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The Cost of Enforcing Building Energy Codes: Phase 1

Alison Williams, Ed Vine, Sarah Price, Andrew Sturges, Greg Rosenquist

Energy Analysis and Environmental Impacts Department
Environmental Energy Technologies Division
Lawrence Berkeley National Laboratory
Berkeley, CA 94720

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List of Acronyms

ACCA	Air Conditioning Contractors of America
ACEEE	American Council for an Energy-Efficient Economy
ARRA	American Recovery and Reinvestment Act
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
BCAP	Building Codes Assistance Project
BCEP	Building Energy Codes Program
BPI	Building Performance Institute
CAD	Computer Assisted Design
DET	Duct and Envelope Test
DOE	U.S. Department of Energy
ECAP	Energy Code Ambassadors Program
EPA	U.S. Environmental Protection Agency
FTE	Full-Time Employee
HERS	Home Energy Rating System
HPwES	Home Performance with Energy Star
HVAC	Heating, Ventilating, and Air Conditioning
ICC	International Code Council
IECC	International Energy Conservation Code
IMT	Institute for Market Transformation
IOU	Investor-Owned Utilities
IT	Information Technology
LEED	Leadership in Energy and Environmental Design
NEEA	Northwest Energy Efficiency Alliance
NRDC	Natural Resource Defense Council
RESNET	Residential Energy Services Network
SPE/I	Special Plans Examiner/Inspector
TEP	Tucson Electric Power

EXECUTIVE SUMMARY

Purpose and Methodology

The purpose of this literature review is to summarize key findings regarding the costs associated with enforcing building energy code compliance—primarily focusing on costs borne by *local government.* The review takes into consideration over 150 documents that discuss, to some extent, code enforcement. This review emphasizes those documents that specifically focus on costs associated with energy code enforcement. Given the low rates of building energy code compliance that have been reported in existing studies, as well as the many barriers to both energy code compliance and enforcement, this study seeks to identify the costs of initiatives to improve compliance and enforcement. Costs are reported primarily as presented in the original source. Some costs are given on a per home or per building basis, and others are provided for jurisdictions of a certain size.

This literature review gives an overview of state-based compliance rates, barriers to code enforcement, and U.S. Department of Energy (DOE) and key stakeholder involvement in improving compliance with building energy codes. In addition, the processes and costs associated with compliance and enforcement of building energy codes are presented.

The second phase of this study, which will be presented in a different report, will consist of surveying 34 experts in the building industry at the national and state or local levels in order to obtain additional cost information, building on the findings from the first phase, as well as recommendations for where to most effectively spend money on compliance and enforcement.

Background

Building energy codes, if complied with, have the ability to save a significant amount of energy. States or local jurisdictions either adopt model or modified model energy codes—codes and standards developed by organizations at the national level with the intention of being used in smaller jurisdictions—or develop and adopt their own energy codes. In 2009, certain funding allocated by the American Recovery and Reinvestment Act (ARRA) required states to adopt national model building energy codes or the equivalent. As adoption alone (without compliance and enfocement) is not enough to achive significant energy savings, states were also required by ARRA to implement a plan to achieve 90% compliance by 2017 (1).

Compliance Overview

Although energy code enforcement occurs in many jurisdictions, energy code compliance rates have been significantly lower than 100%. A survey of the literature, from 1990 to 2012, reveals a complete range of building energy code compliance rates in the United States, from a low of 0% for residential buildings in New York to a high of 100% for residential buildings in Oregon. (See Table 1.) One study demonstrates nine different ways that compliance has been reported (1), and reported compliance rates are affected by sampling error, participant bias, and regional differences.

On the stakeholder side, key barriers to code compliance include: 1) the lack of incentives to comply with code because of low enforcement and lack of significant penalties, and 2) the lack of knowledge from designers, builders, and construction workers regarding the most recent codes and how to implement them. On the local government side, key barriers to code compliance and enforcement include: 1) lack of budget and staff; 2) low prioritization, below life, safety, and structure; and 3) lack of knowledge and training on specific building science and energy code aspects.

Key activities to date have included DOE's Building Energy Codes Program, which offers tools and technical assistance to states, has developed compliance evaluation methodologies, and has researched alternative compliance paths. The non-profit Building Codes Assistance Project (BCAP) provides support on code adoption and implementation to state and local governments. BCAP's Compliance Planning Assistance Program assisted 15 states with gap analyses and 10 states with strategic compliance plans.

Local Government Compliance and Enforcement Processes

Our literature review focuses on those processes associated with enforcing code compliance:

- **The traditional process** used by local governments to enforce building energy code compliance is based on plan review and inspection. The costs associated with this method are based on the incremental time spent on energy code review and inspection beyond the review and inspection for other building codes.

- **Supplemental and alternative processes** can be implemented to further increase building energy code compliance. These processes include:

  - *Third-Party plan review and inspection*, which allows for outsourcing the energy code plan review and/or inspection process, resulting in a special and knowledgeable focus on energy codes, as well as reduced staffing needs in the building department. Builders generally pay fees directly to third parties, while local governments or other entities bear administration and oversight costs.

  - *Performance testing,* which provides additional methods to determine compliance, such as building envelope and duct leakage testing. Similar to third-party review and inspection, builders generally pay testing fees directly to third parties, while local jurisdictions bear administration costs.

  - *Home Energy Rating System (HERS) as Code (Voluntary Programs)*, which provide alternatives to replace traditional processes. In the HERS program, a HERS rater works with developers from start (building plans) to finish (occupancy) and develops a HERS index to determine whether the building complies with code. If jurisdictions recognize voluntary programs as equivalent to code, and enough builders participate, the entire enforcement infrastructure can be borne by the voluntary program administrator, typically a utility.

  - *Commissioning*, which is a quality assurance process that involves agents who deal with the entire building process—starting at construction and continuing through operations. Though building commissioners do not currently focus on energy codes, stakeholders have suggested developing this method as a way to increase code compliance.

  - *Licensing,* which is an available enforcement model for states or local jurisdictions that are unable to support a full energy code enforcement infrastructure. It allows a design professional to stamp plans as well as approve final construction. To be successful, a program must perform random inspections, and licensing bodies must suspend or revoke licenses upon discovery of falsely certified compliance.

Next, the review discusses improvements and investments that can be made in order to increase compliance within any process or infrastructure associated with building energy codes. This includes:

- *Developing information technology (IT) to implement or streamline processes*, which can result in reduced future costs and more time available to focus on energy codes. IT packages may include online plan submission and permit processing, electronic plan review, as well as scheduling and conducting inspections.

- *Training and education*, which can be designed in many different ways to reach the same result: overall greater knowledge of codes and code enforcement practices among code officials. Stakeholders recommend tiered training approaches, and BCAP has been piloting a state-level train-the-trainer program, the Energy Code Ambassadors Program.

- *Tools and outreach*, which can streamline processes for both applicants and code officials and help to inform the community and stakeholders about what information is available and why there is a need for stronger code enforcement. Tools may include guidebooks, case studies, checklists, and easy-to-understand applications.

The review also discusses the roles that utilities and states can play in energy code compliance and enforcement. While utilities have historically focused on training and education, both utilities and states can provide not only funding and infrastructure for third-party programs but also can develop tools and materials. States can also supplement local-level plan review and inspection.

Summary of Key Findings

This study has found that the incremental cost of enforcing energy codes using a traditional review and inspection process can be up to approximately $100 per home, assuming best-practice levels of time spent per home and re-inspection upon failure. Cost for commercial buildings can range to thousands of dollars depending on the complexity of the building. Annual incremental costs for a jurisdiction processing 5,000 residential permits per year range from approximately $150,000 to $530,000, depending on time spent per home and levels of re-inspection. Costs for commercial enforcement would be significantly higher.

One method to reduce the financial burden on local governments is to develop a third-party energy code plan review or inspection infrastructure in which builders pay fees directly to the third party. For energy codes alone, these fees are expected to be approximately $200 per home and up to nearly $1,000 per commercial building. The annual costs borne by the government for infrastructure and oversight for such a program could be as little as $23,000 for a limited local program or range from $150,000 to $300,000 for a program organized and run at the state level.

A supplemental method of improving energy code compliance is the use of performance testing. Following a third-party model, builders would pay third parties $300 to $400 per home, and the local jurisdiction would need an operating budget of up to $130,000 for oversight and administration of the program, heavily dependent on the size of the jurisdiction.

Other alternative methods of energy code enforcement include HERS ratings for residential buildings and commissioning for commercial buildings. The cost for a HERS rating is approximately $450 up to $1,700 per home, while commissioning is expected to cost from 2% to 20% of the total project cost. No data are available on the costs to run such programs. However, in the HERS as Code approach, oversight and administration costs are often absorbed by voluntary programs run by other entities such as utilities.

Any compliance and enforcement process can be enhanced with expenditures for IT, training, and outreach. Acquisition costs for IT cover a broad range based on function and jurisdiction size, ranging from $1,000 to $4,000,000. Training costs for such software can be up to $100,000 per package or as little as $1,500. General energy code training costs also range based on the amount and complexity of the program. The per-person training cost may be less than $100 per course, and annual costs for a jurisdiction with 4 full-time equivalents (FTEs), including costs for downtime, would be approximately $5,000 per year. Effective programs can often be run at the state level; BCAP's recommended train-the-trainer approach, the Energy Code Ambassadors Program, is estimated to cost from $16,000 to $39,000 per state. Outreach to stakeholders can also be used to increase compliance; costs for a local jurisdiction with 4 FTEs are estimated at $39,000 per year.

Utilities and states can also be involved in the compliance and enforcement process. Annual utility expenditures on code enhancement programs (generally focused on training) range from $125,000 for a single utility in Arizona to nearly $4 million for all investor-owned utilities in California. State-level investments can range from $140,000 annually for an energy code collaborative up to almost $1 million annually to run an enforcement program that supplements municipal enforcement (with this cost potentially increasing with the size of the state). States are also responsible for documenting compliance with building codes in accordance with ARRA initiatives; such studies are expected to cost anywhere from $75,000 to $750,000 annually.

This study reported costs primarily as presented in the original source. Some costs are given on a per home or per building basis, and others are reported for jurisdictions of a certain size. In many cases, data are limited with only one source for a given cost metric. In other cases, cost data with disparate sources and assumptions are combined to create more useful estimates or comparisons; this compilation generates uncertainty. Moving forward, federal or state standardization of compliance and enforcement cost reporting across local jurisdictions is recommended. However, even with the current data limitations, this study provides an unprecedented picture of the approximate ranges of costs necessary to develop and enhance compliance and enforcement infrastructure. Although the costs may seem large, IMT noted that nationally, costs required to meet 90% compliance amount to just a fraction of one percent of the value of construction projects (2). The information and costs presented in this report should be useful to local governments, efficiency organizations, utilities, states, and the federal government in efforts to improve building energy code compliance.

1 INTRODUCTION

While building energy codes save a significant amount of energy, there is a well-documented history of non-compliance with residential and commercial building energy codes. Builders comply with energy codes by building in accordance with them. Enforcement is the process of verifying compliance (3). A significant reason for non-compliance is the general attitude towards building energy codes relative to health and safety codes. While health and safety codes (*e.g.,* fire codes) are treated seriously due to the obvious implications for occupant safety and well being, energy codes are viewed as less critical, as their impacts on the operations of the building and its occupants appear to be less dire. Other reasons (as noted below) have to do with market barriers associated with the many parties involved in the design, financing, permitting, construction, and use of the building. Finally, a primary theme impeding compliance is lack of enforcement. In other words, non-compliance occurs due to the general lack of knowledge or concern regarding the energy code and the low probability that responsible parties will be held accountable for any oversights.

While the incremental cost of energy efficiency measures installed to comply with the building code has been well documented, particularly by the Building Codes Assistance Project (BCAP) (4), the cost of initiatives to improve compliance and enforcement has been addressed less thoroughly. However, the estimated cost of compliance and enforcement is thought to be significant. For example, in 2010, an Institute for Market Transformation (IMT) study (conducted with limited modeling based on inputs from a task force) estimated the total cost to reach 90% compliance at $810 million annually, or $610 million of additional funding over the estimated current spending of $200 million per year (5).[1] While this number sounds high, IMT noted that this amounts to a fraction of one percent of the value of construction projects, and that every dollar spent in this manner results in $6 in energy savings (2).

The primary purpose of this study is to assess the *local government* costs associated with energy code enforcement for residential and commercial buildings. The study also provides a current description of the barriers associated with non-compliance and strategies to overcome them. This study focuses on local government, because (as noted below) local government is typically the primary entity responsible for enforcing building codes. This paper represents the first phase of the study of enforcement costs: a literature review of cost information that is publicly available. The second phase of this study, which will be presented in a different report, will consist of surveying 34 experts in the building industry at the national and state or local levels in order to obtain additional cost information, building on the findings from the first phase, as well as recommendations for where money would be most effectively spent.

[1] IMT estimates the $810 million from the following components: 1) plan review and inspection cost based on best-practice level of enforcement: $660 million; 2) implementation and training cost based on best practices (training, outreach, distribution of guides and manuals, compliance evaluation, development of alternative compliance methodologies): $125 million; and 3) national level support: $25 million. Details of the inputs and models used to develop these estimates are not available, so comparisons cannot be made with the data reported in this paper. Plan review and inspection costs seem to be based on a traditional enforcement process.

This study has several limitations. The study will not provide definitive scientific results on the cost of initiatives to improve compliance with and enforcement of building energy codes. It is limited by the information available in the literature, which covers a wide range of time, jurisdiction size, experience, and other parameters that may produce non-comparable results. In many cases, data are limited with only one source for a given cost metric. In other cases, cost data with disparate sources and assumptions are combined to create more useful estimates; this compilation generates uncertainty. Nevertheless, the study is designed to provide an unprecedented picture of the approximate ranges of costs necessary to develop and enhance compliance and enforcement infrastructure. These cost data and related information may be used by local governments when considering initiatives and analyzing budgets. They may also be useful to efficiency organizations, utilities, states, and the federal government in determining where to spend resources to improve building energy code compliance.

This report begins with an overview of building energy codes, the code compliance and enforcement process, estimated compliance rates, and a discussion of barriers to compliance and enforcement, as well as efforts made by the U.S. Department of Energy (DOE), BCAP, and other entities to improve compliance rates. The paper then provides details on the costs associated with the local government enforcement process, including alternative and supplemental means of enforcement and other strategies to improve compliance. Finally, the paper summarizes key findings and discusses next steps.

2 BUILDING ENERGY CODE BACKGROUND

States have been adopting building energy codes since the 1970s (6). Figure 1 shows an overview of the different stages of energy codes (from code adoption through compliance and enforcement) as well as the roles and responsibilities of key parties. Typically, states or local jurisdictions develop and adopt their own energy codes or adopt model or modified model codes. Model codes are codes or standards developed by organizations with appropriate expertise, with the purpose of being used in jurisdictions. The two most widely-known organizations publishing model codes and standards today are the American Society of Heating, Refrigeration, and Air-conditioning Engineers (ASHRAE) and the International Code Council (ICC). The code development and adoption process is discussed in more detail in section 2.1. Following code adoptions but prior to code enforcement, state and local jurisdictions, along with other entities, may provide public outreach about the new codes, educate stakeholders and building officials about the new codes, and develop tools and materials that will help builders to comply with the code and code officials to enforce the new codes. These activities may continue after the code compliance date, when compliance becomes mandatory and enforcement begins. The compliance and enforcement process is discussed in more detail in section 2.2.

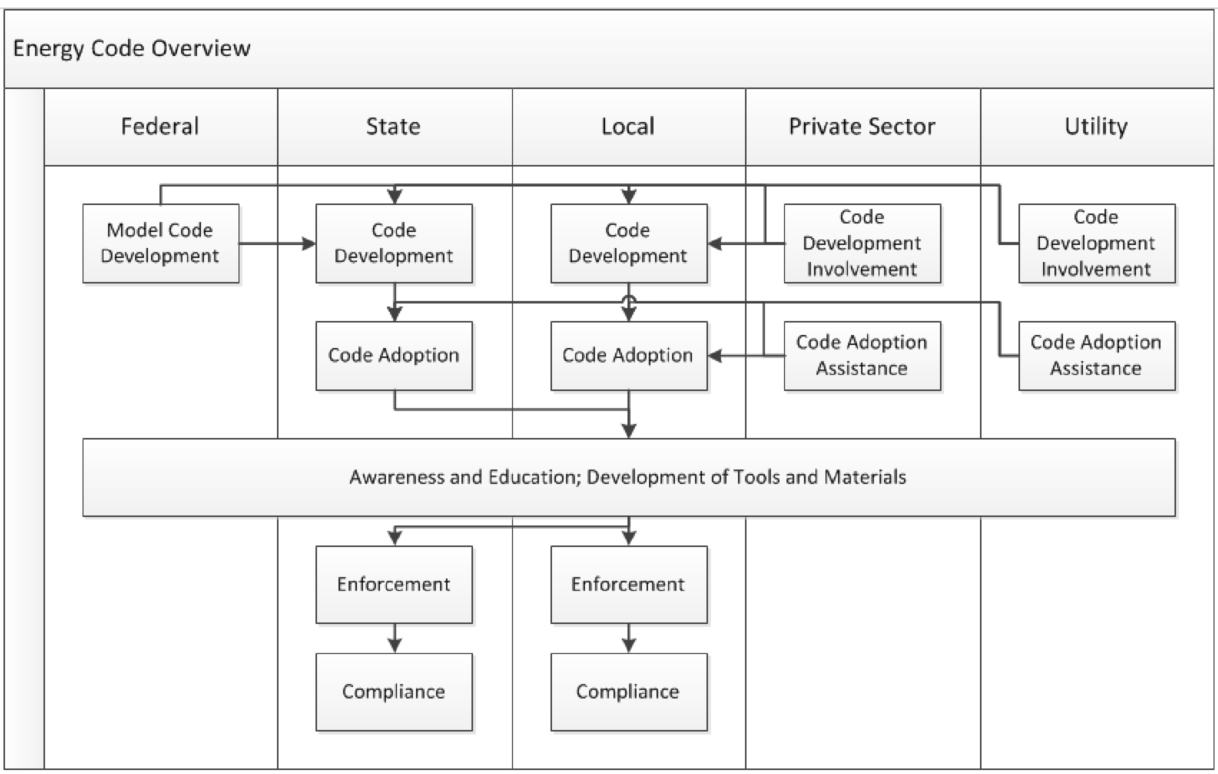

Figure 1: Energy Code Overview

2.1 Code Development and Adoption

At the federal level, the code development process begins when private nonprofit organizations develop national model energy standards and codes (1). These include ASHRAE Standard 90.*1 Energy Standard for Buildings Except Low-Rise Residential Buildings*, used for commercial and high-rise multifamily buildings, and ICC's International Energy Conservation Code (IECC), used for residential and low-rise multifamily buildings (1). Both the ASHRAE standard[2] and IECC code are now on a three-year development cycle.

DOE participates in the development of these codes and standards (7). In addition, federal law requires DOE to determine whether new editions will save energy and, if so, to publish a determination within one year of each new edition (8). If the new standards or codes are found to save energy, states must certify, within two years, that their state building energy codes are equivalent to, or go beyond, the new standard or code (although states may ask DOE for exemption from the residential building energy codes requirement) (9). DOE provides technical assistance and funding to states for this process (10). In 2009, the American Recovery and Reinvestment Act (ARRA) tied federal funding to the requirement that states adopt the national model codes and implement a plan to achieve 90% compliance by 2017 (1). Figure 2 and Figure 3 show the status of state building energy code adoption for both commercial and residential buildings.

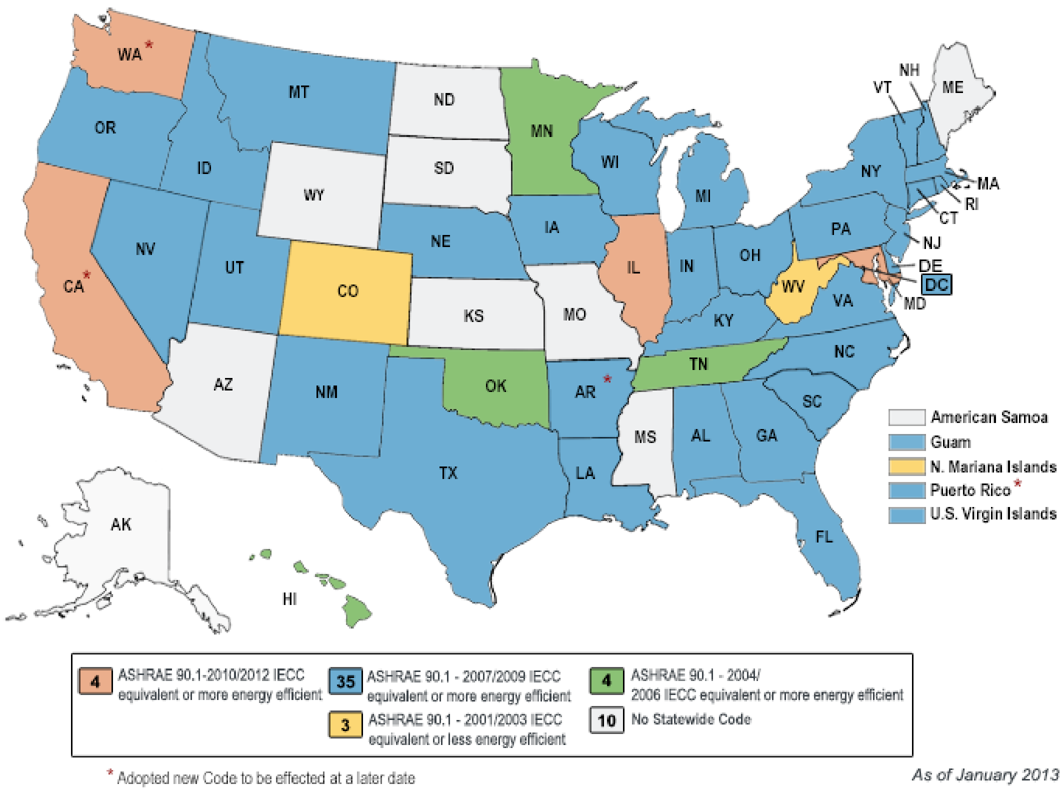

Figure 2: Status of State Commercial Code Adoption (11)

[2] ASHRAE Standard 90.1 is a standard, not a code, but can be adopted by a jurisdiction to become code.

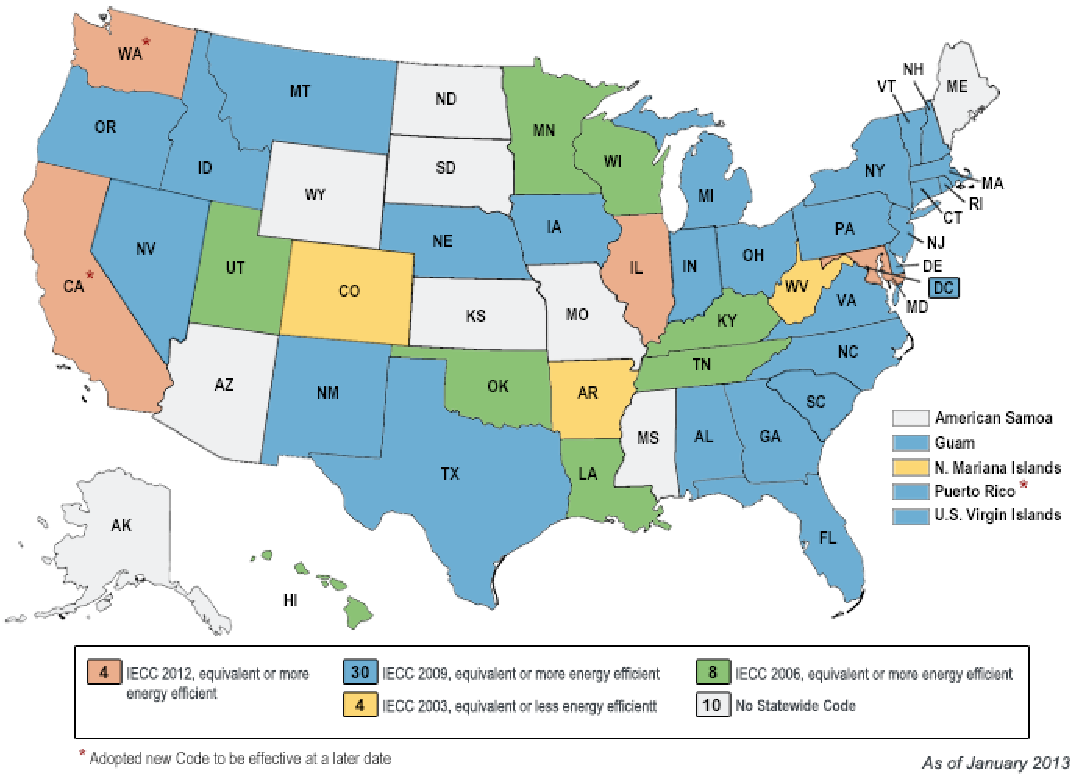

Figure 3: Status of State Residential Code Adoption (11)

Forty-two states have adopted some form of a statewide energy code (12). Although DOE tracks statewide adoption, adoption and enforcement effectively occur at the local level (12). Moreover, some states with statewide energy codes afford flexibility to local jurisdictions as to whether they have to adopt the statewide code. For example, in home-rule states, local jurisdictions may not be required to adopt a code.[3] Other states with statewide codes require local jurisdictions to adopt the statewide code, or, if they do not do so, the statewide code may apply. In some states, a local government may amend a state-adopted code prior to local adoption (13). A recent survey to study the effective adoption rate for jurisdictions within each state found municipal adoption rates of 52% in states with no statewide code, 78% in states with a flexible statewide code, and 95% in states with a mandatory statewide code (12).

State or local adoption of energy codes occurs through legislative or regulatory action (14)(15). The adoption process includes a public review process (15). In legislative action, public review occurs through a formal path. In regulatory action, the state or local government may appoint an industry and stakeholder advisory body, which issues recommendations that then go through a public review process prior to final adoption (14).

[3] Home-rule states have a constitution that grants local jurisdictions the ability to govern themselves as they see fit. However, the U.S. Environmental Protection Agency (EPA) notes that home-rule states can revise laws to allow statewide building energy codes (98).

2.2 Compliance and Enforcement Process

Once codes have been developed and adopted, compliance and enforcement begin. Enforcement occurs after some time has passed since the code was adopted, in order to give the building industry sufficient time to comply with the new code.

Enforcement can take place at the state or local levels, or occasionally through a utility (13)(15)(16). The level of enforcement is not necessarily tied with the entities responsible for adopting the code; for example, states may require local jurisdictions to enforce statewide codes (3). At the local level, municipal officials undertake code enforcement (17). However, local jurisdictions may require code compliance but not provide any enforcement (18). At the state level, state staff may have responsibility for plan review but may or may not provide inspection (16). In the most common version of state enforcement, state inspectors supplement municipal officials (17). In some states, there may be no enforcement, but a design professional must certify that a building is code-compliant in order to obtain a permit (18). In the utility approach, the utility would be responsible for verifying compliance and could enforce it by withholding utility service (*e.g.,* electricity, gas, or both) for lack of compliance (13).

This report focuses primarily on local level enforcement, as it is the most common type of enforcement (16). Local level enforcement generally begins with a permit application (19). Code officials will then review building plans before issuing a permit (13)(18)(19). Sometimes, inspections are preformed during construction to verify compliance (13)(18), as finished buildings may differ from plans (18). A certificate of occupancy will be awarded after compliance is verified (13). Energy codes are just one of the many building codes that will be assessed during the plan review and inspection process.

Figure 4 depicts a sample code compliance and enforcement process with a number of enhancements that might be added to the basic enforcement process of plan review and inspections, such as:

- having a voluntary pre-application meeting (19)(20)(21)(22);
- requiring submittal of additional documents with the permit application (see for example (20)(23)(24));
- conducting multiple inspections (20);
- verifying mechanical drawings during inspections (23);
- comparing construction to the approved plans kept on site (20);
- using a third party to focus on energy code plan reviews or inspections (see section 4.2.1); and
- adding supplemental or alternative compliance verification through the use of performance testing (see section 4.2.2), HERS ratings (see section 4.2.3), or commissioning (see section 4.2.4).

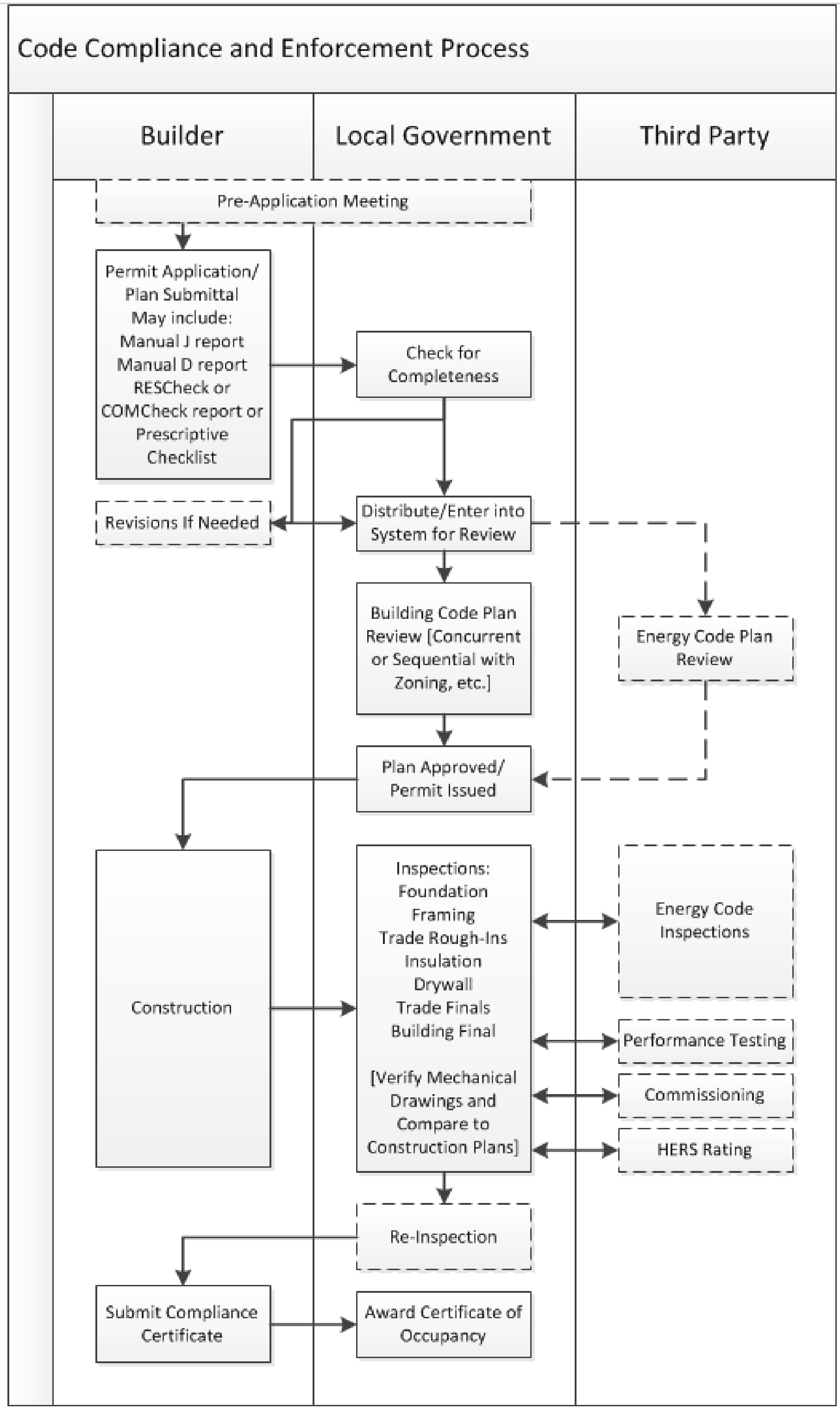

Figure 4: Sample Code Compliance and Enforcement Process

3 COMPLIANCE OVERVIEW

This section provides an overview of building energy code compliance. Code compliance has typically been fairly low as a result of many barriers in the marketplace. Section 3.1 provides an overview of compliance rates across the nation, and section 3.2 describes barriers on both the stakeholder and local government sides. Section 3.3 reviews the efforts undertaken by DOE, BCAP, and other entities to overcome barriers and improve compliance rates.

3.1 Compliance Rates

It is important to note that building energy code compliance studies measure compliance in many different ways. For example, some studies may define a compliant building as one that has less than a certain number of violations, while another may find a building compliant if it uses less energy than a simulated building under the same building code. Analysts must also choose how to interpret prescriptive compliance (*i.e.,* have all the relevant code measures been installed in the building) compared with performance-based compliance (*i.e.,* is the building expected to meet or exceed the energy use requirements of the code). A recent study demonstrates nine different ways that compliance has been reported (1). Reported compliance rates are also affected by sampling error, participant bias, and regional differences. Studies suffer from self-selection bias, in which participants are voluntary and are, therefore, more likely to view energy codes positively (25). Studies may also suffer from market bias, in which a sample might reflect certain construction activity levels, specific climates, or certain types of builders, and the sample might therefore be unrepresentative (25). Regional differences in compliance measurement prevent studies from being compared across states (26). Furthermore, the codes themselves are open to interpretation, an issue exacerbated when plan reviews, site inspections, and follow-up studies are completed by different individuals (27).

Although energy code enforcement occurs in many jurisdictions, energy code compliance rates have been significantly lower than 100%. A survey of the literature, from 1990 to 2012, reveals a complete range of building energy code compliance rates in the United States, from a low of 0% for residential buildings in New York (2002)[4] to a high of 100% for residential buildings in Oregon (1993). Table 1 summarizes these results. As noted previously, the rates in this table are influenced by methodology and other factors.

[4] Using REM/rate and REScheck, on average, all houses failed based on the heat loss rate of composite buildings.

Table 1: Building Energy Code Compliance Rates

State/Jurisdiction	Sector*	Survey Year	Compliance Rate	Source
California	C	2007	50%	(28)
Minnesota	C	1994	50%	(29)
Massachusetts	C	2012	83%	(30)
New York	C	2011	85%	(26)
New York	R	2002**	0%	(6)
California	R	2007	25%	(28)
California	R	1997	38%	(31)
Massachusetts	R	2001	46%	(32)
Massachusetts	R	1998**	46%	(6)
California	R	2003	48%	(33)
California	R	2003	51%	(33)
Idaho	R	2005	52%	(34)
Idaho	R	1996**	52%	(6)
Iowa	R	2000**	53%	(6)
Arkansas	R	2005	55%	(34)
Arkansas	R	1992**	55%	(6)
Oregon	R	1996	55%	(25)
Vermont	R	2000**	58%	(6)
California	R	2003	63%	(33)
Louisiana	R	2000**	65%	(6)
California	R	2005	70%	(34)
Vermont	R	2009	70%	(35)
Vermont	R	2012	72%	(36)
Iowa	R	2011	73%	(35)
New York	R	2012	73%	(26)
California	R	1989	75%	(37)
Illinois	R	2011	77%	(35)
Montana	R	2012	77%	(38)
San Francisco	R	1990	80%	(39)
Idaho	R	2008	86%	(40)
Montana	R	1997**	87%	(6)
Utah	R	2006	87%	(41)
Washington	R	1993	90%	(42)
Washington	R	2008	91%	(40)
Washington	R	2005	93%	(34)
Washington	R	1997**	93%	(6)
Oregon	R	2008	94%	(40)
Oregon	R	1993**	100%	(6)

*R=Residential, C=Commercial

**Code year

3.2 Barriers

Many issues contribute to low rates of energy code compliance. On the **stakeholder[5] side**, barriers to compliance generally focus on a lack of incentive or a disincentive to comply and a lack of knowledge about how to comply. Barriers to compliance include:

- Lack of incentive or disincentive
  - Little or no enforcement (34); little chance of being "caught"(43)
  - Lack of "sticks" (44); perceived consequences of being caught are insignificant (*i.e.,* warning, minor fine, or need to get a permit) (43)
  - Lack of value or demand from consumers (45)
  - Some stakeholders view the energy code as voluntary (46)
- Lack of knowledge
  - Lack of knowledge both from architects and engineers, builders, contractors, and code officials (34)
  - Construction workers unknowingly install products incorrectly (46)(47)
  - Builders and tradespeople cannot recognize incorrect installations (47)
  - Lack of professional licensing for key trades (44)
  - Codes change too frequently to keep up with latest requirements (32)
- Other
  - Owners and developers focus on first costs rather than life-cycle cost (48)
  - Inconsistent code interpretation across communities and between code officials (34)
  - Interpretation issues between end-user, plan reviewer, and site inspector (27)
  - Some new technologies cannot be properly captured in energy code software (27)

On the **local government side**, lack of resources, low prioritization, and lack of knowledge most significantly influence the ability to properly enforce energy codes. Barriers to enforcement include:

- Lack of resources
  - Insufficient budget and staff (time) (30)(44)(48)(49)
  - Building officials enforce other codes and may be burdened with regular inspections of existing buildings (30)
  - While building departments might have a master electrician or master plumber, few have an energy efficiency expert (47)
  - Limited number of IECC-certified energy code inspectors and plan reviewers (44)
- Low prioritization
  - Energy codes are last on the compliance and enforcement list, after life, safety, and structure (30)(48)(49)
- Lack of knowledge and training
  - Insufficient training and experience in enforcing energy codes (50)
  - Building officials need energy specific training (48)

[5] Stakeholders include architects, engineers, contractors, developers, lenders, leasing agents, building managers, and owners or occupants.

    - Building officials lack an understanding of building science (51)
    - Building officials are not qualified to determine code compliance on complex heating, ventilating and air conditioning (HVAC) systems and controls and lighting controls (30)
    - Air Conditioning Contractors of America (ACCA) Manuals J, D, and S[6] are not well understood and, therefore, are difficult to enforce (44)
    - No specialized enforcement of energy (or other) codes (49)
- Other
    - As-built conditions differ from plans (18) and inspections may not occur
    - Insufficient data provided with building plans (44)

3.3 Overview of the U.S. Department of Energy and Other Key Stakeholder Activities to Address Compliance

Barriers to building energy code compliance and enforcement, along with fairly low compliance rates, have led DOE and other entities to develop a range of programs and projects designed to increase overall compliance. DOE's involvement includes collaborative efforts with state and local governments and industry groups to promote greater compliance, as well as ongoing participation in the development and management of a number of programs aimed at assisting states that received funding from ARRA in reaching 90% compliance with building energy codes by 2017 (46)(52). These programs include the following, which are described in further detail below: the Building Energy Codes Program, including the Resource Center and the Technical Assistance Program; the Building Codes Assistance Project; and the Compliance Planning Assistance Program.

Building Energy Codes Program

DOE supports the Building Energy Codes Program (BECP). BECP offers an online Resource Center that provides tools and technical assistance to aid states in verifying their rates of compliance. RESCheck and COMCheck are two of BECP's free support tools, used to provide architects, builders, designers, contractors, building officials, plan checkers, and inspectors with the information needed to easily determine whether residential or commercial buildings in question do, or will, meet appropriate building energy codes (15)(53). Other tools offered through the resource center are: the Residential Prescriptive Requirement website, which gives climate zone information on a county-based level; the State Sample Generator™ tool; the State Energy Code Jurisdictional Survey; Compliance Checklists; and the *Score and Store* website, which uses a checklist system for evaluating building energy code compliance while also allowing states to store field-evaluation data and generate "state scores" for compliance.

In addition to the Resource Center, BECP provides the Technical Assistance Program, which helps with adopting, upgrading, implementing, and enforcing both residential and commercial building codes at the

[6] The ACCA Manual J Residential Load Calculation standard allows mechanical contractors to properly size HVAC systems based on loads (93). ACCA Manual D Residential Duct Systems standard allows mechanical contractors to design residential duct systems based on sizing principles and calculation methodologies (94). ACCA Manual S Residential Equipment Selection provides information on selecting and sizing equipment to meet Manual J loads (95).

state and local level through the provision of tools and resources, including one-on-one assistance, an online resource library, code-related energy savings and cost impacts analysis, information regarding future code options, and the facilitation of peer exchange (46)(54). The Technical Assistance Program has also developed and provided online tools to help increase compliance (46).

BECP partnered with five national energy efficiency partnerships to fund eight energy code compliance evaluation pilot studies in nine states (55). The pilot studies are intended to help States in their compliance efforts, while at the same time providing insight into the effectiveness of BCEP tools and procedures to measure and report compliance. The pilot studies concluded June 30, 2011, and the results are being compiled in a BECP final report to be released soon.

BECP has also published a study that identified compliance verification paths for residential and commercial energy codes. The study describes nine compliance paths that could be used based on how codes are developed (regarding scope and format) in different jurisdictions. These compliance paths include: Traditional Adoption and Enforcement, Traditional Adoption with Peer Review, Traditional Adoption with Self-Certification, Adoption and Compliance as a Function of Licensing, Adoption and Compliance as a Function of Utility Service, Voluntary Sector Program Equivalency, Outcome Based Energy Use Intensity (EUI), Capacity Limits, and Joint Commission (13).

Building Codes Assistance Project

The BCAP initiative was established in 1994 by the Alliance to Save Energy, the American Council for an Energy-Efficient Economy (ACEEE), and the Natural Resource Defense Council (NRDC) as an advocacy organization designed to provide support on code adoption and implementation to U.S. state and local governments as well as other interested stakeholders. DOE, private foundations, the U.S. Environmental Protection Agency (EPA), and individual states through State Energy Program (SEP) grants funded the non-profit (56). BCAP provides adoption support, compliance assistance, and technical expertise to governments, organizations, and non-profits (57).

The Compliance Planning Assistance Program

Through a combined effort of DOE and BCAP, the Compliance Planning Assistance Program (CPA) was started in June 2010. The overarching goals of the 18-month program were to assist 15 states[7] with developing plans for reaching the ARRA requirement of 90% building energy code compliance by 2017. In order to achieve this goal, the CPA would both analyze existing gaps in energy code infrastructure and practices, as well as provide stakeholders with assistance in compliance planning and technical support (9)(58).

The program was divided into two phases. The first phase was the development of the Gap Analysis Report, which was done for all 15 states. Through extensive research done in partnership with state energy offices, other agencies, or other stakeholders, the Gap Analysis Reports identified barriers that states faced for successfully adopting and implementing energy codes, as well as the state's current best

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[7] Arkansas, Colorado, Delaware, Illinois, Kentucky, Michigan, Nevada, New Hampshire, New Mexico, Ohio, South Carolina, South Dakota, Texas, Vermont, West Virginia

practices. After identifying these barriers and best practices, the CPA made recommendations for improving statewide code compliance, which are presented in the Gap Analysis Reports (9).

After the first phase of the program was completed, 10 states[8] were selected for phase 2—the development of a Strategic Compliance Plan. The Strategic Compliance Plan was designed to give multi-year guidance for achieving 90% code compliance by presenting state-specific approaches to compliance based on previously identified gaps, focusing on the following categories: policy, funding, training, consumer engagement, and compliance verification. Ultimately, the Strategic Compliance Plans provided states with a detailed checklist of activities to be accomplished by a specified and diverse group of stakeholders, intended to aid in moving towards 90% state-wide building energy code compliance (9).

[8] Colorado, Delaware, Illinois, Kentucky, Michigan, New Hampshire, New Mexico, South Carolina, Texas, West Virginia

4 LOCAL GOVERNMENT COMPLIANCE AND ENFORCEMENT PROCESSES AND COSTS

This section reviews the processes and resources associated with enforcing building energy codes, primarily at the local level, in order to begin assessing the cost of achieving full compliance. In addition to dollar costs, this section includes information on other resources such as time to complete an action (*e.g*., plan review) or staff needs. Cost data were drawn from a variety of sources including documented program expenditures, examples from “best practice” programs, and estimates from other efforts such as BCAP. Some costs are estimated for particular jurisdictions and are, therefore, dependent on the size of the jurisdiction, the expected level of construction activity, builder experience in constructing energy-efficient buildings, and so on. Other costs are given on a per home or per building basis. While costs are focused at the local level, some state or regional level costs are included where available.

Section 4.1 reviews the traditional compliance and enforcement process at the local level. Section 4.2 reviews supplemental and alternative processes. Section 4.3 discusses ways to improve compliance including information technology (IT), training, and tools. Finally, section 4.4 provides an overview of the potential roles for states and utilities.

4.1 Traditional Process

Local governments typically enforce building codes, including energy codes, primarily through a plan review and inspection process, as shown previously in Figure 4.

Costs: Costs for this traditional method are generally calculated based on the amount of incremental staff time spent on energy codes as opposed to the remainder of the building codes. Sources indicate that less than 10% of time is spent on energy codes (3)(17).

Residential

BCAP estimates that the typical residential energy plan review takes 15-45 minutes, and the typical residential energy inspection takes 30 minutes to an hour, for an overall average of 1.25 hours (49). Using BCAP’s assumed average wage of $25, this amounts to $31 per home. The level of effort and cost will increase with building size and complexity (13). In addition, if time is reallocated for plan review and inspection of buildings that do not meet code upon first review/inspection, the incremental cost may be doubled for that house (49).

The total cost of residential energy code compliance within a traditional enforcement program depends not only on average staff time per building but also on other factors, such as the number of building starts in the jurisdiction, the average wage of an inspector, and the percent of buildings that must be re-inspected in order to achieve compliance (49). BCAP estimates this average incremental cost to be $156,000 annually for a jurisdiction processing 5,000 permits, or $266,000 if re-inspection on 70% of homes is accounted for (49). These estimates do not include training and support infrastructure costs (13). They also do not account for administrative time for staff[9] or overhead.

[9] Hours spent on meetings, paperwork, and so on not directly tied to energy code reviews and inspections.

BCAP also recommends that 2.5 hours be spent for residential building plan review and inspection (34), or twice as much as the current estimated average. For a jurisdiction with 5,000 permits, this would total $312,000 annually, or $531,000 if re-inspection is accounted for.

Maine estimates that residential energy enforcement costs $50-$100 per home, based on a wage of $30 per hour for up to three hours of incremental work (17). The cost would be $125-$400 per home if not incremental. Maine estimates that, in a municipal enforcement model, inspection of half of new homes in Maine would cost $150,000-$1.2 million per year (17).

Commercial

Maine estimates a commercial energy enforcement cost of less than $500 for small, common buildings (6 hours at $30+/hour), but thousands of dollars for more complex buildings, partly because of the increased fees for a professional engineer to do an inspection ($85-$135/hour) (17). Massachusetts received commercial estimates of 10 minutes to 2 hours for plan reviews and 15 minutes to 4 hours for field inspections (30). Using Maine estimates of labor rates, the costs in Massachusetts would range from $13 - $180 per building at $30/hour, up to $810 at $135/hour. An older estimate of commercial energy enforcement cost per building was $543 (3).

Overall

IMT estimates that, at a national level for both residential and commercial buildings, $660 million annually is needed for a best-practice level of plan review and inspection in local jurisdictions (5). This cost estimate is based on replicating, at a national level, enforcement best-practices seen in Austin, Texas. These costs are calculated by "using 8-year average construction data from the US Census Bureau, McGraw Hill, and the Bureau of Labor Statistics," but further details are not available (5). It is unclear if this estimate is still realistic given the downturn of the last several years.

Summary

Table 2 summarizes traditional enforcement process costs. The incremental cost of enforcing energy codes using a traditional review and inspection process can be up to around $100 per home using best-practice levels of time spent per home and re-inspection upon failure. Cost for commercial buildings can range up to thousands of dollars depending on the complexity of the building.

Table 2: Traditional Program Costs

Cost Type	Sector*	Cost	Metric	Source	Notes
Energy Code Review and Inspection	R	$50-$100	Per home (incremental**)	(17)	$30/hour for up to 3 hours
	R	$31-$63	Per home (incremental)	(34)(49), estimate^	1.25 to 2.5 hours at $25/hour; not including re-inspection
	R	$54 - $106	Per home (incremental)	(34)(49), estimate	As above, but including re-inspection
	R	$125-$400	Per home (not incremental)	(17)	
	C	$13 – $180	Per building (incremental)	(30), estimate	25 minutes to 6 hours at $30/hour
	C	Up to $810	Per more complex building (incremental)	(30), estimate	6 hours at $135/hour
	C	<$500	Per small, common building	(17)	6 hours at $30+/hour *(assumed incremental for energy code only)*
	C	$1000s	Per more complex building	(17)	Increased fees for PE ($85-$135/hour) *(assumed incremental for energy code only)*
	C	$543	Per building	(3)	Estimate from the late 1980's; *unknown if this includes both review and inspection (assumed incremental for energy code only)*
Overall	R	$156,000-$266,000	Annual per jurisdiction	(49)	Assumes 5,000 permits per year, average time per home of 1.25 hours, and $25/hour wage; range depends on accounting for re-inspections
	R	$312,000 - $531,000	Annual per jurisdiction	(34)(49), estimate	Based on recommended 2.5 hours per home; range depends on re-inspections
	R	$150,000-$1,200,000	Annual per state	(17)	Maine; assumes ½ of new homes inspected
National	R/C	$660,000,000	Annual	(5)	Best practice plan review and inspection in all jurisdictions

*R=Residential, C=Commercial

**Incremental means the additional cost of enforcing energy codes when other building codes are also being enforced.

^Estimate means that information provided in the cited sources as well as assumptions shown in the Notes column are used to estimate the reported cost.

Fees

Local government enforcement of building codes is often funded from a combination of permit fees and municipal taxes (17). One report found that 79% of building departments in Georgia relied primarily on agency budgets (general fund model), with fewer departments relying solely on the money funded by permitting and inspection revenue (enterprise model) (20). Some fees are used to generate enough revenue for training and other related activities or to create a reserve fund for times of low economic activity. On the other hand, sometimes fees are reduced to encourage growth and economic activity. Therefore, while fees can be used to provide some understanding of the cost of enforcement, they do not generally provide the entire picture.

The fees listed here are for all building codes, not just the energy codes. Plan review fees in Savannah, GA, range from $32 for construction costs of up to $6,000 to $2,000 for construction costs of more than $10 million. Savannah also has permit fees based on $2-$8 per $1000 of construction cost (decreasing as value increases). However, these fees in combination are not expected to cover the cost of plan review and inspection, as Savannah relies primarily on a general fund (20). Chatham County, GA, has an enterprise fund, so their fees are designed to cover their enforcement activities. Chatham County has plan review fees for residential and commercial construction at $2 per thousand dollars of construction value. Permit fees are $6 (residential) or $7 (commercial) per thousand dollars of construction value (20).

Re-inspection fees can also be levied at a rate to fully cover the cost of additional inspections (20). Savannah has re-inspection fees of $30 for the first visit and $50 for the second. Chatham County has a re-inspection fee of $30 only for the third inspection, which they use to train building code inspectors (20).

4.2 Supplemental and Alternative Processes

Some local jurisdictions have been exploring alternative or additional methods of code compliance and enforcement. Some alternatives expected to improve compliance rates are discussed in this section: third- party plan review/inspection (section 4.2.1), performance testing (section 4.2.2), HERS as Code (section 4.2.3), commissioning (section 4.2.4), and licensing (section 4.2.5). However, if a traditional compliance verification model is effective and efficient, it should not be replaced (59). Thus, alternative methods should generally be considered for non-existent or inefficient or ineffective programs (59). Section 4.2.6 provides a cost summary of all the supplemental and alternative processes discussed.

4.2.1 Third Party Plan Review/Inspection

One alternative to the traditional process is to outsource energy code plan review, inspection, or both to a third party. Theoretically building departments could increase and train their own staff through increased permit fees or taxes and might still be able to have lower permit fees than those that would be paid to third parties. However, using a third party option offers several benefits:

- helps alleviate the problem of unpredictable revenue from permit fees as a result of an unstable economy (59), which makes it difficult for governments to staff appropriately;

- provides a solution to jurisdictions where the level of construction activity does not require a full-time code official (16);
- requires reduced staff in the building department itself, which results in cost savings to the local government (59);
- when offered as an expedited process or otherwise optional route for the builder, prevents the need for a mandatory fee increase, which could discourage economic activity;
- takes the burden of enforcing the energy code off regular inspectors, allowing them to focus on life and safety (21)(46)(48);
- saves the local government the expense of funding of extensive energy code specific training(61);
- eliminates the problem of retaining skilled labor during lulls in building cycles (61); and
- adds a level of quality assurance, as local governments audit plans and provide final approval (46)(60).

However, a BCAP study noted that, because energy is integrated into the mechanical, electrical, and structural reviews, it could be inefficient to have an energy-specific review (27).

The third-party alternative can be used for all permits, or for certain cases, such as large projects, to verify complex HVAC systems and lighting controls, or to review energy models(30)(60). More extensive implementations include the model in China, in which large buildings have a third-party design verification company on-site continuously during construction (62). In addition, a study team recommended that New York implement a third-party energy specialist that would go through a design documentation checklist and make multiple site visits during construction, provide on-site training to builders, and complete interim and final construction inspection checklists (26).

While builders are often responsible for paying the third-party fee directly, the local government (or other entity such as a utility or the state) is generally responsible for administration of the program, including setting qualifications and responsibilities for third parties, and providing oversight and quality control (59). The local government can collect fees from third parties for participation in the program (59).

Qualified personnel are key to improving compliance, and setting appropriate criteria for third parties allows for highly qualified personnel (59). Third-party plan reviewers should have a minimum level of experience, potentially hold licenses as professional engineers or architects, be certified through the International Code Council (ICC) for various components, be specifically trained on the energy code, and have continuing education requirements (60)(48). Requirements may vary between residential and commercial (48). However, for third-party systems to be successful, there must be a sufficient pool of qualified reviewers (60). Existing pools for above-code programs, such as HERS raters, can be utilized (48).

Third-party programs require infrastructure and oversight. The Washington SPE/I program included training, testing, lists of certified SPE/I, and guidebooks (63). In China, the extensive third-party program includes regulatory support, financial resources for stakeholders, management of inspection companies, certification and registration of third parties, provision of penalties, and national inspections (64).

A study shows general government cost savings of 20-50% when using the private sector to provide a service (59). It should be noted that this estimate is based on municipal services in general and not directly tied to energy or building codes. In Washington State, the commercial Special Plans Examiner/Inspector (SPE/I) program, a third-party program, resulted in reported increases in compliance rates from 55% to 94% (46), and an overall compliance rate for buildings approved by an SPE/I that was 20% higher than that for all buildings (65).

Costs: One resource estimates the cost of private inspectors for residential reviews or inspections to be $200 to $800 (17), while another reports the average cost for a third-party plan reviewer as $560 (based on 8 hours at $70/hour, likely weighted toward commercial) (60). These costs are for all codes, not just energy. In addition, the $560 value and higher costs may represent a large project with extensive construction plans (60). Maine suggests that, for residential energy code inspection alone, a fee of at least $200 should be expected (17). Washington State's commercial SPE/I program offered $300 - $375 rebates to permit holders to cover the cost of employing an SPE/I (65). The report estimates that today the fee structures would be 2.5 times higher (65), or $750 - $940.

Maine notes that fees for private inspectors for inspections of half of new homes in Maine would cost $600,000 (17).

Third-party programs also require local government expenditures on oversight. On the local level, in Fairfax County, Virginia, a building official spends 15% of time on oversight of expedited residential and commercial plan reviews (60). Using BCAP's estimated wage of $25/hour, this would cost approximately $7,800 per year, or $23,400 if overhead is included (estimated at a factor of 3).

Some implementations of third-party programs occur at the state level, such as in the Washington State commercial SPE/I program. The original Washington State program cost $250,000 in 1994. A little more than half of this cost was split between test development, testing, administration, and evaluation, while the remainder was spent on certification review training courses (63). Research on replicating the program indicated that it would cost $150,000-$250,000 in the first year to develop the program, depending on the scope (65). The lesser cost would be for a program that is smaller in scope, such as one that focused on large projects, projects with high system complexity, or only covered inspections (65). Maine suggests that state implementation and oversight of a third-party program for both commercial and residential codes would require 2-3 state employees at $200,000-$300,000, including overhead (17).

4.2.2 Performance Testing

Performance testing is generally used as a supplemental method for determining compliance in addition to plan review and inspection. The builder, or building owner, is typically responsible for paying a third party for testing the home, while the local jurisdiction incurs cost for oversight and management of the program (61), including spot checks of third-party testing (20)(24).

Performance testing most commonly consists of envelope and duct leakage testing. Testing must generally be performed by someone holding a certification such as a HERS rater, a Building Performance Institute (BPI) analyst, a National Comfort Institute analyst, or a Home Performance with Energy Star (HPwES) contractor. A state or jurisdiction may also develop their own certification process; Georgia offers a Duct and Envelope Test (DET) Verifiers course and examination related to mandatory whole-house and duct leakage testing (66).

Implementation of a performance testing program can be eased by raising awareness about current code compliance problems and helping builders to realize that performance testing allows them to verify that they received code-compliant work from contractors (61).

Austin, Texas, with a population of 800,000, represents the poster child for this type of program. In Austin, homes rarely pass all performance tests in the first round (61), but initial field audits indicate significant improvement in compliance rates as a result of third-party testing (67). Of 50 newly constructed homes, nearly all homes that had performance testing met code requirements, while two-thirds of houses not tested did not meet the code (61).

Costs: Estimated costs for performance testing for single-family homes are approximately $300 to $400 per home (59)(66)(61). The low end is generally for only building envelope and duct leakage, while additional tests such as air flow and static pressure may increase the cost.

Additional costs can be incurred by third parties or local jurisdictions if they have to purchase equipment for testing. The cost for envelope leakage testing equipment is approximately $2,500, and the cost for duct leakage testing equipment is approximately $1,900 (20).

Austin's annual operating budget for the third-party testing program is $131,000, currently funded and administered by the local utility rather than the building department (61). This cost covers oversight for 43 registered testing companies who tested approximately 1,900 homes in 2010; one staff member spends 15% of the time overseeing the program (including certifying, registering, and quality control) (61).

4.2.3 Hone Energy Rating System as Code (Voluntary Programs)

Local governments looking to improve code compliance can use "above-code" programs with built-in third-party verification (59). These programs are generally a replacement for the traditional process rather than supplemental. HERS is a common above-code program, which can be used in a "HERS as Code" approach.[10]

The HERS as Code approach is more comprehensive than a simple performance testing approach, as described previously. A HERS rater works with the developer, starting from the initial building plans through to occupancy (68). HERS raters conduct plan reviews and use software to calculate a projected HERS index based on plan review and a final index after construction. The HERS index, created by the Residential Energy Services Network (RESNET), is a scale on which a home that meets the 2006 IECC

[10] Leadership in Energy and Environmental Design (LEED) is an example of another voluntary above-code program.

scores 100, and a net zero energy home scores zero (68). HERS raters also make inspections during construction and conduct envelope and duct leakage testing.

The cost of a HERS rating is generally paid by the builder but passed along to the homeowner (68). The cost of establishing the HERS infrastructure must be taken on by some entity, whether it be the local jurisdiction or other stakeholders (*e.g.,* a state energy agency, a utility, or a homebuilder's chapter). In Long Island, the utility, an energy efficiency consultancy, and the regional homebuilder chapter assumed the costs of establishing the HERS infrastructure (68). While the Long Island program is based in a state where ENERGY STAR is the adopted code and HERS is, therefore, required (68), HERS can be used for compliance even if ENERGY STAR or something equivalent is not the adopted code (13). RESNET conducted an analysis equating HERS index scores to various versions of the IECC for typical residences in representative U.S. climates, in order to facilitate the use of the HERS index as a performance compliance option for building energy codes in local jurisdictions (69). Alternatively, a jurisdiction could recognize a voluntary program as equivalent to code and allow builders to voluntarily participate in those programs (13). Such programs can increase compliance if the voluntary program is reliable and credible (13).

Costs: The cost of a HERS rater in Long Island is typically $700 to $1,200 per home, or upwards of $1,700 for a home greater than 5,000 square feet (68). However, more typical costs in other areas of the country are around $450 per home (70). It is unclear if this difference is due entirely to location or also to the level of involvement of the HERS rater. The costs for voluntary programs would be borne by program participants (13). However, in order to be viable, a majority of new buildings would have to choose the voluntary program, or the local jurisdiction would not be able to reduce or cease their compliance functions (13).

4.2.4 Commissioning

Building commissioning represents "an intensive quality assurance process that begins during design and continues through construction, occupancy, and operations (45)." While commissioning currently doesn't support code compliance, stakeholders suggested that a process could be developed in which commissioning would track elements of energy code compliance (45). Stakeholders recommended commissioning only for large commercial buildings, such as those greater than 90,000 square feet (45). However, commissioning could improve residential building code compliance also. Commissioning agents should be trained and certified (23)(71).

Costs: Stakeholders noted that traditional building commissioning generally represents 2% of the total project cost for commercial buildings (45). Another resource noted that commissioning represents 10-20% of the total project cost, but recommended commissioning only for HVAC system and lighting controls to reduce that cost (23).

4.2.5 Licensing

When local jurisdictions are unable to support a code enforcement infrastructure, they may use another compliance model that requires fewer resources. The model most likely to maintain or improve compliance in comparison to the traditional model may be the *licensing model*. In this model, a licensed design professional stamps plans, certifying that the building meets code, and also issues a statement that final construction meets the approved plans (72). The final statement must be submitted before occupancy. Local officials could conduct random inspections to provide quality assurance, and authorizing statutes should require suspension or revocation of licenses when compliance is falsely certified. This option could also be modified by using it for plans only rather than construction (72). The design professional may be a state-registered architect or engineer (72), or licensure could take place through mechanical, plumbing, and electrical trades or and building contractors (13).

Costs: The state or local government may have to administer licensing in addition to staffing some inspections, but costs could be recouped through licensing fees (13). No costs are available.

4.2.6 Cost Summary

Table 3 summarizes the costs of alternative and supplemental enforcement approaches. In a third-party energy code plan review or inspection infrastructure, fees paid by builders directly to the third party are expected to be approximately $200 per home and up to nearly $1,000 per commercial building. The annual costs for infrastructure and oversight for such a program could be as little as $23,000 for a limited local program or range from $150,000 to $300,000 per year for a program organized and run at the state level.

A supplemental method of improving energy code compliance is the use of performance testing. Following a third-party model, builders would pay third parties $300 to $400 per home, and the local jurisdiction would need an operating budget of around $130,000 for oversight and administration of the program, depending on size.

Other alternative methods of energy code enforcement include HERS ratings for residential buildings and commissioning for commercial buildings. The cost of a HERS rating is approximately $450 up to $1,700 per home, while commissioning is expected to cost from 2% to 20% of the total project cost. No data are available on the costs to run such programs. However, in the HERS as Code approach, oversight and administration costs are often absorbed by voluntary programs run by other entities, such as utilities.

Table 3: Alternative/Supplemental Program Costs

Cost Type	Sector*	Cost	Metric	Source	Notes
3rd Party Review and/or Inspection	R	$200-$800	Per inspection (all codes)	(17)	
	R	$200	Per inspection (energy code)	(17)	Including travel, overhead, profit
	R	$600,000	Annual total fees for private inspections for half of all new homes (energy code)	(17)	Maine
	C	$750 - $940	Per hiring of special plans examiner or inspector (energy code)	(65), estimate	Based on rebates in the 1990s of $300-$375 (designed to cover costs); assumes 2.5x factor cost increase
	C(/R)	$560	Per review (all codes)	(60)	8 hours at $70/hour; likely weighted toward commercial
	C	$250,000	Annual examiner/ inspector program cost (infrastructure and oversight) (energy codes)	(63)	Washington (test development, testing, admin, training, evaluation)
	(C)	$150,000-$250,000	Annual examiner/ inspector program cost (infrastructure and oversight) (energy codes)	(65)	Program similar to Washington (assumed commercial)
	R/C	$23,400	Annual oversight of expedited plan review program (all codes)	(60), estimate	Fairfax County, Virginia (15% of time, assumed wage of 25$/hour and 3x overhead)
	C(/R)	$200,000-$300,000	Annual administration cost (oversight) (energy codes)	(17)	Maine (2-3 employees including overhead); may be for both residential and commercial; *unclear if program covers review in addition to inspection*
Perform-ance Testing	R	$300-$400	Per home tested	(59)(66)(61)	
	R	$1,875-$2,495	Per test equipment	(20)	
	R	$131,000	Annual operating budget	(61)	Austin, TX (unclear if this includes 15% FTE; if not, may add an additional ~$25,000)
HERS	R	$450	Per home	(70)	Washington state
	R	$700-$1,700	Per home	(68)	Long Island
Commiss-ioning	C	2%	Per project (of total construction cost)	(45)	
	C	10%-20%	Per project (of total construction cost)	(23)	

*R=Residential, C=Commercial

4.3 Ways to Improve Compliance

There are a number of improvements and investments that can be made in order to increase compliance within any process or infrastructure associated with building energy codes. This section focuses on the following options: investing in IT, which is beneficial for streamlining processes (section 4.3.1); training and education, specifically focusing on code officials (section 4.3.2); and tools and outreach, which can provide stakeholders and code officials with guidance documents and other materials to further overall understanding and simplify processes (section 4.3.3).

4.3.1 Information Technology Investments

Regardless of the compliance method used, investing in IT to implement or streamline processes can potentially reduce costs in the mid- to long-term. IT can be used for compliance and enforcement processes including (59)(73)(74):

- online permit application processing,
- electronic plan submission,
- plan tracking and reviewing,
- scheduling field inspections, and
- conducting field inspections.

Any streamlining process should begin with an internal and external review to identify strengths and weaknesses and prioritize needed changes in IT, including low-hanging fruit (59). After up-front investments in IT, which range greatly depending on the size of the jurisdiction and the range of software selected, savings may accrue in various ways. A survey on IT investments related to building codes (not energy specific) noted the following examples of savings (73):

- Staff time required for a building permit was reduced from 1 hour to 15 minutes.
- Staff time to process a package of building permits for commercial structures was reduced from 8 hours to 2.5 hours.
- Staff time required for performing inspection scheduling and inspection was reduced from 2 hours to 1 hour.

This freed-up time could allow local building staff to spend more time on energy codes in addition to the other building codes. Alternatively, the financial savings could be used to invest in additional, highly qualified staff or to contract with a third party for conducting compliance and enforcement activities (59).

Costs: There are a broad range of costs associated with IT investments, depending on the number of administrative and enforcement functions being applied (*e.g.,* permit processing, electronic plan review, scheduling, and so on), as well as the size of the jurisdiction. Costs range from $1,000 for an inspection schedule package and $5,000 for a permit application in a very small jurisdiction to around $38,000 for a software package in a moderately sized jurisdiction and $4 million for a package in a large jurisdiction (73). At the state level, New Mexico spent $75,000 on software for electronic plan review and $100,000 for an electronic permitting system. Training costs for IT ranged from $1,500 for a small jurisdiction on one function to $100,000 on a remote inspections program used by 151 inspectors in a large jurisdiction (73). Costs are summarized in Table 4. The attachments to (73) show acquisition and training costs for all responding jurisdictions.

Table 4: Example of IT Investment and Training Costs

Cost Type	Cost	Metric	Notes: Jurisdiction (population)
Software Acquisition	$4,000,000	In-house and purchased software including permits, plans, and inspection scheduling	Chicago (2,849,000)
	$175,000	Online permit processing system	Clackamas County (334,000)
	$150,000	Package of software for both permit issuance and inspections	Ventura County (753,157)
	$100,000	Electronic permitting system	New Mexico
	$76,350	Permits and inspection software package	Prince George County, VA (28,900)
	$75,000	Electronic plan review	New Mexico
	$38,182	Software package including permit application/processing, plan submittal, licensing, inspection scheduling, inspections, and government reporting	Chula Vista, CA (173,000)
	$5,000	Permit application package	Cobleskill, NY (4,538)
	$1,880	Permit application package	Durham, NH (9,024)
	$1,000	Inspection scheduling package	Cobleskill, NY (4,538)
Training	$100,000	Remote inspections program (151 inspectors)	Phoenix, AZ (1,321,000)
	$80,000	Plans submission and review package	Phoenix, AZ (1,321,000)
	$25,000	Inspection scheduling system	Phoenix, AZ (1,321,000)
	$3,000-$5,000	Permit application process	Cobleskill, NY (4,538)
	$1,500	Inspection scheduling process	Cobleskill, NY (4,538)

Note: Sector information not available.
Source: (73)

4.3.2 Training

Training and education can support all compliance paths and improve compliance levels. While training and education can be targeted to code officials, builders, designers, and the trades, this section focuses on training for code officials. BCAP referenced a Northwest Energy Efficiency Alliance (NEEA) study that showed "trainings had a high impact on the practices of the code officials who attended (49)".

Although many code officials report a fairly high energy code training frequency[11], nearly all still reported a need for more code information (49). BCAP recommends that code officials receive 29 hours

[11] 71 percent receive training 1 to 2 times a year, 11 percent receive training 3 to 4 times a year, and 11 percent receive no training.

per year of training (34). However, staff shortages often reduce the amount of time that staff has to attend trainings.

Training occurs through many avenues including on-line, classroom, and in-field. Some studies have reported that code officials prefer classroom training to in-field training (30)(27); however, circuit riders[12] are often recommended as a valuable training method (59)(75). Code officials also prefer local training over chapter (regional or statewide) training (44). However, states and such regional entities as utilities or energy efficiency organizations may be able to provide larger scale, and more cost-effective programs. (See section 4.4.1 for further information on the role utilities play in training and education.)

Training should begin with an advanced assessment of training needs, and jurisdictions should develop a comprehensive multi-year training plan with an emphasis on industry and utility involvement (59). BCAP also noted that "training should be improved, rather than simply increased, so that it is consistent, and includes not only what is in the code but how to follow, demonstrate, and inspect for the requirements (27). In addition, BCAP stakeholders recommended ending "silo training"[13] and training all stakeholders with the same information (76). Other studies also recommended that training cut across industries and stakeholders (26)(51).

Stakeholders have also recommended tiered training approaches. The Compliance Planning Assistance program states that for high compliance, states should offer: 1) overview training; 2) code provisions including one day each on residential and commercial; and 3) focus areas such as HVAC sizing, lighting design, and so on (9). NEEA recommended a four tier program: 1) overviews, 2) targeted, 3) site visits (building department or construction site), and 4) technical assistance (75).

Targeted or focused training for code officials may include:

- ACCA Manual J (HVAC sizing) (47);
- ACCA Manual D (duct design) (47);
- RESCheck and COMCheck[14] (44);
- how to review RESCheck, Manual J, and building plans together (44);
- relating energy code to basic building science (47); and
- basic building science, HVAC principles, and use of controls (30).

Recently, broader training strategies have been suggested including the use of energy champions, energy code ambassadors, and community energy efficiency management:

[12] Circuit riders are a team of building officials who travel from jurisdiction to jurisdiction in order to review projects in person, respond to outstanding questions, and provide hands-on training (30) (75).
[13] "Silo training" describes training stakeholders (*i.e.*, builders, designers, etc.) separately, and possibly with different information (75).
[14] DOE offers software tools to "simplify and clarify" energy code compliance for residential and commercial building projects. Designers and contractors use these tools to demonstrate energy code compliance to code officials based on project inputs (97).

- Energy champions within a building department might volunteer to become energy experts and receive additional training so that they can mentor their peers (19)(21)(47)(77).
- BCAP recently began piloting a state-level training program for code officials called the Energy Code Ambassadors Program (ECAP). This is a train-the-trainer program in which officials agree to become energy code experts and serve as mentors to other code officials. The program is coordinated with ICC chapters (50). ECAPs are trained on residential code, commercial code, and energy code advocacy. Training may also include ICC energy certification exam content review and administration (50). For an example of expected program reach, according the implementation of ECAP in Michigan is expected to result in roughly 1,899 code officials with current energy code training (78).
- Community energy efficiency management is an infrastructure in which energy efficiency professionals are trained in energy code mentoring and provide assistance to communities with energy planning and to code officials in the form of guidance and training (76).

Other best practices for training include:

- Staff members who attend a training should present a summary to all other inspectors (20).
- Inspectors meet weekly to discuss code issues (22).
- Training developers use information on common compliance failures to target the training (34).

Costs: A local 6-hour ICC training session for IECC plan review and site inspection costs $2,500-$2750 (20)(49). For a class of 40, this amounts to $69 per person; with the cost of materials and food, this reaches $93 (49), or $15.5/hour. The average cost of a 2-hour webinar is $60 per student (49), or $30/hour. In total, the weighted average hourly training cost per employee is $19.[15] This hourly cost, BCAP's recommendation for 29 hours of training per year, and BCAP's average inspector wage of $25 per hour, results in an estimated annual training cost for a jurisdiction with 4 full-time employees (FTEs), including downtime, at $5,119.[16]

Other fees incurred by individual students include ICC certification fees that range from $100-$250 (79) and HERS rater certification course costs that range from $1,000-$1,500 (79).

At the state level, the estimated cost for an ECAP program based on 2 days of training for 8 ambassadors is $37,000 (80), although this estimated cost varies on a state-by-state basis, depending upon the number of ambassadors participating in the program, trainers' fees, and other miscellaneous differences that can be seen in Table A-1 in the Appendix. The ECAP program strives to be cost-free for all attendees and reimburses associated travel expenses not only for the course but also for training colleagues throughout the state (81).

[15] This assumes an average of 1 in-person training session for every 1 webinar. The weighted average could increase if weighted more toward webinars or decrease if weighted more toward in-person training. Note that BCAP reports the total average hourly cost as $46; however this is based on an incorrect calculation of adding the hourly cost of in-person training and webinar training together.
[16] BCAP reports this number at $8,200, again based on the incorrect $46/hour training cost figure.

State-level estimated costs for the recommended three-tier training program are also available, based on experiences in Delaware and Texas. These costs are not only for code officials but also for design and construction and building officials (82)(83).

- Basic (12 half days, 240 attendees): $17,000-$20,000 without code books or $33,000-$53,000 with code books
- Intermediate (12 full days, 480 attendees): $27,000-$33,000 without code books or $59,000-$84,000 with books
- Advanced (intermediate + 3 additional full days): $35,000-$43,000 without code books or $131,000-$133,000 with books

Recent state investments for energy code training and outreach include $264,000 per year in Illinois (84) and $600,000 over 2.5 years in New Hampshire (82).

At the regional scale, NEEA currently spends $750,000 per year on education and training programs in four Northwest states, while implementing their four-tiered vision would cost $1,000,000-$1,200,000 annually (75). Again, these costs apply to the building community in addition to code officials.

Table 5 summarizes these costs.

Table 5: Training Costs

Cost Type	Cost	Metric	Source	Notes
Student	$60	Per general webinar	(49)	2 hours
	$93	Per in-person training workshop	(49)	Including course, materials, food (based on local funding); 6 hours
	$100-250	Per ICC certification	(20)(79)	
	$1,000-$1,500	Per HERS rater certification course	(79)	Residential
Local	$2,500-$2,750	Per ICC training session	(20)(49)	IECC plan review and site inspection (one day, 40 people)
	$5,119	Annual per jurisdiction	(49) revised	Annual training cost for jurisdiction with 4FTEs including downtime (29 hours including local courses and webinars); Residential
State	$17,000-$53,000	Per basic training program	(82)(83)	12 half-day, 240 attendees, with trainers fees; range depends on location and whether code books are provided
	$27,000-$84,000	Per intermediate training program	(82)(83)	12 full day, 480 attendees, with trainers fees; range depends on location and whether code books are provided
	$35,000-$133,000	Per advanced training program	(82)(83)	Intermediate + 3 additional full days; range depends on location and whether code books are provided
	$16,000-$39,000	Per Energy Code Ambassadors Program	(78)(81)(82)(83)(84)(85)(86)(87)	May include trainers' fee, room rent, travel reimbursement, code books, food, exam vouchers, oversight costs; for 3-8 ambassadors
	$264,000	Annual for energy code training and related activities	(84)	Illinois
	$600,000	Per 2.5 year energy code training and outreach program	(82)	New Hampshire
Region	$750,000	Annual education and training	(75)	NEEA: 4 Northwest States
	$1,000,000-$1,200,000	Annual for 4 tier training vision	(75)	NEEA: 4 Northwest States

Note: Sector information not available unless noted.

4.3.3 Tools and Outreach

In addition to software, other tools can be developed to enhance code compliance and enforcement. Some may primarily serve as outreach materials to stakeholders, while others may help streamline processes for both applicants and code officials. According to BCAP, "States and jurisdictions have found that active collaboration with stakeholders can lead to greater compliance, and that therefore states should carry out pro-active outreach for design professionals. 79% of respondents said compliance rates will increase if guidance documents and other materials are more available to stakeholders (49)." Examples of these tools and materials follow:

- General
    - Summaries of code requirements (19)
    - Energy code guidebooks with code changes, basic energy principles for building systems, and reasons for code provisions (30)
    - Handbook of official code interpretations (24)
    - Clarifying memos or brochures for specific requirements such as when the scope of alteration of an existing building triggers energy code compliance (21)
- Design
    - Checklists of features that must be present for code compliance (19)
    - Diagrams and mini-manuals targeted to specific trades (71)
    - Case studies highlighting best practices (71)
    - Computer Assisted Design (CAD) software linked to a DOE-2[17] engine to allow architects to check designs against code as they design (62)
- Permit application and submittal (for builder)
    - Easy-to-understand permit application with checklist of required items (59)
    - An online coaching tool that helps builders determine what needs to be submitted for a permit (19)
    - Guide for completion of Manual J (47)
- Plan review and inspection (code officials)
    - Simple plan checklist and field inspection guide (71)(77)(88)
    - Integration of energy efficiency requirements into plan review checklists (19)
- Other
    - Standard documentation for using energy models to document commercial code compliance (30)
    - Standardized diagnostic testing procedures (23)

Costs: BCAP estimates the total cost of a basic outreach strategy (for a jurisdiction with 4 FTE) to be approximately $39,000 a year, including around $11,000 for resource materials, $28,000 for a website, and $1,000 for presentations (49). These costs are based on BCAP's suggested frequency of 8 resources per year— biannual newsletter and bimonthly fact sheets—and 7 presentations per year. Table 6 summarizes these outreach costs.

[17] DOE-2 is building energy use and cost analysis software developed with funding from DOE (96).

Table 6: Outreach Costs

Cost Type	Sector*	Cost	Metric	Notes
Components	R	$10,800	Annual resource materials per jurisdiction	8 resources: biannual newsletter and bimonthly fact sheets/pamphlets (includes cost of developing resources and cost of production for 25,000 pieces per year)
	R	$27,672	Annual website per jurisdiction	Based on a jurisdiction size of 4 FTE
	R	$1,050	Annual presentations per jurisdiction	7 presentations per year (based on cost of preparing and presenting)
Overall	R	$39,172	Annual total basic outreach strategy per jurisdiction	Sum of the above

*R=Residential

Source: (49)

4.4 Roles for Utilities and States

Although the costs presented to this point have focused on local governments, utilities and states can also assist with building energy code compliance and enforcement efforts. Section 4.4.1 discusses utility code enhancement programs, while section 4.4.2 reviews state level activities including compliance rate determinations (section 4.4.2.1).

4.4.1 Utility Code Enhancement Programs

Utilities increasingly involve themselves in code enhancement programs. This results from both declining savings available from traditional energy efficiency programs as well as improvements in evaluation techniques that allow utilities to receive credit for energy savings from increased code compliance. For example, the DOE BECP method of evaluating and determining compliance could be used to calculate savings and allow utilities to receive credit (1). In Arizona, utilities can receive credit for one-third of energy savings from codes programs when quantified through measurements and evaluations (89). California also has an evaluation model for attribution of energy savings from codes and standards programs (89). The energy code has historically been the baseline for utilities when receiving credit for above-code programs (32)(35), so code enhancement programs can help capture the gap between energy code and actual compliance (1). In addition, the potential for savings with new codes that have more efficiency requirements have begun to compare with traditional utility programs that focus on installation of energy efficiency equipment (1). Energy savings as a result of code compliance are financially beneficial to utilities, as savings can be achieved while avoiding the cost of rebating efforts (89). Participation of utilities in code enhancement programs is also beneficial to local jurisdictions and states, because the utilities can use ratepayer funding for energy efficiency programs (32), shifting some of the financial burden away from the government.

Historically, utility code enhancement programs have focused on education and training, and utilities can participate in many aspects of education and training for improving code compliance and enforcement, including:

- provide on-line or classroom training of code officials (67)(35)(90) or stakeholders (1)(89);
- fund or administer certification programs (1)(46); and
- provide stakeholders with training materials, such as software and code manuals (89).

In addition, utilities can conduct other activities for improving code compliance and enforcement, including:

- fund enforcement tools like code books, equipment, and code field guides (1)(67);
- develop technical resources (67);
- develop marketing materials (1);
- conduct outreach programs with manufacturers to certify products and with retailers to stock compliant products and provide store training (91);
- fund staff or third parties (or utilize their own staff) for plan review, site inspections, or technical assistance (see for example (1)(67)(89));
- provide staff to verify load calculations or inspect mechanical systems in the field (47);
- standardize compliance protocols across jurisdictions (67);
- implement streamlining tools (46);
- fund the purchase of diagnostic equipment (1)(46);
- provide performance-testing rebates (32)(35);
- open lines of communication between varying stakeholders (89); and
- become engaged in stakeholder processes, such as building codes advisory councils (90).

Costs: Costs for utility code enhancement programs, including actions to support code development and adoption, as well as training and education to promote greater compliance, range from $125,000 for Tucson Electric Power (TEP) to $3.8 million for California investor-owned utilities (IOUs) (67). The Washington state SPEI/I training program was heavily subsidized by the state utilities. Funding for the SPE/I training program, along with other code trainings, publications/forms, and a help hotline totaled $5 million over 3.5 years. Education and training accounted for two-thirds of this (67). Table 7 summarizes utility costs.

Table 7: Utility Level Costs

Cost Type	Sector*	Cost	Metric	Notes
Overall Program	R/C	$125,000	Annual code enhancement program	TEP (and an additional 0.5 FTE)
	R/C	$3,800,000	Annual code enhancement program	CA IOUs
	C	$5,000,000	3.5 years of training and other assistance	State utilities for WA SPE/I program

*R=Residential, C=Commercial
Source: (67)

4.4.2 State Level

In some states, the states themselves are responsible for energy code enforcement. Even in states where local jurisdictions are primarily responsible for code enforcement, states can provide assistance to local jurisdictions. States' roles could be similar to many of the roles utilities might play, and may include developing and providing state-specific code training, funding and providing a pool of state-level inspectors for overwhelmed jurisdictions, providing technical assistance payments to jurisdictions to relieve the financial burden of energy code enforcement, or running a third-party certification and registry program for use by local jurisdictions. States can also develop tools, such as checklists and manuals, and may also offer or require training for local code officials. Some states require certification of all local building departments, mandatory training for all code changes, and ICC certification tests for code officials (9). States can monitor enforcement by local building departments (88), or even, as in China, conduct annual inspections in key jurisdictions (62). States can also run an energy code collaborative that focuses on energy code adoption and compliance and conducts training and outreach, among other activities (84)(92).

Costs: Costs for a model in which a state agency supplements the enforcement of local officials were estimated to be $960,000 for Maine (17). This amount funds five inspectors and three office employees, exclusive of training. The state officials would provide technical assistance, code interpretation, and training; investigate complaints; and inspect upon request (17).

An older (1991-1996) state energy office program in Washington made payments to local jurisdictions of $50 for permits and $150 for inspections in a residential program (42). The total payments to 174 local jurisdictions, along with $900 payments to builders to cover incremental costs per home, totaled $40 million over 5 years (42). The Illinois Strategic Compliance Plan suggests that, in a third-party inspection program, the state could fund residential inspections at $300 and commercial certification at market rates (84).

An energy code collaborative in Idaho costs $140,000 annually (84). Table 8 summarizes state-level costs.

Table 8: State-Level Costs

Cost Type	Sector*	Cost	Metric	Source	Notes
Payments	R	$50	Per permit to local jurisdiction	(42)	1991-1996 (WA)
	R	$150	Per inspection to local jurisdiction	(42)	1991-1996 (WA)
	R	$900	Per home to builder	(42)	1991-1996 (WA)
	R	$40,000,000	Total payments over 5 years	(42)	1991-1996 (WA); includes payments to local jurisdictions and builders
	R	$300	Per 3rd party inspection	(84)	Suggested payment by state
Enforcement	C(/R)	$960,000	Annual state agency supplement of local enforcement (training, investigation, inspection - primarily commercial)	(17)	Maine: 5 inspectors, 3 office employees (salary and travel, no training)
Energy Code Collaborative	N/A	$140,000	Annual budget	(84)	Training, outreach, other activities

*R=Residential, C=Commercial

4.4.2.1 Compliance Rate Determination

As mentioned previously, ARRA linked federal funding to several requirements, including one that states must develop and implement a plan to achieve 90% compliance by 2017 and then measure compliance each year. DOE has developed a methodology that states can use for evaluating energy code compliance (93).

Costs: DOE's pilot compliance studies ranged from $75,000 to $750,000 per state (84). In 1993, Washington State incurred costs of $100,000 to $125,000 per year for 2 FTE employees to conduct site visits (inspecting an average of four key measures per site), provide technical assistance, and conduct analysis (42). One study indicates that the cost of site visits for compliance determinations is $500 to $1,000 per home (49). Neither of these last two references is based on the new DOE compliance evaluation methodology. Table 9 summarizes these costs.

Table 9: Compliance Rate Determination Costs

Cost Type	Sector*	Cost	Metric	Source	Notes
Site Visit	R	$500 - $1000	Per home	(49)	Average inspection of four measures
State	R	$100,000 - $125,000	Annual per state	(42)	Estimated for 216 site visits (SF and MF); includes visits, technical assistance, and analysis (~2 FTE)
	R/C	$75,000 - $750,000	Annual per state	(84)	DOE pilot compliance studies

*R=Residential, C=Commercial

5 SUMMARY OF KEY KINDINGS/CONCLUSIONS

Given the low rates of energy code compliance documented in existing studies, as well as the many barriers to both energy code compliance and enforcement, this study sought to identify the costs of initiatives to improve compliance and enforcement.

This study has found that the incremental cost of enforcing energy codes using a traditional review and inspection process can be up to approximately $100 per home using best-practice levels of time spent per home and re-inspection upon failure. Cost for commercial buildings can range to thousands of dollars depending on the complexity of the building. Annual incremental costs for a jurisdiction processing 5,000 residential permits per year range from approximately $150,000 to $530,000. Costs for commercial enforcement would be significantly higher.

One method to reduce the financial burden on local government is to develop a third-party energy code plan review or inspection infrastructure in which builders must pay fees directly to the third party. For energy codes alone, these fees are expected to be approximately $200 per home and up to nearly $1,000 per commercial building. The annual costs borne by the government for infrastructure and oversight for such a program could be as little as $23,000 for a limited local program or range from $150,000 to $300,000 per year for a program organized and run at the state level.

A supplemental method of improving energy code compliance is the use of performance testing. Following a third-party model, builders would pay third parties $300 to $400 per home, and the local jurisdiction would need an operating budget of up to $130,000 for oversight and administration of the program, heavily dependent on the size of the jurisdiction.

Other alternative methods of energy code enforcement include HERS ratings for residential buildings and commissioning for commercial buildings. The cost for a HERS rating is approximately $450 up to $1700 per home, while commissioning is expected to cost from 2% to 20% of the total project cost. No data are available on the costs to run such programs. However, in the HERS as Code approach, oversight and administration costs are often absorbed by voluntary programs run by other entities such as utilities.

Any compliance and enforcement process can be enhanced with expenditures for IT, training, and outreach. Acquisition costs for IT cover a broad range based on function and jurisdiction size, ranging from $1,000 to $4,000,000. Training costs for such software can be up to $100,000 per package or as little as $1,500. General energy code training costs also range based on the amount and complexity of the program. The per-person training cost may be less than $100 per course, and annual costs for a jurisdiction with 4 FTEs, including costs for downtime, would be approximately $5,000 per year. Effective programs can often be run at the state level; BCAP's recommended train-the-trainer approach, the ECAP, is estimated to cost from $16,000 to $39,000 per state. Outreach to stakeholders can also be used to increase compliance; costs for a local jurisdiction with 4 FTEs are estimated at $39,000 per year.

As mentioned previously, utilities and states can also be involved in the compliance and enforcement process. Annual utility expenditures on code enhancement programs (generally focused on training) range from $125,000 for a single utility in Arizona to nearly $4 million for all California IOUs combined. State-level investments can range from $140,000 annually for an energy code collaborative up to nearly $1 million annually to run an enforcement program that supplements municipal enforcement (with this cost potentially increasing with the size of the state). States are also responsible for documenting compliance with building codes in accordance with ARRA initiatives; such studies are expected to cost anywhere from $75,000 to $750,000 annually.

This study reported costs primarily as presented in the original source. Some costs are given on a per home or per building basis, and others are reported for jurisdictions of a certain size. In many cases, data are limited with only one source for a given cost metric. In other cases, cost data with disparate sources and assumptions are combined to create more useful estimates or comparisons; this compilation generates uncertainty. Moving forward, federal or state standardization of compliance and enforcement cost reporting across local jurisdictions is recommended. However, even with the current data limitations, this study provides an unprecedented picture of the approximate ranges of costs necessary to develop and enhance compliance and enforcement infrastructure. Although the costs may seem large, IMT noted that nationally, costs required to meet 90% compliance amount to just a fraction of one percent of the value of construction projects (2). The information and costs presented in this report should be useful to local governments, efficiency organizations, utilities, states, and the federal government in efforts to improve building energy code compliance.

6 PHASE 2

The second phase of this work, as discussed in section 1, involves surveying 34 experts in the building industry, 10 at the national level, and 24 at the local or state level. The results from this phase 1 report will be used to develop the survey questionnaires. The intention of the proposed approach is that the survey findings will provide an overall range of enforcement costs and an indication of where to most effectively spend money to improve compliance.

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APPENDIX A – Energy Code Ambassadors Program

Table A-1 shows a summary of estimated ECAP program costs by state, with variations in number of ambassadors and included expenses.

Table A-1: ECAP Program Summary

State	Total Estimated Cost	Number Ambass-adors	Ambassador Selection	Included Expenses	Source
Colorado	$28,380-$36,880	8	Building inspectors and plans examiners from Denver, Fort Collins, Pueblo, Colorado Springs, & Grand Junction regions	Trainer's fee; Room Rental; Ambassador Travel Reimbursements; Food & Drinks; Code Books; ICC Energy Exam Vouchers (3 tests); Oversight Costs (dependent on Trainer)	(81)
Delaware	$18,365-$31,850	3-6	"At least one plans examiner and/or building inspector from each of Delaware's three counties."	Trainers' Fee; Room Rental; Ambassador Travel Reimbursements; Food & Drinks; Code Books; ICC Energy Exam Vouchers (3 tests); Oversight Costs (dependent on trainer)	(82)
Illinois	$34,240-$49,240	8	"Well-known and respected code enforcement officials should be targeted, and the group should be formed by a diverse set of building departments."	Trainers' Fee; Delegate Travel Reimbursement; Code Books; ICC Energy Exam Vouchers (3 tests); Food & Drink; Oversight of Delegates Post-training; program Administration; Curriculum Prep and Development; Trainer's travel and other expenses	(84)
Michigan	$37,336	8	"The state should post the ECAP description to local code official chapters and invite members to apply. Well-known and respected code officials should be targeted, and the group should be formed by a diverse set of building departments."	Trainers' Fee; Room Rental; Ambassador Travel Reimbursements; Code Books; ICC Energy Exam Vouchers (3 tests); Oversight Costs—can be subcontracted to BCAP/ICC.	(78)
New Hampshire	$32,336	6	"The state should post the ECAP description to local ICC chapters and invite members to apply. Well-known and respected ICC members should be targeted, and the group should be formed by a diverse set of building departments."	Trainers' Fee; Ambassador Travel Reimbursements; Code Books; ICC Books; ICC Energy Exam Vouchers (3 tests); Oversight Costs—can be subcontracted.	(85)
South Carolina	$16,336	8	"Ambassadors can be selected by sending the ECAP description to the state ICC chapter with an invitation for members to apply.	Trainers' Fee; Ambassador Travel Reimbursements; Code Books; ICC Energy Exam Vouchers (3 tests per	(86)

State	Total Estimated Cost	Number Ambass-adors	Ambassador Selection	Included Expenses	Source
			Well-known and respected ICC members should be targeted, and the group should be made up of a diverse set of building departments representing different areas of the state."	attendee).	
Texas	$37,144	8	-	Trainers' Fee; Room Rental; Ambassador Travel Reimbursements; Code Books; ICC Energy Exam Vouchers (3 tests); Oversight Costs (dependent on trainer)	(83)
West Virginia	$16,336	8	"Ambassadors can be selected by sending the ECAP description to the state ICC chapter with an invitation for members to apply. Well-known and respected ICC members should be targeted, and the group should be made up of a diverse set of building departments representing different areas of the state."	Trainers' Fee; Ambassador Travel Reimbursements; Code Books; ICC Energy Exam Vouchers (3 tests per attendee).	(87)

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