A National Framework for Energy Audit Ordinances

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ABSTRACT

A handful of U.S. cities have begun to incorporate energy audits into their building energy performance policies. Cities are beginning to recognize an opportunity to use several information tools to bring to real estate markets both motivation to improve efficiency and actionable pointers on how to improve. Care is necessary to combine such tools as operational ratings, energy audits, asset ratings, and building retro-commissioning in an effective policy regime that maximizes market impact In this paper, the authors focus on energy audits and consider both the needs of the policies' implementers in local governments and the emerging standards and federal tools to improve data collection and practitioner engagement. Over the past two years, we have compared several related data formats such as New York City's existing audit reporting spreadsheet, ASHRAE guidance on building energy auditing, and the DOE Building Energy Asset Score, to identify a possible set of required and optional fields for energy audit reporting programs. Doing so revealed tensions between the ease of data collection and the value of more detailed information, which had implications for the effort and qualifications needed to complete the energy audit. The resulting list of data fields is now feeding back into the regulatory process in several cities currently working on implementing or developing audit policies. Using complementary policies and standardized tools for data transmission, the next generation of policies and programs will be tailored to local building stock and can more effectively target improvement opportunities through each building's life.

Introduction

This paper discusses how American cities are integrating energy audits into their suite of building energy performance policies, discusses the associated data challenges, and presents a path for cities to use federal tools and a standardized data format to both streamline reporting and improve usability of the resulting data.

Policy Landscape

Cities are responsible for 75 percent of global CO2 emissions, with transport and buildings being among the largest contributors to climate change (UNEP 2016). Centralized energy in the form of fossil fuel fired power plants are the largest source of U.S. carbon dioxide (CO^2) emissions which in 2014 was 38 percent of the total U.S. emissions (EIA 2015). Cities bear a large portion of responsibility for climate change, are at serious risk from its impacts, and have the greatest ability to create positive change. As more local governments in the U.S. use policies and programs to drive improvements in energy and emissions rates, the first step should be to gather standardize data that informs smart energy policy.

Energy policy can provide transparency for several pieces of information that help address the market failures that hinder implementation of cost-effective energy efficiency in buildings. An operational rating can provide a clear understanding of a building's overall energy performance. An energy audit can help a building understand what specific measures to take to improve performance. Adding an asset rating can help provide an understanding of the efficiency of a building's capital assets before and after retrofit and can contribute to energy efficiency's incorporation into building valuation. Others have more thoroughly discussed the differences between and uses of operational ratings, asset ratings, and other energy performance indices (Goldstein 2013).

A number of local governments in the US have adopted energy policies related to energy benchmarking and transparency, and assessments (or "energy audits"). These policies are intended to spur building owners to take action on energy efficiency and result in reduced energy consumption (DOE 2015a). For example, a DOE analysis of New York City's suite of building energy performance policies including benchmarking suggested gross energy savings of 5.7% during the first four years of the policies (DOE 2015c). However, there are at least two more reasons that this data is critically important. Baseline data about the building stock assets, and aggregated data about energy consumption help a public agency can craft the details about the square footage and covered building types in a policy. More granular data about the building stock and specific data about energy performance also help a local government, utility programs, or others to effectively design other programs that target energy use reductions. For these reasons, cities benefit from maintaining a dynamic dataset about their building stock and its energy performance.

As a result, the authors have been discussing how best to ensure that policies including energy audits can be most effective. We consider both the needs of the policies' implementers in local governments and the latest federal tools and initiatives to improve data collection, and practitioner engagement. Over the past two years, we have compared several related data formats such as New York City's existing audit reporting spreadsheet, ASHRAE guidance on building energy auditing, and the DOE Building Energy Asset Score, to identify a possible set of required and optional fields for energy audit reporting programs. Doing so revealed tensions between the ease of data collection and the value of more detailed information, which had implications for the effort and qualifications needed to complete the energy audit. The resulting list of data fields is now feeding back into the regulatory process in several cities currently working on implementing or developing audit policies. With complementary policies and standardized tools for data transmission, the next generation of policies and incentives will be tailored to local building stock and able to undertake innovative approaches such as measured performance-based code compliance. By having consistent metrics a jurisdiction will be able to track not only expected performance of a building at design stages, but ongoing energy performance throughout the building's life.

Building Energy Audit Policies

DOE and others have invested significant resources into streamlining and standardizing approaches to collect, transmit, and manage building energy performance data. We are making this effort because the current lack of standardization creates unnecessary friction in the process of using data to make effective decisions about capital and operational expenditures to cost-effectively improve energy efficiency of buildings. Improving interoperability across the buildings industry will increase the value of building energy performance data by making that is already collected more portable, more comparable, and generally more usable by any of the key decision makers who influence improvements in building efficiency. This includes building owners, managers and occupants; building design and construction professionals, building service providers and technology vendors; energy efficiency program administrators, implementers, and evaluators; and policymakers.

More specifically in the context of local energy policies, there are a couple policy designs that are becoming increasingly common that are instructive with respect to data interoperability. The first is benchmarking and transparency laws that are based on data collected through ENERGY STAR Portfolio Manager. These policies benefit from an already-standardized approach to data collection, naming, and organization. Because they all use data that passes through Portfolio Manager, each jurisdiction that has adopted such a policy causes the local real estate market to have access to data that are relatively similar to the data from other jurisdictions with such policies. This allows all parties concerned to become familiar with the types of data, terms involved, and meanings of data values. And it allows this not just for a single jurisdiction, but in a way that is meaningful to building owners, tenants, or service providers who deal with buildings across the country. This is valuable because it reduces the learning required to use the resulting findings in various locations. A single property owner for example can become familiar with the ENERGY STAR score and quickly understand reports on buildings they own across many parts of the country.

Compare this to building energy audit policies. Without a standardized approach to representing the results of a building energy audit, the information resulting from audits under such policies can be difficult to parse. An energy audit is a well-understood engineering concept that can be helpful in assessing opportunities in a building but energy audits have not had results delivered in a sufficiently standardized way to facilitate the kind of mass familiarity described above. A building owner may hire one firm to audit buildings this year and a different firm to audit buildings next year under the same policy in one city. If those firms are providing their findings in a standardized format, this can greatly improve the usability of the data. Lack of data standardization can make it difficult for a building owner to use audit results as effectively as possible. While some measures are implemented very quickly, about half of energy efficiency measures adopted as a result of energy audits are likely to be implement 1-6 years after the audit is completed (Maxwell 2013). Given this, audits can be most helpful if they provide not only a report that spurs action, but the detailed data that can be used several years in the future to quickly re-check assumptions, make updates for building changes or technology changes, and reassess opportunities.

Lack of data standardization can also make it expensive or impossible for the sponsor of an audit program (such as a city or utility) to fully use the resulting data. These program sponsors can potentially use the audit data to better understand the building stock in their territories, plan or market future programs, and guide buildings toward the most cost-effective opportunities. But a program sponsor who receives dozens or hundreds of paper audit reports with no accompanying structured data would be hard-pressed to use the effectively.

These challenges with using building energy audit data can be overcome by standardizing the outputs of energy audits to make them easier to use. An energy audit program in which audit service providers deliver results both in a report and in a data file ”appendix” in a standardized format such as BuildingSync (described in more detail below) can increase the value of the audit to both building owner and program sponsor. Building energy audits are often the starting point for a cycle of capital upgrades and operational changes. Standardized data around audits can flow through the rest of this cycle, making it easier for all parties engaged to understand and manage the work and yielding opportunities to reduce transaction costs in project sales, engineering, incentives, and permitting. Combined with use of parallel data in building design and energy code checking, the industry can move toward having a "living record" for each building that is used and changed from a building's initial design through construction, occupancy, upgrade, and major renovation.

Possible Policy Evolution

Building energy audit policies to date are typically designed to require all buildings to complete energy audits periodically. The theory of change has been that providing building owners with the insights from these energy audits will inform them about the most cost-effective opportunities and motivate them to make improvements. As data interoperability increases in the industry, it will become easier for jurisdictions to maintain a reasonably clear understanding of their building stock and where the most cost-effective opportunities for improving energy performance lie. Combining the collection of energy audit information (which is focused on providing advice to a building owner on cost-effective opportunities to save energy) with the calculation of asset ratings (which are focused on estimating overall efficiency of capital assets) will likely yield the most benefit from the time invested by the energy auditor. As these policies mature, incentive programs may evolve to more effectively link their offerings to known capital upgrade opportunities.

Additionally, policies may evolve to more effectively motivate building owners to invest in capital improvements to save energy. For example, rather than requiring audits on a rigid schedule for all buildings, a policy might be structured to allow any building that is demonstrating sustained excellence (for example within the top quintile of peer buildings locally) or continuous improvement in energy performance (such as meeting a minimum year-over-year reduction in energy usage per occupant) to forego an energy audit. Only if the building is not investing in efficiency improvements would it turn to an energy audit and asset rating to assess its opportunities to improve in future years. This approach is shown in Figure 1.

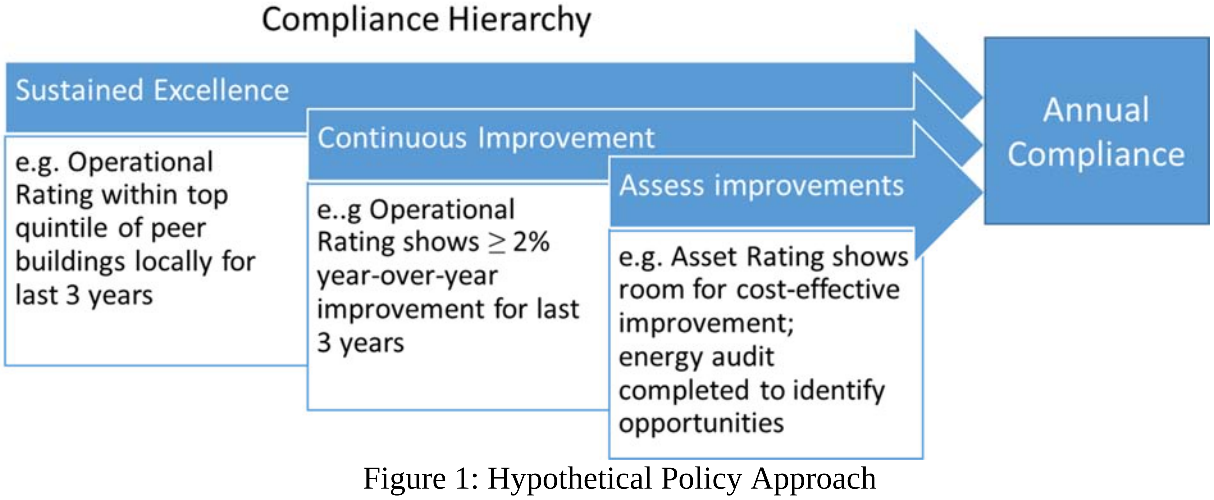

Figure 1: Hypothetical Policy Approach

This could be a more effective policy structure for driving efficiency improvement while avoiding concerns about unnecessary spending on assessment. Those buildings that demonstrate that they are already improving would not need deeper assessment. This would incentivize buildings first and foremost to invest in energy efficiency improvements. Such a policy design is likely to reduce the number of buildings each year providing energy audit data to the jurisdiction, but likely to increase the number of buildings investing in energy performance improvement. This policy design could also begin to function as an extended energy code that paralleled performance-based requirements at building design with measured outcome-based requirements through a building's life.

Matching Tools to Policy

At the heart of our comprehensive list of potential data fields is the Building Energy Data Exchange Specification (BEDES). Although not meant to be an exhaustive list of every term related to buildings or energy, BEDES is a dictionary of terms, definitions, and field formats created to help facilitate the exchange of information on building characteristics and energy use. It laid the groundwork for building consensus around what a cohort of cities could adopt as required fields for reporting in their respective policies.

We have spoken extensively with staff of relevant agencies in cities that have building energy audit policies to understand their thinking about how the policies will incite improvements in building energy performance and how best to manage the data generated by these policies to facilitate the intended outcomes. In general the intent behind today's energy audit policies is to inform building owners about the cost-effective opportunities for saving energy in their buildings through bough operational and capital improvements, while also informing local government about the building stock to better target energy improvements through other programs. As a result, city staff would like the energy audits to be detailed enough to provide trustworthy, actionable information to building owners, without being too expensive or time-consuming.

We reviewed the energy audit reporting spreadsheet developed by New York City, which requires energy auditors to fill in many fields of data describing their findings about the building and the cost-effective energy efficiency measures (EEMs) identified. New York City developed this list based on consultation with engineering professionals. We also reviewed the appendix to ASHRAE Procedures for Commercial Building Energy Audits (ASHRAE 2011), which contains a set of example tables for representing key data collected during an energy audit. The group also considered the ASHRAE Standard Project Committee 211 (SPC 211) which is tasked with further developing the Procedures for Commercial Buildings Energy Audits into a true standard establishing consistent practices for conducting and reporting energy audits for commercial buildings. Finally, we reviewed the inputs used by DOE's Building Energy Asset Score, a web-based tool for assessing the physical and structural energy efficiency of commercial and multifamily residential buildings.

By comparing the data fields used in each of these, a list emerged that included data fields used most commonly. This was discussed with city staff to determine what they thought would be most valuable, and the list was tailored based on their input. This editing was done in part based on the balance between ease of data collection and the value of having more extensive technical information. While the depth of information gathered in energy audits varies widely, even within energy audits that purport to be ASHRAE level 2 energy audits, the list was selected in part based on what was most likely to be discoverable data in a typical audit by a competent engineer who lacked prior familiarity with the building. Aligning with a voluntary industry standard that is widely adopted was identified as a critical component to match the tools specified for compliance with the policy regulations, as well as with the industry standards. This alignment then drove further discussions at DOE and National Laboratories on the development and evolution of BuildingSync, the Standard Energy Efficiency Data Platform (SEED) and the DOE's Building Energy Asset Score.

Understanding the need of the buildings market for more standardized data from energy audits, the BuildingSync XML file format was developed by a group of industry experts led by DOE to facilitate the seamless transfer of data about energy audits (DOE 2016).

As discussed above, BuildingSync[1] is an eXtensible Markup Language (XML) Schema for exchanging building related data, including, but not limited to audit data. Figure 2 represents the issue of data exchange for building-related data sets. A large amount of the data used for cataloging building performance, tracking compliance, evaluating EE programs, aiding in energy efficient designs, etc., is locked in specific programs and/or spreadsheets. These data could more easily be exchanged throughout the building sector, through the adoption common data formats such as the BuildingSync schema.

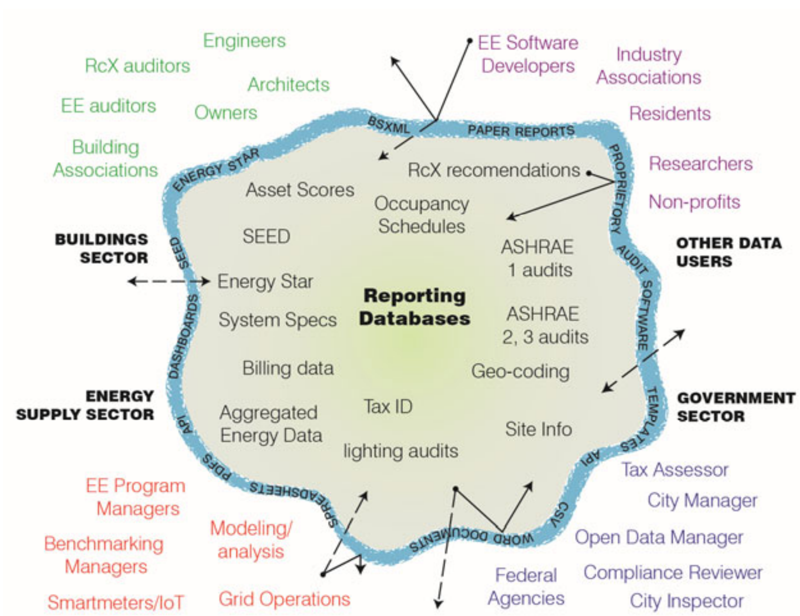

Figure 2: Data integration challenges (Credit: Amanda Lloyd/CBEI)

A number of private sector energy audit software platforms have indicated interest in allowing output from their tools in BuildingSync XML format. If they do this, it will make it quite easy for building owners to report energy audit data under a policy simply by submitting a BuildingSync file from their audit. Audit programs and policies can benefit from BuidlingSync by asking that audit vendors not only provide a report to the customer but also provide data to both the customer and the program sponsor in the form of a BulidingSync-compatible XML file with all the required data. For a jurisdiction with an energy audit policy, receiving these files in a standardized format allows the program administrator to use software to quickly check the

[1] http://buildingsync.net

contents of the audit, and ensure that it meets all requirements for compliance. DOE's Asset Score will output results in BuildingSync XML format along with its report, and the Standard Energy Efficiency Data Platform will soon accept and store data from BuildingSync files.

The advantage of using BuildingSync is rooted in the ability to map specific data to a common third-party format. For DOE software tools, it was natural to utilize the format for internal data exchange to ensure compatibility and completeness.

At least two audit-based software companies are already exporting BuildingSync XML files from their software to be delivered to their clients. These files can be imported into other software for building tracking, and BuildingSync is the enabling data transfer format. In some cases these companies are auditing hundreds of buildings and the data need to be imported into SEED or other databases to comply with laws or ordinances. The industry need for common formats for end-to-end data transport is clear (Eley 2016).

Finally, in conjunction with ASHRAE Standard 211 Committee, the ability to collect standard BEDES-compliant data via a spreadsheet will soon become a reality. The committee will be providing an exemplar spreadsheet along with its forthcoming standard for energy audits and data from this spreadsheet can be directly translated into BuildingSync XML. This will allow auditors to utilize an ASHRAE Standard to collect data, and then export to BuildingSync XML, a comprehensive file format for use in other tools.

Policy Examples

As a result of the involved stakeholder process in shaping these tools, there has been state and local desire to use them and move toward common data formats. With the launch of the SEED Collaborative there is a critical mass of early adopters to demonstrate the mechanics of using SEED to manage data associated with building energy benchmarking and auditing policies.[2] This will show how the SEED software can readily store data for these policies in a reliable and replicable manner. One SEED Collaborative member is the California Energy Commission (CEC). As the CEC is working towards a January 1, 2017 launch of a time-certain, statewide benchmarking regulation under Assembly Bill 802, the CEC envisions a statewide SEED database. Any local government in California that has a benchmarking program or ordinance benefits from also adopting SEED because the local 'child' SEED database can communicate up to the CEC 'parent' database for dual compliance. An example of this is the City of Berkeley, which plans to use the SEED Platform in to manage building energy benchmarking data, building energy audit data, and Home Energy Score data. The data collected by the City of Berkeley can then be transferred in a standard format to the CEC for compliance under the statewide regulations.

The City of Berkeley has aligned their policies with the use of these tools to allow regulatory flexibility while ensuring the receipt of industry-standard metrics such as the, ENERGY STAR score or Asset Score. Berkeley has received stakeholder feedback requesting that the audit reporting requirements align with San Francisco as much as possible.

[2] DOE launched the SEED Platform Collaborative in an effort to assist organizations utilizing the Standard Energy Efficiency Data (SEED) Platform™ to manage building data. The Collaborative, a partnership with state and local governments and efficiency program administrators, leading non-profits and private sector companies that are committed to radically reshaping the data landscape in the buildings sector, is a vital component to the uptake and successful implementation of SEED

The importance of these tools working in concert is demonstrated in the city of Berkeley's Climate Action Plan. The City-wide baseline includes electricity and natural gas consumption in homes, businesses, industries and public institutions (including the City government), which result in about 53 percent of Berkeley's total GHG emissions (Berkeley 2009). Under the plan, the community must reduce the emissions that result from building energy use by 35 percent by 2020. The average energy savings associated with the current ordinance are about 10 - 15 percent per commercial building (Berkeley 2009). Table 1 summarizes the scope of the building stock that has been identified as 'covered facilities.' To effectively meet the targets in its climate plan, the City of Berkeley needs the current building efficiency policy to successfully catalyze energy savings, and needs to use the data resulting from the policy to implement other programs in the future.

Phase In Year	Date Certain Building Size Trigger (sq ft)	Estimated Number of Date Certain Buildings	Estimated Time of Sale Buildings	Estimated Total	Cumulative Total
2016	Over 50,000	110	635	745	1,395
2017	25,000 to 49,999	210	600	810	2,205
2018	15,000 to 24,999	360	575	935	3,140
2018	5,000 to 14,999	1,500	540	2,040	5,180

Table1: Buildings Covered By City of Berkeley's Energy Audit Law

The second California city where there is ongoing development and adoption of standardized tools is Los Angeles. Through a series of stakeholder workshops, it was identified that there is a need for standardized processes and tools to allow building owners and practitioners to meet the compliance requirements. In addition to spurring owners to take action on energy efficiency retrofits like the Berkeley ordinance, the data collected through the Los Angeles ordinance serves another very important purpose. This is to help the city and local municipal utility, the Los Angeles Department of Water and Power (LADWP), to create effective programs that support those building owners in improving efficiency. Having a standardized database of this information acts as a saturation survey for energy efficiency measures. If an entire population of buildings submits information about glazing types, lighting fixtures, mechanical equipment, etc., then the city can work closely with the utility to identify common characteristics of buildings that are ripe for addressing through utility incentive programs. The City of Los Angeles Department of Building and Safety is responsible for administration and enforcement of the ordinance, the same department that manages the building permitting process. By crafting a vision and implementation plan that connects the dots between standardized data collection for benchmarking, audits, and retro-commissioning, as well as the permitting workflow - the city is able to implement smart policies and smart tools to save citizens money. By combining this workflow with emerging simulation-based tools for code compliance[3], the city has the ability to synchronize the data workflow across the lifecycle of a building, from initial code compliance to occupancy to major renovation.

Technical Connections

The OpenEfficiency Initiative (OEI) is a new industry effort building on the concept of a streamlined workflow from benchmarking, to audit, to utility incentive, to permit. This project will help administrators of ratepayer-funded energy efficiency programs use data systems that are interoperable with those being adopted by local governments implementing energy policies. The resulting interoperability will benefit both program administrators and local governments by allowing them to better understand the buildings in which they are trying to improve energy performance, and more effectively find the buildings that will improve.

The project will initially work closely with Xcel Energy and LA County to launch pilot programs that demonstrate an integrated workflow across building project stages and data tools. NYSERDA, PECO (Exelon), and Philadelphia Gas Works (PGW) are also participating in the OEI and exploring future piloting of the Open Efficiency Platform (OEP) in their programs. The initiative delivers a series of whole-building commercial EE program pilots built on an integrated open source platform. The OEP will use the BEDES data dictionary to integrate a range of existing federal tools such as OpenStudio, the Energy Design Assistance Program Tracker (EDAPT), Asset Score, SEED Platform and ENERGY STAR Portfolio Manager, with commonly used program management tools such as Salesforce and custom applications. The OEP will then be released into a broader market, with results from ongoing EM&V presented through a range of peer-based industry forums. A list of features as well as a workflow diagram are in Figure 3.

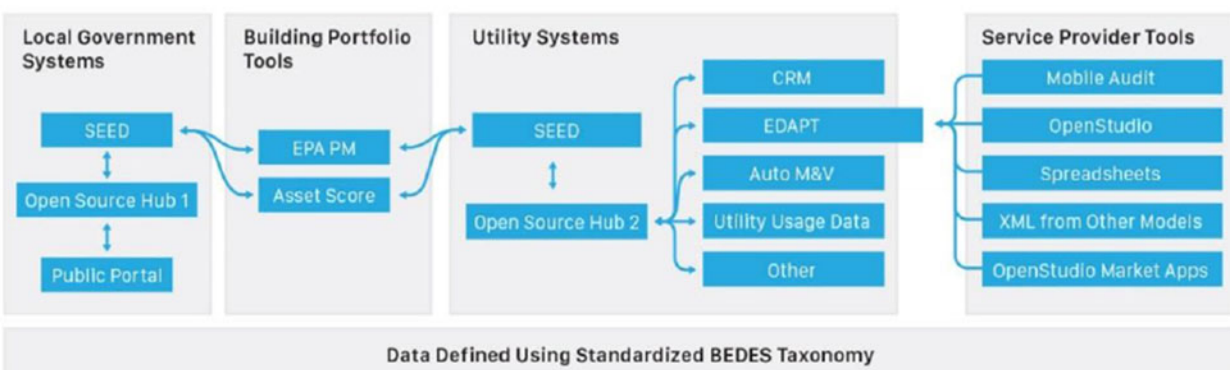

Figure 3: Open Efficiency Platform (OEP) Workflow

[3] The Standards Data Dictionary (SDD) defines the terminology and data model for California's building energy code compliance software

Figure 3 illustrates the connected administrative workflow across the lifecycle of an energy project. Modules for local and state government are connected to tools such as ENERGY STAR Portfolio Manager (ESPM) and the Asset Score. This represents the examples of how the CEC, LA City and Berkeley can manage compliance data. These tools also connect to a utility program administrator's SEED database, and can further communicate with management databases such as Salesforce, or even with utility assistance platforms such as the Energy Design Assistance Program Tracker (EDAPT). Practitioners and service providers can enter this workflow by using BEDES compatible tools with compliant schema. These tools include but are not limited to OpenStudio, spreadsheets, and various XML schema or JSON data files. The CEC Standard Data Dictionary (SDD) for energy code compliance can be aligned with any of the above modules.

As an illustrative example of the benefits of data interoperability consider a property owner with a 50,000 ft^2 commercial office building. They may be required under a local law to benchmark their facility with a tool such as ENERGY STAR Portfolio Manager and submit an energy report to a city. They may also be required to submit an energy assessment and use the DOE Asset Score for to report compliance.

The energy assessment data could be exported from the DOE Asset Score tool in BuildingSync format and used to pre-populate the relevant fields required for a utility incentive application. This application could be hosted in a workflow manager such as EDAPT and further reduce the need for filling out typically tedious forms for customized incentives. For a new building under design, the same energy modeling data from EDAPT could then be used to pre-populate energy code compliance forms. Those energy calculations could further be used to finance the project by using the Investor Confidence Project criteria. With so many touch points there is an enormous potential for a city, state, community choice aggregator, or utility to harness the collective power of this data to gain unprecedented information about the building stock and use it to execute the most cost-effective efficiency improvements. The implementing partners of the OEI are helping link the implementers of ratepayer-funded programs with state and local building energy performance policies to make use of standardized data that was otherwise siloed and unusable.

Data, Policy and Master Planning

Now that the policy framework has been created and tools have built to collect data, cities can more effectively master planning their energy future. The biggest challenge in this planning is gaining intimate knowledge of where, when and why energy is being used in a city. Rather than relying on gross estimates of the building stock and statistical assumptions of equipment saturation, turnover and code compliance, cities are developing a mechanism to gain real knowledge about actual buildings. With this baseline of demand side energy consumption, a public agency can begin mapping out a strategy on how to meet its climate action goals. NREL and National Grid have developed the Customer Optimization For Furthering Energy Efficiency (COFFEE) tool in which large scale analysis of entire regions of buildings can modeled and the efficiency potential can then be parametrically modeled. This mass-scale modeling approach can be directly based on standardized city policy and utility program data. Both utility program administrators and local governments can use this approach to virtually test the results of program and policy designs before rolling them out. This allows improved program design and more effective targeting of the most cost-effective opportunities. By applying the same methodology to both site specific retrofits and district-scale decentralized energy systems, cities can undertake long term planning to deliver more cost competitive, reliable, clean and resilient local energy systems. This planning heavily relies on having the ability to collect standardized data about a large number of buildings in a systematic way. The policies and tools discussed in this paper enable that possibility.

Conclusions

As more cities begin to adopt policies that use energy audits as a tool to drive investment in energy efficiency, it will be critical that they can use a recognized data format and common tools to streamline and standardize the resulting data. By pushing for standardization of their data, their efforts will have much more value to building owners, to efficiency program administrators, and to the cities themselves. Energy audit policies, energy codes, and ratepayer-funded programs can all begin to speak the same "language" of data about a building's energy systems and energy performance. This can help them all use data more effectively and provide commercial real estate appraisers and underwriters with standard recognizable data that can more effectively include energy performance in building valuation.

BuildingSync XML presents an appropriate data format for data exchange supporting audit policies that is aligned with the draft ASHRAE Energy Audit Standard and already used by public and private tools. Because it is connected to DOE's Asset Score, it can also effectively help service providers deliver energy audits and asset ratings together.

Cities who incorporate energy audits into their policy portfolio may also do so over time in a way that de-emphasizes the energy audit itself and emphasizes the importance of continuous improvement to building energy performance. While this may reduce the volume of data flowing from the policy, it is likely to increase the resulting energy savings, which is ultimately the stated public policy goal. It is also likely to align policies for existing buildings more closely with the trend in building energy codes toward more performance-based approaches.

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