Francisco, records with a reported gross floor area of less than 100 square feet or greater than 7,000,000 square feet were removed.[27]

27 "San Francisco Existing Commercial Buildings Performance Report 2010-2014." SF Environment, ULI Greenprint Center for Building Performance. Accessed January 2018. https://sfenvironment.org/sites/default/files/fliers/files/sfe_gb_ecb_performancereport.pdf

- In the benchmarking report for New York City, records for properties that reported a gross floor area that was 30 percent greater or smaller than the values for the property found in the New York City Department of City Planning's Primary Land Use Tax Lot Output database were removed.[28]

Energy Use Intensity (EUI)

- Some cities selected upper and lower bounds that they deemed reasonable. The City of Boston used this approach in its 2015 report on 2013 benchmarking results, setting a lower EUI limit of five kBtu/sq. ft./year and an upper limit of 1,000 kBtu/sq. ft./year.[29]

- New York University Center for Urban Science and Progress developed a statistical methodology for New York City and Washington, D.C. The approach takes the natural logarithm of each record's EUI to normalize the distribution of values by building type. Records that are greater or less than two standard deviations from the mean for that building type are removed.[30]

- In its analysis of New York City's data, Urban Green Council set the upper and lower bounds based on the energy use intensities at which a building becomes too hot or cold for occupancy. This approach resulted in a lower bound EUI of 50 for all building types except non-refrigerated warehouses and an upper bound EUI of 1,000.[31]

ENERGY STAR Score

- Chicago removes records with ENERGY STAR scores of 1, 2, 99, or 100. The City does not remove properties with score of 99 or 100 if they had received an ENERGY STAR certification within the previous two years.[32]

Post-Cleansing Scanning

The City of Seattle is unique in that after performing data cleansing, it scans its data for indicators of quality and conducts a survey of outlier benchmarking reports. Seattle developed a method of searching for systematic errors in its dataset by calculating "indicators" of data quality. These indicators include the percentage of the dataset that used automated uploading of electric, gas, and steam consumption to populate its

28 "The New York City Energy & Water Use 2013 Report." Urban Green Council (2016). Accessed January 2018. http://urbangreencouncil.org/sites/default/files/nyc_energy_water_use_report_2016.pdf

29 "Energy and Water Use in Boston's Large Buildings, 2013." City of Boston Building Energy Reporting and Disclosure Ordinance (August 2015). Accessed January 2018.

30 Erin Beddingfield, et. al. "Putting Data to Work: Using Building Energy Performance Data to Expand the Market for Energy Efficiency in Buildings," ACEEE Summer Study on Energy Efficiency in Buildings (2016). Accessed January 2018. http://aceee.org/files/proceedings/2016/data/papers/7_324.pdf.

31 "The New York City Energy & Water Use 2013 Report." Urban Green Council (2016). Accessed January 2018. http://urbangreencouncil.org/sites/default/files/nyc_energy_water_use_report_2016.pdf

32 "Chicago Energy Benchmarking Results, Analysis, & Building Data." City of Chicago (2017). Accessed January 2018. https://www.cityofchicago.org/city/en/depts/mayor/supp_info/chicago-energy-benchmarking/Chicago_Energy_Benchmarking_Reports_Data.html

benchmarking report and the percentage of office and multifamily buildings that used default values for building use data fields. The City also checked gross floor area values against the King County Assessor's numbers to identify systematic over- or under-reporting, which would affect EUI results.

Seattle also developed an innovative approach to data quality by conducting a survey of properties flagged as outliers during the data cleansing process. One of the survey's most interesting findings was that high EUI values could often be explained by energy-intensive, secondary-use types housed within buildings. These secondary uses were either not entered into ENERGY STAR Portfolio Manager, so that they could be accounted for, or the particularities of the space's actual use were not well described by the most appropriate use type category in Portfolio Manager.[33]

Practical Application: Use Case for Data Cleansing

Jurisdictions have used combinations of the methods discussed above to increase the completeness and accuracy of the benchmarking reports they collect. The District of Columbia, one of the first jurisdictions to implement a benchmarking and transparency policy, illustrates the power of a comprehensive strategy to enhance data quality. Beginning in 2015, the District Department of Energy and Environment increased the level of technical support offered to reporting building owners and increased its focus on checking benchmarking reports for completeness. Only 75 percent of the initial benchmarking reports in the 2015 reporting cycle were complete, meaning they included key metrics such EUI and ENERGY STAR score. By the end of the reporting cycle, the District's greater technical support and data quality-focused enforcement efforts had increased the number of complete reports to 97 percent.[34] An improvement of this magnitude show that efforts to improve data quality are crucial to the success of benchmarking policies.

33 "Seattle Building Energy Benchmarking Analysis Report 2013 Data," Seattle Office of Sustainability & Environment (September 2015). Accessed January 2018. http://www.seattle.gov/Documents/Departments/OSE/EBR-2013-report.pdf.

34 Erin Beddingfield, et. al. "Putting Data to Work: Using Building Energy Performance Data to Expand the Market for Energy Efficiency in Buildings," ACEEE Summer Study on Energy Efficiency in Buildings (2016). Accessed January 2018. http://aceee.org/files/proceedings/2016/data/papers/7_324.pdf.

CHAPTER 5: WHAT'S NEXT?

Market Transformation

Energy benchmarking data is foundational to overcoming information barriers related to building performance in the real estate market, but a transformed market requires that all actors are aware of the existence and value of the data. Figure 5, below, explains the vision of a transformed market that fully integrates energy benchmarking data into the activities and decisions of governments, efficiency program implementers, building owners, managers and tenants, and lenders and investors.

Figure 5: Snapshot of a Transformed Market Integrating Data from Benchmarking into Decision Making

Once energy benchmarking data are incorporated into each market actor's business-as-usual activities, energy consumption becomes a consideration in transactional decisions, and energy-efficient investment and actions result.

For city and efficiency program implementers, creating the conditions for benchmarking data to be complete, accurate, and shared in a clear and understandable way are crucial activities that are underway in many cities. Several cities are also demonstrating the value of combining benchmarking data with additional datasets for targeted customer outreach to provide building decision makers with support, including clear guidance and next steps, to make their buildings efficient. Beyond these activities, cities can build off their benchmarking programs with additional policies and programs, along with collaborating with their servicing utilities, to continue increasing the efficiency of the buildings within their jurisdiction. Specific activities that building owners can take after benchmarking their buildings are discussed in the *Putting Data to Work* tool, "Efficiency and Beyond: Guidance for Energy Efficiency Program Administrators to Aid Building Owners," and the specific city and efficiency program implementer support of those activities is discussed in Chapter 3 of this report.

Policies and Programs

Direct market application of benchmarking data is not the only way that market transformation happens—it also is driven by government policies and energy efficiency programs whose effectiveness can be greatly enhanced by the use of benchmarking and audit data. Information being made available through benchmarking policies can have the potential to incentivize owners to invest more deeply in efficiency, if opportunities for improvement are clear. As market actors become familiar with the value and use of energy benchmarking information, there will be greater uptake of energy efficiency in buildings. This market transformation will likely take a considerable amount of time.

Comprehensive Performance Policies

Several cities have embraced or are considering policies that go beyond benchmarking and transparency, in an effort to more effectively motivate building owners' investment in energy efficiency and therefore more quickly capture the deep energy savings needed to meet their climate goals. Comprehensive performance policies are meant to move building owners toward analyzing their building performance data, identifying measures that can be taken to improve the energy performance of their buildings, and then implementing these efficiency measures to raise performance.

These policies often include a performance path, whereby the building owner has the flexibility to choose the combination of energy efficiency measures that allow them to comply with the law, through showing high performance or improved performance, and a prescriptive path whereby building owners are given clearly defined actions that comply with the law, including energy audits and retrocommissioning. Table 7, below, outlines the prescriptive and performance aspects of existing comprehensive performance policies.

Table 7: Comprehensive Building Performance Policies – Performance and Prescriptive Requirements[35]

JURISDICTION	PERFORMANCE REQUIREMENTS	PRESCRIPTIVE REQUIREMENTS
Atlanta	• ENERGY STAR certification; or • LEED EBOM certification; or • Energy performance at least 25 points better than an average building; or • ENERGY STAR score improved by 15 points or EUI reduced by 15 percent.	Energy audit
Berkeley, Calif.	• Building energy score or green building rating demonstrating an effective level of efficiency as determined by the City; or • Completion of a multi-measure energy improvement project with minimum improvement as determined by the City; or • Completion of an income-qualified weatherization assistance project.	Energy audit
Boston	• ENERGY STAR score of at least 75; or • LEED certification; or • Pattern of significant improvement in efficiency or • GHG emissions; or • Comprehensive energy management plan	Audit or energy action (significant investment in efficiency, comprehensive energy management plan, retrocommissioning (RCx) of energy systems, etc.)
Boulder, Colo.	• ENERGY STAR certification; or • LEED EBOM certification; or • Pattern of significant energy improvement	Energy audit and retrocommissioning; owner must implement any RCx measure with payback of two years
New York City	• ENERGY STAR certification; or • Energy performance 25 points or more better than the performance of an average building; or • LEED EBOM certification	Energy audit and retrocommissioning
San Francisco	• ENERGY STAR certification; or • LEED EBOM certification	Energy audit or retrocommissioning or retrofits
Seattle	• ENERGY STAR certification; or • LEED Gold certification; or • Net-zero energy certification from International Living Future Institute; or • Active monitoring and continuous commissioning; or • Energy savings of at least 15 percent	Building tune-up

35 Zachary Hart, et. al. "Building Performance Policies: A Comprehensive Approach," ACEEE Summer Study on Energy Efficiency in Buildings (2016): page 9-5. Accessed January 2018. http://aceee.org/files/proceedings/2016/data/papers/9_955.pdf

City Government as Responsive Service Provider

City government staff are often driven by the desire to serve and improve their communities. In this vein, many city staff relish the opportunity to provide services to constituents—whether educating them about efficiency opportunities or a referring them to a utility incentive program. In the near future, City government help centers that are currently focused on reacting to compliance questions will evolve into one-stop shops that move customers along the pathway of energy efficiency. Whereas a customer might call to simply ask for help in reporting, she might also leave the conversation with an understanding of an efficiency project's payback, a list of utility incentives to pursue, and an interest in taking the next steps in engaging in an energy audit. In essence, cities are seeing that they can provide services that build upon policies they have put in place, to accelerate interest and action on the part of building owners and those who serve them.

To further enable city government to serve as a first-class service provider to the real estate community, communications and relationships between the city or efficiency program implementers and building decision makers should be carefully tracked and managed. This will ensure that the interactions with building decision makers are streamlined and cohesive, avoiding the "program fatigue" of a building decision maker being contacted repeatedly about disparate programs from different points of contact within the city. Ideally, this interaction is customized to the specific needs of the building, with city government agencies outside of building energy efficiency (for example, regulatory and permitting agencies, city tax offices, planning departments, and others) being involved in the streamlining of communications.

Collaboration between the City and Utility

Cities can work with utilities to streamline the sharing of energy consumption data, through platforms such as Portfolio Manager's Web Services automatic upload. This is a data quality assurance activity discussed as a solution for user entry error, but it also benefits the city and utility through streamlined information sharing. Automatic upload gives a city confidence that the data being reported are more accurate than reporter-collected, manually entered data, and the process of connecting the datasets also gives the utility access to building-level information that may supplement its existing customer data and enhance its targeting and outreach strategy.

Beyond streamlined data sharing, there is the potential to share capacity in outreach and education staff through partnerships, streamline and integrate program offerings to avoid duplication and build off one another, and standardize metrics between City and utility programs. This collaboration would help increase the likelihood that building decision makers will understand how their buildings can be made more energy efficient. For a detailed discussion of the benefits of energy benchmarking data to utilities, reference the *Putting Data to Work* report, "Emerging Uses for Building Energy Data for Utilities."

CONCLUSION

As exemplified in *Putting Data to Work* by New York City and Washington, DC, cities are serious in their commitments to improving the energy efficiency of their communities' built environments and they are designing policies specifically to surface information that will motivate energy efficiency investment. While regulation will surely remain one of the tools with which cities aim to raise awareness of energy efficiency and accelerate investment in it, most cities, including the District and New York, are actively embracing other, non-mandatory approaches in parallel. City governments recognize that by working in partnership with the real estate community—working with them to better understand their barriers and challenges—they will be better equipped to design programs and incentives that are adequately supportive and spur market growth. The District and New York are proving that accelerating investment does not require large sums of cash to be paid out in incentives; there is much to be gained simply by using benchmarking and audit data to target outreach and communications. Building energy policy data has the potential to create fresh dialogue between new stakeholders, igniting powerful connections that result in energy upgrades and—in aggregate—build a privately sustainable retrofit market where energy efficiency is business-as-usual.

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APPENDIX A: ACRONYMS

BEAP	› Building Energy Assessment Professional
BID	› Business Improvement District
BOMA	› Building Owners and Managers Association
CDP	› Carbon Disclosure Project
CEM	› Certified Energy Manager
CFM	› Certified Facilities Manager
CO2e	› Carbon Dioxide Equivalent
DC	› District of Columbia
DCSEU	› District of Columbia Sustainable Energy Utility
DOE	› U.S. Department of Energy
DOEE	› District of Columbia Department of Energy & Environment
DSM	› Demand-Side Management
EMIS	› Energy Management Information Systems
EPA	› U.S. Environmental Protection Agency
ESCO	› Energy Service Company
EUI	› Energy Use Intensity
GHG	› Greenhouse Gas
IMT	› Institute for Market Transformation
LEED	› Leadership in Energy and Environmental Design
NGO	› Non-Governmental Organization
NYC	› New York City
NYCEEC	› NYC Energy Efficiency Corporation
PACE	› Property Assessed Clean Energy
RCx	› Retrocommissioning
USGBC	› U.S. Green Building Council
LEED	› Leadership in Energy and Environmental Design
NGO	› Non-Governmental Organization
NYC	› New York City
NYCEEC	› NYC Energy Efficiency Corporation
PACE	› Property Assessed Clean Energy
RCx	› Retrocommissioning
USGBC	› U.S. Green Building Council

APPENDIX B: U.S. DEPARTMENT OF ENERGY DATA TOOLS FOR CITIES

The U.S. Department of Energy (DOE) has a suite of data tools and standards that cities can use for management of building energy performance data. These include the following tools.

The **Building Energy Asset Score** is a national standardized tool for assessing the physical and structural energy efficiency of commercial and multifamily residential buildings. The Asset Score generates a simple energy efficiency rating that enables comparison among buildings and identifies opportunities to invest in energy efficiency upgrades.[1]

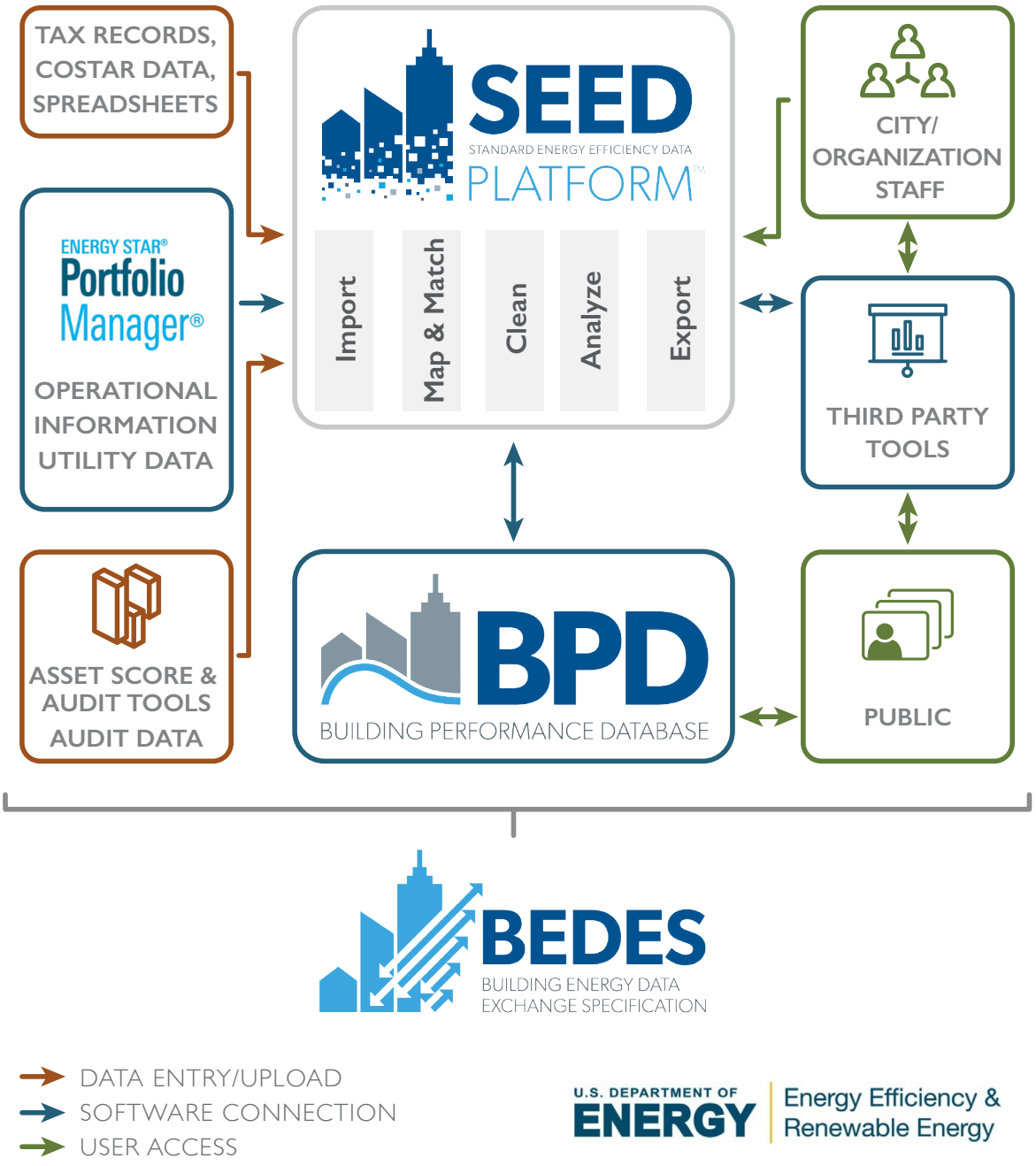
The **Building Energy Data Exchange Specification (BEDES)** is a dictionary of terms, definitions, and field formats which was created to help facilitate the exchange of information on building characteristics and energy use. It is intended to be used in tools and activities that help stakeholders make energy investment decisions, track building performance, and implement energy efficient policies and programs.[2] BEDES allows for standardized terms to be used across applications, and ensures that cities are using the same language when referring to various energy-related systems and topics.

The **Building Performance Database (BPD)** is the largest dataset of information about the energy-related characteristics of commercial and residential buildings in the United States. The BPD combines, cleanses and anonymizes data collected by Federal, State and local governments, utilities, energy efficiency programs, building owners and private companies, and makes it available to the public.[3] This allows for the energy performance of buildings to be compared with their peers based on sector, region, or various physical or operational characteristics.

The **Standard Energy Efficiency Data (SEED) Platform** is an open source, standardized enterprise data platform to manage building performance data from a variety of sources. DOE developed SEED to help public agencies that are either implementing building performance reporting regulations and/or tracking the performance of their own buildings. The SEED source code is free, which significantly reduces software development costs and the need for IT support of custom applications.[4] SEED allows cities to tie together multiple disparate data sources into one secure database, which streamlines implementation of building performance policies, and allows for multiple users to access the same centralized database.

The figure below shows how these tools fit together and can be used by cities implementing building energy performance policies.

1 "Building Energy Asset Score," U.S. Department of Energy, https://energy.gov/eere/buildings/building-energy-asset-score, accessed February 2018.
2 "Building Energy Data Exchange Specification," U.S. Department of Energy, https://energy.gov/eere/buildings/building-energy-data-exchange-specification-bedes, accessed February 2018.
3 "Building Performance Database," U.S. Department of Energy, https://energy.gov/eere/buildings/building-performance-database, accessed February 2018
4 "Standard Energy Efficiency Data Platform," U.S. Department of Energy, https://energy.gov/eere/buildings/standard-energy-efficiency-data-platform, accessed February 2018.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ENERGY STAR® Portfolio Manager®
OPERATIONAL INFORMATION UTILITY DATA
ASSET SCORE & AUDIT TOOLS
AUDIT DATA
SEED
STANDARD ENERGY EFFICIENCY DATA PLATFORM™
Import
Map & Match
Clean
Analyze
Export
BPD
BUILDING PERFORMANCE DATABASE
CITY/ ORGANIZATION STAFF
THIRD PARTY TOOLS
PUBLIC
BEDES
BUILDING ENERGY DATA EXCHANGE SPECIFICATION
DATA ENTRY/UPLOAD
SOFTWARE CONNECTION
USER ACCESS
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