Putting Building Energy Benchmarking Data into Action

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ABSTRACT

Energy benchmarking and transparency laws in the real estate sector are opening the door to a new era of data-driven decision making by a range of stakeholders in cities, from building owners and tenants to utilities and performance contractors. Sixteen cities and counties currently have energy benchmarking and transparency ordinances in place and are piloting innovative approaches to ensure that this newly-created access to building energy performance data ultimately leads to energy efficiency improvements in our built environment. This paper will provide a survey of different strategies, technologies, and tools that cities and their counterparts in the nonprofit, academic, public, and private sectors have developed and deployed to make energy benchmarking data actionable and drive transformation of the real estate market, with a focus on characterization of target audiences and classification of various data delivery methods. The analysis will also provide best practices for how the next wave of jurisdictions can integrate data delivery methods into their planning and implementation of energy benchmarking and transparency laws. Finally, we will identify additional market opportunities to expand the impact and usage of these data.

Introduction

It is estimated that cost-effective energy efficiency upgrades in the residential, commercial, and institutional building sectors represent a $279 billion investment opportunity, returning $1 trillion in energy savings over 10 years.[1] The first step in tapping into that energy efficiency opportunity is to measure and track building performance metrics. Capturing that data allows not only the people directly connected to those buildings – owners, managers, operators, occupiers, investors, engineers – to reduce energy consumption and improve efficiency, but also the entities who drive energy through market and policy forces – such as policymakers, utilities, rating agencies, and codes councils and standards organizations – to use market forces to drive energy reductions in the built environment.

Local energy benchmarking and transparency laws are opening the door to a new era of data-driven decision making by a range of stakeholders, from building owners and tenants to utilities and performance contractors. Since 2008, sixteen cities and counties have adopted legislation that requires private property owners to benchmark energy performance and disclose the metrics, which are either published periodically or released at the time of a real estate transaction. Access to building performance metrics is intended to transform the way that the real estate market values and invests in energy efficiency in buildings, by making the information freely available so it can factor into decision making processes. Cities, partners, and private companies are piloting innovative approaches to ensure that this newly-created access to building energy performance data ultimately leads to energy conservation and efficiency improvements in the built environment.

The real estate industry is a particularly large and fragmented market. Unlike some other industries such as health care or manufacturing, there are few dominant companies. Instead, the market is composed of a vast number of firms and individuals in areas as diverse as building managers and operators, tenants, policymakers, appraisers, financing, energy service providers, engineering and architectural design professionals, construction firms, etc. In order to help move "the market" as a whole, each of these groups has a role to play. Better access to building performance metrics can yield energy efficiency improvements in buildings. But, in order for these data to result in actual energy improvements, the right information needs to be conveyed to the right players, through the right channels, at the right time. Cities have been deploying various data delivery strategies to determine the type of information that will be most relevant and impactful to each segment.

Building Performance Information Delivery Strategies

The optimal strategy for delivering building performance information depends heavily on what information is being conveyed and to whom it is targeted. This section will establish a framework for analyzing delivery strategies based on the granularity of the data (i.e. where does the data lie on a spectrum from real-time submeter points to trend data for large sets of buildings?) and the availability of the data to the public (i.e. where does disclosure lie on a spectrum from private to publicly available and easy to access?).

Access to Building Performance Information

Depending on the level of sensitivity or market opportunity associated with particular information, building performance data are conveyed on a spectrum of publicly available to privately conveyed. The most sensitive information, such as real-time energy use or submetering data, is often shared privately to building owners and managers through password protected portals and dashboards. These tools allow the building management team to track operations and energy performance for internal management, without sharing information that is possibly sensitive to the owner or tenants with the general public. There are also data that are held private because of market opportunity associated with those data. For example, some real estate information aggregation services may collect building performance information as part of a broader database and sell it to interested parties. There are other platforms that collect building performance data and share robust analytics and comparisons only with members, those paying for the service, or those voluntarily sharing private data with the platform. Companies and organizations like these see value in making building performance more relevant, targeted, or easier to access than what is available in the public sphere and are able to capitalize on the delivery of that information.

We also consider data that are released into the public sphere to be on a spectrum, because while any information classified as public in this paper can be accessed by anyone without cost, the relative level of user-friendly interface and targeted messaging can affect how truly accessible, usable, and digestible those data are. So, while some data sets may be publicly released, for example on a city's open data portal, those data are not translated for a general audience or made easily navigable, so the meaning and relevance remain somewhat elusive to general audiences. Similarly, tools or platforms targeted at extremely narrow audiences are not

generally accessible. So, for the purposes of this paper, tools and strategies that are classified as stronger on the public spectrum tend to contain design features that make the building performance information more relevant, relatable, and dynamic for general users.

Granularity of Building Performance Information

Building performance data come in many forms and range from very specific, "granular" data to broad trend and analytical data that span portfolios, geographies, and building types. In recent years, building owners and managers have released more granular data into the public sphere – in some cases voluntarily, and in other cases as a response to local benchmarking requirements. For purposes of this paper, we will classify all data points that can be assigned to a particular building or property as "granular." This includes the information that is made publicly transparent through local benchmarking laws such as annualized whole-building energy use intensities, ENERGY STAR scores, emissions profiles, and water use metrics of a particular building with an associated, disclosed address. Granular data can also be much more specific by drilling down into real-time or interval data

Access to large scale sets of building performance data has allowed for increased analysis and release of "meta" data which looks at trends and high-level statistics to inform the market, policymakers, and other parties about the composition of building stock, to identify what correlations exist between building characteristics and energy performance characteristics across a broad swath of buildings, and to start to parse out high-level areas of opportunity for increased efficiency. Utilizing metadata in conjunction with more granular datasets can allow for a robust assessment of energy efficiency opportunities across a market or sector.

Target Audiences

In order for energy benchmarking to drive investment in energy efficiency, the right audiences must have access to the right data and incorporate it into their regular decision making process at the appropriate time. The most obvious target audiences for energy benchmarking data are members of the real estate sector – owners, managers, and investors – real estate decision makers who directly control or influence how investments are made in a property. Having access to building performance information can influence how these parties make investment and management decisions.

There are other parties who stand to benefit from building performance data as well, and the purpose of many benchmarking laws is to ensure that broad audiences have access to building performance information so that they can make effective and informed decisions, taking efficiency into account. The intended audiences for building performance information, the desired use, and which types of data delivery strategies are relevant to them are discussed in additional detail in Table 1.

Table 1. Market actors, desired action, and relevant building performance data delivery.

Actor or audience	Desired Use of Building Performance Information	Most relevant delivery strategies			
		Public, Meta	Public, Granular	Private, Granular	Private, Meta
Building Managers & Operators	Make operational and asset improvement decision	X	X	X	X
Tenants	Make leasing and transaction decisions		X	X	
Asset Owners	Make investment decisions, set internal standards		X	X	X
Policymakers	Craft effective building policy	X	X		X
Utilities	Design effective energy efficiency programs, allocate resources, and assess impact	X	X		X
Researchers	Assess impact of policies and programs, identify opportunities for large-scale improvement	X	X	X	X
Financiers and Lenders	Invest in energy efficiency improvements (more easily with lower barriers)		X	X	X
Rating Agencies and Actuaries	Assess risk and opportunity of investments and portfolios, inform credit ratings	X	X		X
Energy Service Providers and ESCOs	Target products and services to specific buildings or sectors	X	X	X	X
Codes & Standards Organizations	Assess impact of codes and move toward adoption of performance based codes, and strengthen other performance standards	X	X	X	X
Architectural, Engineering & Construction	Assess real impact of design, and adopt performance-incentivized contracting		X		
General Public	Understand importance of energy efficiency in buildings and demand high performance	X	X		

Survey of Existing Strategies and Tools for Delivery of Building Performance Information

In this section, we will look at existing strategies and tools that have been developed and deployed by local jurisdictions, government agencies, nonprofit partners, and private companies to deliver building performance information. The strategies and tools have been categorized according to their relative level of data granularity and public access (Figure 1), and we will describe the key characteristics of each strategy and provide explicit examples of each, where relevant. While this survey is not exhaustive, it is meant to convey the major trends in delivery of building performance information in a structured manner.

This framework allows us to broadly categorize the function of each type of data disclosure. The public-facing, metadata are meant to convey broad trends to the industry, so they are used to inform broad policymaking and program design, but are not particularly actionable at the individual building level. The public-facing granular data and the private-facing metadata are both meant to drive individual building action through comparative analysis, though with varying degrees of specificity. Finally, the private-facing, granular data are the best suited for informing investment and improvement decisions at individual properties or even on individual pieces of equipment.
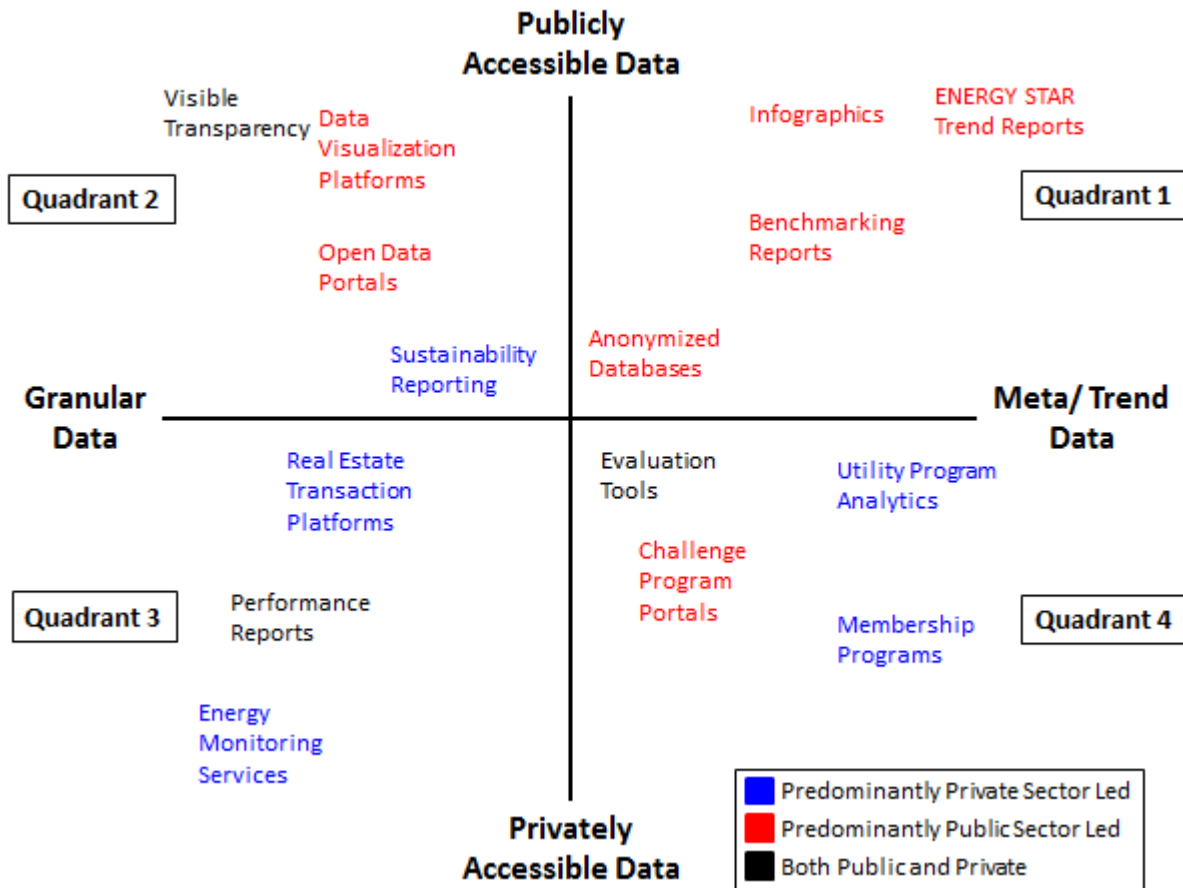

Figure 1. Survey of Existing Strategies and Tools for Delivery of Building Performance Information

Public-facing, Metadata (Quadrant 1)

Building performance information that is conveyed at a high level to a public audience, is intended to influence decisions about building efficiency at the portfolio, city, regional, or national scale by helping identify trends among large groups of buildings. The target audiences for public-facing, meta data are policymakers, utilities, and researchers.

Trend reports. At the least granular level, agencies such as the U.S. Environmental Protection Agency periodically publish reports that analyze aggregate energy use metrics for all properties

that benchmark energy performance in the ENERGY STAR Portfolio Manager® (ESPM) platform. The trend reports can also be broken down for specific property types or sectors, which helps provide more targeted information. Example: Portfolio Manager Data Trend reports[2]

Infographics. Infographics can be an effective way to show summary statistics and portfolio-wide information from benchmarking programs through eye-catching numbers and easy-to-understand images. The message contains interesting, relevant information for a broad audience, while being succinct within one image. Infographics may be published as part of a benchmarking report, or as a separate publication. This delivery strategy promotes awareness and understanding of building energy efficiency in the general public. Examples: 2015 Chicago Building Energy Benchmarking At-A-Glance[3], Solving Seattle's Energy Puzzle 2012[4]

Benchmarking reports. Per some benchmarking ordinances, the local jurisdiction is required to publish an annual report summarizing the disclosed benchmarking data and sharing jurisdiction-wide information about the local building stock. Such high-level statistics can paint a picture about the age, geographical distribution, energy mix, and sectors of local buildings which can be helpful to city officials and researchers alike. Policymakers can use this information to better craft effective policies and programs to incentivize improvements in energy efficiency. Example: City of Philadelphia 2016 Energy Benchmarking Report[5]

Anonymized databases. Data platforms that contain anonymized information provide access to broad and deep data while protecting the privacy of individual buildings. Anonymized databases, such as the U.S. Department of Energy's Building Performance Database, are populated with both voluntary and mandatory benchmarking data. Because no identifying information is disclosed, this public-sector tool can provide deep analysis on building characteristics and energy use data that is not legally allowed to be publicized in most jurisdictions, such as information about specific equipment types and utility costs. Data are typically aggregated at the zip code level, and allow for users to select data fields for custom analytics. Anonymized building performance databases are typically technically-oriented, so fall lower on the public accessibility spectrum, but are excellent resources for in-depth analysis of comparative building performance. Example: Department of Energy Building Performance Database[6]

Public-facing, Granular Data (Quadrant 2)

Building performance information that is attributed to a specific property and available to the public is designed to help market actors make investment decisions. This information is available to the general public and is typically shared for an individual building or a geographically or otherwise constrained subset of buildings, such as a city or portfolio.

Sustainability reporting. Many building or portfolio managers disclose details about sustainability of their properties voluntarily or as part of the environmental, social, and governance (ESG) or corporate social responsibility (CSR) reporting required in publicly available filings. The information included in sustainability reporting can include data on individual buildings or the whole portfolio. This information is targeted at real estate investors and rating agencies to help them effectively assess the risk and opportunity associated with a property or portfolio's energy performance. Additionally, as shareholder and consumer interest

in sustainability continues to rise and increasing pressure is placed on companies to operate in an environmentally friendly way, such public transparency of information will be analyzed by a larger audience. Example: GRESB[7]

Open data portals. In many jurisdictions with benchmarking and transparency laws, the law requires the city to disclose a subset of the data reported by building owners to the public. The method of transparency is often not stipulated in the law, but the easiest and most common method for a city to do this is by posting a spreadsheet of the disclosed benchmarking data on the city's website. If the city has an "Open Data Portal," commonly used to store public data for download, then the benchmarking data are often housed there as well. In both options, the benchmarking data are presented to the public in its most raw form, directly from the ESPM output. While this data delivery strategy conveys the permissible data disclosure for individual buildings that can facilitate research or even targeted marketing, it is not necessarily easily accessible or user friendly. Example: 2014 NYC OpenData Energy and Water Data Reporting for Local Law 84[8]

Data visualization platforms. A newer trend among jurisdictions that manage benchmarking programs is to make the building performance data available to the public in the form of an online data visualization platform – often an interactive map with buildings displayed geographically along with dynamic trend graphics. These tools differ in the amount of data available for each building, the ability to filter and alter the visualization based on different building metrics, and the ability to compare individual or groups of buildings against each other. The overall goal of these tools is to allow a broad audience, like building occupants or energy service providers, to interact with building performance data visually and be able to explore trends across the local building stock in a user friendly and easily approachable way. Examples: Boston's Energy Reporting and Disclosure Ordinance Map[9]; 2015 Chicago Building Energy Performance Map[10]

Visible transparency. At the more extreme end of the granular and public-facing spectrum is visible transparency, a new trend to show real-time building performance data through a public platform like an in-building display or a website. This approach is always voluntary, at the building or portfolio owner's discretion, and demonstrates a commitment to transparency that goes above and beyond what is typically required by local law or even internal reporting. Delivering such a granular level of data in such an open way, can engage a broad audience. For example, building operators and occupants may change their own behaviors based on data conveyed through open transparency, energy service providers can assess building performance before the first conversation with a potential customer, and researchers and policymakers can dive deeper into granular data to better understand broad trends. Example: BuildSmart DC[11]

Private-facing, Granular Data (Quadrant 3)

Tracking data streams at a granular level, ranging from whole-building metering to systems-level submetering or even equipment level monitoring is often sensitive. Accessing this data could tell a viewer when a building is occupied or unoccupied and how it uses certain systems. Building performance data that is provided at this level, tends to be highly actionable, and is able to spur corrective action, operational improvements, and drive investment in energy

efficiency. Because these private-facing data delivery mechanisms are typically proprietary, the examples included in this section include some private companies and fee-for-service. Inclusion in this paper does not constitute an endorsement.

Real estate information platforms. An important part of conveying building performance data is making sure it is integrated into regular real estate decision-making processes. In the real estate sector, platforms and databases that house property information are used in real estate transactions. Increasingly, these databases have included not only information on green labels like LEED and ENERGY STAR, but also a property's energy performance metrics that are publicly available through benchmarking laws. While these platforms may utilize data that is publicly available, it is often delivered as part of a data aggregator service for a fee, reaching a specific, targeted audience of the parties involved in real estate transaction. Example: CoStar[12]

Performance scorecards. In an effort to personalize benchmarking data and make the outputs useful to building owners, several cities with benchmarking ordinances have issued "building report cards" to building owners who complied with the law. The information on the scorecards varies, but the intent is to help building owners see how the energy performance of their building compares to similar buildings in the community and recommend next steps for improvement. This comparison can be based on energy use intensity (EUI) values, ENERGY STAR scores, or other whole-building methods. The report card may also provide links and recommendations to programs that could help a building owner improve their performance. Examples: Cities of Philadelphia, Chicago, Seattle building report cards (not publicly available).

Energy monitoring services. At the most extreme ends of the granular, private-data spectrum are data streams that utilize real-time or interval data at the whole-building or even system submeter level and are extremely private due to the sensitive nature of such information. This information is typically delivered through a dashboard or even to an app on the property management team members' phone so that immediate, corrective action can be taken. Even without real-time data, energy monitoring services and dashboards serve as a structured, visual way to track building performance data over time to inform efficiency improvement decisions. Examples: FirstFuel Software[13], WegoWise[14], BuildingIQ[15]

Private-facing, Metadata (Quadrant 4)

Building performance information that contains trend data and analysis, but is not publicly available serves a similar purpose to the publicly available, granular data – to inform market decisions – but does so utilizing information that is typically treated as confidential, such as systems and equipment data or financial data, so is only shared through private mechanisms.

Membership program portals and reports. Nationally, several groups have emerged that collect and analyze building performance data for a subset of member buildings and issue reports or provide access to benchmarking portals for a fee. Typically the data collected on the platform will be deeper than the data collected by mandatory local benchmarking laws, and include confidential information such as operating expenses, utility costs, system or equipment types, and retrofit activity. Access to these types of data allow the membership programs to make more specific benchmarking comparisons, based on specific building or system trends, and include the

financial implications that are not available through publicly released trend reporting. Example: Urban Land Institute Greenprint Center for Building Performance[16]

Challenge program portals. Across the country, many jurisdictions and organizations have voluntarily joined local or national energy efficiency challenge programs. Some of the most well-known voluntary challenge programs include the Better Buildings Challenge, the Green Office Challenge, and Architecture 2030. Part of the commitment typically includes reporting benchmarking data to the program administrator. In many cases, the challenge programs use data management portals to collect and analyze the building performance data to assess not only individual building progress, but also overall program progress. Some of the trend analytics may be reported publicly, and others are typically communicated only to the buildings and partners participating in the program. Example: Architecture 2030's 2030 Districts Project Portal[17]

Opportunity calculators. Some tools have been developed through public-private partnership that utilize publicly available trend data combined with rich historical performance data from other sources, to predict a building's energy savings potential. These tools are based on existing datasets with some additional private building information, and using an algorithm, perform targeted analysis. This type of calculator tool allows users to evaluate opportunities in a specific building based on custom analysis that utilizes publicly available trend data from local benchmarking requirements, private datasets from partner groups, and user-provided, building-specific inputs like utility costs or system types. Example: NYC Energy Efficiency Corporation (NYCEEC) efficienSEE™ Calculator[18]

Recommendations for Best Practice and Further Development

Access to and interest in broad scale building energy performance data are relatively new and as such the industry is evolving rapidly. Cities and other interest groups are providing more useful ways to access the publicly available data collected through benchmarking laws, but there is room for improvement in the way that information is collected, shared, and utilized. Several recommendations for best practice and areas for continued development are identified and described below:

Testing and improvement. It is important to recognize that the industry is still in a relatively nascent stage of delivering building performance data. Many of the delivery strategies have been designed by subject matter experts, with varying levels of outside input or end-user feedback. It is critical to continually run tests, focus groups, and collect feedback on the impact of data delivery strategies to ensure that the right information is being delivered to the right audiences, and spurring the desired actions. New products and iterations on existing products should incorporate the results of testing in a continuous feedback cycle.

Common data structure. For building performance information to have an impact beyond tracking performance over time in a single building, it must be formatted in a way that is comparable to other buildings. For this reason, it is critical that building performance data be collected and delivered using a common data structure. The Department of Energy has developed the Building Energy Data Exchange Specification (BEDES), which is a data dictionary and

structure specification, to ensure that building energy data are compatible across datasets. Furthermore, the DOE has also taken steps to ensure that the way jurisdictions collect and process benchmarking data through local laws is as consistent as possible. The Standard Energy Efficiency Data (SEED) Platform is an open-source software tool that cities, states, or other entities utilize to manage building performance information. The SEED Platform is not only BEDES compliant, but also brings standardization to the ways jurisdictions perform data quality and compliance assessments. Outside tools and platforms can utilize data from SEED using its open application program interface (API), which enhances consistency of publicly available data, while minimizing ongoing data management burden on third-party developers. Specifications like BEDES and common platforms like SEED are important to making data compatible across buildings, portfolios, cities, and the nation. Development of further data delivery tools, platforms, and schema should adopt common data structure specifications as a best practice and utilize the SEED Platform API whenever possible.

Open ecosystem. As the saying goes, a rising tide lifts all boats. Public access to building performance data is a new phenomenon and an influx of attention to and investment in these data will drive more demand for infrastructure, tools, platforms, and analytics to collect, manage, understand, and measure the data. The market will benefit from a collaborative ecosystem, not only where common data structures and specifications are adhered to, but also where lessons learned are shared and progress achieved by one organization can accelerate the innovation of another. Several tools have been designed in this spirit, such as the SEED Platform, which has open architecture, and the City Energy Project data visualization platform, which was built using open-source components with an open codebase. Openly sharing advancements in basic infrastructure and architecture, or new, basic tools will help move the industry more rapidly toward a place where building performance information is accessible and utilized by all target audiences in their everyday activities. The more quickly energy performance data becomes business-as-usual, the more quickly there will be a robust market for a wide variety of data collection, management, and analytic tools and services.

Joint procurement. Across the country, many of the data delivery needs and strategies are similar. For example, cities and jurisdictions with benchmarking and transparency laws all commonly need to deliver building performance data through benchmarking reports, infographics, open data portals, and data visualization platforms. There is tremendous opportunity to achieve economies of scale through jointly procuring such tools across multiple cities. As an example, the City Energy Project (CEP) works with ten cities that collect either voluntary or mandatory energy benchmarking data. Despite different use cases, CEP was able to identify a set of common goals and design a platform that was customizable and inexpensively deployed across multiple cities. Such consolidation of effort can be led by partner organizations that work with multiple jurisdictions, or a coalition of interested parties, such as a cohort of cities. In addition to the public-led efforts, there is opportunity for private solutions to enter the space to provide cost-effective solutions to not only cities, but also portfolios or energy service providers.

Measurement and verification. In the data-driven environment of policy design and compliance, it is crucial to ensure that programs are producing anticipated results. By collecting both granular and metadata, parties like municipalities and utility energy incentive programs, are

better able to follow trends to ensure programs are on track and also dive deeper into granular data to identify the reasons why or why not. The existing tools and data management platforms offer minimal functionality for tracking trends or identifying anomalies. There is an opportunity to further build out the measurement and verification technologies to meet the demand for effectiveness tracking in government and utilities.

Performance based outcomes. Intention is no substitute for outcome. Increasingly, transparency laws have shown that newly-constructed buildings are not performing as designed, or, after measurement and verification, buildings are not achieving energy targets for green building certification and recognition. With existing benchmarking and transparency laws to facilitate it, jurisdictions could move toward performance based codes, where newly constructed buildings are required to demonstrate that they actually perform to the specified standard after a year or more of operation. There is opportunity for better integration between existing code compliance technologies and emerging performance data technologies.

Underserved audiences. Most of the data delivery strategies analyzed in this paper are targeted at the direct decision-makers in the real estate market: managers, tenants, and owners. In order to transform the market and drive increased investment in energy efficiency, these are very important audiences. However, there is opportunity to target upstream market influencers with more specific and targeted data delivery strategies. For example, making energy performance data more usable to lenders will increase the ease at which improvements are financed, and delivering usable data to rating agencies will allow them to bake-in utility cost or regulatory risk into their assessment of portfolios, spurring asset owners to invest in efficiency. Other actors involved in the improvement of buildings, such as energy service providers, ESCOs, architects, engineers, and construction companies can all be more deeply engaged through new data delivery strategies including, custom analytics, lead generation tools, marketplaces, and other service lines that capitalize upon the emergent building energy efficiency vertical. To reach the full spectrum of actors in the real estate market there is a tremendous market opportunity for the private sector to drive the development of new technologies.

Conclusion

Many new and useful tools, platforms and technologies have emerged as strategies to deliver building performance information to a range of audiences. Historically, building owners and operators have had access to private, granular building performance data, but increasingly, building benchmarking data are becoming more widely available through local laws and voluntary programs, along with robust trend analysis and metadata that provide unprecedented insight into how existing buildings are performing. Access to data is an important first step in transforming the way the real estate market values energy performance in buildings, but the next step is ensuring that the right audiences are armed with the right pieces of information at the right time to make actionable decisions. This requires data delivery mechanisms that are tailored to their target audiences and delivered through the appropriate technology solution.

The analysis set forth in this paper provides both a characterization of the relevant target audiences for building benchmarking and energy performance data as well as a framework for classification of data on a scale of granularity and public accessibility that can be utilized by

local governments and organizations in the nonprofit, academic, public, and private sectors can use to assess appropriate methods of data delivery to maximize market impact.

While the current landscape of tools is extremely valuable, there is opportunity to take the delivery strategies to the next level by implementing identified best practices, continually assessing effectiveness to make improvements, and taking advantage of emerging market opportunities that will fill gaps in data delivery and ensure that all audiences and market actors are utilizing data in a transformative way.

References

(1) Rockefeller Foundation and DB Climate Change Advisors. "United States Building Energy Efficiency Retrofits Market Sizing and Financing Models." March 2012. https://assets.rockefellerfoundation.org/app/uploads/20120301221532/United-StatesBuilding-Energy-Efficiency-Retrofits.pdf

(2) U.S. EPA. "ENERGY STAR Portfolio Manager DataTrends." October 2012. https://www.energystar.gov/buildings/about-us/research-and-reports/portfolio-manager-datatrends

(3) City of Chicago. "2015 Energy Benchmarking At-A-Glance." December 2015. http://www.cityofchicago.org/content/dam/city/progs/env/EnergyBenchmark/2015_Benchmarking_At_A_Glance_Thumb.jpg

(4) City of Seattle. "Solving Seattle's Energy Puzzle." 2012. http://www.seattle.gov/Documents/Departments/OSE/Seattle_Benchmarking_2012.pdf

(5) City of Philadelphia. "2016 Building Benchmarking Report." 2016. http://www.phillybuildingbenchmarking.com/wp-content/uploads/2016/04/2016-Benchmarking-Report.pdf

(6) Lawrence Berkeley National Lab. "Building Performance Database." https://bpd.lbl.gov/

(7) GRESB. https://www.gresb.com/

(8) NYC OpenData. "Energy and Water Data Disclosure for Local Law (2014)." 2015. https://data.cityofnewyork.us/Environment/Energy-and-Water-Data-Disclosure-for-Local-Law-201/jzst-u7j8

(9) Greenovate Boston. "Building Energy and Reporting Disclosure Ordinance Map." 2015. http://berdo.greenovateboston.org/#Map

(10) City of Chicago. "2015 Chicago Building Energy Performance Map." 2015. 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

(11) BuildSmart DC. http://www.buildsmartdc.com/

(12) CoStar.com. http://www.costar.com/

(13) FirstFuel Software. http://www.firstfuel.com/

(14) WegoWise. https://www.wegowise.com/

(15) BuildingIQ. https://www.buildingiq.com/

(16) Urban Land Institute. "Greenprint Platform for Environmental Management." http://uli.org/research/centers-initiatives/greenprint-center/greenprint-environmental-management-platform/

(17) Architecture 2030. http://architecture2030.org/2030_challenges/2030-challenge/

(18) NYCEEC. "efficienSEE Calculator." http://nyceec.com/efficiensee/