Streamlining the Energy Code Compliance Process to Reduce Enforcement Challenges and Harvest Real Energy Savings

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ABSTRACT

Model building energy codes provide in excess of 30% energy savings compared to many currently adopted codes, however; much of this intended potential goes unrealized. Recent studies commissioned by the U.S. Department of Energy (DOE), regional energy-efficiency organizations, and several states demonstrate that energy code compliance often suffers, and proper enforcement can be a challenge for local building departments due to lack of resources and expertise specific to energy requirements. Jurisdictional compliance processes can also vary across construction stages—from initial permitting and plan review through multiple field inspections prior to final occupancy. As a result, there is an opportunity to standardize compliance workflows and software tools to overcome enforcement challenges and generate better data for local building departments.

This paper will draw upon findings from recent DOE compliance evaluation studies and discuss streamlining building energy code compliance verification processes from the perspective of the jurisdictional authority. An implementation approach will be presented, harmonizing resources and data formats for preparing, submitting, and reviewing compliance documentation. The paper will highlight available tools with the potential to be broadened through central data repositories and integrated with additional software features to further enable electronic permitting and compliance documentation. The proposed approach will provide several added benefits for local jurisdictions, including the ability to develop customized compliance reports, identify and track high priority issues that may inform targeted education and training, and capture data to support larger compliance goals.

Introduction

In the United States, buildings consume 40% of the nation's total energy and 70% of electricity (EIA 2012). As the largest sector of U.S. energy use, energy efficiency in residential and commercial buildings provides an enormous opportunity to reduce our country's overall energy consumption. Energy codes can influence the acceptance of energy efficient technologies and include requirements for energy efficient design and operation of buildings. According to the Building Codes Assistance Project (BCAP 2008), modern energy codes save consumers money, stimulate the economy, ensure health and safety, and improve long-term sustainability. In 2008, the average U.S. household spent approximately $2,225 on energy bills, with another $183 billion spent to supply commercial buildings. Considering the life of a building, initial design decisions will impact the energy consumption of the building for many years to come. DOE estimates savings due to codes of 53 quads of full-fuel-cycle (FFC) energy (1992-2040), which is comparable to a year's worth of consumption in U.S. commercial and residential sectors at current rates. Building energy codes also have the potential to significantly reduce consumer costs and carbon emissions—up to $230 billion in utility bill savings and almost 4 million tons CO_2 (Livingston et al. 2013).

Though energy codes have become more stringent and have great potential to save energy, much of these benefits are not realized due to problems with low compliance. Several recent studies have concluded that the energy code compliance rates are significantly lower than 100% (Stellberg 2013, Williams et al. 2013) and may be below 50% in many jurisdictions (Yang 2005). Because it does not qualify as a life-health safety code, the energy code was reported to be a lower priority, receiving less attention from inspectors resulting in a lower likelihood of compliance (BCAP 2008). Some of the other frequently cited issues impacting poor energy code enforcement are lack of resources, lack of code enforcement infrastructure, lack of training, complexity of codes, and expertise required for determining compliance. One recent study evaluated the impact of code compliance in the state of New York and estimated $1.3 billion in potential energy savings are lost due to non-compliance over five years' worth of construction in the state (Harper 2012).

Building departments are beginning to use electronic permitting systems, mobile devices and streamlined code enforcement processes (HUD 2004, Wible 2007), which can be adapted to improve energy code compliance rates. Based on the lessons learned from recent compliance evaluation studies, this paper presents a model to bolster compliance through traditional plan review and field inspection processes, while providing additional data for evaluating compliance rates, identifying compliance issues, and establishing priorities for training.

Energy Code Compliance Paths

Model energy codes for residential and commercial buildings are developed through public processes administered by the International Code Council (ICC) and American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE). Each organization has a well-established process and publishes new editions every three years.

The scope of the energy code typically includes performance requirements for building envelope, mechanical and lighting systems that have a significant impact on the overall energy use of the building. Energy codes offer more than one compliance pathway to demonstrate compliance. The most common pathways include (Conover et al. 2011):

1. *Prescriptive*: Simple, singular performance metrics which individual building components often must satisfy
2. *Component Performance*: Performance of a particular component, system, or sub-system of a building
3. *Total Building Performance*: Modeled performance of a designed building as compared to the same building constructed to base code requirements

Some states may support variations of the performance path, such as complying with the ENERGY STAR program administered by the Environmental Protection Agency (EPA), or through achievement of a specified Home Energy Rating System (HERS) score.

Considered even more progressive are outcome-based or capacity-constrained compliance paths, which have been utilized as an alternative to traditional paths. For example, an outcome-based energy code pushes the burden of proof post-occupancy, where compliance is determined by evidence of actual building energy consumption. This can be accomplished by a square footage metric (i.e., Energy Use Intensity [EUI]), or through a simple comparison of utility bills. Capacity, or peak, constraints impose limitations on the design side, such as limiting utility power supplies or setting maximum equipment sizes.

Current Code Compliance Process

While model energy codes and standards are developed nationally, implementation occurs at the state and local levels of government. Building code compliance and enforcement are typically the responsibility of the authority having jurisdiction at the local levels of government, with over 39,000 jurisdictions nationwide (Meres et al. 2012). A key challenge in developing policy to support increased compliance is the dissociated nature of stakeholders, such as builders and designers, as well as the traditional building code enforcement infrastructure (i.e., code officials).

BCAP identified the following four models commonly used across the country in enforcing energy codes (BCAP 2008):

1. Self-certification
2. State agency enforcement
3. Third-party enforcement
4. Local enforcement

According to BCAP (2008), local code enforcement, such as that performed by a local building department, is the most commonly relied upon model. Self-certification, or first-party assessment, is performed when an entity responsible for compliance certifies their own work as code compliant. For example, a builder or contractor submitting a statement of compliance and indicating all required code provisions have been satisfied. Second-party assessment involves certification by an otherwise involved party, such as a building owner or financial institution. Finally, third-party certification is performed by a non-affiliated body, such as a contracted individual hired for the sole purpose of measuring and verifying compliance with the building such as HERS raters. DOE has also embraced a similar set of models and issued guidance on how to demonstrate state energy code compliance rates. While DOE emphasized and encouraged the third-party approach, it also highlighted notable benefits from the alternative compliance models (DOE 2010).

Code compliance is traditionally driven by prescriptive code requirements, which are adopted at state or local levels and administered through local construction regulation. The responsibility for traditional code compliance verification varies by state and within jurisdictions. Traditional code compliance verification consists of the following:

- Reviewing construction documents, building plans, specifications, test data, evaluation reports, certification listings, and other information that documents compliance of the building as a whole or by its components separately and compliance of the building as a whole with the adopted codes.

- Issuing permits to initiate or to continue subsequent stages of construction based on a review and inspection of the construction against the approved plans.
- Inspecting buildings during various stages of construction and conducting onsite testing to validate performance of particular components or portions of the building.
- Issuing a certificate of occupancy (CO) after it has been determined that the code has been satisfied.
- Verifying that existing buildings continue to be maintained safely and all additions, alterations, repairs, renovations, or change of use applied to existing buildings also satisfy adopted codes.

There are various means and methods beyond testing, certification, and product evaluation that may need to be used for code compliance determination. Plan reviews, field inspections, and field-testing can be used to evaluate the compliance of the assembly of components comprising a building system. Compliance can also be determined by applying the concept of component validation with product standards to an entire building.

The compliance verification and enforcement processes vary widely between jurisdictions, and often projects may have specific components or systems that require individual consideration during plan review and field inspection. One recent report (Meres et al. 2012), in particular, reviews case studies conducted by the Institute for Market Transformation (IMT), and encourages governments to develop strategies for streamlining existing processes, leveraging third-party enforcement, and targeting advanced training opportunities to improve compliance with building energy codes.

Lessons from Recent Compliance Evaluation Studies

To encourage the adoption and implementation of updated building energy codes, DOE made funding available as part of the American Recovery and Reinvestment Act of 2009 ("Recovery Act"). The funding opportunity conditions included implementation of a plan to achieve 90 percent compliance with updated energy codes by 2017, to include active training and enforcement programs, and annual measurement of the rate of compliance as per Section 410 of the Recovery Act (2009). DOE developed procedures to help states evaluate and measure energy code compliance rates using a uniform methodology (DOE 2010), which was later supplemented by a collection of associated compliance tools.

DOE also followed in funding a series of state compliance studies, working with the Regional Energy-efficiency Organizations (REEOs, formerly referred to as Energy-efficiency Partnerships or EEPs) to identify and fund eight studies across nine states to pilot the DOE compliance methodology and tools. Through the pilot studies several important observations and lessons were learned regarding energy code compliance enforcement (DOE 2013):

1. **Lack of compliance information on plan submissions**: Several pilot studies cited a lack of information submitted with permit applications, limiting the plan review stage of the compliance evaluation process. Documentation demonstrating compliance with code requirements was often found to be missing from plans and specifications.
2. **Simpler and customized checklists needed**: Some of the items in the DOE compliance inspection checklists are seen as impractical or not verifiable in certain applications (e.g.

post-construction), and more broadly the checklist items should be simplified and customized for projects.

3. **Discrepancies between submitted information and as-built**: A strong correlation with higher compliance rates is observed when software tools are used to demonstrate and document code compliance based on trade-off or performance-based compliance approaches. However, discrepancies were often observed between information entered into the software and conditions seen in the field. A tendency to seek a bottom line pass or fail score was also found, hiding many of the conditions actually installed within the building.
4. **Coordination of field inspection activities**: Multiple site visits are required as part of the field inspection process. It is often not possible to complete field inspection of all the energy code requirements in a single visit due to the various systems and trades that work on specific components or systems such as foundation, envelope construction, lighting and mechanical systems.
5. **Lack of training:** In addition, pilot studies reported that there is significant confusion and lack of understanding of the energy code requirements among code officials and field inspectors. This highlights the need for education and training to better understand and identify and apply code requirements.

Several other related studies echo the above findings and acknowledge further limitations often present within states and local enforcement jurisdictions. The BCAP Compliance Planning Assistance Program conducted a series of Gap Analysis for states to identify barriers and successful practices within unique state scenarios, finding challenges with the cost of adopting codes, enforcement funding, state regulatory frameworks (e.g., *Home Rule*), coordination of diverse stakeholders, and access to training and education (Panetti et al. 2012). The analysis was followed by a series of recommendations presented in state Strategic Compliance Plans.

Another recent study (Williams 2012) analyzed jurisdictional processes surrounding the enforcement of building energy codes. Findings indicate that jurisdictions are challenged by limited funding for energy code enforcement, often receiving support from a single funding source. The majority of plan review and inspection activities are conducted by in-house staff, and, in some cases, the energy code is unenforced. Local jurisdictions were also found to predominantly maintain traditional paper plans and, although many include an option for a digital format. The study also estimated the cost of conducting a compliance evaluation as ranging from $100,000 to $150,000 per jurisdiction, exclusive of efforts to raise compliance rates, such as educational and training activities.

A number of tools are currently available to builders, designers and code officials to assist in demonstrating compliance with the energy code. However, much of the current toolset is disjointed, covering different aspects of energy code compliance. For example, COM*check* and RES*check*™ software provided by DOE assists in demonstrating minimum code compliance, while the Score + Store software serves as a web-based solution for states to report findings from their compliance measurement activities and to calculate state compliance rates. Additional private sector software tools provide further abilities, such as allowing calculation of an energy rating in addition to code compliance. Aside from software, DOE also provides a suite of compliance tools and resources[1] to assist in evaluating and measuring energy code compliance, including a web-based building sample generator and inspection checklists to supplement model code requirements.

In August 2013, DOE published a request for information (RFI) in the *Federal Register*, requesting feedback on its previous guidance for evaluating and measuring compliance with building energy codes (78 FR 47677). The Notice sought stakeholder comment on the DOE compliance methodology and supporting tools, and targeted several areas of particular interest informed by state pilot studies, including means of reducing the challenge of conducting evaluations while maintaining adequate statistical reliability. The Notice also identified top barriers to compliance, stated as a lack of training, resources, and information submitted to local enforcement jurisdictions.

Streamlining the Compliance Process

Streamlining energy code compliance and enforcement processes involves the removing of burdensome, duplicative and fragmented data and documentation requirements and allowing local governments to focus on their core permitting, review and inspection processes. Recent strategies proposed for streamlining the building regulatory process (Wible 2007) and energy code compliance (Meres et al. 2012) have focused on implementation issues and administrative processes, e.g. identifying and adopting codes, local procedures for scheduling plan review and inspection, training, and selection of permitting software. Though the overall objectives are similar, the concept of streamlining compliance as presented in this paper targets improvements to reduce the complexity of collecting and managing the energy code compliance data such as gathered through the traditional plan review and field inspection processes.

The proposed strategy seeks to integrate and build upon the current collection of code compliance tools, while also unlocking significant data potential. Compliance data captured through traditional review and inspection processes can be stored in a centralized database, with analysis capabilities, potentially requiring no additional resources for compliance evaluation. Combined with a sensitivity analysis performed through energy modeling, individual code provisions could be weighted based on their expected savings impact. Statistical analysis of compliance data could then performed to identify and prioritize core inspection items, and better understand the relationship between compliance with unique code provisions and resulting energy savings.

Builders and designers use code compliance tools as a means of determining and demonstrating compliance. Depending on the compliance method used, compliance reports may contain simple or detailed information that can be used for plan review and field inspection. Figure 1 illustrates the proposed implementation scenario and flow of information.

In order to support the streamlined process, all tools used in the compliance determination and evaluation process should use a common data repository to maintain consistency, concurrency and avoid duplication. Such a data repository can be hosted either by jurisdictions or by third party service providers. Traditional energy code compliance reports already include inspection checklist items which need to be verified during plan review and field inspection processes. In the proposed approach, designers submit compliance data electronically

[1] http://www.energycodes.gov/resource-center

to the enforcement official through the software tool, and use the common data repository to continue to update the plan review and field inspection comments. This workflow provides for dynamic data exchange and electronic record keeping of the compliance process. If this data is stored in a central data repository with a project identifier for each compliance report, it is possible to develop a user-interface that code officials and field inspectors can use to verify and document their findings along with the compliance reports in the same central location. The code official's user-interface is envisioned as a specialized view of compliance data required for plan review and field inspection, along with additional features for customizing inspection checklist items and capturing deficiency reports. In addition to user-interface changes, jurisdictions may implement the infrastructure to allow the code official to send the project back to the submitter for revision, track actions that are taken, maintain an audit trail of the compliance process. This approach relieves the burden for jurisdictions to duplicate the data entry from compliance reports and track the inspection findings in different systems.

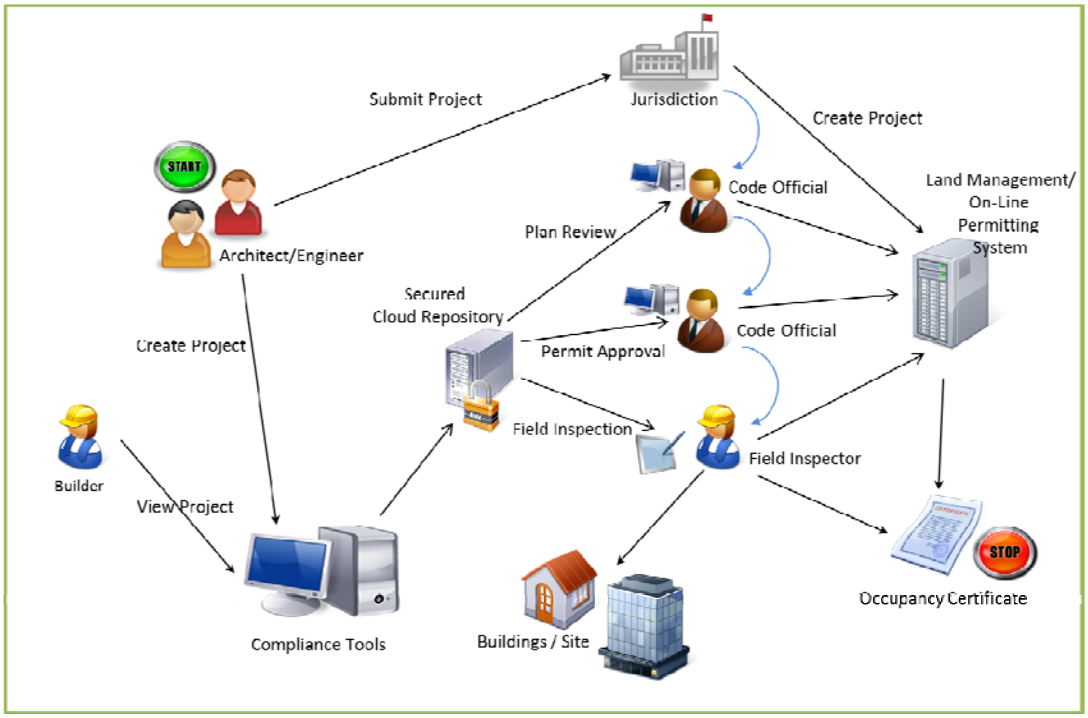

Figure 1. Proposed implementation scenario.

Figure 2 shows a potential workflow for streamlining the plan review process. Currently compliance tools are used in Step 1 to determine compliance and generate a compliance report which is either submitted as a printed or electronic document (Step 2). Once this submission is received as part of a permit application, the code official or plans examiner reviews and either approves the submission or prepares a deficiency report and sends the compliance report back to the designer for resubmission (Step 4). Subsequent to the receipt of the plan review comments/deficiency report, the designer revises the design as needed and resubmits the compliance report (Steps 5-8). Depending on the findings from the next cycle of plan review, the process is repeated until it is approved for construction. It is possible to develop software tools and add functionality to existing tools that designers can use to accomplish the tasks in Steps 1, 2, 6, 7 and 8; and another user interface (code official user-interface) for plans examiners to review and prepare compliance approval or deficiency reports in Steps 3, 4, 5 and 9. These two sets of tasks can be integrated to work with a central database to eliminate data duplication and use the same software infrastructure for all the steps. A similar workflow can be used for the field inspection process.

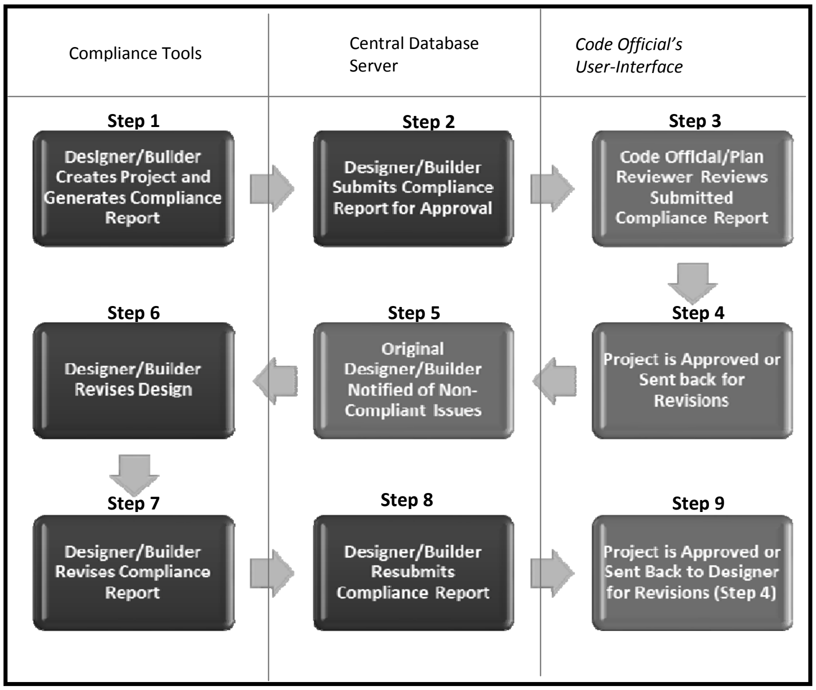

Figure 2. Potential Workflow of Plan Review Process

Electronic permitting systems for administering permit applications and scheduling field inspections for building code requirements have made significant advancements during the past decade. Mobile devices and navigation systems are used to document inspection findings and address some of the communication challenges within the compliance process (HUD 2004). Most local building departments provide an option for electronic submittal of plans and specifications (Williams 2012), and an electronic repository has been suggested for use in the state of California to embody data on energy code compliance and other construction characteristics (Benningfield et al. 2012). Further, improvements in local enforcement processes have the potential to inform and empower ongoing educational needs through better access to information and understanding of local compliance issues. This information can be used to target advanced topics and necessary improvements beyond traditional training approaches (Cohan 2012), as well as to reinforce building science principles underlying code requirements and best allocate available training resources.

Benefits of the Streamlined Process

The proposed strategy for streamlining the energy code compliance process has the potential to provide several benefits:

- Allowing for increased accessibility through remote or electronic submissions
- Providing a consistent and familiar user interface while reducing workflow ambiguity
- Clearly designating responsible parties and procedural steps
- Tracking progress and current status of applications, reviews and inspections
- Communicating and documenting required submissions
- Increasing the overall efficiency of the approval process, shorten the time to certificate of occupancy
- Making available more accurate 'as built' information for future reference

The implementation model provides a solution that can be scaled across the U.S. and add significant value to the energy code compliance process. Building on existing enforcement infrastructure, traditional stakeholders will benefit from improved procedures, while also engaging a new source of data that can empower states and local building departments to better understand their commercial and residential building stock. The proposed model may also integrate with many existing tools while supporting a continued effort to reduce enforcement challenges and maximize benefits associated with energy code compliance. Jurisdictions will have the option to clearly define processes, responsible parties, documentation requirements, and anticipated timelines.

Scalability across States and Municipalities

Many building departments have made a shift toward electronic permitting, which can assist in streamlining existing compliance processes, and better incorporate technology into departmental systems. A consistent user interface adds predictability and familiarity for stakeholders, and lessens the need for varying processes in each local jurisdiction, particularly beneficial for designers or builders whose projects span multiple municipalities. Using inputs typically gathered through traditional phases of the enforcement process (e.g., plan review and field inspection), such a tool could perform automated analyses of compliance data, reducing the need for expensive and time-consuming manual calculations. These could essentially be integrated with existing enforcement processes to improve the overall compliance experience.

One of the most significant challenges in achieving energy savings through building codes is aligning national and state-level goals with localized enforcement infrastructure—an implementation dilemma. The proposed implementation scenario provides the option to customize and prioritize the code requirements at the jurisdictional level. It is possible to enable the nationally developed model code requirements to be adapted locally and managed with the electronic permitting systems used by local jurisdictions, and integrate the data with the central repository for aggregating the compliance data at the state and national level. In addition to encouraging more uniform jurisdictional processes, the proposed software capabilities can contribute to larger policy aspirations, such as utility energy-efficiency programs and state energy consumption or climate change goals. It is also intended to support federal initiatives, supporting states honoring commitments surrounding energy code compliance (e.g., Recovery Act goals), and in leveraging previous funding and related projects already undertaken.

The proposed implementation strategy can serve as a prominent fixture within state compliance evaluation, measurement and tracking programs, which can be supplemented by code education and training. Many states have already taken action to install such compliance programs, often coordinated by a collaborative group of interested stakeholders, representing building design and construction professionals, industry, state and local government, and even private citizens. These partnerships may serve as a valuable test bed in considering and evaluating such a tool within states and across local code enforcement jurisdictions.

Further, the proposed code official user-interface tool can be applied in every project. In the past, states and localities have commissioned compliance studies for the purpose of better understanding compliance processes and establishing baseline compliance rates within a particular region. This is understood to be costly, resource-intensive, and complicated relative to traditional enforcement processes and construction phases. If successful, this tool can be utilized in determining compliance with any project, generating expected compliance rates from the broader data set, and leveraging more traditional on-the-ground compliance studies to validate findings. Limited resources previously allocated to conduct baseline studies may then be redirected to support activities that more directly have the ability to improve compliance rates.

Empowering Local Building Departments

The most significant advantages of the proposed strategy are realized at the local level. Several previous studies have reported building departments as often lacking the resources to fully enforce the energy code. Common constraints typically center on education, time and money, especially in comparison to life-safety codes. The proposed code-official user-interface tool is intended to address these primary barriers, while empowering local officials, reducing enforcement challenges, and maximizing overall energy code compliance.

The tool is also intended to be flexible, in that it has the ability to address all requirements contained in the energy code, while offering building departments the ability to customize their experience based on jurisdictional processes or the particular project being evaluated. Some previous users of existing compliance methods, for example through the DOE state pilot studies, reported exhaustive requirements that often do not apply in, or cannot be evaluated for, every project. The tool is meant to preserve the capability to evaluate the entire code in a comprehensive, provision-by-provision manner, but also to eliminate unnecessary code provisions, such as those not applicable to a particular building type or characteristic. This feature may reduce workload while focusing attention on the most applicable code provisions.

It is also possible to provide data to local building departments through an electronic, computer-based, compliance dashboard containing information on their projects. For example, automated statistics generated on the number of projects submitted, progression and status through plan review and/or field inspection stages, number of projects completed, and even the design characteristics seen in those projects. Projects could be classified as commercial or residential, by building type, or characterized by specific compliance issues or failures. Users could also generate reports on current activity to identify issues and track their resolution, or to demonstrate overall compliance rates. This information is intended to support local building departments in managing their compliance resources, as well as the risks associated with enforcing the energy code.

A key opportunity is in identifying and more readily assessing compliance levels for individual code requirements. Currently, energy code compliance and enforcement is considered highly volatile and can vary significantly based on a number of localized factors. The proposed model gives building departments the ability to tailor their enforcement process around the most impactful code provisions based on consideration for available resources. In theory, localities unable to comprehensively enforce the energy code could choose to develop an abbreviated approach informed by the most impactful or most practical requirements, while maintaining alignment with the larger data set. For example, a jurisdiction using the tool could potentially develop a process based on a series of core requirements (i.e., those with maximum relative energy impact), and then elect additional items for particular projects, or at random to preserve a statistical sampling of their various project characteristics, such as building type, climate zone, and specific building systems.

Detailed tracking of individual provisions will also allow building departments to better understand their local building stock compared to code prescription. Data provided by code officials could provide for analysis of commonly selected building systems, applications and design practices, as well as corresponding efficiency levels. In addition, deeper insight could be gained on the cost-effectiveness and practicality of specific measures, tradeoffs between systems (as permitted by code), local construction practices relative to prescriptive code requirements, and overall market performance relative to minimum code.

Education and Training

Staff qualifications and training are commonly cited as a means of improving enforcement and streamlining compliance processes, including the ability to identify inspection failure rates and common infractions, communicate such information to stakeholders, and develop advanced training to improve understanding of concepts underlying energy code requirements. (Meres et. al. 2012). The proposed implementation strategy not only can help improve jurisdictional enforcement processes, but also increase compliance by identifying high priority training and educational needs. The central database of information can be analyzed at the jurisdictional or state level to identify high priority compliance issues, common construction practices, and training opportunities. With the ability to better identify and focus on issues of non-compliance, more targeted training programs can be initiated.

Other Benefits

The proposed implementation model has the ability to link with larger building energy-efficiency programs and code development processes. Lessons learned through implementation could be communicated to state or regional efforts, and inform proposals submitted to the national model code development processes. The proposed implementation provides the ability to link with complimentary tools used for determining energy and emissions saved, as well as energy ratings/scores for commercial and residential buildings. Future development could include private sector tools and encouraging data exchange using building information modeling (BIM), and furthering initiatives to bridge the divide between as-designed and as-built.

Conclusions and Future Work

Recent compliance evaluation studies have thoroughly demonstrated the need to improve compliance rates, and the use of compliance software tools has historically been recognized as a successful strategy that can be implemented within the current building code enforcement infrastructure. The present study proposes streamlining compliance processes through additional software functionality, and a standardized approach that can be tailored to meet the needs of local building departments. A code official user-interface and central data repository are needed to integrate existing processes, technologies, and to unlock better understanding of compliance data, creating an enhanced understanding of compliance issues. The suggested implementation model also has the potential to inform advanced training and ongoing compliance programs supporting greater efficiency goals and environmental policies. Effective compliance and enforcement is essential, and the proposed approach could serve as a key asset in reducing challenges and ensuring intended energy savings.

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