ENERGY CODES AND THE RECOVERY ACT:
GUIDANCE FOR STATES ADDRESSING 90% COMPLIANCE REQUIREMENTS

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ABSTRACT

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The *American Recovery and Reinvestment Act of 2009* provided state financial support aimed at stimulating the national economy while creating efficiency gains through the implementation of modern building energy codes. These requirements call for compliance with targeted energy codes, including a plan to demonstrate a 90% compliance rate by 2017. In support of these requirements, the Federal Government has published a recommended methodology for states to reference as they work to demonstrate compliance with new energy codes. Unfortunately, the path to meeting this goal remains unclear and many questions still exist at the state and stakeholder levels.

The present study examines compliance issues faced within U.S. states to enable effective policy decisions, with a primary goal to provide states with guidance and options to address energy code compliance requirements. A descriptive statistical analysis of survey responses gathered in code enforcement jurisdictions provides a baseline of local practices and current implementation issues. State challenges and subsequent recommendations are analyzed through recent case studies, and considered against expectations of the Federal methodology. Findings culminate in a set of recommendations with consideration for unique background scenarios and barriers observed in the study. The resulting guidance can be considered by states as they install policies and take action in addressing Recovery Act requirements.

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ACRONYMS AND ABBREVIATIONS

ACEEE	American Council for an Energy Efficiency Economy
AIA	American Institute of Architects
ANSI	American National Standards Institute
ARRA	American Recovery and Reinvestment Act
ASHRAE	American Society of Heating, Refrigerating & Air-conditioning Engineers
BCAP	Building Codes Assistance Project
BECP	Building Energy Codes Program
BLS	Bureau of Labor Statistics
DOC	U.S. Department of Commerce
DOE	U.S. Department of Energy
EECBG	Energy Efficiency Conservation Block Grant
EISA 2009	Energy Independence and Security Act of 2009
EPA	U.S. Environmental Protection Agency
EPA 2005	Energy Policy Act of 2005
GSA	General Services Administration
HBA	Home Builders Association
HERS	Home Energy Rating System
IBC	International Building Code
IC	Insulation contact
ICC	International Code Council
ICLEI	International Council for Local Environmental Initiatives

IECC	International Energy Conservation Code
IESNA	Illuminating Engineering Society of North America
IMT	Institute for Market Transformation
IRC	International Residential Code
LEED	Leaders in Energy and Environmental Design
MSHDA	Michigan State Housing Development Authority
NASEO	National Association of State Energy Officials
NEEA	Northwest Energy Efficiency Alliance
NEEP	Northeast Energy Efficiency Partnership
NEPA	National Environmental Policy Act
NFRC	National Fenestration Rating Council
PNNL	Pacific Northwest National Laboratory
RECA	Responsible Energy Codes Alliance
REEO	Regional Energy Efficiency Organization
RESNET	Residential Energy Services Network
SEHN	Science and Environmental Health Network
SEP	State Energy Program
SHGC	solar heat gain coefficient, dimensionless
SWEEP	Southwest Energy Efficiency Partnership
UCS	Union of Concerned Scientists
USGBC	United States Green Building Council

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

In the United States, buildings in which we live and work account for about 40 percent of our total energy consumption, and 70% of the nation's electricity use. Based on current levels, this costs the U.S. $400 billion every year. (U.S. Department of Energy, 2012b) In terms of energy consumption, residential and commercial buildings consume the majority of our energy, even more than transportation and industry sectors. One approach to increasing energy efficiency and combating consumption is through the implementation of efficient building energy code policy at national, state and localized levels.

The *American Recovery and Reinvestment Act of 2009* (identified as the *Recovery Act*) provided states with a large sum of funds aimed at stimulating state and national economies through job-production and financial security. With part of these funds, the Federal Government aimed to improve building energy efficiency on a national scale, and took a major step empowering nationally recognized and accepted model building energy codes. The Recovery Act requires adoption of more efficient building energy codes for all states and a rate of *90% compliance* by 2017 (these requirements hereon referenced as *90% Compliance*). As part of this requirement, states must develop a plan to reach the compliance goal and demonstrate improvement through annual reporting criteria. Suggested paths and approaches to meet Recovery Act compliance goals are still without understanding, even to policymakers and stakeholders within the building construction industry. Although a program to assist compliance has been unrolled by the Federal Government, several technical and policy barriers to actual code compliance still exist, and the actions states should take to address compliance requirements remain unclear.

The present study sets out to address these problems through a review of relevant literature, followed by investigations into background conditions, barriers, and recommended actions at both state and localized levels. These efforts were applied through an approach typical of qualitative research methods, but also included a descriptive statistical analysis of survey response data obtained from local code enforcement jurisdictions. Reports from recent case studies of individual state compliance scenarios in relation to compliance requirements were also analyzed, providing further insight on implementation issues. Findings from the combined approach can be generalized into guidance for states to consider as they prepare to address Recovery Act 90% Compliance requirements.

1.2 BACKGROUND

> *"Simply put, building energy codes are the quickest, cheapest and cleanest way to improve energy efficiency in the building sector and should be a critical component of any comprehensive national or international policy to achieve a sustainable and prosperous future."*
>
> --Building Codes Assistance Project (2011)

What are Energy Codes?

Building codes set minimum requirements governing safety and occupant welfare within residential and commercial structures. Energy codes, a subset of building codes, have historically set minimum efficiency requirements for particular systems within a building. (DOE, 2012b) The systems commonly addressed by the energy code are: building envelope, HVAC, lighting, and service water heating. Certain requirements in the code are intended to prevent the gain or loss of heat between the building interior and surrounding environment, while other code requirements are designed to limit fuel use or mitigate moisture intrusion into building components.

Benefits of Energy Codes

As the largest sector of U.S. energy use, energy efficiency in residential and commercial buildings provides an enormous opportunity to reduce our country's overall energy consumption. Energy codes are often credited with mitigating greater social challenges, can influence the acceptance of energy efficient technologies within the marketplace, and provide a common foundation upon which to evaluate building performance (DOE, 2012b). According to the Building Codes Assistance Project (BCAP), modern energy codes save consumers money, stimulate the economy, ensure health and safety, and improve long-term sustainability. In 2008, the average U.S. household spent approximately $2,225 on energy bills, with another $183 billion spent to supply commercial buildings. Since buildings last an average of 50 years (many much longer), decisions surrounding building energy policy today will affect our energy consumption through 2059 and beyond.

1.2.1 The Recovery Act of 2009

On a national scale, the Recovery Act carried energy code provisions applicable to states accepting federal government-issued stimulus funds. In acquiring this financial support, states accepted an obligation to adopt *target codes* as outlined in Section 410 of the Recovery Act. These requirements mean states must adopt the 2009 International Energy Conservation Code (IECC) for residential buildings and ASHRAE Standard 90.1—2007 for commercial buildings, and prove 90% code compliance within eight years of the Recovery Act's issuance. This timeline is not simply a deadline for states to prove compliance, but is issued as a developmental period to place supportive code training, evaluation, and reporting systems. A measurement of compliance is also required on an annual basis leading up to the compliance deadline.

1.3 STATEMENT OF THE PROBLEM

Several U.S. states, territories, and local governmental jurisdictions utilize energy codes to set base levels for energy efficiency within buildings. Unfortunately, this alone does not guarantee desired levels of energy use, and several circumstances can impede true energy savings. Many residences and commercial buildings do not comply with the intended code, and, therefore, end up wasting more energy and money than legally intended for years to come. Many stakeholders agree; additional resources supporting energy code compliance are vital in generating increased compliance rates. (IMT, 2010b) The Recovery Act of 2009 addresses the need for higher compliance with energy codes, sets specific versions of residential and commercial codes for states to reference, but, in the process, also confronts states with brand new requirements and a set of challenges surrounding code compliance.

A recent task force, coordinated by the Washington, DC-based Institute for Market Transformation (IMT) set out to analyze the cost-benefit of compliance with building energy codes. The group found potential annual energy savings of approximately $2.7 billion attributed to increased compliance by the year 2020, and growing to a figure almost four times that amount by 2040. (IMT, 2010b) While energy codes are considered a valid political mechanism for creating desired levels of efficiency in residential and commercial buildings, true energy savings must be measured through actual compliance at the state and local levels. This responsibility can often become burdensome upon states and localities, especially in those jurisdictions adversely affected by recent economic hardship. According to the Bureau of Labor Statistics (2010), over 7.2 million people are employed in the U.S. construction industry, most of which have a stake in the development of our nation's residential and commercial buildings. For most of them, additional requirements for energy code compliance may also add to a list of already fatigued responsibilities, and states will need to be able to do more with less money to support these efforts.

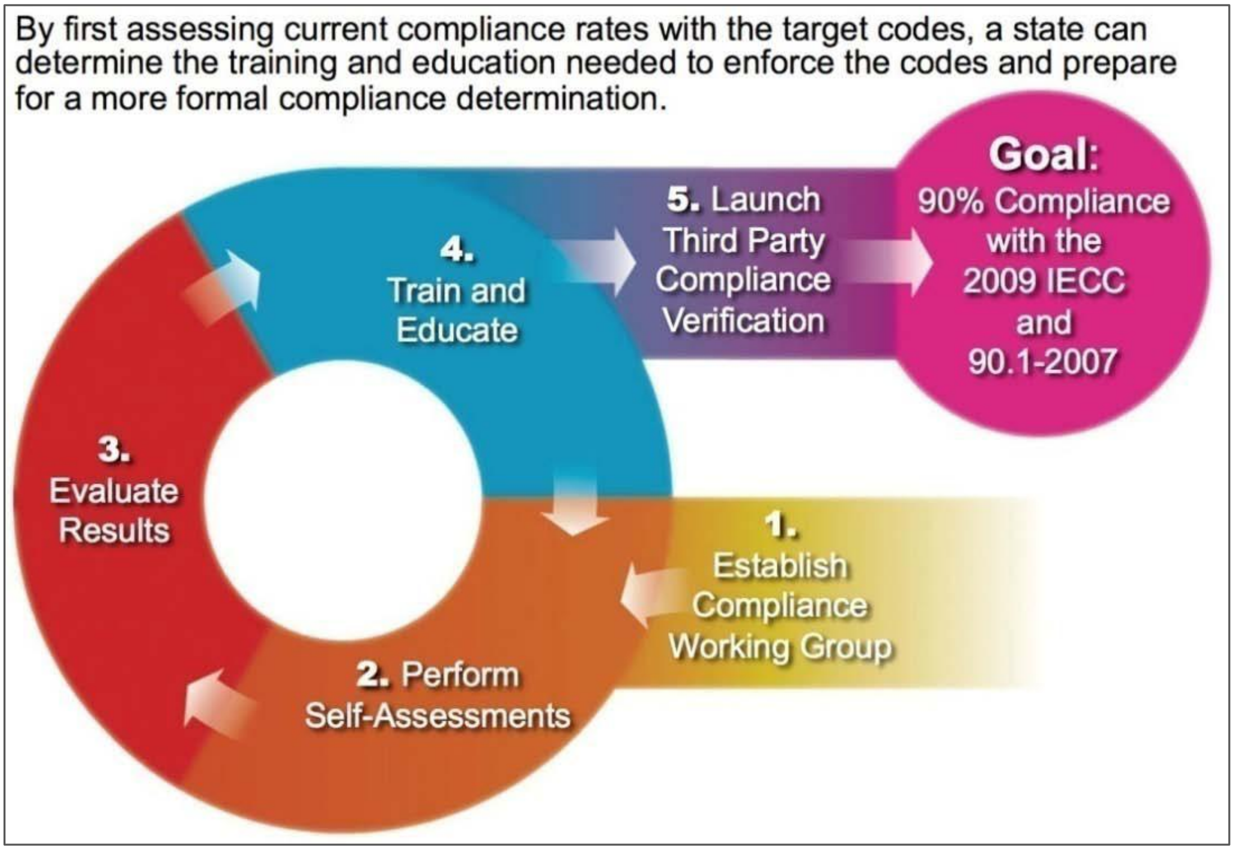


Figure 1: Overview of state compliance process

NOTE: For interpretation of the references to color in this and all other figures, the reader is referred to the electronic version of this thesis)

The U.S. Department of Energy (DOE) and Pacific Northwest National Laboratory (PNNL) have created a methodology by which states can work towards satisfying Recovery Act compliance requirements. As seen in Figure 1.3, the PNNL method suggests a process of self-assessments, annual measurement, training and education to improve existing state compliance rates. This process initiates with the formulation of a Compliance Working Group, more recently identified as an *Energy Code Compliance Collaborative*.

1.3.1 Need for Study

The present study set out to identify and provide guidance to states creating policy and regulatory infrastructure around energy code compliance requirements resulting from the Recovery Act of 2009. All 50 U.S. states have accepted stimulus funds spawning from the Recovery Act, and are, therefore, subject to the requirements and obligations therein. Code enforcement and regulatory infrastructure varies significantly from state-to-state. State budgets and local code enforcement jurisdictions are heavily burdened by difficult economic circumstances, and are unable to immediately satisfy Recovery Act compliance requirements. Even the first steps in the process have proven difficult, and policymakers unfamiliar with energy codes have hesitated to implement policy requiring additional government regulation with limited financial resources.

1.3.2 Research Question

In order to properly understand the reality of Recovery Act compliance requirements, baseline conditions and issues were analyzed surrounding implementation at state and local levels. An understanding of the proposed requirements, and outstanding challenges, was needed in order to make applications across U.S. states. Energy codes are not uniformly implemented or regulated in all states; therefore it was necessary to pair national guidance with state and localized perspectives to better understand the true ramifications of such an effort. Generalizing across state scenarios and informed by local implementation issues, the present study sought to understand: *How should states address energy code 90% Compliance requirements of the Recovery Act of 2009?*

1.3.3 Goals and Objectives

In support of the central research question, sub-questions were developed targeting background information, existing conditions, identified challenges, and recommended actions from both top-down and localized perspectives. These were addressed largely in a sequential manner, yielding findings aligned with the primary inquiry. The following sub-questions support the central research question:

1. What expectations are contained in the Recovery Act?
2. What resources and previous state experiences can be referenced?
3. How are energy codes currently enforced?
4. What local compliance issues currently exist?
5. What actions have other states taken?
6. What hinders a state's ability to meet compliance goals?
7. How should states take action to address 90% Compliance requirements?

What expectations are contained in the Recovery Act?

Many of the questions and uncertainties impeding state compliance efforts surround the actual interpretation of Recovery Act requirements. The Federal Government has issued some limited guidance at a national level, including a recommended methodology, but many defining questions remain. Two years after the issuance of the Recovery Act, many states are still unclear on even general expectations and recommended practices.

What resources and previous state experiences can be referenced?

A number of resources and tools are available to support compliance with building energy codes. Once general expectations are better understood, states can rely on many existing options to supplement the implementation of new policy. Insight can also be taken from states who adopted target codes early, many of which have initiated compliance measurement activities.

How are energy codes currently enforced?

Energy code enforcement can vary significantly between regulatory systems, states, and even across local jurisdictions. It will be important for states to understand practices and processes relied on by local stakeholders. Localized actors will be depended on to implement compliance requirements.

What local compliance issues currently exist?

Several barriers have historically sabotaged full compliance with adopted energy codes. States need be aware of traditional impediments, as well as those specific to new compliance requirements. A review of enforcement practices and processes was needed to understand local issues and better inform state-level policy decisions.

What actions have other states taken?

A handful of states have started to take action to address and fulfill 90% Compliance requirements. Some states have placed compliance working groups and initial strategies, while others have begun more formalized compliance measurement activities. Actions states have taken were reviewed to inform future state decisions.

What hinders a state's ability to meet compliance goals?

At the state level, policymakers need awareness of the underlying regulatory infrastructure and broader issues surrounding energy code adoption and implementation. Common pitfalls often can undermine environmental policy as it is passed from federal to localized levels. State-specific efficiency policies and supporting stakeholders were also leveraged. How should states take action to address 90% Compliance requirements?

In addition to existing resources and experiences in early adopting states, recent case studies reviewing individual state scenarios yielded several recommendations. Solutions were extracted with eventual findings generalized for state consideration. In approaching the problem from multiple angles, comprehensive guidance can be offered to states preparing to address Recovery Act requirements.

1.3.4 Expected Contribution

Although the Recovery Act was issued three years ago, substantial questions remain surrounding its expectations. State policymakers could benefit from an easier understanding of building energy codes, as well as the policies and political mechanisms available for their implementation. State officials, local enforcement jurisdictions, and other building energy stakeholders could benefit in better comprehending expectations and their supporting role. Resources and experiences from states having already initiated measurement activities are compiled and centralized into recommended guidance and supplemented by available tools. This guidance can be presented to states to provide an outline of necessary background information, issues, and recommendations to aid and inform compliance demonstration. These efforts will serve as a foundation from which to build state policy to support Recovery Act requirements.

1.3.5 Limitations

Certain limitations should be considered within the scope and methods of the present research study. Although a background is given on energy code compliance policy, the study was directed specifically at the requirements of the Recovery Act of 2009. It is assumed states must follow-through in addressing and meeting Recovery Act compliance requirements. The method provided by PNNL is referenced as a model solution for meeting these requirements, however; over the course of time this method may be modified. Legal requirements and expectations surrounding the Recovery Act may also change. A time period of several years and a general set of expectations are defined in the actual legislation, leaving the door open for changes well after the present study is complete. Model residential energy codes, such as the IECC, are updated on a three year cycle, and more recent versions have been developed since the issuance of the Recovery Act. As the 90% Compliance requirements are directed solely at Recovery Act target codes, direct applications of updated code provisions fall beyond the scope of the present research. The study is also based on several bodies of pre-existing work, both quantitative and qualitative. Assumptions and limitations pertaining to specific methods are discussed further in the *Research Methods* chapter. Most importantly, while the present study is built upon a collection of federal reports and may provide specific guidance, it should be considered first and foremost as an educational exercise.

1.4 CHAPTER SUMMARY

This chapter provides an introduction to the building energy codes and the compliance requirements included in the Recovery Act of 2009. The need for research clarifying these requirements and related expectations is proposed, including an examination of issues facing states and local code enforcement jurisdictions. The study seeks information which may be considered relevant for states preparing to consider Recovery Act compliance requirements. Goals and objectives for the study are presented, followed by the expected contribution and limitations of potential findings.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

The implementation of federal policy to the state and localized levels is often littered with unforeseen challenges and consequences. Not only establishing, but fully understanding and *complying* with, what may resemble a national energy code will come with a variety of hurdles, including some encountered in past implementation of public policy, and many specific to the requirements of the Recovery Act. A review of relevant literature and existing discourse indicates typical challenges confronting the implementation of policy. As environmental protection and conservation measures are often created at the federal level and implemented by states, these regulations are often viewed through the lens of a mandate. It becomes important to understand both state and federal roles, existing barriers, and available resources in an effort to find a common ground strong enough to build a successful base to provoke social change.

2.2 POLITICAL BACKDROP

> *"Public policy can be defined as a course of government action in response to social problems; it is what governments choose to do about those problems."*
>
> --Kraft (2011)

> *"All politics is local."*
>
> --Tip O'Neill (1935)

2.2.1 Public Policy Defined

Public policymaking is said to have many definitions, and is often viewed as occurring across a continuum. "Some people view public policymaking as simply whatever governments decide to do. At the opposite end, others think of public policymaking as an intertwined relationship of offices, public leaders, and issues, all of which constantly change in a kaleidoscope-like fashion." Implementing modern policy, such as Recovery Act energy code compliance requirements, can become a highly complex and vulnerable process. Beyond basic definitions, it is important to understand how those policies are classified, and how they might translate into successful requirements. "At a minimum, public policymakers attempt to resolve public issues; questions that most people believe should be decided by officials at the appropriate level of government—national, state, or local." (Gerston, 2002)

Environmental Policy and Politics (2011) by Michael E. Kraft sets the stage for many of the larger policies and political issues behind the implementation of public policy, and classifies policies within two basic categories. *Regulatory* policies create choices available to achieve a designated social goal by encouraging or prohibiting through a series of governed sanctions and incentives. Most environmental protection policies, such as the Clean Air Act, are considered regulatory in nature. Historically speaking, many natural resources and conservation policies are classified as *distributive*. These policies serve to allocate public resources, often through financial subsidies or in providing benefits to designated groups. "The purpose has been to achieve social goals such as providing access to public lands for mining, grazing, forestry, or recreation; protecting biological diversity; or fostering the development of energy resources, such as oil, coal, or nuclear power." These policies are often criticized on the grounds of inefficient use, or may even be attributed to environmentally destructive practices. (Kraft, 2011)

2.2.2 Environmental and Conservation Segments

Environmental regulation and compliance policies often fall within two specific tracks of public policy: environmental and conservation segments. Energy policy is generally considered a joint venture between environmental protection and natural resource policy. These policies are said to represent a collective decision, based on society's collective agenda. "Such decisions are at least as important in the United States as they are in other nations, and the ecological consequences are probably greater here than in any other nation in the world." (Kraft, 2011) Environmental policy is best associated with the year 1973, the year in which the Federal Government began regulating oil prices and supply in response to the oil embargo—the decisions from which the U.S. Department of Energy was created. "Several years into the twenty-first century, Americans now have almost four decades of collective experience of unprecedented experimentation in environmental management. The ultimate test of the ambitious U.S. regime of environmental regulation will be not how well it was conceived but how well it endures." Energy, in particular, finds itself center-stage amidst political agendas as ranging from environmental protection, to Defense spending and national security. "The nation's energy agenda in the second decade of the twenty-first century will become environmental policy by another name." (Rosenbaum, 2011)

2.2.3 The Political Environment

Energy policies must be accountable to a number of perspectives, both foreign and domestic. Americans make up approximately 4.5 percent of the world's population, but consume about 19.6 percent of the world's energy. (EIA, 2009) Many of the nation's major pollution problems are caused directly by current methods of producing and consuming this energy. (Rosenbaum, 2011) While these policies are often controversial, more and more public policymakers are agreeing on the overall need for action within environmental and conservationist segments, especially surrounding fossil fuel and Greenhouse Gas (GHG)-producing sources. With 5,903 million metric tons of CO2 (UCS, 2010), the U.S. trails only China in GHG emissions—a trend rising consistently in recent decades. (Rosenbaum, 2011) In 1970, 23 percent of U.S. oil was imported from other countries. Today, that number is 58 percent. Of all the energy consumed in the U.S., about 85 percent comes from fossil fuels. (Kraft, 2011) Policymakers operate in a shifting, influential, and unpredictable political setting. "At any given time, there will be differences between what policymakers want and what they can accomplish, between what they are compelled to do and what they would prefer to do, and between what is feasible and what is not." Several circumstances contribute to this change and flow, including changing political parties, shifts in public opinion, economic health, and regulatory control. "These can be called the changing seasons of policymaking." (Rosenbaum, 2011)

2.2.4 Making Environmental Policy

Policymaking processes rely on a number of political actors in both government and private sectors. It is also described as a continuous process, subject to a variety of constraints, checks and balances. "Policymakers—whether of the legislative, White House, or bureaucratic type—can seldom act without restraint. Their discretion is bounded and shaped by many constraints: the constitutional separation of powers, institutional rules and biases, statutory laws, shared understanding about the 'rules of the game' for conflict resolutions, political realities, and more." This mixture of political and scientific agendas is often plagued with controversy. (Rosenbaum, 2011) "The U.S. policy-making process is often highly complex, frequently contentious, and sometimes utterly mystifying in the bargains that must be struck to make progress." (Kraft, 2011)

Kraft presents several theories and models utilized by political scientists (Kraft, 2011):

- *Elite Theory*: Underscores the role elites, such as a powerful corporate or government leader, who may hold values or preferences differing from those of the general public.
- *Group Theory*: Policy as produced as a result of the continuous struggle of organized interests, such as environmental groups.
- *Institutional Theory*: Highlights formal and legal aspects of governments, based on hierarchy or procedural obligations.
- *Rational Choice Theory*: Explains policy as a collection of actors, who make decisions based on maximization of personal interests.

According to Kraft, “The most sweeping public policies are developed at the national level of government, where actions of national public policymakers tend to affect almost everyone.” The role of the states in providing an organizationally similar, yet quite diverse, set of policymaking environments is also emphasized. (Kraft, 2011)

Energy codes are typically born at the national level. *Model codes* are developed through the processes of the International Code Council (ICC) and the American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE). A wide range of stakeholders are involved in these processes, which enable anyone to participate. The model codes are generally considered to include the International Energy Conservation Code (IECC) produced by the ICC and ASHRAE’s Standard 90.1. Once published, these codes can be adopted by states or local municipalities as law, regulating minimum energy performance requirements in residential and commercial buildings.

Based on the theories presented by Kraft, the model code developmental process most signifies *Group Theory*. On a three year update cycle, stakeholders submit change proposals, public comments, and defend their positions through a series of two public hearings. A variety of organized interests participate in this process, including governmental organizations, state and local officials, environmental interests, product manufacturers, industry professionals, and contracted third parties. While individuals seek and make decisions upon personal benefit, the wide range suggests a struggle more applicable to the group perspective. More institutional mechanisms, such as federal and state regulatory requirements, also enable the adoption of new versions of model codes.

2.2.5 Policy Cycles

An issue passes through several phases on its road to becoming environmental policy, starting with the placement of a governmental agenda. *Environmental Politics and Policy* (2011) by Walter A. Rosenbaum characterizes the general policy cycle as progressing through the following stages:

1. *Agenda Setting:* Getting issues heard by decision-makers, on legislative calendars, before committees, up for bill introduction, accepted by a regulatory agency, or on the White House's list of legislative proposals.
2. *Formulation and Legitimation:* Further developing the problem, by setting goals, creating plans, and selecting a means for implementation. This can be carried out through judicial decisions, administrative procedures, or any means by which an issue can justify public authority.
3. *Implementation*: Translating of a policy into operational programs.
4. *Assessment and Reformulation*: Evaluating the social impact of a policy, conducted by typical actors, such as the courts and mass media.
5. *Termination*: The assignment of a deliberate conclusion to a particular policy. As many policies often adapt over their lifetime, some essentially are left everlasting.

Several adaptations of this model are echoed by Kraft, citing several well-recognized and influential sources: Anderson (2006), Jones (1984), and his own previous work (Kraft and Furlong, 2010).

Energy code requirements in the Recovery Act of 2009 are assumed to have followed this basic approach, but perhaps in a uniquely expedited fashion. Three years following the issuance of the Act, states remain in early implementation phases. Recovery Act legislation contained many specific goals, but was largely, and in some cases reluctantly, accepted by states in order to secure much needed stimulus funding. Agenda Setting, as well as Formulation and Legitimation stages were likely expedited in order to enable immediate access to financial support during a time of economic duress. While the Recovery Act is not intended for Reformulation, the eventual Assessment may be the stage by which history defines the stimulus legislation. Termination of stimulus funds and embedded requirements carry varying deadlines, although those requirements specific 90% Compliance are set due in 2017 (based on language prescribing an eight year timeline). The penalty for delay or failure to comply has not been defined.

2.2.6 Energy Code Legislation

Environmental policy has evolved into several well-known pieces of legislation. Kraft reviews a list of major federal environmental laws, including many of those empowering the regulation of energy through building energy codes (Vig & Kraft, 2010):

Table 1: Federal legislation empowering building energy codes

Year	Legislation
1969	National Environmental Policy Act, PL 91-190
1992	Energy Policy Act, PL 102-486
2005	Energy Policy Act of 2005, PL 109-58
2007	Energy Independence and Security Act of 2007, PL 110-140
2009	The American Recovery and Reinvestment Act of 2009, PL 111-5

National Environmental Policy Act

Since its initial adoption, the National Environmental Policy Act (NEPA) has "transformed expectations for the way government agencies should consider the effects of their actions on the environment." NEPA sets a higher standard for government-owned facilities. For example, as the single largest owner, the General Services Administration (GSA) is subject to advanced standards surrounding the design and operation of all federally-owned buildings and facilities. Beyond the U.S., almost 100 other countries have duplicated and adopted at least portions of NEPA. (Kraft, 2011)

Energy Policy Act of 1992

The Energy Policy Act of 1992 called for the reduction of foreign oil dependence, and encouraged cleaner energy use through the use of renewables and efficiency measures. (Rosenbaum, 2011) In addition, the Act required states to review their building energy codes in comparison to the Model Energy Code. Many states realize significant savings through the implementation of such provisions. For example, California building and appliance code programs save an estimated $6 billion per year. (Kraft, 2011)

Energy Policy Act of 2005 and Energy Independence and Security Act of 2009

The Energy Policy Act of 2005 and later Energy Independence and Security Act of 2009 were directed at increasing the supply of energy resources. These pieces of legislation also called for improved efficiency, while accelerating energy research and development efforts. These were prescribed to include a heavy reliance on fossil fuels and nuclear power. (Rosenbaum, 2011)

The Recovery Act of 2009

The American Recovery and Reinvestment Act of 2009 (ARRA or the "Recovery Act") provided over $100 billion in targeted spending, tax incentives, and loan guarantees directed at energy efficiency, renewable energy, and climate change control. Rosenbaum provides an outline of the Recovery Act, which included over $80 billion directed toward the creation of jobs and technologies aiding cleaner energy. Included were improved standards for buildings, common household appliances, and activities specific to DOE, including (Rosenbaum, 2011):

Table 2: Energy efficiency funding within the Recovery Act

Allocation ($)	Purpose
5 billion	Weatherize modest-income homes
4.5 billion	State and local governments to increase efficiency in federal buildings
2.5 billion	Energy efficiency research
3.2 billion	Energy Efficiency and Conservation Block Grants (EECBG)
500 million	Training of green-collar workers
300 million	Purchase of energy efficient appliances
250 million	Increase energy efficiency in low-income housing

Estimates provided in the Kraft text indicate $39 billion in funding went to the DOE. "By its size alone, the measure constituted the biggest energy bill in U.S. history." (Kraft, 2011)

2.2.7 Role of Government

Governments are considered to serve an essential role in resolving environmental problems. Public bodies are often charged with establishing over-arching efficiency goals or energy targets. This sets the stage for a cast of supporting energy policies. "We look to government for such policies because environmental threats represent public or collective goods problems that *cannot* be solved through private action alone." (Kraft, 2011) Unfortunately, the creation of these policies alone does not satisfy savings goals, nor does it remedy the original social need. Therefore, government's role does not cease following the policy creation phases, and is arguably all the more valuable in assuring policies are implemented properly to reach their full potential.

2.3 ENVIRONMENTAL POLICY IMPLEMENTATION

Environmental policies can be put in-place through a variety of means, guided by commonly referenced models for implementation. In the case of the Recovery Act of 2009, a heavy stimulus of funds was injected into the U.S. economy in an effort to combat economic downturn. Several requirements were also attached to this funding, including the building energy code 90% Compliance goal. Motivated by the desire to acquire substantial financial support, all states accepted stimuli funds, and are now obligated to comply with all requirements set forth in the Recovery Act. Many have characterized these requirements as an unfunded government mandate, drawing comparisons to historical instances where state and federal regulatory powers have collided following the creation of public policy. Rosenbaum reinforces the implementation phases, highlighting the tall task of converting policy commitments into actual practice. "Much like the bulky, unseen mass of a huge iceberg, implementation tends to be almost hidden from public view." (Gerston, 2002) The following section provides key policy implementation models, addresses some of the primary issues and barriers facing each, and presents options through which these models can be applied.

2.3.1 Implementation Models

Political and legislative requirements can spawn from a variety of levels, from that of the U.S. Federal Government to ordinances created by local governmental boards. In certain cases, a globalized social interest is created at the federal level, but responsibility for implementation is passed to state and local governments. In contrast, localized concerns often outgrow their grass roots, and are adopted on the state or even federal levels. Depending on the situation, the models through which public policy are created, nurtured, and set free can often function on this one or two way street.

Top-down and Bottom-up Approaches

The broadest theoretical fields surrounding public policy implementation is predominately split into two perspectives: top-down and bottom-up implementation. Researchers can take a variety of approaches to these two perspectives, often times adopting one school of thought for the other, or synthesizing portions of each into a hybrid model. Referencing strategies for *top-down* implementation models, Matland (1995) provides the following recommendations:

1. Make policy goals clear and consistent
2. Minimize the number of actors
3. Limit the extent of change necessary
4. Place the implementation responsibility in an agency sympathetic with the policy's goals

The article also describes common criticisms facing the top-down approach. In taking statutory language as a starting point, this fails to consider earlier actions taken in the process model. A top-down model also can see implementation as a purely administrative process. This often leads to ignoring political aspects of the decision process, or can even try to eliminate the political aspect altogether. (Matland, 1995)

In contrast, the *bottom-up* models may contain a more realistic understanding of implementation. This model views public policy from the perspective of the target population and those who eventually "deliver the service." The article builds upon previous theories, which accept policy implementation as occurring at two levels. These levels are described as *macroimplementation* and *microimplementation*. "At the macroimplementation level, centrally located actors devise a government program; at the microimplementation level, local organizations react to the macro level plans, develop their own programs, and implement them." The article also classifies local-level implementers as key, and without the freedom for local adaptation, the overall policy is likely to fail. The article also supports a thorough understanding of the process, stating "Bottom-uppers argue that the goals, strategies, activities, and contracts of the actors involved in the microimplementation process must be understood in order to understand implementation." (Matland, 1995) While the top-down model tends to support a prescriptive approach, a bottom-up view places more emphasis on factors which prevent reaching stated goals, such as local challenges and barriers.

Energy code requirements set forth in the Recovery Act largely focus on the demonstration of a 90% compliance rate. This outcome was stated directly in the language of the Recovery Act, and is considered to represent a common top-down approach by which federal mandates are deployed to and through different levels of state and local governments. Although mandates generally follow these models, implementers need to remain aware of the potential for their efforts to be undermined by increasingly localized issues and barriers.

Federalism

There exists a symbiotic, but often controversial relationship between state and national governmental bodies, often referenced as *Federalism*. According to Kraft (2011), "About 75 percent of the major environmental protection program functions have been delegated to the states, a rate that has increased significantly over the past two decades." As one of the most predominant environmental implementation models, Federalism is said to fragment government authority between the national and state levels. A 1967 publication by Grodzins proposes the timeless remark, "There has never been a time when it was possible to put neat labels on discrete 'federal', 'state', and 'local' functions."

According to Gerston (2002), state and localized governments have resurged in recent years, referring to what has been identified as a *New Federalism*. Still, states are also responsible for the majority of enforcement, delegated under most federal environmental laws, although these specific roles have varied significantly over time. Kraft warns of localized limitations, such as the resources or commitment to put broader social agendas into effect, citing the "reality that states and localities will continue to depend on federal research and technical support that cannot be duplicated at the state level." (Kraft, 2011) Many states argue current federally regulated programs would be better managed by states and local governments, although such an effort carries a heavy financial expense and administrative burden. (Rosenbaum, 2011) While policy implementation may have certain advantages through the models of federalism, these efforts are often viewed as heavy-handed mandates, and encounter strong opposition at localized levels.

Incrementalism

In opposition to the previous model, *Incrementalism* favors more gradual political changes over time. According to Rosenbaum, "Public officials strongly favor making and changing policy incrementally." This model relies on past experiences as guidance, carefully considering all angles of proposition before committing to any changes, and rejecting any innovation deemed too aggressive. Although this model is credited with being most empathetic to localized needs, this heightened concern may come with its own set of issues. The National Environmental Policy Act of 1969 and Clean Air Act (1970) are said to have been created by congress after repeated failures to deal with environmental issues in an incremental fashion. “Finally, Congress put an end to this incrementalism with the avalanche of new, forceful federal environmental laws in the 1970s mandating national pollution standards and regulations that compelled state compliance and enforcement.” (Rosenbaum, 2011) While contrary to more federalist approaches, the incremental approach likely overcompensates, bringing forth a new set of overwhelming challenges.

The Precautionary Principle

A final, and potentially very *real*, consideration, known as the *Precautionary Principle*, has gained traction with Congress within topics of energy and environmental policy. Faced with potentially extreme threats, some issues have begun to transcend typical policy implementation issues and barriers. As these potential threats outgrow common metrics and decision-making protocols, scientific and environmental communities push to err on a side of caution and protection not provided for under traditional risk assessment procedures. The principle calls for precautionary measures to be taken, even when a scientific cause and effect relationship may not be fully established. (SEHN, 1998) Rosenbaum further describes the principle as mandating preventative action in response to uncertainty, as opposed to waiting for a clear quantification of acceptable risk and resolution to existing controversies. He also describes it as shifting the burden of proof to proponents of a harmful activity or substance, who then assume the role of defending its safety in the public forum. This principle forms the basis of many modern day climate change initiatives, as well as Al Gore’s somewhat infamous statement; “Uncertainty is no excuse for complacency.” (David & Guggenheim, 2006)

2.3.2 Policy Options

Following choice of model, one must be familiar with the many options available for implementing social policies. Kraft (2011) presents a variety of common applications, ranging from regulatory to incentive-based programs. Potential government actions, followed by a related example, are explored in the following sections:

- *Regulation:* Establishment and enforcement of standards with sanctions for non-compliance (common environmental regulation, such as the Clean Air Act, Superfund, or energy efficiency requirements)
- *Market Incentives*: Imposed taxes, charges, or development of tradable permits creating incentives or disincentives for action (raising gasoline taxes to encourage fuel conservation, or tradable permits for carbon dioxide emissions)
- *Education*: Information for the public through specific formula programs or other actions (disclosure of chemical releases, auto efficiency labels, environmental education and training programs)
- *Taxing and Spending*: Taxation of an activity to encourage or discourage behavior (tax credits for fuel efficiency vehicles) or deliberate spending on preferred programs (energy research)
- *Purchasing Goods and Services*: Purchase of products and services for government agencies (efficient fleet vehicles, recycled paper products)
- *Rationing*: Limiting access to scare resources (permits for camping in National Parks, restrictions on water use during dry periods, fishing limits)
- *Privatization and Contracting*: Transfer of public services or property from government ownership to the private sector (concessions on public land, sale of federal property)
- *Charging Fees*: Fees for government services (use of State Parks, contracted land for grazing or mining, or contracted waste clean-up services)
- *Use of Subsidies*: Loans, direct payment, tax credits and pricing support (agricultural subsidies, educational loans)
- *Public Trusts*: Placement of property in public trusts (conservation trusts)
- *Support of Research and Development*: Conducting or supporting research efforts (EPA, NOAA, NSF, DOE)
- *Assessment for Damages*: Use of civil law to award damages (private suits against corporations, Superfund natural resource damage assessments)
- *Self-regulation*: Voluntary adoption of performance standards (environmental management standards, responsible care programs, state environmental regulation programs)

Several of the above programs may be applicable for encouraging compliance with building energy codes. The regulatory approach is present at the national level, as well as within states lacking a statewide energy code. Educational training programs in some form are offered in most states, many of which have been recently supported by Recovery Act stimulus funding. Many training programs and third-party evaluation services are contracted to existing private businesses, while also creating new opportunities. At the federal level, organizations such as the U.S. Department of Energy fund research and development through national scientific laboratories and contracts with private research organizations.

In considering future options, market incentives provide a powerful effect influencing the uptake of new regulation. Rebate programs could be considered for energy codes, such as have been successful with emerging technologies and high-efficiency equipment otherwise eluding the market. Self-regulation mechanisms could also be considered to streamline often burdensome compliance processes. Although a wide variety of options are present, choice of the appropriate action will vary significantly by state regulatory and funding scenarios. While some states may hold legislative authority for increased regulation, others will likely need a more indirect or voluntary approach. While incentive-based programs are often greeted more positively, current state economic scenarios may unfortunately limit available resources.

2.3.3 Implementation Issues

In order to fully understand the models by which policy lives, one must consider the various levels of affected government, as well as challenges and realities facing the created policy as it is passed from policymaker, to implementer, and to eventual stakeholder. This is often referred to as the *Implementation Dilemma.* Osborne (2002) submits; those who carry-out prescribed policy are often as influential as those who created the policy, stating, “Front-line public managers can have as much influence in shaping policy by their implementation of it, as do policy makers and politicians.” He continues in arguing for an approach that not only makes prescription, but also gives additional consideration for what it might take the successfully implement a given policy measure. “What is needed is a greater integration of policy making and implementation, not their separation.” (Osborne, 2002)

Local Actors

Osborne examines the relationships and realities at increasingly localized levels of government. “Every (policy) implementation agency probably has a set of management controls, a firmly entrenched collection of operating routines, some process for eliciting the involvement of the implementers, and a set of internal and external bargaining relationships. The important question is not whether these elements exist or not, but how they affect the implementation process.” When a particular mandate is deployed at local levels of government, as such is often the case with federal mandates, the implementer grows increasingly detached from the original intent of the mandate with each additional level of implementation. Osborne describes actors as “street level bureaucrats” who “Interact directly with citizens in the course of their jobs and have substantial discretion in the execution of their work.” He argues these intermediary bureaucrats are forced to find a way to meet demands placed upon them while still confronting the common reality of resource limitations. He continues in describing the presence of accommodations and ‘coping mechanisms’, the embedded development of behavioral patterns, which essentially become the government program when delivered to the end stakeholder. “In a significant sense, then, street level bureaucrats *are the policymakers* in their respective work arenas.” (Osborne, 2002) In a sense, this would imply policy is renewed with each level of implementation.

The case of the street level bureaucrat can be assumed to be significantly applicable in the case of the 90% Compliance mandate. Implementers of this policy will be government representatives, policy makers, compliance officials and even home builders. As a policy will be implemented and eventually live within a pre-existing network of traditional professional relationships, it is necessary to hear those who will deliver this policy. Special consideration must be given to those existing roles, responsibilities and relationships, especially in comparing those realities back to the prescribed desired outcomes of the Recovery Act.

Issues facing actors implementing public policy are further discussed by Rosenbaum, who states, "There are almost no contemporary environmental problems for which a technical or scientific solution does not exist or cannot readily be found. . .*what* could solve the problem is usually much easier to imagine than *how* to accomplish it." He describes a changing political character and pace, based on changing public moods, resources, and available personnel, while charged by economic, political, and cultural motivations. "Practically every important environmental ill has been targeted by a major federal law, but delays and difficulties in program implementation routinely impede enforcement." (Rosenbaum, 2011)

The Complex Regulatory Process

Rosenbaum (2011) introduces several challenges surrounding policy implementation, beginning with a growing complexity of the general regulatory process. "The average size of statutes has inflated from about fifty pages in the 1970s to more than five hundred pages currently. The original Clean Air Act (1970) weighed in at 788 pages, and the regulations required for their implementation will exceed 10,000 pages." The author also cites a comparison of public agency responsibility and available resources, referencing a growing discrepancy between expectations and budget allocations. Many environmental requirements also depend on voluntary compliance through self-regulation. "Few states, for example, routinely inspect public and private drinking water systems, even though such inspections are required by the Safe Drinking Water Act (1974)." Many states lack technical resources to develop these standards and instead are left to deal with the resulting damage in a reactive manner. Economic and population growth also impose challenges, often diminishing the effectiveness of prescribed controls over time. For example, automotive emission controls and improved fuel regulation have decreased the average new car's emissions significantly. However, the number of automobiles in the U.S. has increased by 71 percent—80.4 million in 1970 to 137 million in 2006. This population expansion more than counteracts any achieved reductions, leaving many present day policies ill-equipped to deal with tomorrow's social problems. Finally, litigation presented as a significant barrier, citing bureaucratic disagreements, and difficult coordination between federal, state and local governments. According to Rosenbaum, "It is easier to defeat legislation and other governmental policies than to enact them, to frustrate incisive governmental action on issues than to create it." (Rosenbaum, 2011)

Financial Allocations

The cost of environmental regulation should also be weighted in deciding how to implement public environmental policies. "Although some environmental programs are very costly, the total public and private cost of regulation to the United States appears reasonable." The U.S. currently spends 1.5-2.5 percent of its gross domestic product on environmental protection, and approximately 1.5 percent of recent federal budgets. Compared to other developed nations, these are actually quite modest figures, especially when compared to other traditional social programs, such as Medicare (12 percent) and Social Security (22 percent). (EPA, 2001) In terms of cost-benefit, "The U.S. Environmental Protection Agency (EPA) has calculated, for instance, that the economic benefits from the Clean Air Act (CAA) alone are four times greater than the cost." (Rosenbaum, 2011) Similar figures presented for building energy efficiency suggest an energy savings of six dollars for every dollar spent on energy code compliance (IMT, 2010b), indicating a strong collective benefit in addressing these large social-scale problems.

Government Oversight

The division of responsibility in responding to such large-scale, modern environmental problems can also be considered an implementation issue. Among federal agencies, twenty-seven separate entities share these responsibilities. By Rosenbaum, “Regulating even a single pollutant often necessitates what might appear to be a bureaucratic convention.” (Rosenbaum, 2011)

Kraft provides an overview of several agencies within the Executive Branch of government, all with some level of responsibility for environmental oversight. These are as follows (Kraft, 2011):

Executive Office of the President:

- *White House Office*
  - Overall policy
  - Agency coordination
- *Council on Environmental Quality*
  - Policy coordination
  - Oversight of NEPA
  - Quality reporting
- *Office of Management and Budget*
  - Budget
  - Agency coordination
- *Office of Science & Technology Policy*
  - Advises president on issues

Government agencies:

- *Environmental Protection Agency*
  - Air and water pollution
  - Pesticides and radiation
  - Solid waste
  - Superfund
  - Toxic substances
- *Department of the Interior*
  - Public lands and minerals
  - Energy
  - National parks
  - Wilderness and wildlife
  - Endangered species
  - Continental shelf
- *Department of Agriculture*
  - Forestry and Soil conservation
- *Department of Commerce*
  - Atmospheric monitoring
  - Coastal zone management
  - Marine mammal protection
- *Department of State*
  - International environment
- *Department of Justice*
  - Environmental litigation
- *Department of Defense*
  - Civil works construction
  - Dredge and fill permits
  - Defense pollution control
  - Environmental restoration
- *Department of Energy*
  - Energy policy coordination
  - Nuclear waste disposal
  - Research and development
  - Waste management
  - Environmental restoration
- *Department of Transportation*
  - Mass transit and roads
  - Airplane noise
  - Oil pollution
- *Department of Housing and Urban Development*
  - Housing
  - Urban parks
  - Urban planning
- *Department of Health and Human Services*
  - Health and family planning
- *Department of Labor*
  - Occupational health
- *Nuclear Regulatory Commission*
  - Regulating nuclear power
- *Tennessee Valley Authority*
  - Electric power generation
- *Department of Homeland Security*
  - Biochemical
  - Infrastructure security
  - Emergency response

Additional Discussion

According to Rosenbaum, “Environmental degradation is a twenty-first century problem resolved according to eighteenth-century rules.” Policy implementation models suggest a need for balance between the often heavy-handed federal will, and needs of the acting stakeholders. It is important to understand the fragile dynamic existing between national and state governments, while understanding polices so often live or die at the hands of the individual implementing actors. States preparing to address energy code compliance requirements of the Recovery Act should be aware of these theoretical models, their inherent issues and challenges, and take inventory from the range of available implementation options—these realities and the nature of general policy implementation need not go unnoticed. Following the inaugural Earth Day, the oil embargo, and 1970s energy crisis, President Jimmy Carter encouraged energy efficiency, stating; “Every gallon of oil each one of us saves is a new form of production.” (Rosenbaum, 2011) Almost three decades later, we are still plagued by many of the same challenges.

2.4 ENERGY CODES AS A POLITICAL MECHANISM

Energy codes are generally accepted as a political solution in support of over-arching conservation policy. To many, energy codes are a one-sized approach to ensure a desired end. Government agents, elected officials and policymakers look to the code as a functional mechanism to bring efficiency goals to life. The code must accommodate a wide range of construction types, climates, and product uses. Product manufacturers and organizational interests tend to participate heavily in the code development process to influence future requirements and ensure business alignment. A single specified change can alter traditional and well-known construction methods, pave the way for a new technology into the market, or even eliminate the use of a fading technology. Although, the code is designed to create product neutrality, any change will have some degree of ramification on individual stakeholder or professional groups. Needless to say, this process is of key importance to product manufacturers and professional trade associations. Advancing codes also seek unprecedented levels of energy efficiency, however; if too specific, states and adopting jurisdictions may balk at the lack of flexibility. The function of the code as a political mechanism within greater arenas of environmental policy need be examined, including benefits of new requirements, as well as associated barriers impeding energy code compliance.

2.4.1 The Compliance Process

Energy codes function based on a series of traditional models and compliance *paths.* A number of factors empower the actual code, such as the scope of included provisions, regulatory frameworks, and the degree to which the code is enforced.   Within the code are further options, as well, in the form of multiple paths by which compliance can be demonstrated. These enforcement models and embedded compliance paths are discussed briefly in the following section.

Compliance Models

A 2008 report by the *Building Codes Assistance Project (BCAP)* identifies four primary models commonly used across the country in enforcing energy codes (BCAP, 2008):

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

According to BCAP (2008), local code enforcement, such as that performed by a local building department, is the most commonly relied upon model. Self-certification, or *first-party* assessment, is performed when an entity responsible for compliance certifies their own work. For example, a builder or contractor submitting a statement of compliance, and indicating all required code provisions have been satisfied. *Second-party* assessment involves certification by an otherwise involved party, such as a building owner or financial institution. Finally, *third-party* certification is performed by a non-affiliated body, such as a contracted individual hired for the sole purpose of measuring and verifying compliance with the building. Parties most influential in the compliance process are often code officials, zoning departments, fire marshals, health departments, or other *authorities having* jurisdiction to enforce the code, as set forth by state or local law. Other parties can also influence the process, such as product manufacturers, testing, and certification agencies hired to validate compliance. This validation is often performed post-construction, but may be performed at several stages, such as initial occupancy or even post-occupancy (Conover et. al., 2011).

Compliance Paths

Within the actual code, several options exist to demonstrate compliance with the necessary requirements. A 2011 report by the Pacific Northwest National Laboratory (PNNL) outlines traditional paths, as well as some considered to be more progressive. Traditional paths include (Conover et. al., 2011):

- *Prescriptive:* Simple, singular metrics which individual building components often must satisfy
- *Component Performance:* Performance of a particular component, system, or sub-system of a building
- *Equivalent Performance:* Performance of a designed building as compared to the same building constructed to base code requirements

Several states add alternative paths deemed acceptable as complying with the code. Amendments may include provisions establishing a minimum alternate performance path, such as complying with the ENERGY STAR program administered by the Environmental Protection Agency (EPA). ENERGY STAR is a federal program through which homes meet efficiency criteria in excess of typical code requirements. Some states also allow compliance demonstration if a specified HERS score is achieved. The Home Energy Rating System (HERS) sets criteria for modeling home energy usage, as well as for post-construction testing. Homes are also scored based on HERS criteria, a number which is often equated to automobile MPG ratings.

Considered even more progressive *are outcome-based* or *capacity-constrained* compliance paths, where the code abandons exhaustive prescriptive requirements in favor of a simple as-designed metric. For example, and outcome-based energy code pushes the burden of proof post-occupancy, where compliance is determined by evidence of actual building performance. This can be accomplished by a square footage metric (i.e., Energy Use Intensity [EUI]), or through a simple comparison of utility bills. Capacity, or peak, constraints impose limitations on the design side, such as limiting utility power supplies or setting maximum equipment sizes.

Code compliance is traditionally driven by prescriptive code requirements, which are adopted at state or local levels and administered through local construction regulation. Plans are often submitted to a local building department, which then inspects the building during the construction process to ensure installed features are placed as designed. Upon completion of construction, the building department will issue a *Certificate of Occupancy*, granting permission for the building to be occupied by the owner (Conover et. al., 2011).

2.4.2 Benefits of Compliance Policy

The Washington, DC based Institute for Market Transformation (IMT) recognizes building energy codes as, "one of the most affordable and effective mechanisms for advancing energy efficiency in buildings." Compliance with energy codes, however, is often observed at poor levels. An IMT task group, consisting of several prominent environmental advocacy organizations, identified six dollars in energy savings yielded from each dollar of input expense.

"By simply enforcing existing energy codes, local governments can achieve dramatic energy reductions at a relatively modest cost." (IMT, 2010a)

Buildings that comply with energy codes are also identified as more energy-efficient and use less energy in their lifetimes. The benefits of adopting, implementing and enforcing codes extend well beyond utility bill savings. Energy codes can improve occupant comfort, increase our country's energy independence, and reduce emissions of harmful pollutants. Moreover, and perhaps even more importantly in the current economic climate, well-enforced building energy codes can provide local jobs at all skill levels in the building inspection, construction, and design industries. (IMT, 2011)

A 2011 report released by the *Climate Policy Initiative* expects modern codes to experience widespread use with the potential for significant energy savings. Key findings outlined in the report include an approximate 10% overall decrease in energy consumption in comparison to homes not built to modern codes. The report goes on to cite energy codes as an inexpensive option for government to support efficiency policy, especially in comparison to monetary incentives or financing measures (Deason & Hobbs, 2011). Aside from energy savings alone, building energy codes may offer additional economic and environmental benefits. "They also create economic opportunities for business and industry by promoting new energy-efficient technologies." (Halverson & Shankle, 2003) A recent Building Energy Codes 101 publication also cites the potential for reduced building owner and operational costs, in addition to benefits of significantly reduced carbon emissions over the life of the building. (DOE, 2010a)

2.4.3 Barriers to Energy Code Compliance

Advancement of efficiency policy through the use building energy codes can be confronted by a variety of barriers throughout multiple stages of the code development and implementation processes. Model energy codes are developed on the national stage by a wide range of stakeholders, but are then left to states, cities or local jurisdictions to adopt as law and enforce. True energy savings are only realized through adequate enforcement and actual *compliance* with the provisions intended by the code.

The 2008 article, *Putting Codes into Action: How Newly Updated Building Codes Translate into Practice,* provides valuable insight into the process of implementing fresh code policy. This article offers a methodology of evaluating building codes common to most compliance or baseline studies. Methods utilized in the study included a visit to nine local building department offices across several California climate zones. A sample of over 400 records was reviewed, made up of permitting documents, plans, drawings, and project specifications on file. Actual site inspections were also administered for 144 buildings in the larger sample. "Beyond the non-compliance values themselves, this study was able to provide valuable insight into the various building department processes and procedures in-place across the state." (Levy, et. al., 2008) Many procedural inconsistencies were found, largely attributed to the unique nature of each building department's internal policies for determining compliance. "All building departments keep records of permits by address, date and permit numbers; however, the methods by which they categorize, store, and support projects differ in every jurisdiction. In particular, we found that the level of project detail available for viewing was inconsistent throughout the state." The study also cites an alignment of compliance evaluations with the goals of supervisors and city council members whom lack a true understanding of the energy code. Unfortunately, the discrepancy is reaffirmed between the prescribed code for an area, and what measures are truly enforced in the field. A lack of knowledge and 'grandfathering' clauses are also typically cited as creating a large gap between code policy and actual enforcement criteria. (Levy, et. al., 2008)

A second article, *Regulatory Standards and Barriers to Improved Performance for Housing*, identifies many existing barriers impeding a clean implementation of energy code or similar policy. One of the primary barriers cited is often present within the language, itself. “The main barriers to progress are located in policy, process and availability of human resources, rather than in technology as narrowly defined.” (Lowe, et. al., 2008) The verbiage as written in the political document is mentioned, often written in vague or general terms for the purpose of encompassing several potential situations. When analyzed or considered by end-users, the result is often confusion or discrepancy over terminology or intent of the passage. Communication and the lack of adequate resources are also cited as defiant to policy implementation. “Regulatory confusion is enhanced by inadequate resources for regulatory development and enforcement.” Several remedies are suggested, such as improved cooperation within the government, an integration of demand and supply-side policies for energy performance in housing, and an improvement in research and training support for energy efficiency. “It will be clear for the foregoing that the government has a key role to play in setting clear goals in this area and implementing policies to achieve them.” (Lowe, et. al., 2008)

Energy codes can deliver their potential energy savings only when projects actually comply with the code. Although many local jurisdictions have adopted or will soon adopt the latest model energy codes, many new and renovated structures fail to comply with mandatory energy efficiency requirements, consuming far more energy and money to operate than they should. Many jurisdictions lack the necessary training and enforcement resources to ensure compliance, and compliance rates in many states, cities and towns are well below 50 percent. To maximize the benefits of building energy codes, local efforts to enforce codes must be enhanced by providing education, training and resources to local code officials, plan reviewers and industry stakeholders. (IMT, 2011)

The 2008 BCAP report also addressed several barriers impeding compliance with building energy codes. Lack of available manpower for code compliance measures was identified as one of the top barriers in enforcing residential energy codes. Insufficient time to spend on the energy code was also cited, resulting from the common need for a single code official to enforce multiple residential and commercial codes—mechanical, electrical, structural, and plumbing to name a few. Codes containing life and safety provisions are considered to take precedence over provisions designed to save energy. "Because it does not qualify as a life-health safety code, the energy code was reported to be a lower priority, receiving less attention from inspectors resulting in a lower likelihood of compliance." (BCAP, 2008) Building code officials were also found to have a mix of technical knowledge, experience, and educational backgrounds. Many code officials were labeled as having a desire to improve their knowledge of the energy code, but were limited by current workloads. (BCAP, 2008)

2.4.4 Best Practices

Looking past barriers, previous studies have extracted best practices and positive outcomes in the pursuit of energy code compliance. A 2007 *Southwest Energy Efficiency Partnership (SWEEP)* report (Schlegel & Troncone, 2007) compared best practices related to code compliance and enforcement in the State of Arizona. Continued education and training was identified as an important aspect. "Education and training for both the building industry and for code officials and inspectors is an essential practice in municipalities with successful implementation of building energy codes." Regular interaction between building departments and the construction industry is considered a positive trait, creating venues for information exchange on code updates, compliance options, and advancing construction applications. Many of the more progressive building departments were found to provide inspectors with software and practical enforcement tools. Many of these were as simple as checklists of key compliance features. Regular training was also commonly observed within leading programs, as was the presence of an *energy code champion* within the community to pursue optimal compliance strategies. (Schlegel & Troncone, 2007)

BCAP echoes the need for training, stating, “Overwhelmingly, code officials believed energy code training is essential to effective energy code enforcement.” (BCAP, 2008) Most code officials included in the BCAP study said their jurisdiction required a certification or licensing program, presenting the opportunity for energy code-related training through continuing education requirements. Training programs cited were most often offered by DOE, state energy offices, local building official organizations, or regional/national energy efficiency groups. Survey responses suggest a preference for state-specific in-person training, followed by the ease of online methods, such as webinars, self-paced courses, and supplemental compliance resources. These were stated as leading to an improved understanding of new code requirements, “directly impacting compliance and enforcement.” (BCAP, 2008) The use of computers and other information technologies within the enforcement process was also identified as streamlining the process, helping to reduce permitting time, improve efficiency, and enhance the productivity of departmental operating funds. Furthermore, the importance of assigning value to the energy code was addressed, indicating a need to connect with the consumer through modern sources, such as through the internet, presentations, newsletters, and other common media outlets.

A third study (Benningfield & Hogan, 2003) reviewed enforcement practices in the State of California and the City of Seattle, and stresses the importance of involving all key participants in code development and compliance processes. These stakeholders are identified as including: architects, mechanical engineers, lighting designers, equipment manufacturers, contractors, and installers. "One benefit is that the resultant code language will likely end up being clearer and will likely address common problems. The other benefit, which is not to be underestimated, is that these participants can then go back to their respective organizations and build support for the energy code requirements." This study again cited the importance of educational and training programs, citing them as necessary to summarize requirements, but also to provide background and supporting rationale. "This helps later when questions come up for unusual situations that are not specifically addressed in the code." The avoidance of risk was also implied as an indirect benefit to additional knowledge of code requirements, providing the opportunity to remedy problems and potential code violations earlier in the process before construction is underway. "Third-party plan review and field inspection can relieve the responsibility from one agency and assign it to another. In some cases, this works well because typically the third-party agency specializes in this service and consequently the technical knowledge is quite high." (Benningfield & Hogan, 2003)

2.5 EXISTING GUIDANCE AND AVAILABLE RESOURCES

Energy code compliance requirements were issued in concert with the Recovery Act in 2009. Today, their application yet remains far from understood by state and local governments. Many states and code enforcing agencies have hesitated to initiate activities in support of compliance requirements, and have waited for others to take the lead in this potentially consuming endeavor. Several states have participated in federal pilot programs, or have even responded with compliance studies of their own. A variety of resources have also been made available by national and state sources. The following section points readers to many of these resources, and provides an overview of known guidance specific to Recovery Act requirements.

2.5.1 Recovery Act Requirements

Section 410 of the Recovery Act includes the following language pertaining to building energy codes (U.S. Congress, 2009):

> *(2) The State, or the applicable units of local government that have authority to adopt building codes, will implement the following:*
>
> > *(A) A building energy code (or codes) for residential buildings that meets or exceeds the most recently published International Energy Conservation Code, or achieves equivalent or greater energy savings.*
> >
> > *(B) A building energy code (or codes) for commercial buildings throughout the State that meets or exceeds the ANSI/ASHRAE/IESNA Standard 90.1–2007, or achieves equivalent or greater energy savings.*
> >
> > *(C) A plan for the jurisdiction achieving compliance with the building energy code or codes described in subparagraphs (A) and (B) within 8 years of the date of enactment of this Act in at least 90 percent of new and renovated residential and commercial building space. Such plan shall include active training and enforcement programs and measurement of the rate of compliance each year.*

To be eligible for stimulus package funding, governors from all fifty states submitted letters certifying their states' obligation to fulfill Recovery Act requirements. While both the Recovery Act and pre-existing legislation legally requires states to adopt *target energy codes*, these requirements are fulfilled in a variety of ways—the two most common being statewide or by local jurisdiction. "The State, or the applicable units of local government that have authority to adopt building codes" seems to refer to this dynamic (U.S. Congress, 2009). Whether adopting statewide or local jurisdiction (known as *Home Rule*), all states appear to fall under the purview of the Recovery Act.

Part A imposes requirements surrounding energy codes for residential buildings. At the time the Recovery Act was *drafted*, the 2009 version of the International Energy Conservation Code (IECC) was still being developed through processes owned by the International Code Council (ICC). This process had completed by the time the Recovery Act was officially published, however. Therefore, the 2009 IECC is the best choice in fulfilling, “A building energy code (or codes) for residential buildings that meets or exceeds the most recently published International Energy Conservation Code.” (U.S. Congress, 2009) The language also retains flexibility to opt for a different code deemed to achieve equivalent levels of energy savings, which is considered to include more recent (and more efficient) versions of the IECC.

Commercial buildings are covered under Part B, which follows a similar format to the previous. In this case, the target code is specified by name: Standard 90.1—2007, developed by the American National Standards Institute (ANSI), the American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE), and the Illuminating Engineering Society of North America (IESNA). Similar language allowing an equivalent or greater energy savings is provided. While standards are not typically adopted as code (law), Standard 90.1 is an exception, and is written in enforceable code language. Therefore, commercial adoption requirement can be met directly, or by reference, as it is also included in the next newer version of the IECC.

Part C serves as the focus of this thesis, and ventures beyond regulatory requirements paved by previous legislation. The Recovery Act requires a *plan* to achieve 90% Compliance in accordance with the above codes within eight years. Herein lays requirements for training programs, active enforcement, annual compliance measurement, and the majority of state heartburn. Guidance from DOE and other national organizations have attempted to provide guidance and resolution to a number of state issues, but no clear marching orders exist. While many of these concerns are addressed within the PNNL suggested methodology, states may be left to resolve significant and unprecedented challenges in meeting Recovery Act requirements.

2.5.2 DOE and PNNL Methodology

Perhaps the most centralized document pertaining to the 2009 Recovery Act compliance mandate is the *Measuring State Energy Code Compliance* report released by the PNNL and DOE in March of 2010. This document aggregates a previously developed series of *compliance briefs* issued by PNNL over the preceding months, each brief focused on one particular compliance issue, and culminating in a suggested methodology to address Recovery Act compliance requirements. The report covers topics, such as: developing a statistically valid sampling of buildings for evaluation, checklists, implementation resources, and how to meet annual reporting criteria. Some limited consideration is given to constraints, such as funding and manpower constraints. The report also directs readers to the eventual evaluation tools suggested to states for determining building energy code compliance, and provides a limited framework suggesting how states should plan for new requirements.

Compliance briefs have since been aggregated into a single, comprehensive report, providing; "A detailed set of procedures that may help states as they engage in (these) activities, most notably those associated with measuring and reporting rates of compliance." (DOE, 2010b)

Unfortunately, there exists a significant amount of static friction for states as they start thinking about the Recovery Act compliance requirements. While the suggested process may provide an ideal approach, it does not provide guidance detailing how states should initiate this process.

Many states remain unaware of what challenges they are likely to face, what resources are at their disposal, and simply do not know where to begin. The following sections represent a categorized overview of existing federal guidance, and provide a flavor of expectations for states.

Introduction

The purpose of the PNNL suggested methodology is to provide states with guidance in meeting compliance requirements of the Recovery Act. While there is no requirement for states to use this methodology or supporting materials, it does provide a founding set of expectations deemed by the Federal Government to meet prescribed compliance requirements. The method also provides a level of consistency, both in approach and as a means of gathering comparable state data.

The PNNL methodology seeks four primary types of building samples (DOE, 2010b):

1. Residential new construction
2. Commercial new construction
3. Residential renovations
4. Commercial renovations

Each type must consist of a statistically valid sample of buildings, and be evaluated against target codes as defined by the Recovery Act. To achieve continuing benefits, the PNNL methodology also suggests states may wish to continue compliance measurement activities even after the 90% compliance rate is demonstrated. (DOE, 2010b)

Code Adoption and Equivalency

This section of the report address code *equivalency*—a question becoming key as more recent versions of the IECC and Standard 90.1 are developed. "During (the) 8-year period, it is certain that more recent codes, such as the 2012 IECC and ASHRAE 90.1—2010, will be developed and could possibly be adopted by states. If the format of these new codes is similar to the format of the target codes, the checklists developed for the target codes would continue to be applicable." (DOE, 2010b) This description also carries an assumption that newer code versions would carry additional stringency beyond target codes, and therefore meet requirements for equivalent (or better) energy savings. In state measurements, however, states would remain accountable for compliance with the target codes.

Annual Measurement

A reminder of the requirement for annual compliance measurement is presented, outlining alternative options, as well as methods for conducting a formal evaluation. "In some states, formal annual onsite evaluations may not be feasible or productive because of a lack of manpower, because nothing has changed since a previous onsite audit, or because the state intends to wait until a newer code is adopted." (DOE, 2010b) No single method for conducting the compliance evaluation is required, and many states are asked to focus early efforts on adoption before progressing to the following compliance measurement activities. States initiating the process are encouraged to conduct self-assessments before moving onto formal evaluations, in attempt to develop an informal baseline. This is suggested in concert with training and education activities, and the possibility of third-party assistance. States are provided the following guidance in beginning the process (DOE, 2010b):

1. Establish Compliance Working Group
2. Perform Self-assessments
3. Evaluate results
4. Train and educate
5. Launch third-party compliance verification

Surveying the Jurisdictions

A survey approach is suggested as a less costly means of evaluating compliance, especially in interim years between more robust compliance measurement activities. This application is also suggested to introduce local enforcement jurisdictions to Recovery Act objectives and potential follow-up needs. The survey is also suggested to emphasize the correlation between jurisdictional processes and overall compliance rates. “Questions pertaining to the jurisdiction’s energy code plan review, inspection, and administrative processes could provide some indication of the degree to which energy code requirements are enforced, which, in turn, can inform training and educational decisions.” A survey mechanism may also be utilized as a follow-up to field inspections, or as a spot-check in jurisdictions exhibiting lower compliance rates. “During formal onsite evaluations, BECP recommends that the evaluators include a short jurisdictional survey as part of their onsite data collection process.” (DOE, 2010b) The methodology also recommends the option of focusing the survey on only one of the sample populations each year, rather than addressing all samples on an annual basis.

Evaluation Approaches

The PNNL suggested methodology puts forth three approaches for evaluating building plans and construction (DOE, 2010b):

- First-party
- Second-party
- Third-party

A *first-party* evaluation is defined as self-reporting data, and self-certifying any reported compliance measurements. The report describes this method as, “Not a recommended approach for a formal code compliance evaluation.” The *second-party* approach is conducted by an overseeing state agency or local government. These entities would be responsible for the compliance measurement process, and reported data. The *third-party* approach is recommended as the most objective of the three. “In this case, the building owner or developer can retain an accredited and recognized third-party entity that acts on behalf of the state or local agency to conduct a review of the design and construction for purposes of ensuring compliance." (DOE, 2010b) This third-party would act on behalf of project stakeholders, and be charged with carrying-out the compliance measurement.

Sample third-party approaches defined in the report include: verification through state or local regulatory agencies, hiring a non-local inspection agency, or contracting a private sector testing and verification professional, such as a Home Energy Rater. States are also encouraged to adopt appropriate certification and accreditation credentials for third-party evaluators, including those offered by the ICC, ASHRAE, RESNET, or BPI.

Manpower and Funding

Financial and human resource constraints are briefly discussed in the report. PNNL recognizes the need for additional manpower, regardless of chosen approach, especially in developing ongoing compliance measurement programs. "When construction activity is down, fewer resources are available. Additionally, code compliance assessment activities may not be covered by permitting funds since they are over and above what is covered by the permitting functions." Several options for securing additional manpower are presented, including (DOE, 2010b):

- *Use of Recovery Act funds: S*tated as job-creation legislation
- *Cross-training of existing personnel: T*o leverage funding to enhance compliance with energy, as well as health and life safety codes
- *Adding staff to oversight agencies*: Identified as a creative opportunity to bolster assistance in agencies poised to assist local governments
- *Retain third-parties*: To assist regulatory infrastructure or oversee work
- *Recruiting volunteers*: Described as "unlikely"

Funding is, of course, needed to address above manpower constraints, as well as additional administrative processes surrounding compliance measurement. The Recovery Act was suggested as an immediate source of funding to support new requirements, but comes in a limited timeframe. This approach is also recommended to be scaled-back in out years after the installation of compliance infrastructure.

Suggested funding sources are as follows (DOE, 2010b):

- *Building Energy Codes Program technical assistance*: Funding available through the PNNL.
- *Federal energy efficiency funding*: State Energy Program (SEP) and Energy Efficiency and Conservation Block Grant (EECBG) funding.
- *Revolving Loans*: This mechanism skirts Recovery Act expiration dates, and lasts beyond the three-year ARRA timeline (must be loaned in the in initial three-year funding period with repayment stretched over several years).
- *Training and certification costs*: Collect fees for third-party training and certification.
- *Assessment of fees*: Higher or tiered fees passed to owners for expedited review and approval processes.
- *Utility funding*: For example: Utility Code Group (UCG) in Washington State and Springfield Utility Board (SUB) in Oregon. Also suggests higher utility rates for non-compliant buildings (penalty or disincentive).
- *Local, State and Federal funding*: Matching state grants, or continuation through funding programs initially setup through Recovery Act funds.
- *Foundation support from the community*: References local program where the Community Foundation for Southeast Michigan awarded grant to Eight Mile Boulevard Association to enhance code enforcement in the area.
- *Streamlining of enforcement processes*: Justification through long-term labor savings and more efficient administrative processes.

Sample Populations

The PNNL suggested methodology recommends separate reporting for each building type sample within a state. “It is quite possible that a state will find that their compliance rate is above 90% in one metric, but does not attain 90% in another.” This section of the report focuses strongly on what constitutes a valid sample. “For most states, BECP recommends a minimum sample size of 44 in each population. This recommended minimum number of buildings will vary by state, starting with a minimum of 44 buildings but incorporating fewer or more samples depending on the degree of building construction in each of the four building populations within the state.”

Two equations are presented for identifying an appropriate sample size (DOE, 2010b):

$$n = \frac{S^2 \left(Z_{1-\alpha} + Z_{1-\beta} \right)^2}{\Delta^2} + 0.5 Z^2{}_{1-\alpha}$$

Where: *n* = the number of buildings that must be evaluated from the state

s^2 = the square of the standard deviation (sample variance)
Z = a standard normal score from a normal distribution
$1\text{-}\alpha$ = the confidence level
$1\text{-}\beta$ = the power
Δ = the minimum true difference from 90% that is important to correctly detect as being different from 90% (the detectable difference)

The first equation provides a state with a 95% confidence rate over the computer compliance score. A second equation is provided to test if the compliance threshold is met (DOE, 2010b).

$$\bar{x} + 1.645 * \frac{s}{\sqrt{n}}$$

Where: $\bar{x}$ = the mean
s = the standard deviation
n = 44 (the number of buildings in the sample)

The report also further breaks down further sample criteria, such as new commercial building size (classifications for small to XX-Large), and gives consideration for various residential use types, such as modular homes, detached dwellings, townhouses, and multifamily apartments and condominiums. The methodology assumes sample buildings will be drawn across all such classifications.

Sample buildings are also recommended taken *across* weather regions, or *climate zones*. The steps for generating such a distribution are as follows (DOE, 2010b):

1. Calculate the average number of building starts for the previous three years in each climate zone within the state.
2. Calculate the proportion of building starts in each climate zone and remove any climate zones with a proportion smaller than 0.02 (i.e. 2%).
3. Calculate the number of samples for each included climate zone, excluding the most densely populated climate zone, by multiplying each proportion by the total number of samples (*n*) and round up to the nearest integer.
4. The number of samples for the most densely populated climate zone is the total number of samples minus the sum of the numbers calculated in Step 3.

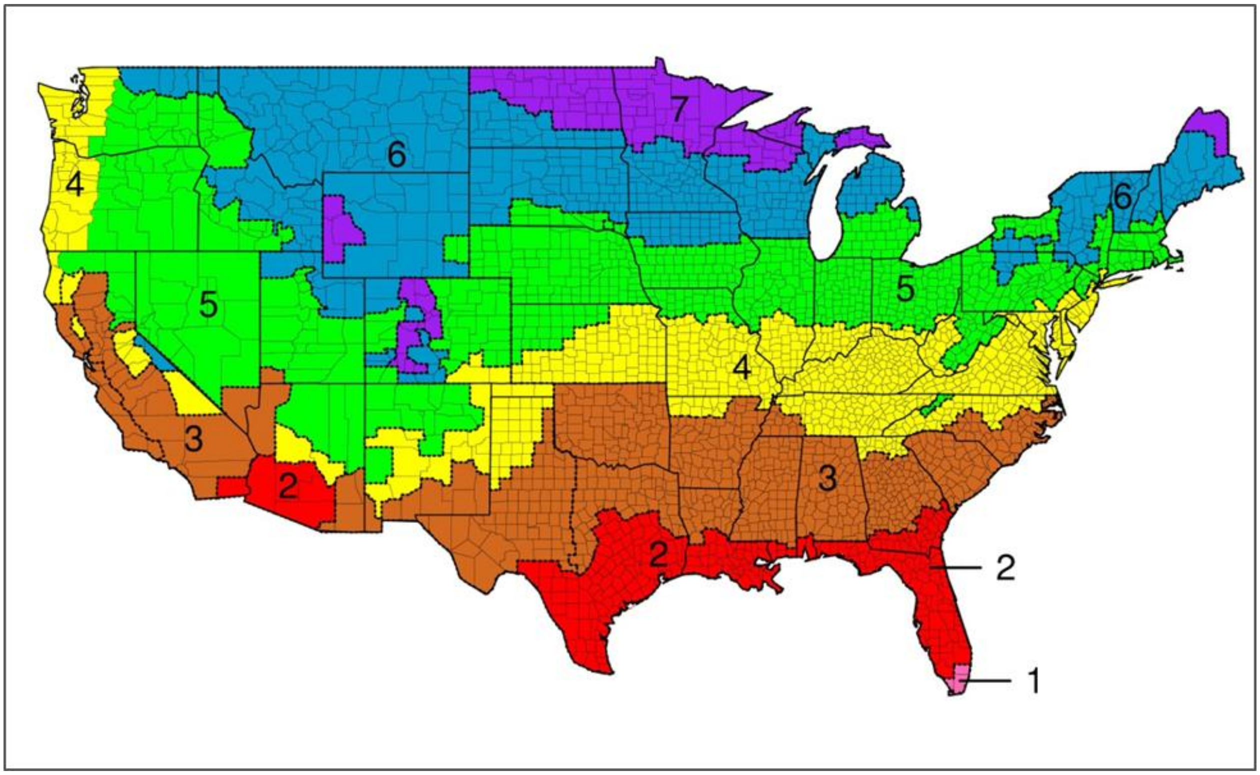


Figure 2: U.S. Climate zones (DOE, 2012c)

The report continues in identifying a process for generating similar strata within climate zones, allocated by county (DOE, 2010b):

1. Using the average number of building starts based on the previous three years; identify the number of building starts for each county. For commercial buildings, identify building starts within each building size strata for each county.
2. Remove any counties with an average building start value of less than 2 buildings.
3. Create a list of counties, where each county is included in the list as many times as the number of buildings starts calculated in Step 2.
4. Randomly select the number of buildings needed from the list created in Step 3, and summarize how many samples were chosen from each county. Random selection can be from an automated process, using functions in a spreadsheet, or simply by pulling county names from a hat.

Caution is given in ensuring a final sample represents a reasonable cross-section of buildings within a particular state. "Recognizing that some buildings of a given type might not be available in a given state, the state should attempt to select from as varied a sample set as possible." Documentation to indicate deliberate attempts to avoid sample bias are also encouraged.

Once a sample is obtained, the PNNL methodology proposes two potential methods by which compliance can be measured (DOE, 2010b):

1. *Method 1*: Evaluated buildings either pass or fail the energy code evaluation, and the percentage of buildings within the state that are deemed to comply is reported. For example, if 90% of the buildings sampled in the state receive a passing score, the reported metric is 90%.
2. *Method 2*: Evaluated buildings are each assigned a compliance rating of 0-100% based on the proportion of code requirements that each has met, and the evaluated buildings' scores within a state are averaged to derive an overall compliance metric.

The reports concludes *Method 2* is the more appropriate choice in generating a true compliance score, and recommends this as the metric for state measurement activities.

Compliance Approaches

Several compliance approaches (otherwise identified as *compliance paths*) are presented by which a building may comply with target codes. These approaches are consistent with formats observed within the model codes, such as the IECC. The three approaches are as follows (DOE, 2010b):

- Prescriptive
- Trade-off
- Performance

Compliance evaluators are encouraged to choose the approach as indicated on compliance documents, such as building plan and specification submissions. The PNNL suggested methodology is intended to support any one of the three approaches.

Inspection checklists developed to aid compliance evaluation are based on five key phases during the typical construction process (DOE, 2010b):

- Plan review
- Foundation
- Framing/Rough-in
- Insulation
- Final

Inspection checklists also allow for the inspection of multiple buildings in generating a single sample. "The checklists can be used to gather data during different stages of construction on different buildings that have the same general attributes in order to yield a resulting single composite building compliance evaluation in lieu of evaluating a single building throughout construction." This is a precedence cited as utilized in previous influential residential compliance studies. The suggested method further allows for one primary building to be used to generate a single sample, with any missed or non-observable items to be made up in a separate building.

Compliance Measurement Activities

Although many states have been slow to address energy code compliance requirements in the Recovery Act, some have undertaken forward-leaning activities to study compliance. The PNNL *90% Compliance Pilot Studies* are perhaps the most visible inquiry, however; many states have initiated compliance activities of their own. These studies exhibit a range of efforts, both in terms of depth and breadth of inquiry. While most have followed the prescription of the PNNL-suggested methodology, others have chosen alternative approaches to better address financial constraints or state-specific scenarios. Many of the DOE compliance tools and resources have also found their place within state studies. A summary of state compliance measurement activities to date is provided in the following section.

2.5.3 PNNL 90% Compliance Pilot Studies

The *PNNL 90% Compliance Pilot Studies* (PNNL, 2011a) were put into motion in 2010. Fueled by Recovery Act stimulus funds, the pilot studies were conducted in several states, and can be considered the core effort in response to Recovery Act compliance requirements. Feedback on specific building samples, study approaches, and geographic locations were sought, in addition to general applications of the methodology and accompanying compliance tools. Although no single pilot study generated a true state baseline compliance rate (based on the PNNL methodology), each did offer valuable insight into many of the realities, challenges and barriers impeding energy code compliance.

Each Pilot is listed in the following table, along with the partnering Regional Energy Efficiency Organization (REEO) and focus of each study (PNNL, 2011a):

Table 3: Pilot study states and focus of their studies

State (REEO)	Focus of Pilot Study
Utah (SWEEP)	Utah conducted a study in two phases. The Phase 1 study evaluated 11 new residential and 6 new commercial buildings against the 2006 International Energy Conservation Code (IECC) and ASHRAE/IESNA 90.1-07/2009 IECC respectively. The Phase 2 study evaluated 42 new residential buildings against the 2006 IECC. A jurisdictional survey was used as part of the Utah study.
Iowa (MEEA)	Iowa evaluated 50 new residential buildings against the 2009 IECC.
Massachusetts (NEEP)	Massachusetts evaluated 50 recently constructed homes, and used Home Energy Rating data from 50 ENERGY STAR qualified homes, to derive a total of 100 samples. The samples were evaluated against the 2006 IECC. Massachusetts reported compliance in a number of alternative formats, including Home Energy Rating System (HERS) scores.
Georgia (SEEA)	Georgia evaluated 69 new commercial buildings, but several were partial evaluations that were intended to be combined into single samples for a total of 44 commercial building evaluations. A jurisdictional survey was used as part of the Georgia study.
Wisconsin (MEEA)	Wisconsin evaluated 44 new commercial buildings, using state inspectors to conduct the evaluations.
Northwest Lighting Study (NEEA)	For the Northwest Commercial Lighting Study (Washington, Oregon, Idaho, and Montana), plans were reviewed for 91 commercial buildings to evaluate code lighting requirements, and field inspections were conducted on 29 buildings.
Northwest Jurisdictional Survey (NEEA)	The Northwest Jurisdictional Survey Study (Washington, Oregon, Idaho, and Montana) implemented a survey approach to determine current residential and commercial data collection, documentation, and storage practices and identify opportunities for improvement.
Montana (NEEA)	Montana's study was extended under additional funding and has not yet been completed. They are evaluating 125 new homes, with half of the homes being pulled from locations under jurisdictional control and half from locations where builders self-certify.

The objectives of the PNNL 90% Compliance Pilot Studies included (PNNL, 2011a):

- Test the PNNL suggested methodology and supporting compliance resources
- Revision of procedures and tools based on study feedback
- A Better understanding for states conducting a study:
    - State compliance rates
    - Where to focus training
    - Needs of individual jurisdictions
    - Common impediments to compliance
    - Issues with the energy code itself
- Evaluation of national trends using Pilot Study data:
    - Common compliant and non-compliant code requirements
    - Code requirements often not observed and not applicable
    - Alternative approaches
    - Aggregated results from jurisdictional surveys
    - Further analysis of compliance rates by:
        - Building use
        - Building system
        - Building size
        - Compliance path

Pilot studies kicked-off with regional training sessions, conducted in Iowa, Utah, Wisconsin, and Georgia. PNNL staff provided training on available compliance tools and procedures, including the PNNL Compliance Checklists developed for field inspections against Recovery Act target codes. Training attendees included third-party contractors, building officials, state energy office personnel, and other interested and affected stakeholders. Non-pilot states were also invited to attend training sessions, many of which would participate in their own follow-on compliance measurement activities. Georgia, Utah and a collective Northwest study applied the PNNL Jurisdictional Survey as part of their study. These pilot study states (with the exception of Georgia), along with a Michigan survey study, are analyzed in the *Data Analysis* chapter. The following sections provide an overview of findings, including many of the barriers and successful practices discovered in Pilot Study activities.

Evaluation Time

Compliance measurement activities were found to be a substantial undertaking for states. Pilot studies were allowed a 10-month timeframe for completion, which proved to be inadequate to conduct a full, especially first, compliance measurement. Several sources of potential bias should also be identified, due to the tight timeline. Most pilot states were those who had some level of existing compliance infrastructure or regulatory system in-place.

Access to sample buildings had to be achieved almost instantly in order to fit the following building inspections. The amount of time required to evaluate the average building varied significantly between residential and commercial projects. The four site visits required for inspections were often challenging, due to timing of the visits. Inspections performed outside of the pre-defined changes yielded mixed results, with many features not observable later in the construction process.

Table 4: Time required for the average building evaluation

Building Type	**Plan Review** (min.)	**Field Inspection** (min.)
Residential	38	75
Commercial	218	413

General Barriers and Findings

State pilot studies reported a variety of barriers. Many of these were identified through state survey responses, while others were noted through plan review and field inspection activities. A summary of reported barriers discovered through pilots are as follows (PNNL, 2011a):

- Lack of training
- Lack of resources
- Lack of compliance information on plan submissions
- Data sources used to generate sample sets can be inaccurate
- Studies are costly and require multiple visits to the same project site
- Timing site visits with desired phases of construction is difficult
- Access to building sites

Study conclusions also highlighted inconsistencies between evaluators. Most of the pilots relied upon contracted third-parties to review plans and conducted building inspections. It was determined many evaluators did not have a clear understanding of the energy code. Many clarifications requested through PNNL technical support pertained to the code itself, as opposed to a specific compliance resource.

Feedback on PNNL Methodology and Supporting Tools

Positive feedback was generally offered on the PNNL-suggested methodology and supporting suite of compliance tools. All 90% Compliance Pilot Studies were required to use the PNNL method and resources. Study conclusions indicated value, but also several areas for potential future improvement (PNNL, 2011a):

- Checklists were valuable tools for third-party evaluators and were expected to have value to state and local inspectors in normal enforcement efforts
- Use of software tools, such as COMcheck and REScheck, demonstrate strong correlation with higher compliance rates
- Methodology does not work well post-construction
- Provide additional guidance to define when ‘Not Applicable’ and ‘Not Observable’ should be used
- Many checklist items cannot be easily identified by third-party inspectors (e.g. As-built drawings submitted post project completion)

Best and Worst Areas for Compliance

The majority of Pilot Studies sought compliance data through plan review and field inspections for buildings being constructed at the time. These reviews and inspections were performed using the PNNL Compliance Checklists, which allowed for identification of compliance by specific code provision. This included the most often compliant items, as well as the most common infractions. Individual evaluator responses were also examined for instances where the provision was most often marked ‘not applicable’ or ‘not observable’. As many inspections were conducted post-construction, many building components affecting energy consumption were hidden behind walls and by later finishes. The tables on the following pages summarize the most and least compliant code items, and are labeled corresponding to the individual code provision within the PNNL Compliance Checklists (PNNL, 2011a).

Table 5: Least compliant *residential* checklist requirements (least compliant listed first)

Checklist ID	Checklist Text
FI7	Certificate posted.
PR2	HVAC loads calculations Heating system size(s): Cooling system size(s):
FI6	Lighting - 50% of lamps are high efficacy.
FR22	Fenestration and doors labeled for air leakage.
PR1	Construction drawings and documentation available. Documentation sufficiently demonstrates energy code compliance.
FR14	Duct tightness via rough-in test.
FR21	Swinging door air leakage.
FI5	Heating and cooling equipment type and capacity as per plans.
FI4	Duct tightness via post-construction test.
FR20	Glazed fenestration air leakage.
FI2	Ceiling insulation installed per manufacturer's instructions. Blown insulation marked every 300 sq. ft.
IN13	All installed insulation labeled or installed R-value provided.
FO2	Slab edge insulation installed per manufacturer's instructions.
FO9	Crawl space continuous vapor retarder installed with joints overlapped by 6" and sealed, and extending at least 6" up the stem wall.
FO10	Exposed foundation insulation protection.
IN1	Floor insulation R-value.
FR12	Duct insulation.
FI1	Ceiling insulation R-value.
FI3	Attic access hatch and door insulation.
IN15	Air sealing of all envelope joints and seams via visual inspection: dropped ceilings, knee walls, assemblies separating garage, tubs and showers, common walls between units, rim joist junctions.
IN14	Air sealing of all openings and penetrations via visual inspection: site-built fenestration, window/door openings, utility penetrations attic access openings.
FO3	Slab edge insulation depth/length.

Table 6: Least compliant *commercial* code requirements (least compliant first)

Checklist ID	Checklist Text
FR3	Fenestration and doors labeled for air leakage.
FR12	Fenestration products rated in accordance with NFRC.
FR2	Doors meet maximum air leakage requirements.
FR1	Fenestration meets maximum air leakage requirements.
PR1	Plans and/or specifications provide all information with which compliance can be determined for the building envelope and delineate and document where exceptions to the standard are claimed.
FR13	Fenestration products are certified as to performance labels or certificates provided.
PR4	Plans, specifications, and/or calculations provide all information with which compliance can be determined for the lighting and electrical systems and equipment and delineate and document where exceptions to the standard are claimed. Information provided should include interior and exterior lighting power calculations, wattage of bulbs and ballasts, transformers and control devices.
PL4	Heat traps Installed on non-circulating storage water tanks.
PR3	Plans, specifications, and/or calculations provide all information with which compliance can be determined for the service water heating systems and equipment and delineate and document where exceptions to the standard are claimed.
PR2	Plans, specifications, and/or calculations provide all information with which compliance can be determined for the mechanical systems and equipment and delineate and document where exceptions to the standard are claimed.
FR14	U-factor of opaque doors associated with the building thermal envelope meets requirements.
EL5	Ballasted one- and three-lamp fixtures with >30 W/lamp have two lamp tandem wired ballasts when >2 fixtures in same space on same control.
FR5	Roof insulation R-value.
FR8	Vertical fenestration U-Factor.
FR10	Vertical fenestration SHGC value.
IN2	Roof insulation R-value.

Table 7: Most compliant *residential* code requirements (most compliant first)

Checklist ID	Checklist Text
FR19	Dampers installed on all outdoor intake and exhaust openings.
FI9	Programmable thermostats installed on forced air furnaces.
FR2	Glazing U-factor (area-weighted average). Up to 15 sq. ft. of glazed fenestration, including skylights, may be exempted from U-factor and SHGC requirements under the prescriptive approach.
FR15	Building cavities NOT used for supply ducts.
FR4	Glazing labeled for U-factor (or default values used).
FR3	Glazing SHGC value, including sunrooms (area-weighted average). Up to 15 sq. ft. of glazed fenestration, including skylights, may be exempted from U-factor and SHGC requirements under the prescriptive approach.
IN7	Basement wall interior insulation depth.
FR1	Door U-factor. One side-hinged door up to 24 sq. ft. can be exempted from the prescriptive door U-factor requirements.
FR16	IC-rated recessed lighting fixtures meet infiltration criteria.
IN3	Wall insulation R-value.
IN4	Wall insulation installed per manufacturer's instructions.
FI10	Heat pump thermostat installed on heat pumps.
FR17	HVAC piping insulation.
IN12	Air sealing complies with sealing requirements via blower door test.

Table 8: Most compliant *commercial* code requirements (most compliant first)

Checklist ID	Checklist Text
FI2	Heating and cooling to each zone is controlled by a thermostat control.
FI3	Temperature controls have the following features: dead band controls, set point overlap restrictions, off-hour controls, automatic shutdown, setback controls.
ME10	Ducts and plenums sealed based on static pressure and location.
FI18	Installed lamps and fixtures are consistent with what is shown on the approved lighting plans.
FI17	Furnished O&M instructions for systems and equipment to the building owner or designated representative.
ME17	Zone controls can limit simultaneous heating and cooling and sequence heating and cooling to each zone.
EL7	Exterior grounds lighting over 100 W provides >60 lm/W unless on motion sensor or fixture is exempt from scope of code or from external LPD.
ME14	Means provided to relieve excess outside air.
ME36	Service water heating equipment meets efficiency requirements.
EL2	Independent lighting control installed per approved lighting plans and all manual control readily accessible and visible to occupants.
PL2	Temperature controls installed on service water heating systems <=110 ^{o}F for intended use serving dwelling units and <=90 ^{o}F serving other occupancies.
ME4	Outdoor air and exhaust systems have motorized dampers that automatically shut when not in use and meet maximum leakage rates. Check gravity dampers where allowed.
IN14	Exterior insulation is protected from damage with a protective material.
EL3	Automatic lighting controls for exterior lighting installed.

Table 9: *Residential* code requirements most often marked "Not Applicable"

Checklist ID	Checklist Text
FR9	Sunroom skylight U-factor.
IN10	Sunroom ceiling insulation R-value.
IN11	Sunroom ceiling insulation installed per manufacturer's instructions.
IN9	Sunroom wall insulation installed per manufacturer's instructions.
FR10	Mass wall exterior insulation R-value.
FR11	Mass wall exterior insulation installed per manufacturer's instructions.
FR8	Sunroom glazing U-factor.
IN8	Sunroom wall insulation R-value.
FI12	Pool heaters, covers, and automatic or accessible manual controls.
FO11	Snow melt controls.
FR6	Skylight SHGC value. Up to 15 ft^2 of glazed fenestration, including skylights, may be exempted from U-factor and SHGC requirements under the prescriptive approach.
FO7	Crawl space wall insulation R-value.
FO8	Crawl space wall insulation installed per manufacturer's instructions.
FO9	Crawl space continuous vapor retarder installed with joints overlapped by 6" and sealed, and extending at least 6" up the stem wall.

Table 10: *Residential* code requirements most often marked "Not Observable"
(Requirements marked in **bold** are also included among the least compliant provisions)

Checklist ID	Description
FR21	**Swinging door air leakage.**
FR20	**Glazed fenestration air leakage.**
FI11	Circulating service hot water systems have automatic or accessible manual controls.
FR22	**Fenestration and doors labeled for air leakage.**
FR18	Circulating hot-water piping insulation.
FO2	**Slab edge insulation installed per manufacturer's instructions.**
FR1	Door U-factor. One side-hinged door up to 24 sq. ft. can be exempted from the prescriptive door U-factor requirements.
FO3	**Slab edge insulation depth/length.**
IN16	Air sealing of all other sources of infiltration, including air barrier, via visual inspection. If applicable, verification via blower door should be marked N/A.
FO1	Slab edge insulation R-value.
IN15	**Air sealing of all envelope joints and seams via visual inspection: dropped ceilings, knee walls, assemblies separating garage, tubs and showers, common walls between units, rim joist junctions.**
IN6	Basement wall interior insulation installed per manufacturer's instructions.
IN14	**Air sealing of all openings and penetrations via visual inspection: Site-built fenestration, Window/door openings, Utility penetrations, Attic access openings.**
FI5	**Heating and cooling equipment type and capacity as per plans.**
FR4	Glazing labeled for U-factor (or default values used).
FR2	Glazing U-factor (area-weighted average). Up to 15 sq ft of glazed fenestration, including skylights, may be exempted from U-factor and SHGC requirements under the prescriptive approach.
IN4	Wall insulation installed per manufacturer's instructions.
FR19	Dampers installed on all outdoor intake and exhaust openings.
FR13	Duct sealing complies with listed sealing methods.
FO5	Basement wall exterior insulation installed per manufacturer's instructions.
FR15	Building cavities NOT used for supply ducts.
FR17	HVAC piping insulation.
FI4	**Duct tightness via post-construction test.**
FR7	Skylights labeled for U-factor (or default values used).
FR16	IC-rated recessed lighting fixtures meet infiltration criteria.

Table 11: *Commercial* code requirements most often marked "Not Observable"
(Requirements marked in **bold** are also included among the least compliant provisions)

Checklist ID	Description
FR1	**Fenestration meets maximum air leakage requirements.**
FR2	**Doors meet maximum air leakage requirements.**
FR14	**U-factor of opaque doors associated with the building thermal envelope meets requirements.**
ME13	Return air and outdoor air dampers meet minimum air leakage requirements.
FR3	**Fenestration and doors labeled for air leakage.**
FR12	**Fenestration products rated in accordance with NFRC.**
FR13	**Fenestration products are certified as to performance labels or certificates provided.**
IN4	Skylight curbs insulated to the level of roofs with insulation above deck or R-5.
FR9	Skylight fenestration U-Factor.
ME26	Reduce flow in pumping systems of any size to multiple chillers or boilers when others are shut down.
EL3	Automatic lighting controls for exterior lighting installed.

Potential for Bias

Several sources of potential bias were reported in the PNNL Pilot Studies, many due to the tight timeframe in which the studies were required to be completed. Many of these sources could have contributed to higher scores than can be assumed on a statewide or national basis. For example, many jurisdictions were found to be non-responsive or non-cooperative when project access was requested. This forced many of the original random samples to be altered, in order to gain access to the necessary number of sample buildings. Many of the inspections were also conducted after the building was constructed, or implemented by parties with an active history of involvement in energy code activities. In general, building access within the required timeframe may have introduced an element of self-selection to the study samples.

Although two of the four building types identified in the PNNL methodology are based on existing buildings, only a few evaluations were secured for renovations. Therefore, no final results were reported surrounding those building populations. "Many renovations are completed without pulling a permit, and accurate data sources for sampling and locating samples are not available." This highlights a potential barrier in identifying statistically valid samples of existing buildings, let alone securing access for inspections and evaluations. The New York study, in particular, makes notes of this problem, reporting more permits pertaining to existing buildings than new pulled on an annual basis. Only about 6% of the permits listed in the PNNL data source applied to renovation projects (PNNL, 2011a).

Alternative Approaches

Several approaches are also presented as alternatives to the PNNL methodology. Although these are not endorsed as a formal or complete evaluation, states may consider these methods for their own purposes. While not sanctioned options, they may relieve some of the financial and logistical burdens of implementing the full PNNL prescribed methodology.

Post-construction evaluation

Many compliance studies rely on post-construction evaluations as a more cost-effective option for assessing building energy code compliance. "Post-construction evaluations would likely be less costly, because onsite building evaluation would occur in a single visit rather than two to four visit during construction." This approach is also considered effective in rural jurisdictions where repeat site visits may prove extraordinarily time consuming and expensive. As cited in Pilot Study results, a disadvantage of this approach is the inability to verify certain items once construction is completed. "Approximately 58% of the residential checklists requirements and 23% of the commercial checklist requirements were determined to be potentially difficult to evaluate post construction." (PNNL, 2011a) If such an approach is used, an overall building testing procedure may be required, such as a blower door test. Infrared camera technologies may also assist in verifying behind-wall installations where visual inspections may not be feasible. A subset of post-construction provisions, or even a spot-check of certain measures, could also be applied, as opposed to the entire checklist.

First or Second-party Evaluations

The second-party evaluation approach is also suggested as a potential alternative. "A second-party evaluation could be done by building department staff within their own jurisdiction, and a first-party evaluation could be one where builders self-certify." Several advantages to these methods are presented, including (PNNL, 2011a):

- Building department staff are often at the building sites, eliminating expensive travel
- Department staff have authority over the construction process
- Potential for larger sample sets
- Checklists and compliance tools can be used as training resources

A number of disadvantages are also discussed, including a lack of sustainability in utilizing third-party contractors (often hired on a contract of limited duration). Many jurisdictions do not fully inspect to the energy code, leaving a potential for gaps in inspections. The involvement of jurisdictional staff in the compliance process may also prove to be a conflict of interest. Furthermore, some jurisdictions do not have a building department, eliminating this option in such situations.

UA and Performance Approaches

Many states and local enforcement jurisdictions already recognize compliance reports generated by DOE RES*check* and COM*check* software (i.e. the *tradeoff* compliance approach). Several mandatory and prescriptive requirements, however, are not part of the software's overall UA calculation, creating a discrepancy between these approaches and the necessary provisions contained in the PNNL Compliance Checklists. "Approximately 28% of the code requirements on the (PNNL) checklist could be considered as part of a RES*check* UA compliance result." (PNNL, 2011a) If mandatory code requirements were also verified, an approach incorporating compliance through the tradeoff approach may be feasible.

2.5.4 Additional Compliance Measurement Activities

In addition to the PNNL Pilot Studies, several states have undertaken their own efforts in addressing Recovery Act compliance requirements. While some of these states have also based their actions on all or part of the PNNL methodology, other states are exploring further alternatives. Activities within three such states—New York, Illinois, and Maine—are discussed in the following section.

New York

The New York State Energy Research and Development Authority (NYSERDA) started an assessment in 2010 to establish a baseline rate of compliance. This study included both residential (New York State Energy Conservation Construction Code) and commercial (ASHRAE 90.1—2004 or 2007 depending on when project initiated) buildings. The New York study was based on parts of the PNNL methodology, in concert with other methods chosen by the state, including approaches relying on tradeoffs and Annual Energy Cost calculations. The study also conducted surveys and interviews with builders, contractors, designers, engineers, code officials, and homeowners.

New residential construction was determined to have a compliance rate of 67%, based on 44 building samples. New commercial construction exhibited an 84% rate of compliance, based on a sample of 26 buildings. Similarities were drawn between the New York and Massachusetts approaches, with both choosing to evaluate buildings post-construction. In contrast to the Massachusetts study, however, the New York study heavily involved local building departments. Successful tactics utilized in the New York study included a small financial incentive to participate in the study ($100 for residential buildings and $150 for commercial). State agencies also sent introductory letters and a following email to stakeholders, helping to recruit commercial projects and gain the cooperation of local code officials. The study had difficulty overcoming non-cooperative jurisdictions, making access to sample projects a significant issue, and suggesting a self-selection bias. The New York study included several of the PNNL compliance tools, including COM*check* and RES*check* for UA tradeoff calculations. Other software tools, such as REM/RATE (residential) and eQuest (commercial) were also used to simulate annual energy performance.

A discrepancy was observed between the New York study and PNNL Pilot Studies. "In the commercial sector, the New York study found lower compliance rates for smaller buildings compared to larger buildings." (PNNL, 2011a) The small sample (26 commercial buildings) obtained in the New York study was noted, as this trend was not observed in any of the PNNL studies.

The typical New York residential inspection was performed in approximately 2-3 hours. This information was obtained through survey response data supplied by local code officials. Other survey findings include (PNNL, 2011a):

- Insulation installation levels and quality are often evaluated, but other code requirements are not consistently verified.
- Residential inspections averaged 100 minutes and commercial inspections averaged 200 minutes (these results are noted as skewed, due to a few respondents who reported extremely long evaluation times).
- Contractor knowledge of energy code requirements was cited as a major impediment to compliance.

Other New York survey findings (continued):

- New requirements, such as duct sealing and HVAC loads calculations, were cited as seldom implemented.

The New York study also included commercial building case studies where additional interviews were conducted with involved code officials, architects, engineers, and contractors. Conclusions noted from theses interactions are as follows (PNNL, 2011a):

- Contractors typically built what was indicated on the plans, however, in some circumstances (e.g. budget constraints) changes were made altering energy code requirements. These changes are seldom questioned.
- Most code officials rely on others to document and verify energy code requirements
- There was an awareness to look for COMcheck reports (which the state requires), but COMcheck reports were only found for about one third of the buildings sampled. When COMcheck documentation as submitted, not much was done beyond ensuring 'Pass' was on the report. When inspections did occur, they were generally for insulation only.
- Architects felt there should be a codes 'hotline' or other source for code interpretations. They also felt that continued free access to tools such as COMcheck and REScheck was critical, as is local training.
- Both architects and engineers are required to put their seal on commercial building plans and are often aware of energy code requirements; however, neither group is responsible for verifying that the as-built system matches the plans unless the building owner retains them to oversee construction.

Illinois

A further study of compliance in relation to Recovery Act requirements was conducted in the State of Illinois. The Illinois Energy Conservation Code is currently based upon the 2009 IECC (including ASHRAE 90.1—2007). The Illinois study was based conducted through plan reviews and field inspections, and utilized several pieces of the PNNL methodology. The PNNL Sample Generator was relied on to create a sample from 35 Illinois jurisdictions, including 44 new residential buildings, one residential renovation, and 10 new commercial buildings. The overall compliance scores derived were 87.2% for new residential construction, and 98.2% for new commercial.

Of the new residential buildings evaluated in the Illinois study, approximately 47% were found to rely on the prescriptive approach, 36% used the UA tradeoff approach (i.e. RES*check*), and the remaining 18% chose the performance approach (i.e. REM/Rate). The most common infractions discovered through building field inspections included (PNNL, 2011a):

- Heating and cooling system sizing, type, and capacity did not match submitted load calculations
- HVAC load calculations were often not submitted at all
- Air leakage labels were not attached to most fenestration and doors

For commercial buildings, 70% used the prescriptive approach, and 30% tradeoff (i.e. COM*check*). The most common violations in the commercial category were (PNNL, 2011a):

- Heating and cooling system sizing, type, and capacity did not match submitted load calculations
- Slab-edge insulation R-values were incorrect
- Slab-edge insulation was not installed in accordance with code requirements or manufacturer's instructions

Many Illinois evaluators noted a discrepancy between COM*check* reports and field installations, indicating need for additional training on the use of the software tool. An average of 60 minutes was spent on plan review, and an additional 135 minutes on the average field inspection. Evaluators also noted building department staff in all jurisdictions was "generally cooperative, knowledgeable, and helpful." (PNNL, 2011a)

Maine

The Maine compliance study set out to established baseline practices for commercial buildings throughout the state. The study utilized post-construction evaluations, and did not rely on the PNNL-suggested methodology or supporting compliance resources. Reported results may, therefore, not be entirely comparable to the remaining studies where these methods and resources were implemented.

A series of stakeholder meetings was conducted to initiate the study. Sought attributes focused on (PNNL, 2011a):

- Sample design
- Site selection
- Recruitment of sample buildings
- Plan and specification review
- Site visits
- Data collection
- Building owner and operator interviews

In addition to code compliance, the study also compared energy use intensity (EUI) calculations. A total of 74 commercial buildings of various types and size were evaluated, including several existing buildings that were not of recent construction.

Conclusions from the Maine study indicate construction is highly variable within the state. On average, compliance with code provisions was observed to be significantly lower than those adopted by the state. The Maine study, however, did indicate high levels of compliance within schools and grocery stores—possibly due to the State's High-performance Schools Construction Program.

2.5.5 Tools and Resources

Resources designed to enable compliance with the energy code are made available through a variety of sources. Both federal and state governments have provided funding for the creation and availability of training materials and compliance tools. Some of the more popular options are provided by DOE. In many cases these tools are accepted by states and local code enforcement agencies as a means for demonstrating code compliance, or as the foundation for many state training curricula. In other cases, non-governmental organizations provide resources to aid compliance. Some of these organizations may offer products for purchase or fee-based services. It is also common for universities or professional trade organizations to provide such resources. The following section provides an overview of tools and resources available to support compliance with the energy code.

Federal Sources

The U.S. Department of Energy hosts several compliance tools and resources designed to support states and local code enforcement. These resources take several forms, starting with background training courses covering basic residential and commercial code requirements. Many states also allow for demonstration of code compliance through the use of DOE's RES*check* and COM*check* software. Several tools were also created specifically to assist states in demonstrating a 90% compliance rate with the PNNL suggested methodology. The entire collection of DOE resources are often popular, as they are offered free of charge via the DOE Building Energy Codes website:

- *DOE Building Energy Codes Program:*
  www.energycodes.gov
  (accessed: November 5, 2012)

Training presentations

DOE provides training presentations covering basic code requirements for both the residential and commercial energy codes. These presentations form the basis for DOE's Train-the-trainer program, and are also available for use in state training programs. Such presentations can also be customized for use by local code enforcement jurisdictions, or regionalized training programs. The following training presentations are provided on the DOE Building Energy Codes website:

- Residential requirements of the 2009 IECC
- Residential requirements of the 2012 IECC
- Commercial requirements of the 2009 IECC
- Commercial requirements of the 2012 IECC
- Commercial requirements for ASHRAE 90.1—2007
- Commercial requirements for ASHRAE 90.1—2010

Training presentations typically cover all compliance paths included in the applicable code, but tend to focus predominately on the prescriptive requirements. Special emphasis is placed on mandatory provisions, or changes in comparison to the previous version of the code. Additional resources are presented at the end of each presentation.

Jurisdictional survey

To support Recovery Act compliance requirements, PNNL created a *Jurisdictional Survey* to assist states as they established contact with local enforcement jurisdictions. This survey attempts to gather background information on local agencies, their staff, and processes by which compliance is determined. Questions, such as the number of permits issued, use of third-party compliance verification, training methods, and commonplace infractions are included in the survey. (PNNL, 2010) An explanatory letter was provided with the survey, allowing states to customize and send as a first step in contacting local jurisdictions (PNNL, 2010).

PNNL's Jurisdictional Survey is valuable to states as part of early compliance measurement processes. To date, the survey was administered in several states, including Georgia, Idaho, Michigan, Montana, Oregon, Utah and Washington. While some states chose to administer the original survey, other states modified the content slightly; either in customizing existing questions, or in providing additional questions to generate desired data. (DOE, 2012a) The original survey and supplementary letter are also included in Appendix A.

State sample generator

Following the gathering of background information, the PNNL methodology instructs states to generate a statistically valid sample of buildings. This sample forms the basis for compliance measurement activities, and will become the subject for later plan reviews and eventual building inspections. Specific instructions explaining how to generate this sample are outlined in the previously discussed *Measuring State Energy Code Compliance* report. (DOE, 2010b) To further automate the sample creation process, DOE created the *State Sample Generator* tool. (DOE, 2012a) The State Sample Generator functions based on mathematical equations presented in the report. Rather than constructing such a sample manually, the Sample Generator automates the calculation process, and identifies a collection of potential projects of appropriate building size and type across the desired geographical area. The tool draws upon a database of recent construction projects, and will produce a statistically valid sample in a matter of minutes, only requiring minimal user input. (DOE, 2012a)

Users begin by choosing their state and desired sample based on the building types outlined in the PNNL proposed methodology. The Sample Generator will produce a sample of buildings across all state climate zones. Weighted by recent-year construction permits, the number of buildings in each county will be returned to the user. Although the tool does not necessarily provide specific projects for compliance measurement, it does instruct users where to seek those projects in order to create a statistically valid sample. Local building departments can then be contacted to identify specific sample projects.

Inspection checklists

Following the identification of sample buildings, the process of compliance verification is initiated. PNNL created *Inspection Checklists* to be used throughout the various stages of the building construction and permitting process. Starting with the review of submitted plans and specifications, the checklists guide compliance officials as they verify the building is designed to meet energy code requirements.

These checklists are later taken into the field to verify the installation of designed elements, such as prescribed efficiency measures, equipment, and proper installation techniques. The checklists are intended to apply to primary stages of construction, from the early foundation phases, through later rough-ins, and to eventual final inspections prior to occupancy.

Several checklists versions are offered by DOE, covering recent versions of the model energy codes. While these checklists were created to support Recovery Act compliance measurement activities, they may be used for more traditional energy code inspection efforts (DOE, 2012a).

Score + Store

The *Score + Store* tool is also built upon the PNNL methodology. The suggested approach is designed to minimize duplicative efforts, and to generate comparable data across states and local code enforcement jurisdictions. Score + Store was created to house data collected in a particular state and through individual compliance measurement efforts.

The tool allows users to input information gathered via the Inspection Checklists, and that data is electronically stored in a centralized database. Each building checklist is assigned a score based on checklist data, and those are aggregated to generate a statewide compliance score. This allows for comparisons to be drawn across states and localities, but also from a national perspective (DOE, 2012a).

REScheck and COMcheck Software

A compliance approach, known as the *Trade-off Approach,* is included in both the residential and commercial IECC. This approach allows for comparison between a code-equivalent baseline design and a proposed building design. An area-weighted U-factor is calculated based on a proposed building design, and that design is then compared against the same house designed exactly to code. If the proposed design performs equal or better to the code design (including all mandatory code criteria), the building should be expected to pass code.

DOE produces RES*check* and COM*check* software to automate the Trade-off Approach. Users choose the applicable code, enter basic project information, and input building envelope dimensions and U-factors. The software then performs the trade-off comparison, as opposed to demonstrating this compliance approach through manual calculations. To a certain degree, the software will guide a user through the necessary inputs, and will produce an eventual checklist and certification label based on user inputs. This information can then be provided for verification by a building inspector or code official.

Additional training materials are provided specific to the software. Presentations walk users through the process of entering data, and allow them to become familiar with the software. Graphic prompts and cues highlight problem areas, such as proper insulation installation. Projects may also be saved for later access and retrieval (DOE, 2012a).

Resource guides

A series of resource guides were also created by DOE to aid energy code compliance. Each guide addresses a particular topic or stakeholder group, and can be created and published in partnership with that group's professional organization. The following guides are currently available (DOE, 2011):

Table 12: PNNL Resource Guide series by partnering organization

Title	Partner Organization
Code Officials	International Code Council (ICC)
Policy Makers	N/A
Commercial Buildings for Architects	American Institute of Architects (AIA)
Beyond Code Guide	N/A
Air Leakage	N/A

These resource guides explain basic processes and highlight valuable resources. Sample resources are included in the guides, as well as additional information specific to related energy code requirements. Additional guides outlining advanced wall insulation techniques and for lighting designers are also scheduled for future release (DOE, 2011).

State sources

Several resources are also available at the state level. Many of these are provided by state energy offices or other government agencies. Others may be provided by code compliance or advocacy organizations, aimed at information regarding general code compliance process or at more specific state requirements. These resources are discussed in the following sections.

RECA cards

In addition to those provided by the Federal Government, several state-specific resources supporting energy code compliance also exist. The Responsible Energy Code Alliance (RECA) provides laminated cards for distribution through state energy code training programs. Cards outline residential energy code requirements, based on the applicable version of the IECC within a state. These are also made available to code officials, contractors and designers by request. (RECA, 2011)

State Energy Code Websites

Many state governments also host energy code websites. These typically fall under the oversight of a state energy office, division of construction, or other applicable agencies. A few examples may be referenced as follows:

- *Colorado Department of Local Affairs:* http://www.colorado.gov/cs/Satellite/DOLA-Main/CBON/1251591390175 (accessed: November 5, 2012)

- *Michigan Bureau of Construction Codes:* http://www.michigan.gov/lara/0,4601,7-154-10575---,00.html (accessed: November 5, 2012)

State Energy Code Websites (continued):

- *Nebraska Energy Office:*
  http://www.neo.ne.gov/
  (accessed: November 5, 2012)

- *Nevada State Energy Office:*
  http://energy.state.nv.us/
  (accessed: November 5, 2012)

- *Texas State Energy Conservation Office:*
  http://www.seco.cpa.state.tx.us/tbec/
  (accessed: November 5, 2012)

Many states utilize the website to outline basic requirements or to provide access to empowering legislation. Other states may take the concept even further, and provide access to training resources, compliance materials, reference studies, or even a state code history. While the breadth and depth of information tends to vary from state to state, these sites are often a highly valuable source of information affecting state energy code compliance.

Other sources

Resources beyond government can also provide a wealth of compliance information. Professional and stakeholder organizations often provide such resources to their membership base. Educational institutions, such as colleges or universities, extension outreach and vocational training programs often contract with state or local governments to provide code training and instructive services. Local municipalities may provide compliance resources through a sustainability office or agency responsible for development oversight. Other private organizations or individual consultant services also commonly provide code interpretations or additional compliance information.

Professional Associations

An array of professional organizations and societies dedicate their business to building energy efficiency and energy code compliance. The Building Codes Assistance Project (BCAP) provides technical resources supporting energy code compliance, as well as analyses of state compliance scenarios and cost-benefit reports. (BCAP, 2012a) The National Association of State Energy Officials (NASEO) maintains a committee of state energy office representative focused on energy efficiency issues in buildings. Some of NASEO's recent resources include webinar presentations, with a 2010 webinar specific to the Section 410 requirements of the Recovery Act, and a 2011 follow-up on general energy code compliance. (NASEO, 2012a) The Institute for Market Transformation (IMT) has also provided several recent compliance resources. IMT has produced a number of case studies exploring various strategies for generating increased compliance, and partnered a recent webinar with the National League of Cities outlining local strategies for increasing compliance with building energy codes. (IMT, 2010b)

Educational Institutions

Resources provided by private organizations or educational institutions are also valuable sources of compliance information. States often leverage federal energy funding through energy code training contracts. These are often conducted by consultants, professional instructors, or educational institutions. Training programs, such as those offered by Michigan State University (MSU) Energy Code Training and Implementation Program (MSU, 2012) and the Washington State University (WSU) Extension Energy Program (WSU, 2012) provide guidance to code officials, architects, engineers, and home builders (MSU, 2012). These programs are often a go-to source of information for energy code guidance, technical support, and compliance assistance within a state.

- *Michigan State University:*
  http://energycodes.spdc.msu.edu/
  (accessed: November 5, 2012)

- *Washington State University Extension:*
  http://www.energy.wsu.edu/BuildingEfficiency.aspx
  (accessed: November 5, 2012)

- *Appalachian State University:*
  http://ncenergystar.org/nc-energy-code-resources
  (accessed: November 5, 2012)

Municipalities

Many cities also provide energy code compliance resources to support progressive conservation or sustainability goals. A large number of cities across the U.S. maintain offices dedicated to sustainable development, many of which rely on energy codes. For instance, the Oklahoma City Office of Sustainability (City of Oklahoma City, 2012). The City of Seattle maintains a webpage dedicated to energy codes through its Department of Planning and Development. (City of Seattle, 2012) Some cities, including Seattle, include guidance on alternative compliance mechanisms, such the use of outcome-based codes. In this situation, compliance is verified in comparing actual utility bill consumption to designed energy use targets. Cities located in Home Rule states, such as Peoria, Illinois, often have a webpage or other source of information dedicated to energy codes. (City of Peoria, 2012)

Consultant Services

Additional private organizations may offer access to compliance resources as part of a service package or in attempt to generate business. Many states may rely on code consultants for interpretations describing how to apply or comply with the building energy code. This is especially common in states with codes unique to the individual state, such as California or Florida. Most of these services are acquired on a time or fee-based structure. It is also common for interested corporations, such as large building product manufacturers, to retain code consultants for the purpose of making interpretations, tracking code requirements, and for product positioning in future code development processes.

2.6 CHAPTER SUMMARY

This chapter provides an overview of the political backdrop behind many efficiency policies, such as 90% Compliance requirements of the Recovery Act. Environmental and conservation segments of public policy are discusses, followed by common implementation models and options for policy application. Several barriers, issues and best practices are presented for general state and policymaker awareness. Primary references include a methodology recommended by the Federal Government, supplemented by recent pilot studies conducted in several U.S. states. The closing sections can be considered a summary of existing guidance, valuable compliance tools, and other available resources which may be appropriate for use by states and local code enforcement jurisdictions.

CHAPTER 3: RESEARCH METHODS

3.1 EXPERIMENTAL DESIGN

The central research question asks how states can address energy code 90% Compliance requirements included in the Recovery Act of 2009. To address this question, a baseline understanding of current conditions in local enforcement jurisdictions is needed. Using the approach recommended by the Pacific Northwest National Laboratory (PNNL) as a model, the study addresses the research question through two complimentary perspectives:

- A *quantitative* analysis of survey response data gathered from code enforcement jurisdictions to provide local background, including current compliance processes and associated challenges.
- A *qualitative* analysis of recent compliance studies providing state implementation barriers and recommendations on how to address 90% Compliance requirements.

Past compliance studies provide a limited background on enforcement barriers, local implementation issues, and policy options pertaining to energy code compliance. Many of these studies were, however, standalone efforts within one particular state or region. Present data sources provide insight across several states, and allow for both a bottom-up, baseline understanding of current local compliance practices, as well as a top-down review of issues facing states. This cross-state approach seeks to centralize existing knowledge, concerns, and potential solutions, culminating in a set of recommendations for states preparing to address 90% Compliance requirements.

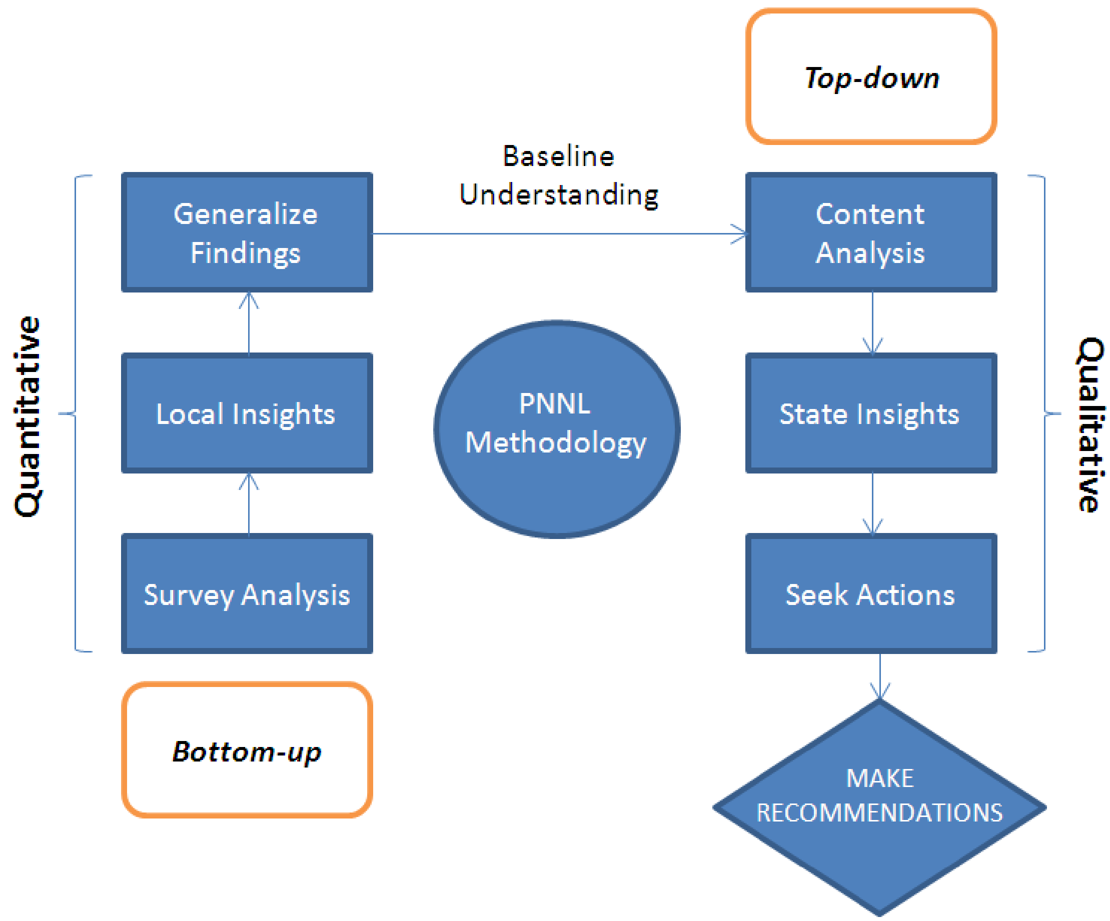


Figure 3: Combination of approaches

3.1.1 Qualitative Paradigm

> *"Interpretation rather than quantification; an emphasis on subjectivity rather than objectivity; flexibility in the process of conducting research; an orientation towards process rather than outcome; a concern with context—regarding behaviour and situation as inextricably linked in forming experience; and finally, an explicit recognition of the impact of the research process on the research situation"*
>
> --Cassel and Symon (1994)

The study is based on methods typical of qualitative inquiry. Much of the work can be considered *experiential* and *interpretive*, due to a direct relationship between the researcher's professional role and the subject matter. An analysis of survey responses across several states was used to develop a baseline understanding of realities within local code enforcement jurisdictions. Textual reports produced through related studies were then reviewed as case studies, guided by commonly accepted methods for interpretive content analysis. Educational and professional experiences also helped to guide the researcher in this inquiry, with inherent limitations and assumptions discussed in the chapter. The approach relied upon in the study is considered appropriate in pursuit of the research question, while balancing perspectives between state and local governments, various stakeholder groups, and complex requirements of compliance policy implementation.

3.1.2 Site and Participant Selection

An introductory background investigation began in the fall of 2010. The present study was performed in partial fulfillment of graduate coursework sequence on the campus of Michigan State University (MSU) at the School of Planning, Design & Construction while under supervision of faculty members in the Construction Management Program. Later portions of the study were continued through a fellowship at the U.S. Department of Energy (DOE) Headquarters in Washington, DC. These sites were selected by the researcher primarily out of convenience of geographic location. While data and resources were originally collected in several states across the country, all analyses and final reporting was conducted on the MSU campus and DOE Headquarters.

Several parties contributed to the research, including: Michigan State University faculty, DOE federal employees, Pacific Northwest National Laboratory (PNNL) scientific staff, state energy office personnel, and other building energy code stakeholders. Survey participants were not selected by the researcher, but as the result of previously conducted energy code compliance studies. These original sample populations were selected based on the needs of an independent collection of studies. Participant and site selection were also limited by the parameters and timeframe allowed for the completion of the graduate thesis project.

3.1.3 Personal Relationship to the Research Question

As a graduate student assisting energy code training in the State of Michigan, a level of potential bias likely existed in the decision to pursue the subject matter. A literature review was engaged for the unique purpose of this study, however; the researcher carried a degree of pre-existing knowledge into impending applications. The inquiry was conducted while the researcher was employed as a Fellow at the U.S. Department of Energy, managing projects specific to building energy efficiency, energy codes, and compliance measures. The researcher's original graduate assistantship was also sponsored by flow-through grants from DOE to Michigan State University (by way of the former Michigan Bureau of Energy Systems) for the purpose of studying energy code compliance. While the potential for bias should be considered in framing eventual conclusions drawn from the study, the danger of cross-contamination is not considered detrimental to, and arguably enhances, research findings.

3.1.4 Influential Works

Influence was drawn from existing theories spawning from quantitative and qualitative roots. The inquiry held two basic components: a descriptive statistical analysis of survey response data and an interpretive analysis of textual documents, providing a consistently applied case study perspective across U.S. states. While conclusions were drawn from both qualitative and quantitative approaches, the study did not include a comparative test of similarity between survey samples. As the quantitative portion of the analysis was used only to acquire a description of the data set, the overall study can be considered qualitative in nature. Several established models guided this process, with the specific contribution of unique works presented in the following sections.

Survey Analysis

The experiment initiated through the analysis of survey response data previously collected from local energy code enforcement jurisdictions across several states. Although data had been previously collected, it was provided to the researcher in raw form. The process was guided by several influential works, which present the foundation by which survey data is organized, analyzed, and presented in later chapters. The following sections identify specific reference works, and provide an overview of how each contributed to the present study.

Much of the survey analysis was framed as presented in *Designing and Conducting Survey Research* by Rea and Parker (1997). These methods are appropriate for survey-based research conducted in the fields of social science and public administration. Commonly accepted statistical definitions are presented, including basic claims enabling researchers to generalize on a population through examination of a subset of that population. The authors also present common measures of central tendency and dispersion within data sets, identifying the combination as "descriptive statistics." (Rea & Parker, 1997)

Rea and Parker chapters on ensuring scientific accuracy and analyzing data sets became an influential focus. Eleven stages of the survey research process are presented, however; the first nine of these take the user through survey implementation. Stages ten, *Coding the completed questionnaires and computerizing the data* and eleven, *Analyzing the data and preparing the final report,* were most useful in application, and assisted in reconciling the various degrees of raw state survey data. Several advantages were also presented, including: cost savings, convenience of completion, time requirements, reduced interviewer bias, and accessibility.

Disadvantages include: reduced response rates, a potential for self-selection, and lessened researcher control. (Rea & Parker, 1997) These helped to better comprehend the designed capabilities of the survey instrument, as well as understand the potential for bias inherited through their original application.

Applied Survey Data Analysis by Heeringa, West and Berglund (2010) reinforces the use of the quantitative surveys within contemporary social science disciplines. Heeringa et al. recognizes the ability of these methods to, "measure the preferences, needs, expectations, and experiences of consumers and to translate these to indices and other statistics that may influence financial markets or determine quality, reliability, or volume ratings for products as diverse as automobiles, hotel services, or TV programming." The authors emphasize the use of large-scale surveys within our society, stating, "These larger and longer-term programs of survey research are critically important to social scientists, health professionals, policy makers, and administrators and thus indirectly to society itself." In contrast to the stages presented by Rea and Parker, the authors expand on the survey *analysis* process through the following steps (Heeringa et. al., 2010):

1. Definition of the Problem and Statement of the Objectives
2. Understanding the Sample Design
3. Understanding Design Variables, Underlying Constructs, and Missing Data
4. Analyzing the Data
5. Interpreting and Evaluating the Results of the Analysis
6. Reporting of Estimates and Inferences from the Survey Data

Chapter Six, *Categorical Data Analysis*, was also found valuable, due to the prevalence of categorical response questions included in the survey instrument used to collect thesis data. The author claims the majority of survey questions in social science and related fields can be classified according to four specific response types: binary choice (yes/no), multinomial response categories (e.g. ethnicity), ordinal scale (e.g. strongly agree to strongly disagree), or a discrete count of events. (Heeringa et. al., 2010) More specific applications are also further explored by Lavassani et al., who describes challenges faced when a single observation may be classified into more than one category. The article provides background in relation to common statistical tests, and their application within multiple response data sets. Historical developments are considered, with new statistical tools applied to recent data sets. (Lavassani et. al., 2009)

A step-by-step approach published by the University of Wisconsin was referenced in analyzing survey responses through the Microsoft Excel software tool. The suggested process can be summarized in the following progression:

1. Create an Excel database
2. Code the data
3. Enter the data
4. Clean the data
5. Analyze the data

A background on the software's potential for organizing and coding data categories is presented, followed by a discussion on common entry challenges, such as the handling of unclear, incomplete, or unexpected responses. The author stresses the importance of consistency in addressing these problems. Data is cleaned to ensure accuracy, and is then subjected to a range of common statistical tests to establish a comparison between expected and observed values (Leahy, 2004).

Data outliers were identified as skewing the analyses, significantly displacing the central tendency of response curves. The Box Plot Method serves as a means for identifying outliers within the data set, in attempt to bring descriptive statistical tests in-line with the core response set. Common statistical calculations are performed, and then presented through a combination of histograms, box plots, and graphs. (Walfish, 2006) More advanced statistical tests are also identified for comparing state sample types. These tests include the t-test and analysis of variance (ANOVA). These tests were chosen to draw comparisons between pairs of state samples, as well as in comparing three or more samples collectively. (Kohlmann & Moock, 2009)

Although not specific to social scientific inquiry, *Introductory Biological Statistics* by Hampton and Havel (2006) provides a comprehensive and well-illustrated overview of common statistical tests applicable to basic quantitative analysis. This text was most influential in understanding specific statistical tests relevant to the acquired data sample set. It also aided in identifying the several underlying hypotheses behind each of individual survey questions. This text was strongly referenced in addressing the survey study, as well as in determining how to present the final analysis of quantitative data (Hampton & Havel, 2006).

Content Analysis

The second component of the study was conducted through a qualitative process analyzing reports produced by recent studies surrounding energy code compliance requirements. Complementing the analysis of survey data, reports were analyzed across several states to effectively outline compliance scenarios, including state-level adoption and implementation barriers. These reports also include a set of recommendations provided to states as they work to meet requirements of the Recovery Act. The process of analyzing these documents was guided by accepted qualitative methods, and is outlined in the following sections.

Qualitative methods are often relied upon to explore phenomena or seek a better understanding of a problem. These methods tend to be more open-ended and interpretive in nature, and vary significantly from the specific inquiries typical of quantitative models. "In a qualitative study, inquirers state research questions, not objectives (i.e., specific goals for the research) or hypotheses (i.e., predictions that involve variables and statistical tests). These research questions assume two forms: a central question and associated sub-questions." The first step in formulating a qualitative study is establishing the research question. "The *central question* is a broad question that asks for an exploration of the central phenomenon or concept in a study. The inquirer poses this question, consistent with the emerging methodology of qualitative research, as a general issue so as to not limit the inquiry. To arrive at this question, ask, 'What is the broadest question that I can ask in the study?'" This becomes the point from which the study gains its structure, and by which later sub-questions can be developed. The research question also serves as the starting point for the more specific content analysis applications, such as the use of textual reports as case studies. Qualitative methods examine a complicated set of factors in relation to a central question, attempting to decipher different meanings held. (Creswell, 2009).

Following the formulation of a central research question, a series of supporting sub-questions is assembled. "Several sub-questions follow each general central question; the sub-questions narrow the focus of the study but leave open the questioning. Generally, five to seven sub-questions are recommended to support the central research question. These questions can evolve to be more specific in nature, and can be used in later applications, such as in conducting participant interviews or in reviewing documents as evidence. "Begin the research questions with the words *what* or *how* to convey an open and emerging design." Other words, for example *why*, are said to represent an inquiry more aligned with quantitative methods and the interaction of specific variables. "Expect the research questions to evolve and change during the study in a manner consistent with the assumptions of an emerging design. Often in qualitative studies, the questions are under continual review and reformulation (as in a grounded theory study)." This approach is also described as, "problematic for individuals accustomed to quantitative designs, in which the research questions remain fixed throughout the study." Open-ended questions which do not directly reference the literature or a specific strategy of inquiry are also recommended. (Creswell, 2009)

The Use of Qualitative Content Analysis in Case Study Research by Florian Kohlbacher provides an introduction to this method, and examines applications as a process of text-interpretation within case study research. Several related studies are referenced, including translations of work performed by Mayring (2002), which defines qualitative content analysis as a, "systematic, theory-guided approach to text analysis using a category system." The author continues in citing Glaser and Laudel's (1999) description of the method as, "synthesizing two contradictory methodological approaches: openness and theory-guided investigation." Bryman (2004) is also cited, who views the method as, "an approach to documents that emphasizes the role of the investigator in the construction of the meaning of and in texts. There is an emphasis on allowing categories to emerge out of data." Earlier work by Cassell and Symon reinforce this submission, describing content analysis as less imposing and restrictive in comparison to other data collection methods, as well as, "less driven by very specific hypotheses and categorical frameworks and more concerned with emergent themes and idiographic descriptions." (Kohlbacher, 2006) Further comparisons are also often drawn to the more central ethnographic methods or grounded theory.

Kohlbacher discusses the specific strategy of inquiry, *Qualitative Content Analysis,* and adopts Mayring's (2006) method as accountable for much of the core body of work making up this methodology. Several points are emphasized, including the importance of placing emergent categories at the center of the analysis, which are then revised through the inclusion of feedback loops throughout the process. Mayring's approach also reduces the process of qualitative content analysis to "three distinct analytical procedures," beginning with a paraphrased summary down to only essential content, followed by an explication of remaining material, and finally the act of filtering feature categories. "In the course of a first appraisal of the material the data locations are marked, and in a second scrutiny these are processed and extracted. If necessary the system of categories is re-examined and revised, which necessitates reappraisal of the material." Results are then processed during the final stage. (Kohlbacher, 2006)

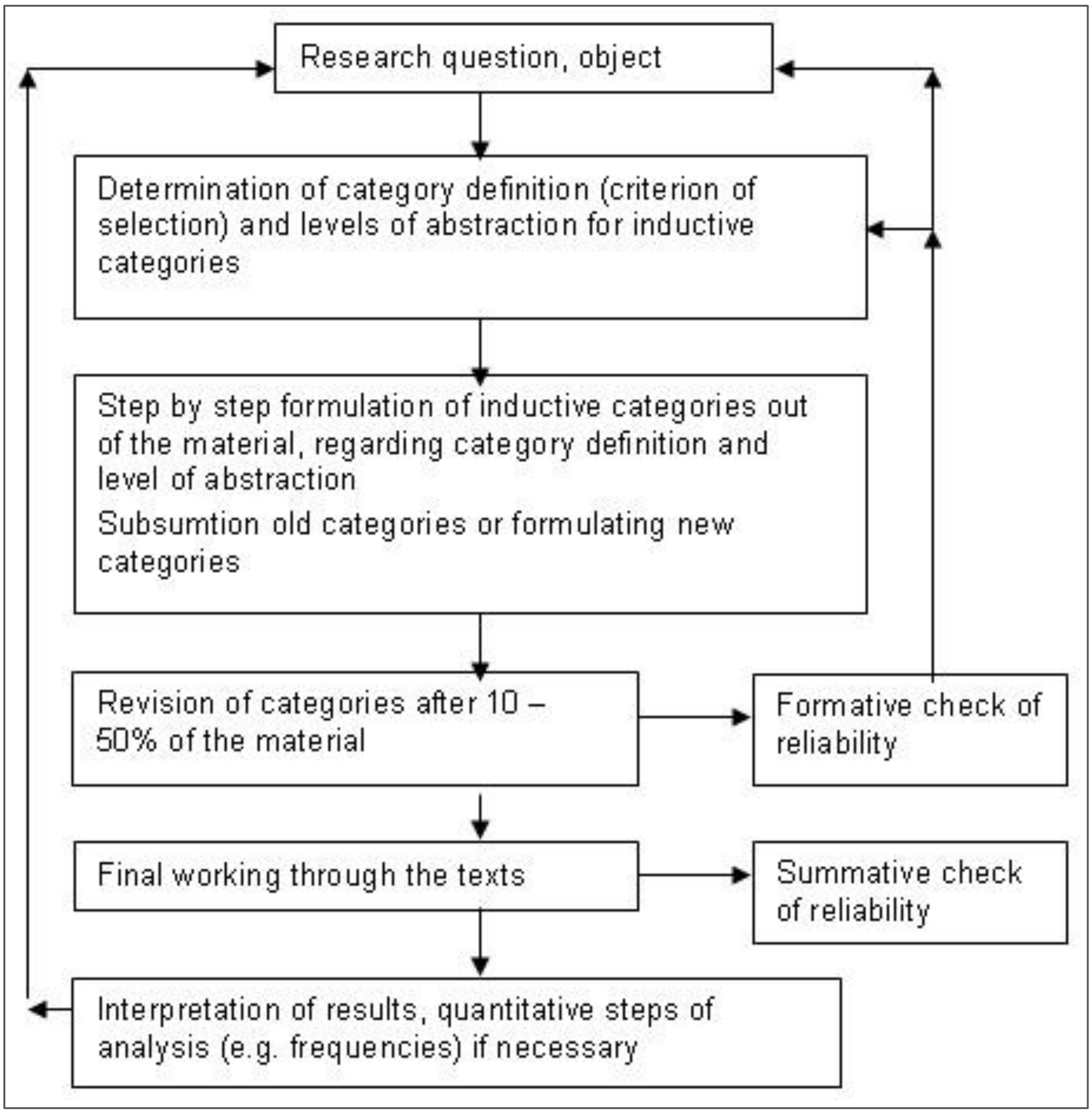


Figure 4: Mayring's step model for inductive category development (Kohlbacher, 2006)

Kohlbacher reinforces methods of qualitative content analysis in quoting Yin (2003), who proposes the addition of a pilot study in preparation for the data collection phase. According to Hartley (2004), data is then allocated around emerging topics, themes, or questions central to the data set. Once these expected categories are populated, data is re-examined to discover how well of a fit was performed. Ryan and Bernard (2000) describe content analysis methods as, "reducing texts to a unit-by-variable matrix and analyzing that matrix qualitatively to test hypotheses. The researcher can produce a matrix by applying a set of codes to a set of qualitative data (e.g. written texts), with the assumption being that the codes of interest have already been discovered and described beforehand. (Kohlbacher, 2006) This concept of extracting previously discovered information in a structured manner is perhaps why the process is recognized as, "the longest established method of text analysis among the set of empirical methods of social investigation." (Titscher et al., 2000)

Cultivating the Under-Mined: Cross-Case Analysis as Knowledge Mobilization by Khan and VanWynsberghe (1998) expands upon basic content analysis methods and proposes a new model utilizing case studies as evidence. "Cross-case analysis allows the researcher to compare cases from one or more settings, communities, or groups. This provides opportunities to learn from different cases and gather critical evidence to modify policy." Under this approach, data is *mined* from multiple cases, and can then be interpreted for broader purposes. (Khan & VanWynsberghe, 2008)

On a broader scale, these models should also be considered within the framework of general qualitative methods. *Qualitative Data Analysis: A User-Friendly Guide for Social* Scientists by Ian Dey (1993) illustrates the general process of analyzing and synthesizing qualitative research data.

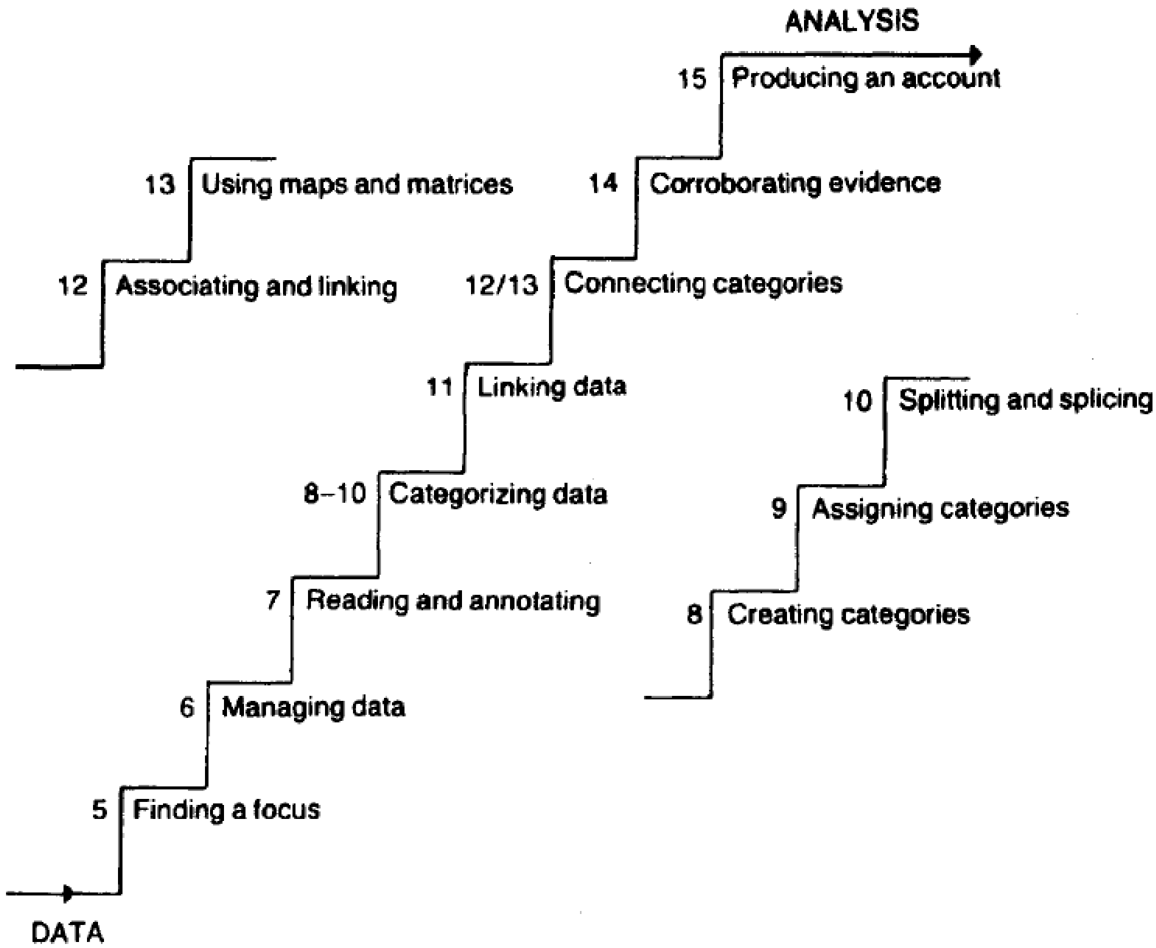


Figure 5: Dey's approach to qualitative data analysis (Dey, 1993)

Across several chapters, Dey presents a series of steps to be followed in analyzing qualitative data. This process begins in establishing a focus for the inquiry, followed by the reading of documents. Text is read by the researcher and annotated in a structured approach. Categories are created, with data extracted from the text to populate categories as assigned. Logical associations and linkages begin to form within the data, which may then be reorganized into maps and matrices for better presentation. At this point, additional evidence may be used to corroborate phenomena observed within the data set. This process culminates in the researcher producing an account based on findings from the qualitative data set. (Dey, 1993)

Further associations can also be drawn to other methods of qualitative research. Donald Ratcliff (2004) provides an overview of fifteen Methods of Data Analysis in Qualitative Research. The most recognizable similarities exist in relation to *Constant Comparison* and *Grounded Theory*. By these methods, the researcher reviews a document as evidence and seeks potential categories. Text is coded within the document, and then allocated to the assigned categories. A point of saturation is reached when no new codes are formed—all data fits within designated categories. Eventually certain categories become the central focus, as trends and phenomena within the data are discovered by the researcher. Ratcliff suggests reviewing documents in search of emerging themes based on several frequently discussed key trends. He also proposes reading the entire way through a document before specifying rules for coding.

Triangulation of Methods

A variety of complimentary data sources applicable across several states were used in the study in attempt to triangulate related findings between qualitative and quantitative analyses. "Recent developments in the philosophy of science have argued that the two traditions should not have a separate-but-equal status, and should instead interact." Olsen (2004) claims the use of this strategy to deepen understanding, as well as in validating eventual findings through a combined, mixed-methods approach. (Olsen, 2004) Todd (1979) provides reinforcement, and stresses the ability to strengthen generalizations in approaching a concept through both quantitative and qualitative perspectives. "Given basic principles of geometry, multiple viewpoints allow for greater accuracy. Similarly, organizational researchers can improve the accuracy of their judgments by collecting different kinds of data bearing on the same phenomenon." Todd also proposes the ability of multiple methods in ensuring variance is a result of studied subjects, and not of the chosen method. (Todd, 1979)

Justification for Chosen Methods

The quantitative portion of the study analyzed survey response samples acquired in several states. As influenced by referenced methods, calculated measures are presented through a variety of sample curves, charts and graphs to illustrate core properties of the response sets. The original survey instrument was not created as part of the thesis experiment (data was provided directly by individual states in raw form), therefore; referenced methods were chosen primarily based upon *analysis* methods pertaining to the social sciences. Collectively, a significant number of survey responses were analyzed, however; comparisons between individual state samples only qualified for more basic descriptive statistical tests. Most of individual state samples were not of sufficient sample size for more advanced statistical tests.

In addition to the survey-based inquiry, several reports were also acquired for qualitative analysis. Starting with the central research question and guided by accepted methods, evidence was extracted from individual state reports as case studies. As relevant themes were encountered, they were coded into categories and sub-categories within a database of qualitative observations. Findings can then be generalized for consideration by other states preparing to address compliance requirements. An emerging process was deemed appropriate to a structured review process to the reports; establishing appropriate categories, and allocating coded data. Findings were collected, and corroborated by interrelated data sources, including related case studies and perspectives gained through quantitative survey analysis.

Referenced works provided a clear and rigorously sound overview of basic quantitative and qualitative data analysis procedures. The experiment desired a glimpse of state energy code compliance and local enforcement scenarios, calling for the acquisition of data across U.S. states. Multiple cross-state data sets were constructed based upon survey responses and recently published reports specific to compliance requirements of the Recovery Act of 2009. The designated methods allowed data to be analyzed as distinct sets, with related phenomena and findings successfully emerging from the collection. Conclusions could then be *discovered* across all sets, based on the unique contributions from each experiment.

Inherent Assumptions and Limitations

In relying on existing methods of quantitative and qualitative analysis, several inherent assumptions must be considered. Each referenced approach contains a unique set of circumstances which may include bias, and influence study findings and eventual conclusions. Common limitations associated with referenced models are discussed for both the survey and content analysis phases of the experiment.

Survey Analysis Methods

The choice of a survey as an instrument of qualitative inquiry is subject to several limitations, as is the resulting response analysis. A true statistical analysis requires a significantly valid sample size. A portion of the state survey samples were limited to only a few responses, and, therefore; do not represent a statistically valid sample set. The potential for self-selection is also present when using a targeted survey. (PNNL, 2011a) A self-selection bias is also suspected within results reported by PNNL 90% Compliance states, due to the short time period allowed for completion of a study.

The original design of a survey instrument may also introduce bias into an experiment, spawning from the questions' wording and response format. Further potential for bias exists during analysis stages, especially when various sets of raw data display inconsistencies, creating the need for certain points to be judged for inclusion or exclusion. This is often the case where a response does not exactly match the expected format. Vulnerability is increased when responses are modified from their native format, such as when imported to a database and in accordance with resulting database formatting decisions. It is also important to consider choices made in the presentation of quantitative data, as eventual conclusions are displayed based on a certain degree of researcher preference. The potential for bias in these areas may be reduced through consistent applications in addressing potential outliers in the data set, and through the utilization of a common approach to presentation graphics.

Content Analysis Methods

Several assumptions and limitations also accompany methods of qualitative content analysis. As a researcher produces a matrix through a given set of codes, there is an assumption the codes of interest have already been discovered by an earlier party. (Kohlbacher, 2006) There is also an assumption of meaningful linkages within cross-case analyses, which may yield greater generalizations for the individual. (Khan & VanWynsberghe, 2008)

The stripping of context is further mentioned as a potential downfall within content analysis theory. A primary goal is defined as the identification of themes across multiple cases. Such themes are removed of their contextual origins, which are replaced by membership within a particular group or category. This new context supplants the importance of the original context. (Khan & VanWynsberghe, 2008)

The selection of cases should also be considered as a potential limitation. A greater number of sample cases is a tactic of reducing bias within most quantitative methods. In the qualitative case-oriented approach, fewer cases may be used (not less than two). Saturation is reached not when a statistically valid number of cases have been explored, but when no new insights are found to emerge from the data. The unit of analysis is defined as categorical themes, as opposed to typically larger units, such as entire state samples, as found within the survey analysis experiment. (Khan & VanWynsberghe, 2008)

Similar to inherent bias affecting quantitative methods, the potential for bias also exists in choosing a guiding qualitative method. Decisions must be made while coding themes identified by the researcher and in organizing the dataset. Although these choices are made based on logical inference, a certain level of discretion is exercised by the researcher as relationships are discovered, and as data is discovered and consolidated. While the coding of themes is somewhat an evolutionary process, the resulting categories are considered reliable. Given the codes assigned and identical data sources, the approach utilized in the study is considered poised for future repetition.

Lastly, the use of both quantitative and qualitative methods is stated as adding a deeper understanding to the subject, as well as an increased validity to eventual findings. In drawing on this possibility, one assumes a balance between methods, that is; weaknesses in one method will be compensated by the other. (Todd, 1979) Assumptions and limitations present within individual methods, as well as combined, are considered within all findings and conclusions flowing from the study.

3.2 METHODOLOGY

Guided by a central research question, research progressed through a process of literature review, followed by descriptive interpretations guided by qualitative and quantitative frameworks. An overview of methods is presented in combination with specific instruments utilized within the study. Applications were administered through the analysis of survey response data and case study reports investigating compliance requirements. Resulting findings are intended to inform states as they to address energy code compliance requirements in the Recovery Act of 2009.

3.2.1 Research Process

The study entertained realities exhibited at localized levels of policy implementation, as well as recommendations provided to states from a national perspective. A baseline understanding of enforcement conditions was sought to help states better understand implementation issues, including background on processes and associated barriers. Specific recommendations were also desired to help states understand Recovery Act energy code compliance requirements.

Accepting the Pacific Northwest National Laboratory recommended approach as a model, the study addresses the central research question through a complimentary approach, including both quantitative and qualitative analysis methods.

Specific information was desired outlining implementation barriers and recommendations, in addition to general compliance background information. An analysis of survey data drawn from several U.S. states was performed to reveal local code enforcement practices. A database drawing on responses was constructed to allow for a cross-state comparison. In addition, the Building Codes Assistance Project (BCAP) produced several recent studies reporting on individual state compliance scenarios. These energy code *Gap Analyses* and *Strategic Compliance Plans* (BCAP, 2012a) were compared across states in an attempt to identify common challenges, themes and practices applicable to a state preparing to address Recovery Act requirements. Findings are validated amongst multiple data sources and against those reported by 90% Compliance Pilot Study states (PNNL, 2011a). The product has also been reviewed by industry professionals, with feedback incorporated into the study deliverable.

The general process undertaken in forming and executing the study is outlined on the following page.

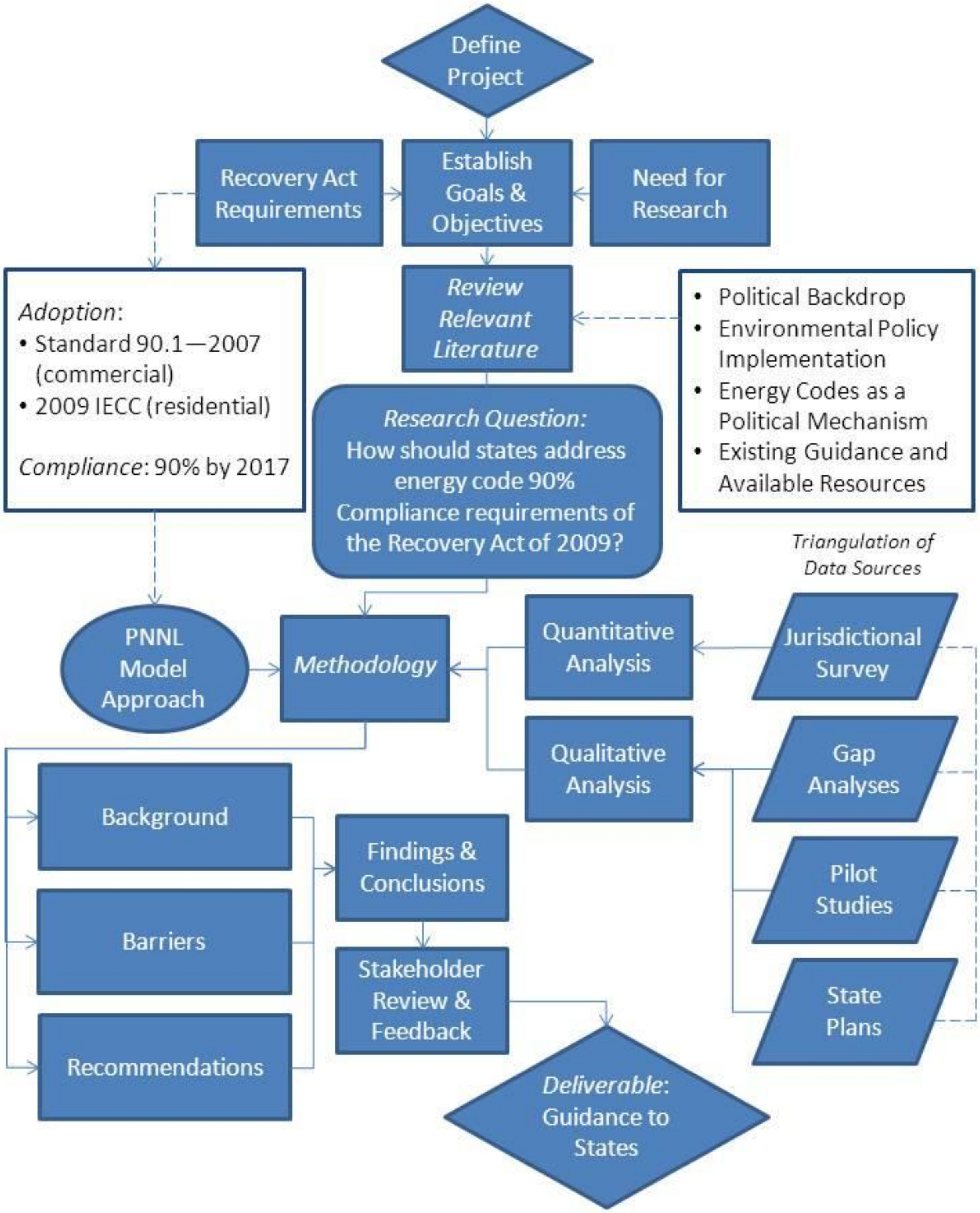


Figure 6: Research process

Research Question: How should states address energy code 90% Compliance requirements of the Recovery Act of 2009?

Supporting sub-questions:

1. What expectations are contained in the Recovery Act?
2. What resources and previous state experiences can be referenced?
3. How are energy codes currently enforced?
4. What local compliance issues currently exist?
5. What actions have other states taken?
6. What hinders a state's ability to meet compliance goals?
7. How should states take action to address 90% Compliance?

The following table indicates the document section where each objective is addressed, followed by contributing data sources:

Table 13: Document section addressing study objectives

Research Sub-question	Primary Category
1. *What expectations are contained in the Recovery Act?*	(Literature Review)
2. *What resources and previous state experiences can be referenced?*	(Literature Review)
3. *How are energy codes currently enforced?*	Local Background
4. *What local compliance issues currently exist?*	Local Challenges
5. *What actions have other states taken?*	State Background
6. *What hinders a state's ability to meet compliance goals?*	State Challenges
7. *How should states take action to address 90% Compliance?*	Recommendations

Data Sources

The Recovery Act of 2009 made compliance with building energy codes increasingly relevant. The U.S. Department of Energy, Pacific Northwest National Laboratory and the Building Codes Assistance Project have provided some of the most recent and comprehensive resources when it comes to addressing compliance requirements at the state level. These organizations have conducted studies across several states to identify strengths, weaknesses, and recommended practices in demonstrating energy code compliance. The present study seeks to evaluate these findings from a cross-state perspective in an attempt to identify the information, trends and practices most relevant to states strategizing to address 90% Compliance.

Four primary sources of data were included in the study:

Table 14: Data sources with respective sample size

Data Source	Number of States
Jurisdictional survey	6
Gap Analysis reports	15
Strategic Compliance Plans	12
State Pilot Study reports	9

Initial analyses were conducted on survey response data gathered through federally funded pilot studies testing the PNNL-suggested methodology. Reports published by the Building Codes Assistance Project (BCAP) were then mined as state case studies for additional information considered relevant to Recovery Act compliance requirements. Specific information was sought to identify background scenarios, including local enforcement practices, processes and barriers. State-level issues were identified through the analysis of BCAP and pilot study reports submitted by individual states, providing further insight on state-level barriers and recent recommendations. Findings were generalized based on three primary categories:

1. Background information on compliance processes and local enforcement practices
2. Barriers and implementation issues facing states and local code enforcement jurisdictions
3. Recommended actions to take in addressing Recovery Act 90% Compliance requirements

The preceding categories are designed to orient data in support of sub-questions included in the study that required investigation beyond the scope of the literature review. These categories also served as the basis for the qualitative portion of the study, against which findings generated through the qualitative portion of the study was considered. Individual data sources provide a collection of perspectives, mixing national, state, and local stakeholder levels.

The following graphic outlines the contribution of each unique data source to the assigned categories.

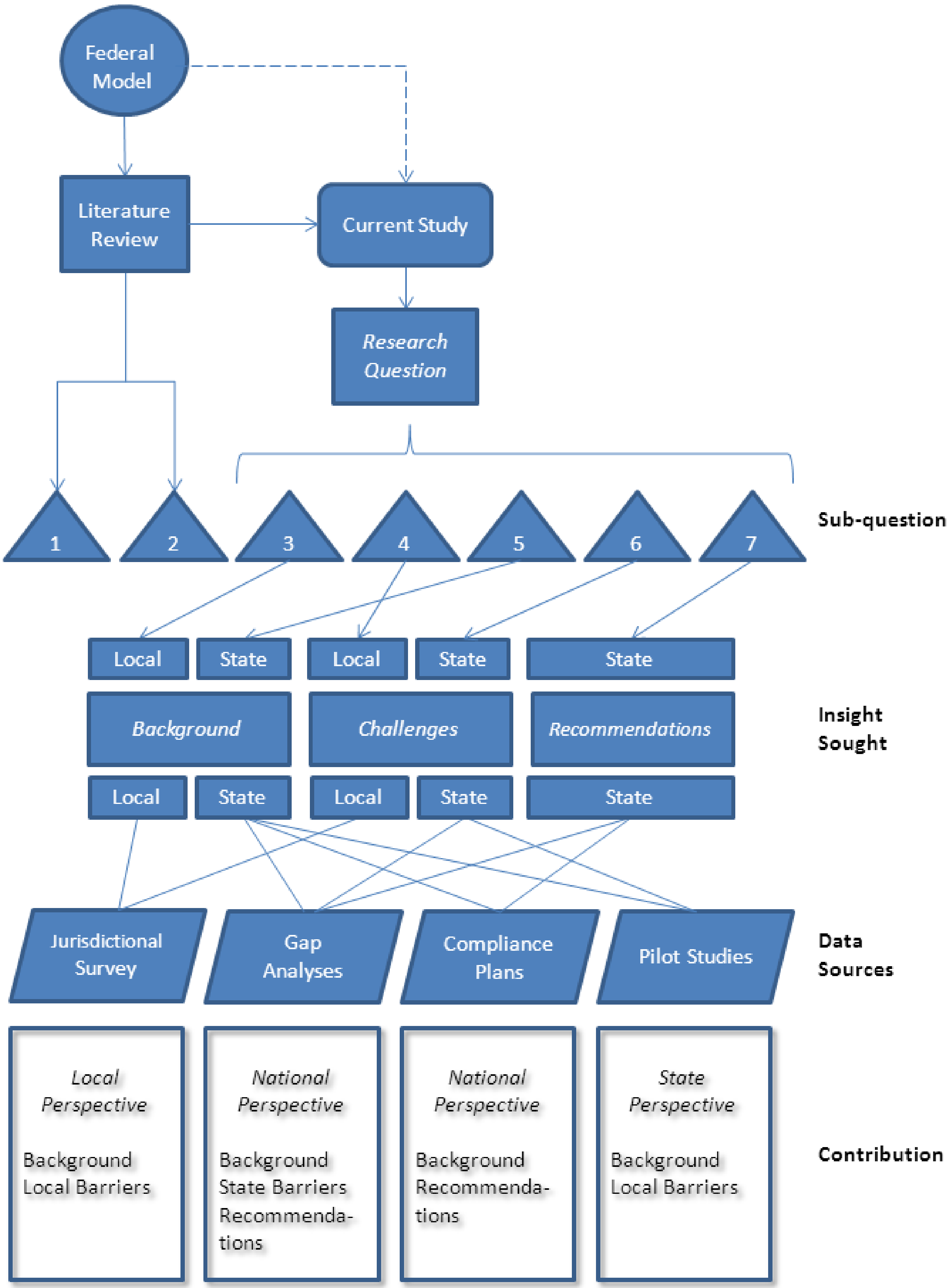


Figure 7: Contribution of unique data sources

3.2.2 Survey Analysis

To support 90% Compliance requirements of the Recovery Act, DOE and PNNL funded a series of pilot studies. These studies set out to test the suggested PNNL methodology for assessing baseline conditions and demonstrating a statewide compliance rate. Funding was issued on a competitive basis, and a selection of several states were chosen based on varying state conditions, such as: type of building sample proposed, state regulatory infrastructure and control over jurisdictional practices, expected rates of compliance, and ability to perform the work within a limited timeframe. While not the sole focus of the pilot studies, a survey of state and local practices related to the enforcement of building energy codes was included as a component in several states (*Note: the survey was conducted as a component of several pilot studies, but should not be confused with the final pilot study reports submitted by individual states as a separate data source)*. This *State Energy Code Jurisdictional Survey* (referenced as Jurisdictional Survey) sought information about local enforcement practices, demographics, and common challenges witnessed by code officials and building inspectors (the original survey instrument is included in Appendix A). Although its application varied slightly between states, response data provides valuable insight in framing localized conditions faced by building energy code stakeholders.

In total, 21 questions are included in the original survey, seeking jurisdictional information, staff practices, and general processes:

Questions about Your Jurisdiction:

- Agency name and location information
- Estimate of population served
- Respondent contact information
- Number of permits issued in the previous year
- Funding sources

Questions about Your Staff:

- Who conducts plan reviews and field inspections
- Level of energy code education and training
- Preferred training delivery method

Questions about Your Processes:

- Methods used to determine compliance
- Time spent on plan review and field inspections
- How permit data is maintained
- Limitations impeding enforcement capability
- Common code infractions
- Code aspects covered in plan review and inspection
- Information available to inspectors
- Compliance reports accepted
- Missing information
- Usage of software and other information technologies

The original Jurisdictional Survey was designed in a digital, web-based format, and is publicly available on the DOE Building Energy Codes website (DOE, 2012a). Many of the questions segregate responses pertaining to residential and commercial buildings. Some questions call for a numerical response, such as population size and number of permits issued, while most responses are categorical in nature—check any or all applicable boxes. Many questions also offer the opportunity to respond ‘other’, in which case a blank is given for the entry of a text-based response. Such questions offer the opportunity for analysis of open-ended responses.

Selection of Survey States

Survey responses were collected across multiple states from local code enforcement jurisdictions. Raw survey response data was provided by pilot states, as well as states choosing to administer a survey as part of subsequent or independent studies. While the PNNL Jurisdictional Survey was not issued verbatim in all cases, many questions were consistently administered across several states and present an opportunity for analysis. States were not bound by strict rules in implementing the survey, and some chose to add or delete questions, as desired. Only those questions found to be present across multiple states are included for the purposes of this thesis. Overall, the survey provides insight on variations of practice between U.S. states. In total, 390 survey response samples were collected across six U.S. states:

Table 15: Survey respondents by state (sample size)

Survey State	Number of Respondents
Michigan	283
Oregon	50
Utah	26
Idaho	15
Montana	10
Washington	6
TOTAL	**390**

The 90% Compliance Pilot Studies did not specifically require implementation of the survey in all states. The pilot study effort reached beyond the survey inquiry, in attempt to test the overall PNNL methodology, and to generate baseline state compliance rates for specific building types. Some states chose to administer a state-specific custom survey in lieu of the Jurisdictional Survey, while other pilot study states did not administer a survey in any form. In some cases, the survey was modified, however; most questions are consistent in language and response format, allowing for an analysis of responses within and across states.

For example; Michigan, was not chosen as part of the formal 90% Compliance Pilot Study effort, and chose to administer a survey in a following project under the Michigan State Housing Development Authority (MSHDA). In this case, the state administered a modified version of the PNNL Jurisdictional Survey. As seen in other states, certain questions were omitted, and other state-specific questions were added to the survey. The original Michigan survey instrument is provided is Appendix A. (MSHDA, 2011b)

State survey respondents were initially contacted by mail or email, with some follow-up phone contact. Georgia setup a confidential, online survey for respondents to enter and submit. (Towson, 2011) Utah contacted select jurisdictions as determined by the PNNL Sample Generator tool. Selected jurisdictions were asked to complete the survey, and following inspections were requested. (Navigant, 2011a) The Northwest study sent an online version of the survey to every state jurisdiction, and followed with in-person interviews to further substantiate survey responses. (NEEA, 2011b) Michigan followed a similar approach, sending the survey to all licensed code inspectors within the state. The study also followed in conducting three focus groups made up of trainers, researchers, state officials, local code enforcement officials, and builders. State findings generated through such follow-up activities were described as largely reinforcing survey results. (MSHDA, 2011b)

Some efforts were found to be more in depth than others, often resulting in larger, statistically valid sample sizes. Other states simply set out to test the survey and targeted a very small sample, while others targeted a larger number of respondents. For example, the Michigan study focused solely on the survey, and respondents were pursued more aggressively in comparison to some other survey states. Within the pilot study states, the survey was often administered as an exploratory effort in advance of conducting building inspections (the primary focus of the pilots).

While the smaller state samples cannot be considered statistically valid, they may still offer some insight into jurisdictional practices within the state.

Thesis Applications

Raw, non-identifiable survey response data was obtained and input to a database and analyzed using statistical methods. Data was analyzed to draw conclusions by state, and then compared to a non-weighted, aggregated total, consisting of responses combined from all six survey states. This format allowed for conclusions within an individual state, as well as from a broader perspective across states. The sample is non-weighted, and therefore the resulting aggregate may be dominated by the larger sample sizes. Some sample sizes were not of adequate size to be considered statistically valid, yet have been included as an educational exercise, as well as to avoid excluding any relevant insight into those states' jurisdictional practices.

The questions included in the survey were found to provide a mix of inquiry and response types. Some survey questions are formatted to accept a numerical response, however; most are setup with the potential for multiple categorical responses—the respondent may choose one or more options in answering a question. Most questions were formatted to result in a non-mutually exclusive set of responses. Numerical data, such as population size, was analyzed and presented as a distribution. Categorical data was presented in the manner determined to best describe commonly selected responses or relative combinations thereof. A collection of histograms, population curves, and pie charts is utilized to present and communicate the final analyses of survey data.

Initial data analysis revealed the need to review the range of numerical responses, and consider the exclusion of data outliers. Some responses were found to fall well beyond the range of acceptable responses. For example, in responding to jurisdictional population size, one

Michigan respondent indicated serving a population of 50 million people—far more than the population of the entire state. Not only was this response confounding, it was found to significantly skew the sample data set.

The *Box Plot Method* was utilized to identify and eliminate outliers skewing state sample data sets. This basic and commonly accepted protocol divided the response data into quartiles, and allowed for identification of those responses exceeding the threshold for inclusion. This practice ensures a sound approach and representation of the core data set. In all cases, the highest frequency of responses favored the more common, smaller jurisdictions. As numerical questions only pertained to non-negative responses (i.e. population size, time spent, etc.), negative outlier values were not encountered. Outlier values were those varying most significantly in the positive direction. As a result, sample data sets and results presented are intended to preserve the average, core set of respondent behaviors.

Quantitative survey response data was analyzed for descriptive trends to identify information relevant to states addressing Recovery Act requirements. Results of the analysis are presented for each survey question, followed by overall findings considered relevant for the final deliverable. This analysis is included in Chapter Four: *Quantitative Analysis*.

3.2.3 Content Analysis

Energy code compliance scenarios vary significantly between states. While model building codes are produced on a national stage, the implementation of these policies lies within the hands of individual states. This results in a range of regulatory scenarios. While some states exhibit a strong statewide energy code, others lack the authority to require these types of regulations.

To further understand state limitations, DOE funded the Building Codes Assistance Project (BCAP) in 2010-2011 to conduct a series of analyses to review compliance and enforcement gaps within individual states. Building upon these scenarios, BCAP followed with a series of guidance, outlining what actions specific states might take in addressing requirements of the Recovery Act. These reports, in combination with individual state 90% Compliance Pilot Study reports, were processed to reveal considerations for additional states preparing to address compliance requirements.

The content analysis portion of the study included three series of documents as data sources:

1. BCAP *Gap Analysis* Reports
2. BCAP *Strategic Compliance Plans*
3. 90% Compliance *State Pilot Study Reports*

Gap Analyses

BCAP's first approach to the compliance problem reviewed existing conditions within states in relation to the expectations and compliance goals of the Recovery Act. This initial effort applied a uniform inquiry across fifteen U.S. states. Known as *Gap Analyses*, these would effectively paint much of the background affecting implementation of new building energy codes. The following provides a summary of information included in Gap Analysis reports for each state:

- Demographic information
- Energy portfolio
- Potential for energy codes
- Supporting policies and legislation
- Status of state codes
- Related initiatives
- State and local trends
- Compliance potential
- Gaps and recommendations

Within this background, areas of vulnerability were identified accompanied by recommended action. Although the analyses were conducted within individual states, the consistent approach allows information to be tracked across multiple states included in the effort. For the purposes of the present study, common themes provide insight for other states preparing to approach compliance requirements of the Recovery Act.

Strategic Compliance Plans

BCAP continued their compliance efforts in developing *Strategic Compliance Plans* designed to provide guidance to specific states based on their unique scenario. The plans set out to capture a state's existing energy code scenario, and provide actions necessary to achieve a 90% compliance rate with the 2009 IECC by 2017. Plans were developed for twelve states, some of which were included in the previous study. Like the Gap Analyses, the Strategic Compliance Plans follow a similar format and approach across several individual states. In each case, the plan provides background and guidance directed towards a specific group at the state level. This group is typically that which is charged with oversight over building energy codes adoption or compliance efforts within the state. This may be a state agency or designated group. In Texas, for example, this group is known as the *Energy Code Compliance Collaborative*.

After a compliance oversight group is established, the plan is organized into several focus areas with tasks and desired outcomes directed towards the end goal of full compliance with the target residential energy code. Each report typically provides information and recommendations in the following areas:

- An introduction to energy code compliance
- Funding options
- State and local policy
- Outreach to stakeholders
- Training needs and opportunities
- Conducting a compliance evaluation
- Timeline for implementation

The analysis of this data followed a similar process to the previous Gap Analyses. Final plans were mined for phenomena contributing to background and recommendation categories. This data was input to a database, and reviewed with considerations for energy code requirements of the Recovery Act. Data was then allocated, constructing a matrix for comparing similar data across several states. Trends across the data set were then used to inform the final set of guidance to states.

State Pilot Study Reports

In response to energy code compliance requirements contained in the Recovery Act, DOE commissioned a series of *90% Compliance Pilot Studies* to test the PNNL suggested methodology for measuring and demonstrating compliance. The overall study was comprised of nine U.S. states across six unique studies. Each study was chosen for a specific focus, such as a desired building type, new or existing construction, sample size, or compliance approach. States were also able to test areas of specific interest, such as the use of third-party evaluation services, post-construction inspections, or alternative compliance paths, such as ENERGY STAR or a Home Energy Rating.

As a requirement of the pilot study, each state produced a final report, providing PNNL details on the study experience, barriers to compliance, logistics of implementing the suggested methodology, and other relative information. Individually, these state reports describe the process and findings of specific states. When assembled as a collection and subject to methods of qualitative content analysis, findings can be drawn across states, and can be further evaluated for embedded guidance for states preparing to address Recovery Act compliance requirements.

Selection of Documents

Content chosen for this thesis experiment was identified as applicable through a review of relevant literature. These documents represent some of the most recently completed work performed in response to Recovery Act compliance requirements, and include the potential to compare various state scenarios. Each set of reports included a unique collection of sample states, enabling a cross-state comparison of trends, themes, and consistencies. States examined within each data source are as follows:

Table 16: State reports analyzed for qualitative data

Gap Analyses Reports	Strategic Compliance Plans	Pilot Study Reports
Alabama	Colorado	Georgia
Arizona	Delaware	Idaho*
Delaware	Illinois	Iowa
Illinois	Kentucky	Massachusetts
Kentucky	Michigan	Montana*
Michigan	New Hampshire	Oregon*
Nebraska	New Mexico	Utah
Nevada	South Carolina	Washington*
New Hampshire	Texas	Wisconsin
New Mexico	West Virginia	
Ohio		
South Carolina		
South Dakota		
Texas		
West Virginia		

**Four states participated in a joint Northwest States pilot study*

Content analysis data sets were selected from several document sources across multiple states to secure reliability with overall findings and validate the final guidance set. Themes found to be present within individual states were considered relevant for consideration, especially when reinforced by similar themes validated through multiple data sources.

Applications

Guided by accepted qualitative methods, case study reports were analyzed for information, guidance, and emerging themes to be captured as data relevant to 90% Compliance requirements. As encountered, themes were *coded* into categories and sub-categories. This created a categorical system for housing captured data. Through several reviews of each report, categories were organized, consolidated, and simultaneously populated with data extracted from each state report (as was available). An overview of the theory underlying this approach is presented in section 3.1.4.

The following basic process was used to identify and code qualitative applications:

- The process is informed by the central research question (and evolving sub-questions). Sub-questions requiring investigation beyond the literature review were referenced in assigning the three *primary categories* to which all extracted data was allocated:
    1. *Background*: Information identified as relevant to 90% Compliance, as well as information on local enforcement processes and common practices.
    2. *Barriers*: Issues and challenges impeding energy code compliance faced by stakeholders at state and localized levels of implementation.
    3. *Recommendations*: Actions provided to states encouraging specific intervention in addressing Recovery Act compliance requirements.
- Themes considered relevant to the research question were identified and coded within each primary category based on general contribution (e.g. energy code 'Adoption' or 'Implementation'). These general categories were largely influenced by the formatting of the original series of documents under review (i.e. Gap Analysis reports, Compliance Plans, or Pilot Study reports). Formatting was observed to be consistent across the majority of textual documents within each series.
- As more specific information was encountered, sub-categories were created within established categories. For example, if a specific stakeholder group was presented as affecting implementation, this group was placed within the 'Implementation' category. This resulted in an outline or *tree* structure:
    - *Assigned Category*: Implementation
        - *Assigned Sub-category*: Stakeholder organizations
- After reviewing several reports in a series, new categories began to emerge in comparison to those previously identified. Additional context forced a return to the first documents to seek information previously overlooked or unrecognized. This process was completed continually throughout the examination of an entire series of reports.
- Categories were organized and re-organized throughout the process as their relationships were better understood—these relationships often emerged following identification of the theme category.
- Created categories were populated as they were identified and coded.
- A single category was populated for each state. If a created category was not addressed within a particular report, the cell for that state/category was left blank.
- A final organization was applied to all populated categories, again checking reliability of the final data set against all state reports. This provided final assurance that no desired data had been missed.

Overall, over one hundred unique categories were developed for each of the three sets of reports. These were then edited to focus on more powerful themes and key phenomena. A database was constructed to hold data in a *matrix* format, with the constructed category scheme displayed on the vertical axis and included states displayed on the horizontal axis. This display format is recommended as effective for specific content analysis methods. A list of the final categories coded in the study is displayed (by data source) in Appendix C.

A similar process was administered across all sources to establish data sets and produce the qualitative portion of the study. Individual state reports were reviewed to become familiar with their content, and eventually to identify and target relevant data. Guided by the central research objectives, each new data piece was allocated based on fit within established categories, or used as justification for the creation of a new category. This process continued until all documents had been reviewed, and no new information could be extracted from the individual document—a point of saturation. With all data pieces acquired, a check was performed to verify the matrix adequately represented this information. Texts were also given a final review to ensure no relevant data pieces had been excluded due to the evolving categorical system. The process was then closed, with all included data considered eligible for consideration towards the final deliverable.

Qualitative data was analyzed for themes and emerging phenomena in an attempt to identify information relevant to states preparing to address Recovery Act compliance requirements. Overall findings are presented and were used to form the final deliverable. Analysis of this data is included in Chapter Five: *Qualitative Analysis*.

3.3 DELIVERABLE

The result of the study is a guidance document for states to reference as they address Recovery Act 90% Compliance requirements. Although compliance measurement activities have been initiated by some states, information on the subject remains scattered across a variety of sources. The study helps to centralize information garnished from related studies, and balances it against conditions, processes, and experiences of states and local enforcement jurisdictions. Findings are summarized and validated by stakeholders at national and state levels of government. A summary was formed based on recommended practices, providing guidance to states based on guidance found in existing literature and related studies.

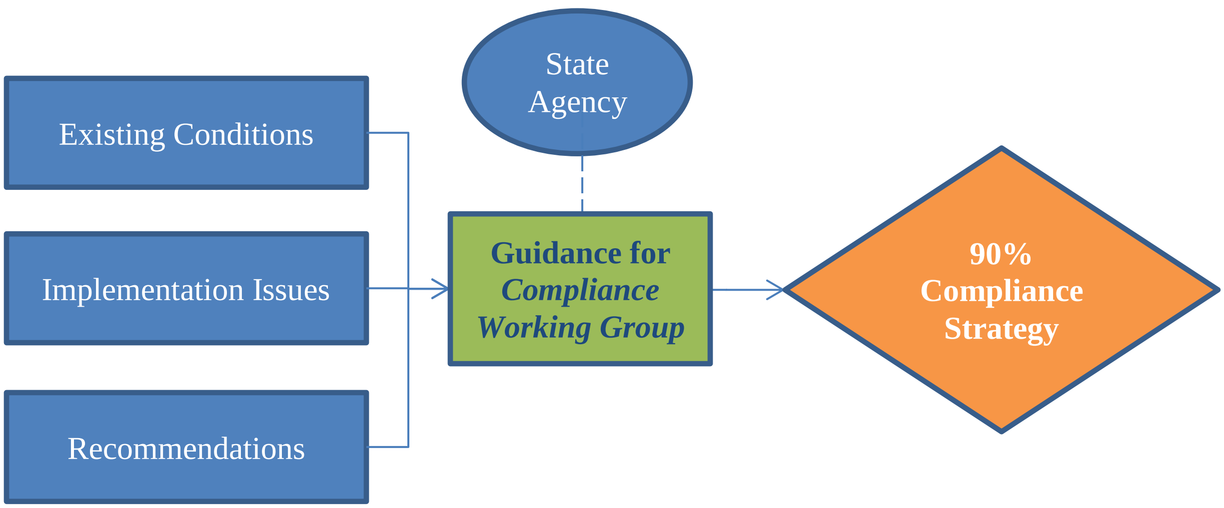


Figure 8: Orientation of study deliverable

The PNNL recommended methodology is accepted as a model approach to demonstrating a 90% compliance rate with energy codes targeted by the Recovery Act. Findings of the study are especially useful in the early stages of the PNNL suggested methodology; formation of a compliance working group (sometimes referred to as an Energy Code Compliance Collaborative). This group operates under the oversight of the state agency responsible for energy code compliance.

What value does it have?

Although the Recovery Act was issued three years ago, substantial questions remain surrounding its expectations. State policymakers benefit from a clearer understanding and step-by-step guidance to address compliance requirements. This guidance is especially useful to state agencies less familiar with energy code compliance requirements, as well as those forming a compliance working group or individual compliance strategy. It also serves to guide policy decisions as the regulatory infrastructure is placed to support Recovery Act compliance requirements. Background information, available resources and actions are provided, informed by experiences observed across early adopting states. In centralizing available information, tools and recommendations, states coming to the table have a starting foundation from which to build their own policies to address Recovery Act compliance requirements.

Who does it serve?

The product will prove useful to several groups addressing Recovery Act requirements, with a primary audience including state officials, policymakers, institutions supporting code compliance, and general building energy stakeholders. Guidance and recommendations offer potential within varying state regulatory and code enforcement scenarios. Existing barriers to energy code compliance are also considered, providing specific emphasis on those issues specific to the Recovery Act.

The guidance document also informs state compliance working groups as they take initial action and begin to allocate limited resources. One of the first steps in the PNNL suggested methodology is the formation of a compliance working group, or Energy Code Compliance Collaborative. This is the group to be charged with organizing and steering compliance activities within a state. The delivered framework serves as a template for the compliance group to populate as they come to terms with their own state scenario. Furthermore, the framework informs state officials in advance of forming a working group, helping to identify the appropriate parties and organizations from which to solicit membership.

How was it formed?

The deliverable was formed based on findings drawn from the quantitative and qualitative analyses executed within the study. Findings were rolled-up and generalized from each independent analysis, and provided insight on local enforcement practices, barriers, and recommendations coming out of related studies. Information was allocated, combined, and transformed into a comprehensive set of recommendations for states to consider as they address 90% Compliance requirements. Further description of the applied methods is found in the *Research Methods* section of the document.

3.3.1 Validation

Presented findings are drawn across multiple methods of inquiry and unique sources, therefore providing *triangulated* reinforcement for generated findings and overall conclusions. Guided by existing methods, data sources were acquired from previous studies encompassing national, state and local perspectives. The final product is intended to be broad enough in nature for applications across varying state scenarios, yet specific enough to inform states of valuable resources as they approach the requirements of the Recovery Act.

To further substantiate the resulting set of recommendations, a draft version of the guidance document was also presented to professional stakeholders for review. These individuals included DOE Building Technologies Program personnel, PNNL Building Energy Codes Program scientific research staff, and state energy office employees. These stakeholder groups provide a balance between state and federal perspectives. Feedback was solicited on a voluntary basis the form of a brief questionnaire emailed to reviewers. The questionnaire contained a combination of binary (yes/no) and open-ended questions. Specific information was sought on the accuracy of reported information, including gaps or conflicts not adequately addressed. An opportunity to provide general comments was also provided. Volunteers were recruited by the researcher, with feedback reviewed, considered, and applied to the final version of the deliverable.

Who was contacted?

Officials from state energy offices and federal scientific staff were contacted with a request to review the final deliverable. Approximately 2-3 reviewers were desired, targeting individuals with a high degree of familiarity with energy code adoption and compliance issues. Reviewers were identified through interaction at professional conferences and day-to-day business meetings.

How were they contacted?

A formal email was written and sent to potential reviewers asking for their participation. The message included a brief introduction to the topic and general purpose of the research study. The identity of reviewers was kept confidential, with feedback destroyed after processing. Reviewer comments were gathered via email, and stored on the researcher's personal computer until incorporated into the study in a non-identifiable manner. All feedback, including the original emails, was then permanently deleted to eliminate any unintended risk to participants. The original email content and accompanying list of questions, is contained in *Appendix E*.

What were reviewers asked?

Reviewers were asked five open-ended questions inquiring upon the quality and accuracy of the final deliverable. The request for stakeholder review included the following questions:

1. Will the presented guidance empower states to pursue 90% Compliance? (why?)
2. Does the document accurately portray key challenges impeding the adoption and implementation of building energy codes? (please explain)
3. Is there missing information which should be included in the guidance? (please explain)
4. Do you have any concerns with the guidance provided?
5. Please include any additional questions or comments you may have (feedback may be written or provided via tracked changes)

Responses were requested via email, with the option for reviewers to input suggested changes directly into the document for consideration.

How was feedback accommodated?

Reviewer feedback was reviewed and considered for the final deliverable. Only one round of comments was requested, with feedback accommodated at the discretion of the researcher. While feedback was incorporated into the final product, individual comments were not retained for later consideration. A simple thank you message was provided to those able to contribute.

3.4 CHAPTER SUMMARY

The chapter provides an overview of theories representative of research methods utilized within the research study. A descriptive statistical analysis was performed on survey response data acquired through local code enforcement jurisdictions across several U.S. states. Multiple series of reports were also administered reviewing the capability of specific states in addressing 90% Compliance requirements in the Recovery Act. Through this combined approach, guidance can be generalized and further developed for states to consider as they prepare to implement policies empowering energy code compliance requirements. Assumptions and limitations inherent to guiding methods were also presented.

CHAPTER 4: QUANTITATIVE ANALYSIS

4.1 OVERVIEW

The investigation initiated through a descriptive statistical analysis of survey response data gathered from local code enforcement jurisdictions across several U.S. states. The survey, designed by PNNL and known as the *Jurisdictional Survey*, was created to help states acquire consistent background information on baseline compliance conditions within a particular state. Many of the states administered the survey as part of their 90% Compliance Pilot Study. A range of questions inquired upon specific enforcement practices, processes for determining energy code compliance, as well as associated barriers. Survey responses were input to a database and analyzed to better understand local background and implementation challenges.

State Samples

Survey responses were submitted by individual respondents across six states engaging energy code compliance measurement activities. All survey states, with the exception of Michigan, were selected as part of a PNNL 90% Compliance Pilot Study. Michigan administered the survey as a following independent effort to study baseline compliance conditions within the state. Some states administered the survey as designed, while others provide a customized version. The survey provides insight on stakeholder perspectives, and a glimpse of practices undertaken in local code enforcement jurisdictions.

Table 17: Survey sample size by state

Survey State	Number of Respondents
Michigan	283
Oregon	50
Utah	26
Idaho	15
Montana	10
Washington	6
TOTAL	**390**

Survey samples were analyzed by individual state and aggregated to form a single, uniform sample. State samples were generated from responses to each survey question, with some questions yielding a greater response rate than others. Sample sizes also varied based on the overall role of the survey in each state compliance study. For example, the survey was the primary inquiry in the Michigan study, and a comparatively robust sample was generated. In all other studies, the survey was administered as a preliminary and supplementary measure prior to conducting other evaluation activities as suggested by the PNNL-proposed 90% Compliance methodology. In these cases, the survey was a portion of a greater study, which prioritized building inspections and compliance evaluations in an attempt to estimate a baseline state compliance rate for particular building types.

Scope of Survey

The survey is designed to collect responses in three topic areas: background on the local *jurisdiction* or building department, background on inspection and evaluation *staff,* and p*rocesses* for conducting energy code compliance assessments. While personally identifiable information was provided during the original data collection, this information was not provided for the present study, and was not included within the analysis.

The research study analyzed the following questions:

Questions about Your Jurisdiction:

1. Estimate of population served
2. Number of building code permits issued in the previous calendar year (residential & commercial)
3. Agency funding sources

Questions about Your Staff:

4. Party responsible for conducting plan reviews
5. Party responsible for conducting field inspections
6. Level of energy codes education received by agency staff

Questions about Your Processes:

7. Methods used for documenting code compliance (paths)
8. Time devoted to energy code *plan review*
9. Time devoted to energy code *field inspection*
10. Format used to maintain permitting data
11. Limitations impeding energy code enforcement
12. Residential energy code infractions
13. Commercial energy code infractions
14. Information commonly observed as missing or incomplete
15. Acceptance of software compliance reports

4.2 SURVEY DATA

Survey questions are presented in the original language as administered in survey states. Each question is formatted based on two classifications:

1. Numerical
2. Categorical

In several cases, questions are formatted to segregate responses applying to residential or commercial buildings. *Numerical* questions include the unit of response, such as number of permits or hours of time spent on a particular activity. In this case, respondents are asked to input their response to a blank text-entry box. The second classification provides for a *categorical* response, presenting several specific options to respondents (check boxes). Categorical questions include both mutually exclusive, as well as non-mutually exclusive response properties, which were translated to the eventual data set.

To present the final data analysis, the next section introduces each survey question in the following general format:

Language*: (language from the original survey question with any response options listed)*

Classification: (numerical or categorical response format)

Each question includes a discussion of trends observed within the respective data set. Through a descriptive statistical analysis, observations are provided across the aggregate data set. Questions are organized by the topic areas and ordered as presented in Section 4.1. Where residential and commercial buildings are inquired upon independently, the analysis is segregated to mirror the original survey question. Additional state-by-state analysis is also included in Appendix B. Findings are presented for each question, and generalized at the end of the section based on their contribution towards the final deliverable.

Questions about Your Jurisdiction

These questions gather limited background information and contact information on the agency completing the survey. The following questions were included in the data analysis.

Question #1: Population Served

Language: *Estimate of the population served.*

Classification: Numerical (number of people)

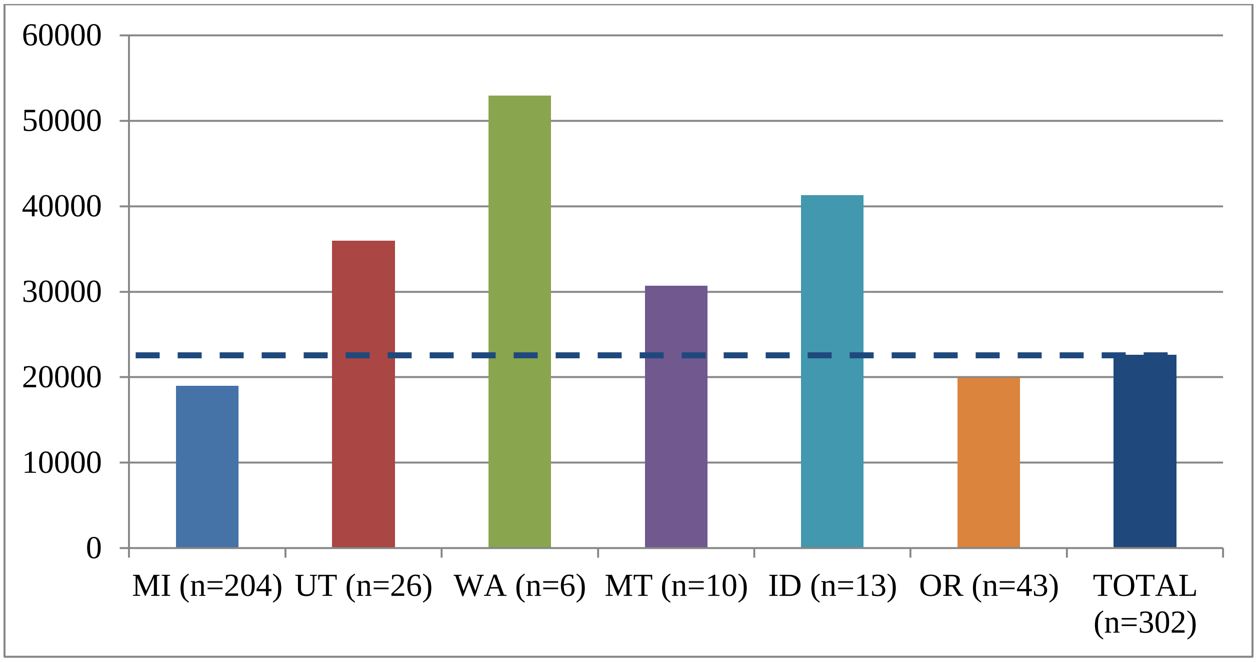


Figure 9: Average jurisdictional population

This question provides an overview of the state and total respondent populations, and allows for a basic statistical analysis of the sample. Size of local code enforcement jurisdictions was measured by population (number of people) residing within the jurisdictional geographic area. Population is observed to vary significantly by state. Michigan, with the largest sample size, exhibited the smallest average jurisdictional population with just over 19,000 people. In contrast, Washington respondents indicated an average population of over 50,000 people. The average population for all 302 respondents is observed to be 22,617 people residing in the typical code enforcement jurisdiction.

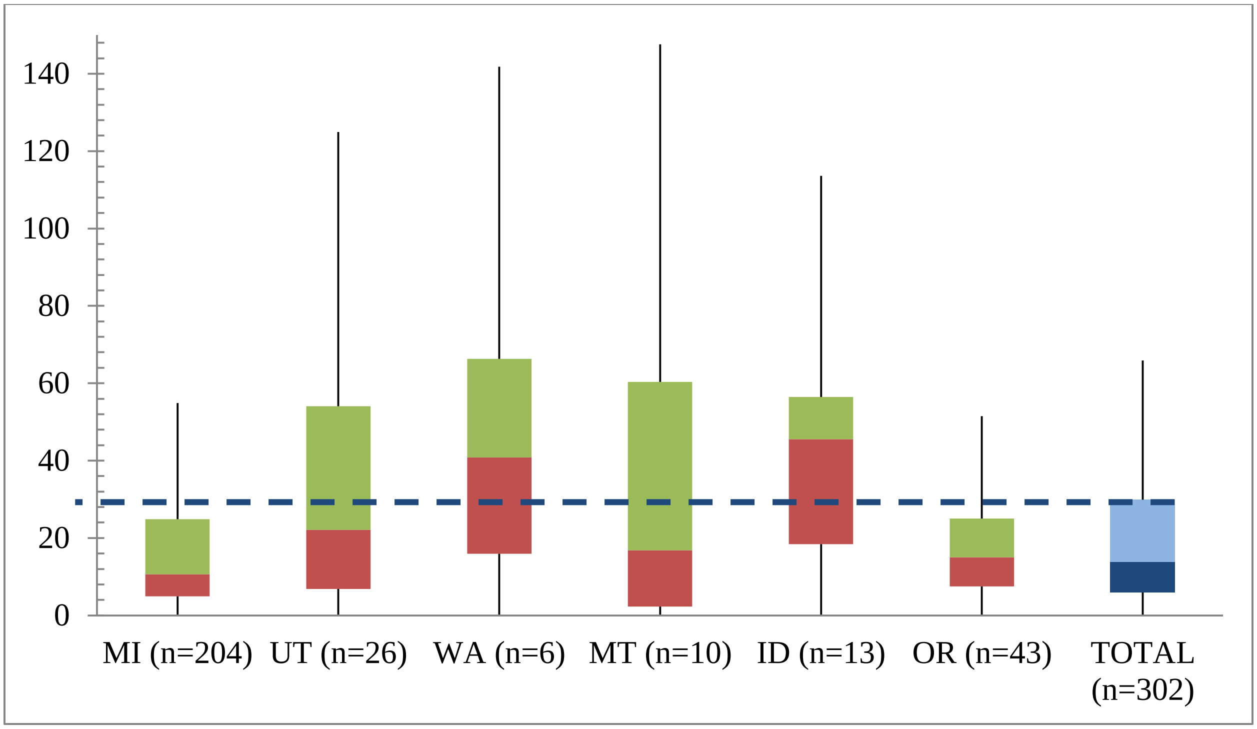


Figure 10: Population samples by state (thousand people)

The aggregate total curve is influenced heavily by the larger sample states due to the nature of numerical response. Michigan, Utah, Montana, and Oregon samples are nearest to the overall average. Oregon exhibits the greatest amount of variance in comparison to other survey states. Montana, Utah and Washington indicate similar values, all below the average variance for the total sample. Survey states with smaller sample sizes seem to present average populations furthest from the overall average.

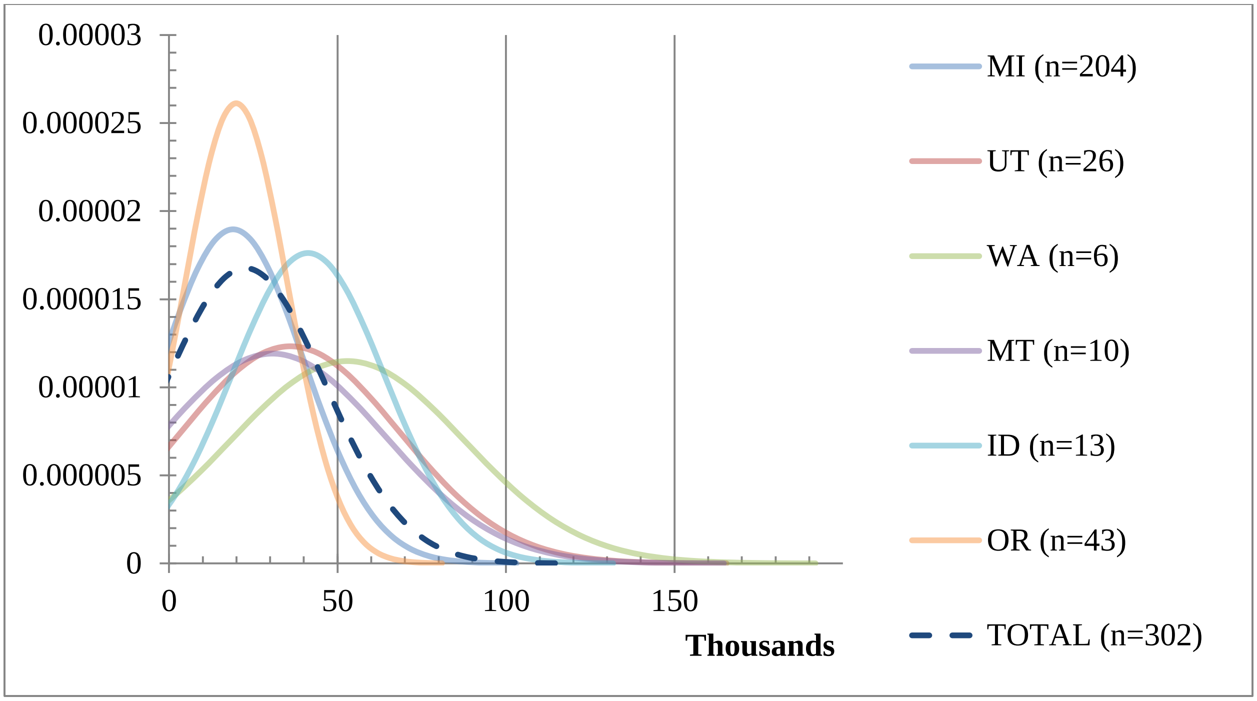


Figure 11: Population sample distribution (thousand people)

Jurisdictional population was also analyzed incrementally to study the frequency of responses as population increases. Overall, the majority of survey respondents were found to serve smaller jurisdictions (in terms of population). In fact, 43% of total respondents indicated serving a jurisdiction of less than 10,000 people. The largest population bins were observed to contain less than 1% of the overall respondents. The correlation between population size and number of respondents is determined to be inversely proportional; the percentage of respondents serving large jurisdictions decreasing exponentially as sample size increases.

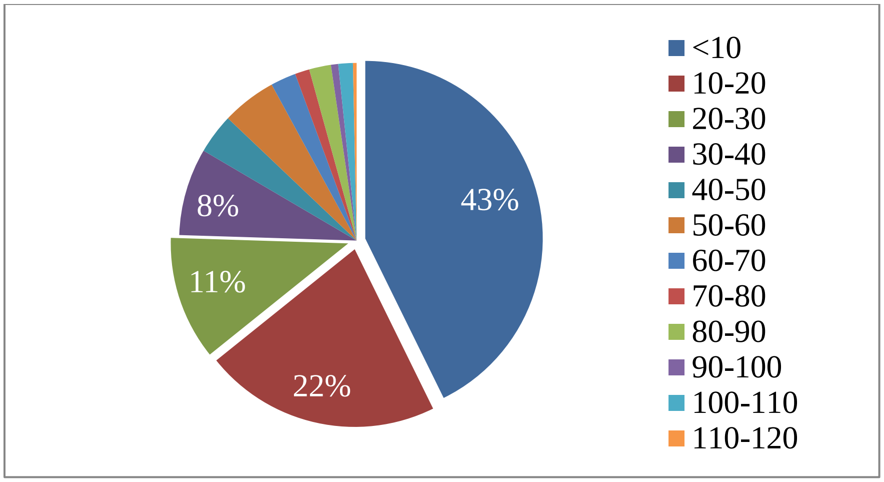


Figure 12: Population frequency (thousand people) (n=302)

Observed Trends

The following trends were observed from the individual question analysis:

- 302 total respondents indicated an average jurisdictional population of 22,617 people
- Inversely proportional relationship: as sample size increases, the percentage of respondents serving large jurisdictions decreases
- The vast majority of code officials surveyed serve smaller jurisdictions—43% of all respondents serve a jurisdictional population of less than 10 thousand people

Question #2: Building Permits Issued

Language: *In the previous calendar year, how many building permits were issued by your agency?*

a) Residential building permits
b) Commercial building permits

Classification: Numerical (number of permits)

This question identifies the number of residential and commercial building permits issued by the respondent's agency or local code enforcement jurisdiction within the previous calendar year. The question sample size is made up of 256 residential and commercial responses across all six survey states. Overall, respondents indicated an average of 162 residential and commercial permits combined, which represents a unit rate of approximately 7.16 permits issued per 1000 people served.

Residential

The greatest number of residential permits observed was submitted by a Washington respondent, indicating 1100 residential permits issued in the previous year. Interestingly, some agencies had issued no residential permits. In total, the average code enforcement jurisdiction issued 105 residential building permits in the previous calendar year. In comparison to jurisdictional size, this represents 4.64 residential permits per 1000 people served.

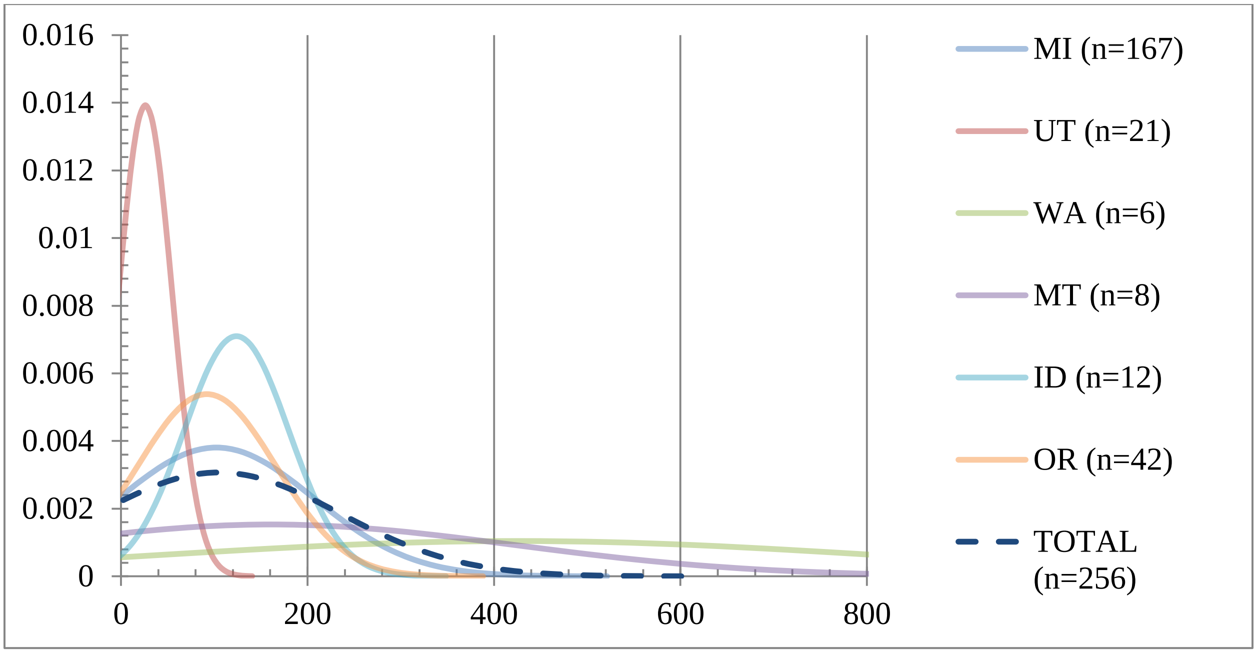


Figure 13: Residential permit sample distribution (number of permits)

The majority of jurisdictions indicate having issued fewer residential permits. Approximately 66% of all respondents replied as having issued less than 100 residential building permits in the previous calendar year. This could be a factor of a slowed building economy, but also must be considered in relation to population served; most code officials seemingly serve a smaller jurisdiction in terms of population. However, 6% of all jurisdictions surveyed indicate having issued in excess of 300 residential permits in the previous year.

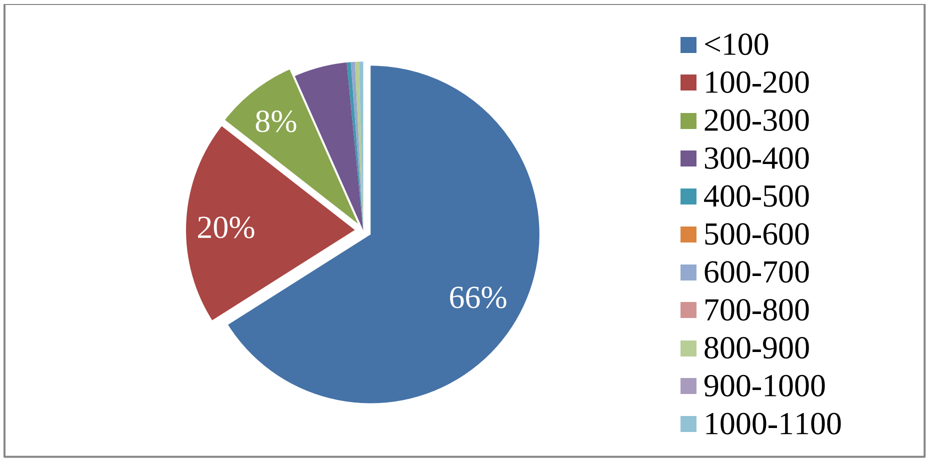


Figure 14: Total residential permit distribution (number of permits) (n=256)

Commercial

Enforcement jurisdictions in three of the six survey states indicated no commercial permit activity in the previous calendar year. The average jurisdiction saw 57 commercial building permits, which equates to 2.52 permits per 1000 people served. The state of Washington exhibited a high of 1000 commercial permits.

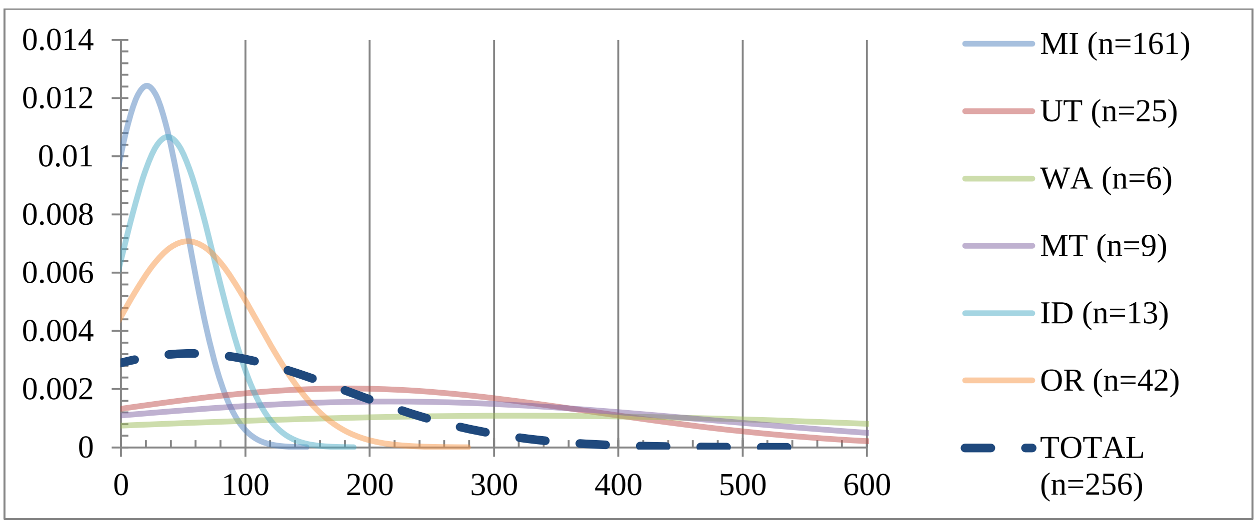


Figure 15: Commercial permit sample distribution (number of permits)

A trend towards fewer permits is again observed in commercial buildings, with a majority of respondents indicated having issued less than 100 commercial building permits in the previous year. This is even more extreme than the similar trend witnessed for residential permits. Nearly 95% of all jurisdictions issued less than 200 commercial permits. Even Michigan, with 161 respondents, 98% stated issuance of less than 100 commercial permits—100% of respondents in the less than 200 category.

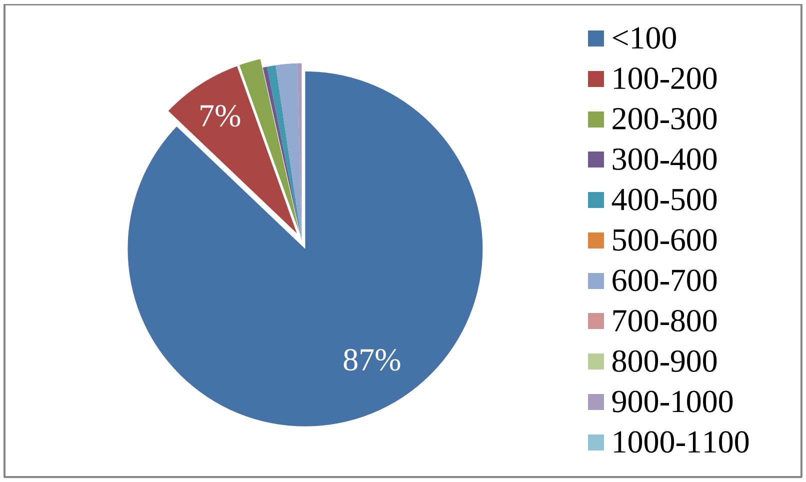


Figure 16: Total commercial permit distribution (n=256)

Observed Trends

The following trends were observed from the individual question analysis:

- 256 residential and commercial respondents indicated an average of 162 permits issued in the previous calendar year—an average of 105 residential buildings and 57 commercial
- A trend was observed favoring the issuance of fewer building permits—similar to the trend towards smaller jurisdictional population observed in the previous question
- 66% and 87% of respondents indicated having issued less than 100 residential and commercial building permits, respectively
- Compared to jurisdictional population, the average respondent saw 7.16 building permits per 1000 people served—4.64 residential permit and 2.52 commercial

Question #3: Funding Source

Language: *How is your agency funded? (Check all that apply)*

a) *Permitting revenue*
b) *Jurisdictional budget*
c) *State funded*
d) *Other (please specify)*

Classification: Categorical *(check all applicable responses)*

The majority of agencies were observed to acquire funding from a single source. Approximately 20% of Michigan and 33% of Utah jurisdictions indicated funding from more than one source. 100% of all respondents from Washington, Montana and Idaho said their jurisdiction pulled funding from a single source. (*Note*: Survey data pertaining to jurisdictional funding was not gathered in the Oregon study)

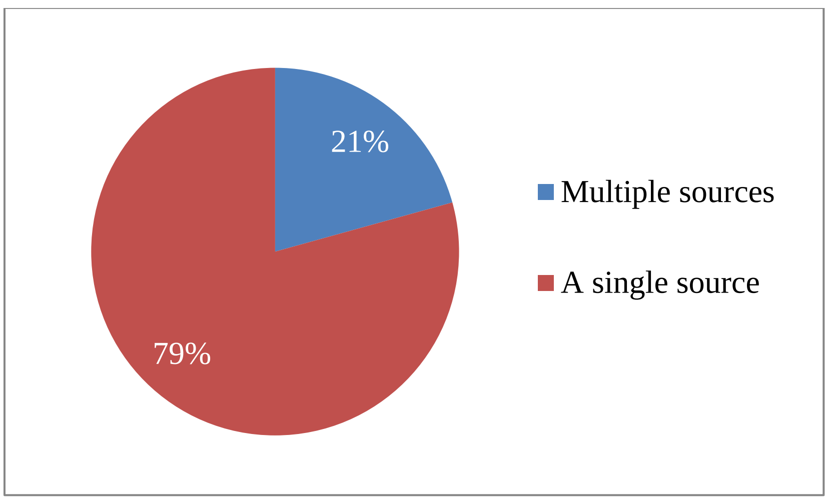


Figure 17: Jurisdictional funding source (n=319)

Funding revenue is often gained as a result of fees charged for plan review and permitting processes. This option was identified in most states as the primary source of funding. Other methods of funding often involve formulaic allocation from a municipal budget or secured through state government agencies. Respondents were asked to indicate applicable funding sources.

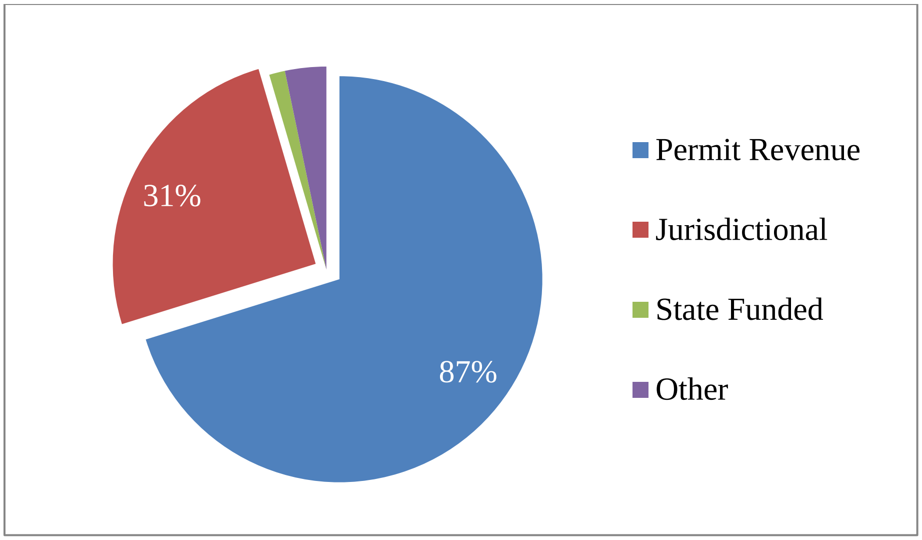


Figure 18: Type of jurisdictional funding (n=319)

Permit revenue appears to be the most common form of financial support, with 87% of survey respondents identifying funding of this form. Approximately one-third of responses indicate funds spawning from a jurisdictional budget, such as that provided by a local municipality.

Observed Trends

The following trends were observed from the individual question analysis:

- Most (79%) code enforcement jurisdictions obtain funding from a single source
- 87% of respondents stated permit funding as primary funding
- Approximately one-third (31%) of respondents also indicated funds were received as part of a jurisdictional budget—funding from state agencies and other sources were not found to be of significant contribution

Questions about Your Staff

These questions inquire upon characteristics of staff employed for the purpose of energy code enforcement. The following questions were included in the data analysis.

Question #4: Plan Review

Language: *Who conducts plan reviews for energy code compliance? (Check all that apply)*

- *a) In-house staff*
- *b) 3rd party staff*
- *c) Other jurisdictions or government agencies*
- *d) Not done*
- *e) Other (please specify)*

Classification: Categorical *(check all applicable responses)*

Local code enforcement jurisdictions were asked to identify the party responsible for conducting review of building plans. This process typically involves checking building plans, specifications and other documents when submitted for approval as part of the permitting process. Ideally, an individual will have ample information to determine compliance with the energy code. This survey question aims to identify who is performing this assessment.

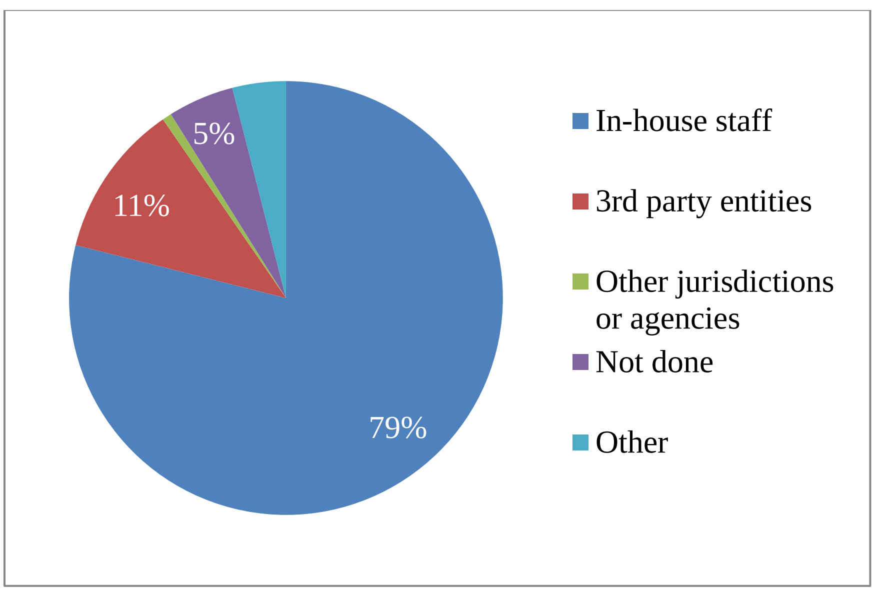


Figure 19: Party conducting plan review (n=382)

Most plan reviews were found to be conducted by in-house staff employed by the local jurisdiction. In most cases, staff persons performing this assessment will be code officials, often completing plan reviews, as well as building inspections in the field. 79% of respondents indicated in-house staff as performing plan reviews. A second option exercised was the use of third parties to complete the plan review—11% of respondents indicated this option. Interestingly, approximately 5% of those responding to the survey stated no plan review step was performed at all as part of the compliance assessment process.

Observed Trends

The following trends were observed from the individual question analysis:

- In-house jurisdictional staff personnel conduct the majority of plan reviews (79%)
- 11% of reviews not performed by in-house staff utilize third party contracted reviewers
- Approximately 5% of all respondents indicate no plan review is conducted in determining compliance with building energy codes

Question #5: Field Inspections

Language: *Who conducts field inspections for energy code compliance? (Check all that apply)*

a) In-house staff
b) 3rd party staff
c) Other jurisdictions or government agencies
d) Not done
e) Other (please specify)

Classification: Categorical *(check all applicable responses)*

Similar to the previous question surrounding plan review, local jurisdictions were asked a question seeking the responsible party for performing building energy code field inspections. This typically involves travel to a project site, accessing the site, and a thorough inspection of all applicable code provisions. Infractions are marked and must be remedied before a project can proceed to completion and receive a Certificate of Occupancy. Inspectors may often be the same party responsible for performing the plan review stage of the compliance assessment process. In cases of major code infraction, an inspecting official usually carries the authority to shut down the project until problems are resolved. This question aims to identify the party responsible for performing this inspection.

Field inspections were found to be performed most often by in-house staff. Across all states surveyed, 83% were completed by staff of the local jurisdiction. Third party contractors were found to perform approximately 8% of field inspections. Only 1% of respondents indicated this stage was performed by an outside agency, with 5% of the total stating field inspections were not conducted at all.

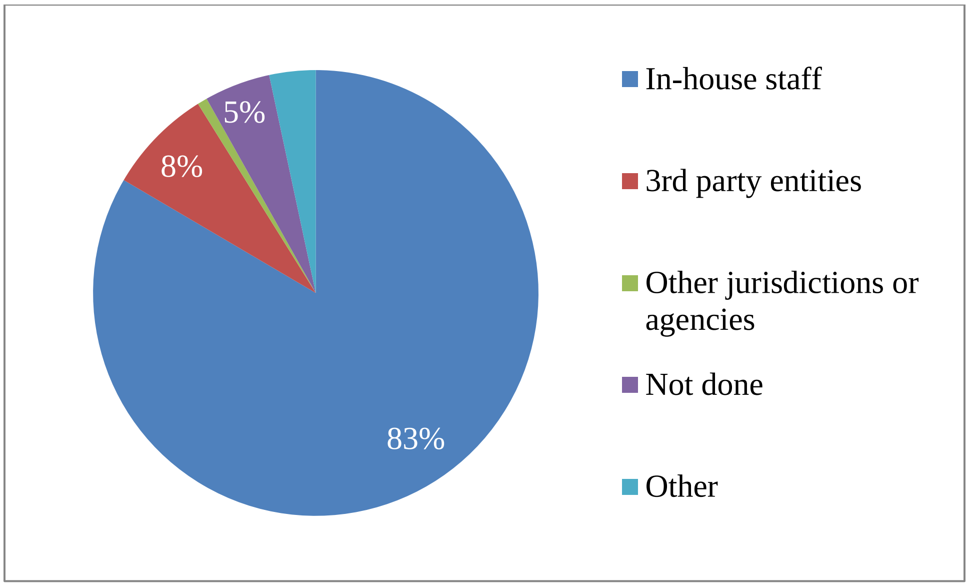


Figure 20: Party conducting field inspection (n=382)

Observed Trends

The following trends were observed from the individual question analysis:

- In-house staff conduct 83% of building energy code field inspections
- 8% of inspections are performed by a third party
- 5% of respondents indicate no field inspection is performed in their jurisdiction

Question #6: Education & Training

Language: *What level of education and training does your agency staff receive specifically for energy codes?*

a) *Residential energy codes training*
b) *Commercial energy codes training*

Classification: Categorical (Choose only one rating 1-4)

Many states and or building official organizations conduct energy code training to better understand its requirements. A survey question was included to quantify the level of training code officials received specifically pertaining to the energy code. Several response options were included, ranging from training required as part of a professional certification or licensure program, to informal on-the-job training, or even no training at all.

The majority of code officials (56%) were found to receive periodic formal training, commonly delivered by the International Code Council (ICC), sponsored by the state, or through a code officials association. The second most frequent response (25%) indicated professional certification and annual training requirements—a highly positive outcome following a recent push to increase the availability of energy code training. Approximately 6% of respondents stated only periodic training received, while 11% reported no training provided.

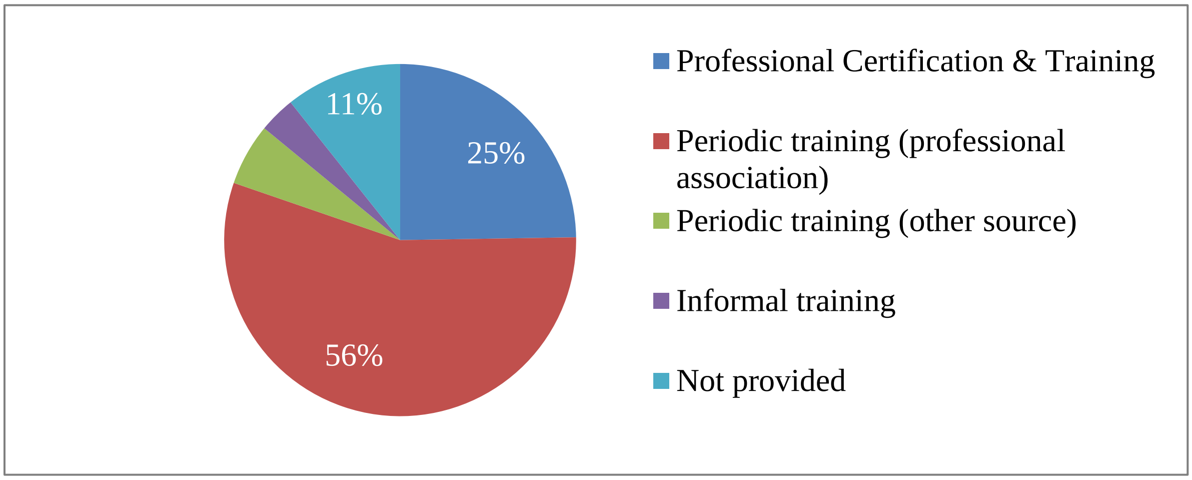


Figure 21: Method of training delivery (n=299)

A spectrum of mutually exclusive response options is included in the question. These range from a seemingly highly positive condition (professional certification and mandatory training) to a presumed negative (no training provided). An integer rating was assigned to each response, ranging from a max score of 4.0 (associated with higher levels of training) to a low score of 0.0 (assigned to responses indicating no provided training). Each state was then scored based on the level of training available to survey respondents. Unlike many of the survey questions, only one singular response could be chosen.

Under the scaling method outlined above, an average rating of 2.80/4.00 was observed across all states. Utah code officials reported the highest levels of energy code training (3.36), with Idaho achieving a rating of 3.27. Washington and Michigan exhibited a rating of 2.72 and 2.00, respectively.

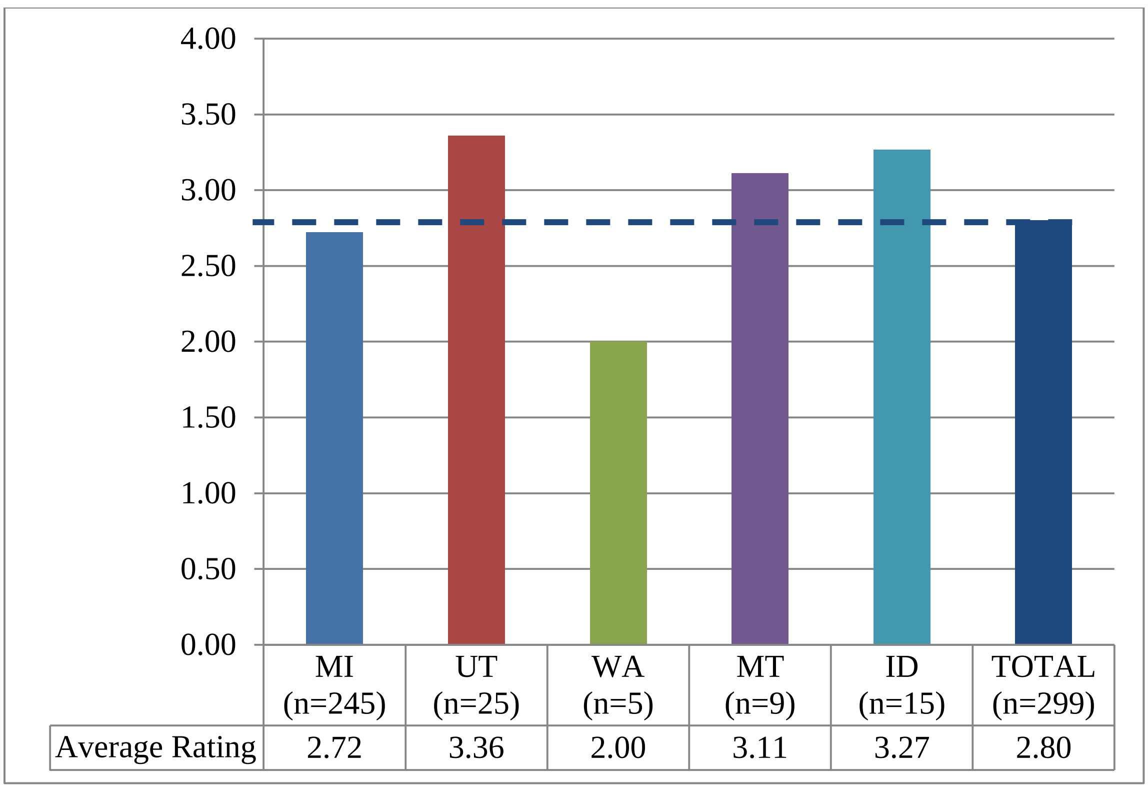


Figure 22: Rating of training by state

Observed Trends

The following trends were observed from the individual question analysis:

- Most code officials (56%) receive periodic formal training, often provided by the International Code Council, code officials association, or a state-sponsored training program
- 25% of code officials receive mandatory training, such as that tied to a professional certification or continuing educational program requirement
- Approximately 11% of code officials receive no energy code training whatsoever

Questions about Your Processes
These questions gather information on processes for assessing compliance with energy codes. The following questions were included in the data analysis.

Question #7: Compliance Path

Language: *What methods are used as a basis for documenting energy code compliance and in what percentages? REScheck and COMcheck are considered trade-off methods. Use whole numbers without a % sign to complete the question.*

a) Prescriptive
b) Trade-off
c) Performance

Classification: Numerical (separate percentage entries for residential and commercial)

Residential

The residential energy code, commonly based on the International Energy Conservation Code published by the International Code Council, allows for three primary options for demonstrating compliance with the code. These are often referenced as *compliance paths.* These options include a *prescriptive* checklist or 'cookbook' approach, *trade-off* options where a proposed design is compared to a baseline home, or a simulated *performance* approach. Some states allow compliance to be demonstrated through the use of the RES*check* software, produced by the U.S. Department of Energy, following the trade-off approach (based on an area-weighted heat resistance factor). Other states also allow for a home energy rating, such as those performed by a HERS Rater. This survey question seeks the compliance path most often utilized in local jurisdictions.

The majority of code officials (54%) report the use of RES*check* software as the most prominent option for demonstrating energy code compliance. The prescriptive path is chosen on average 38% of the time; with the performance path option utilized only 8% of the time. It should also be noted that while all surveyed states acknowledge RES*check* as a valid path, not all states accept this method of demonstrating compliance with the residential energy code.

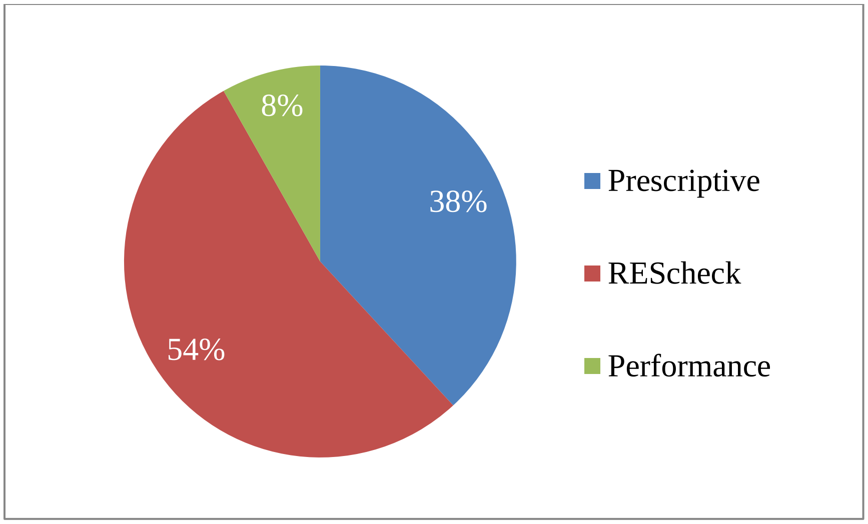


Figure 23: Residential compliance path (n=230)

Commercial

The commercial energy code is based on ANSI/ASHRAE/IESNA Standard 90.1, published by the American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE). Like the residential code, the commercial code allows similar options for demonstrating compliance, including the same *prescriptive*, *trade-off*, and *performance* approaches. Some states allow compliance to be demonstrated through the use of the COM*check* software, published by DOE as a counterpart to the residential version, and based on the same trade-off approach. This survey question seeks the compliance path most often utilized in local jurisdictions to demonstrate commercial code compliance.

The majority of code officials (57%) report the use of COM*check* software as the most common option for demonstrating compliance with the commercial energy code. The prescriptive path is chosen on average 34% of the time; with the performance path option utilized only 8% of the time. While all surveyed states acknowledge COM*check* as a valid approach, not all states accept this method of demonstrating compliance with the commercial energy code.

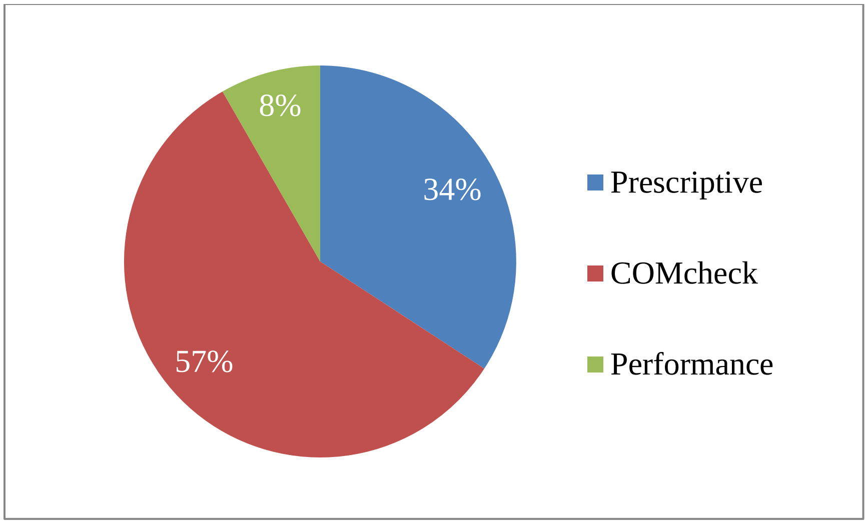


Figure 24: Commercial compliance path (n=211)

Observed Trends

The following trends were observed from the individual question analysis:

- Most projects achieve energy code compliance certification through the trade-off method—often through RES*check* or COM*check* software
- The prescriptive method is the second most commonly utilized compliance path
- Compliance through building energy performance simulations occur more often on residential homes than on commercial building projects

Question #8: Time Spent on Plan Review

Language: *How many hours are devoted to the average plan review for energy codes? If energy plan reviews are performed in conjunction with reviews for other code provisions, estimate the time for the energy-related reviews only.*

a) Residential buildings
b) Commercial buildings

Classification: Numerical (hours of time)

Residential

A key question included in the 90% Compliance Pilot Studies surrounded time dedicated to evaluation processes. Existing studies have cited available resources as a primary barrier to full enforcement of the energy code. The plan review process typically involves the checking of plans and specifications to ensure a house is designed to comply with the applicable energy code.

The survey set out to capture an estimate of how much time is dedicated to the average residential plan review.

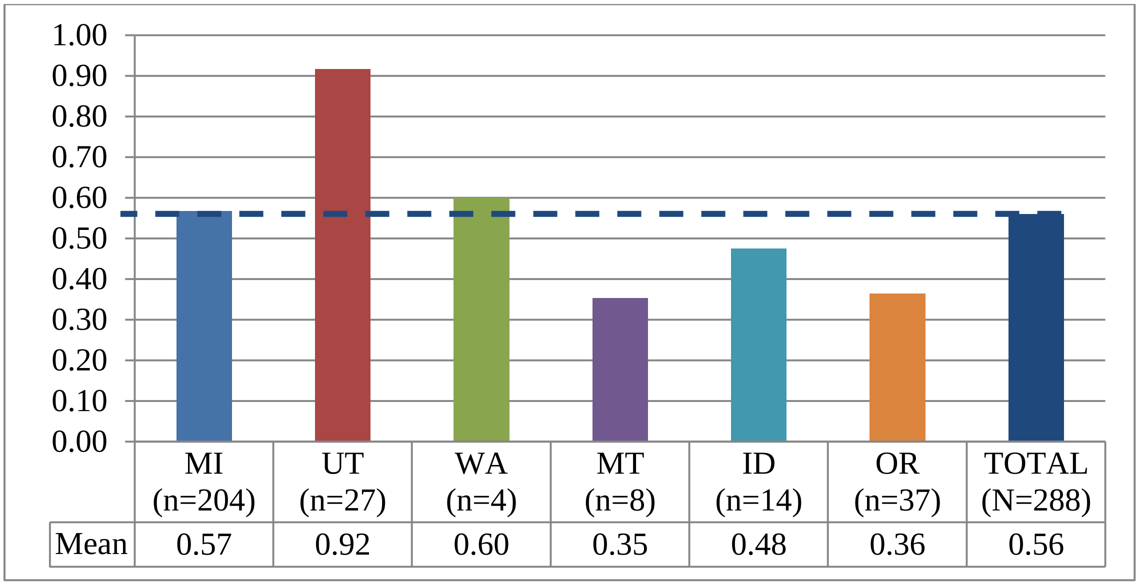


Figure 25: Average time spent on residential plan review by state (hours)

The average residential energy code plan review was reported to take 0.56 hours to complete. Within individual states, Utah was found to spend a high of 0.92 hours, while Oregon stated an average of 0.36 hours dedicated to energy code plan review. While some individual respondents reported upwards of an hour spent, and some indicating several hours, all states average less than one hour to complete the residential energy code plan review process.

Commercial

The survey also sought an estimate of time spent on plan reviews for commercial buildings. The commercial code is generally considered to be more detailed, and incorporates more complex systems than are found in residential dwellings. Commercial projects also more often include licensed architectural or engineering services.

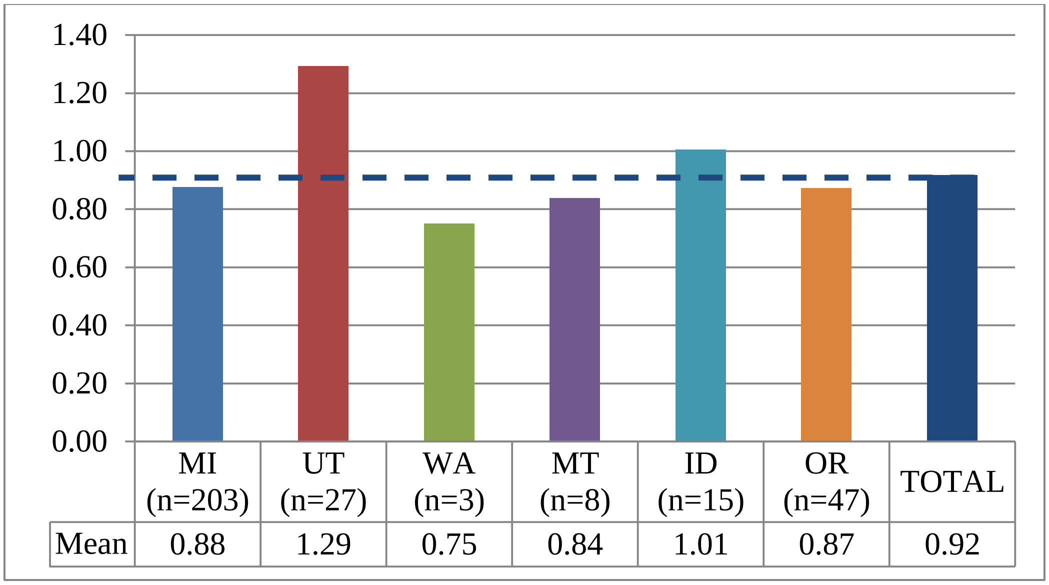


Figure 26: Time spent on commercial plan review by state (hours)

The average commercial plan review was reported to take 0.92 hours to complete. Within individual states, Utah was found to spend a high of 1.29 hours, while Idaho stated an average of 0.75 hours dedicated. In comparison to residential projects, a greater number of respondents indicated one or more hours spent on the commercial plan review—observed within the greater overall average time spent.

Observed Trends

The following trends were observed from the individual question analysis:

- Code officials on average spend just over a half hour (0.56) on residential plan reviews—all states spend an average of one hour or less
- The average time for a commercial plan review is approximately 0.92 hours—a longer process for more complicated commercial buildings than for homes

Question #9: Time Spent on Field Inspection

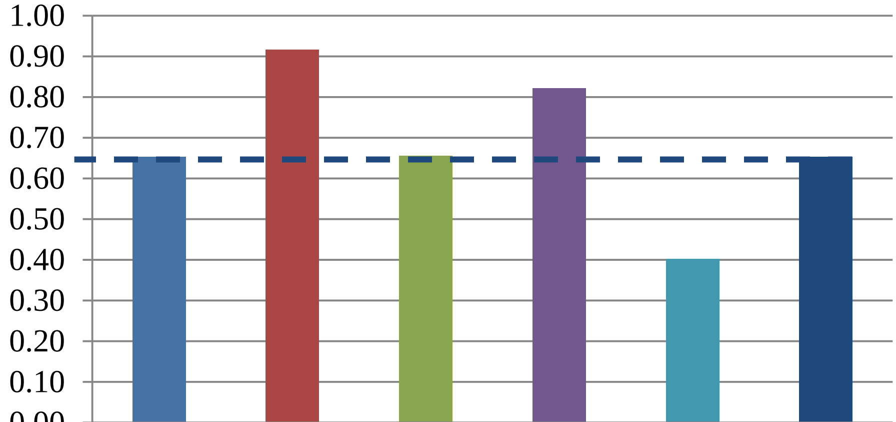
Language: *How many hours are devoted to the average field inspection for energy codes? If energy field inspections are performed in conjunction with inspections for other code provisions, please estimate the time for the energy-related field inspections only.*

a) Residential buildings
b) Commercial buildings

Classification: Numerical (hours of time)

Residential

Building on the previous question, the survey attempted to quantify time requirements for field inspection. As this stage of the process, verification is conducted at the project site, which is typically more time consuming in comparison to plan review. Additional resources may also be required as the process moves from the office setting to the field.



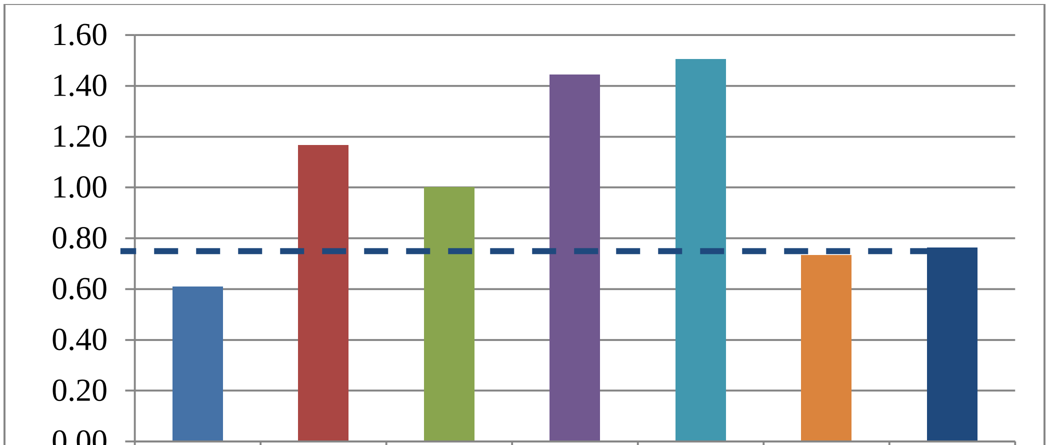
	MI (n=223)	UT (n=24)	MT (n=8)	ID (n=15)	OR (n=36)	TOTAL (N=306)
Mean	0.65	0.92	0.66	0.82	0.40	0.65

Figure 27: Time spent on residential field inspection by state (hours)

The average residential energy code inspection was conducted in 0.65 hours. Within individual states, Utah was found to spend a high of 0.92 hours—the same amount of time estimated in the state for the plan review process. On the low end, Oregon reported an average of 0.40 hours dedicated to energy code field inspection. Similarly to plan review, although individual respondents stated upwards of an hour spent inspecting each home, all states average less than one hour to complete the residential inspection.

Commercial

On the commercial side, the survey also sought an estimate of time spent in the field inspection stage of the compliance assessment process.



	MI (n=176)	UT (n=24)	WA (n=9)	MT (n=12)	ID (n=14)	OR (n=46)	TOTAL (N=272)
Mean	0.61	1.17	1.00	1.44	1.50	0.73	0.76

Figure 28: Time spent on commercial field inspection by state (hours)

The average commercial field inspection was reported to take 0.76 hours to complete—larger state samples were quite comparable to the amount of time spent inspecting a home. Within individual states, Idaho was found to spend the most time (1.50 hours) on the inspection process. Montana exhibited a close second, dedicating on average 1.44 hours to the commercial inspection. With the exception of Michigan and Oregon, code officials report spending significantly more time on commercial field inspections than on residential inspections.

Observed Trends

The following trends were observed from the individual question analysis:

- The average residential field inspection takes approximately 0.65 hours to complete—all states averaging less than one hour
- The commercial energy code inspection averages 0.76 hours
- A greater number of respondents indicate more time spent on the commercial inspection compared to residential, however the averages for each category remain comparable

Question #10: Format of Permitting Data

Language: *What format does your agency use to maintain permitting data?*

a) Paper
b) Digital
c) Other (please specify)

Classification: Categorical *(check all applicable responses)*

Some building code compliance organizations are starting to utilize technological alternatives to the standard inspection and compliance assessment process. These may include conversion of plans, specifications and other compliance reporting documents to digital, or paperless, formats. Prescriptive checklists may be also be converted. In some cases, inspection data can be entered through a computer or onsite tablet device, and later exported for storage or further analyses. This question addresses the format a local jurisdiction uses to maintain permit data collected as part of the energy code compliance assessment process.

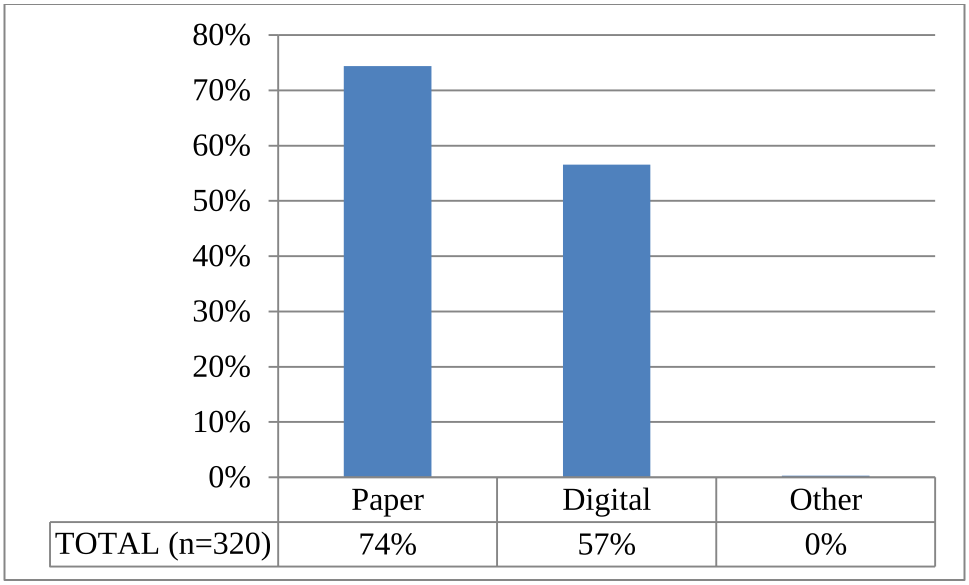


Figure 29: Format used to maintain permit data

The majority of local code enforcement jurisdictions (74%) conducts and maintains permit data in the traditional paper format. At 57%, a significant portion also reports digital maintenance of this data. At the state level, a similar trend is observed. Most state samples indicate the paper format. Idaho respondents, however, indicate a greater prevalence of digital.

Observed Trends

The following trends were observed from the individual question analysis:

- Local code enforcement agencies most often maintain permit data in paper format—74% of respondents
- 57% of local jurisdictions also report maintaining data in digital format

Question #11: Limitations

Language: *What limitations impede your ability to enforce the energy code? (Check all that apply)*

- *a) Time or staff*
- *b) Money*
- *c) Code books*
- *d) Education or training*
- *e) Data provided with plans*
- *f) Building access*
- *g) Equipment*
- *h) Not applicable*
- *i) Other*

(if responded other, text entry box is included for description of this condition)

Classification: Categorical (check all applicable responses—separate classification for residential and commercial buildings)

Residential

One of the primary questions included in the survey surrounds limitations and challenges impeding local jurisdictions. Data was collected classified into nine distinct categories, based on common barriers. These included: time and staff constraints, financial, availability of code books, education and training, data provided with plans and specifications, access to the project site, equipment, not applicable, and other. This portion of the response data quantifies the prominence of these common barriers to energy code compliance.

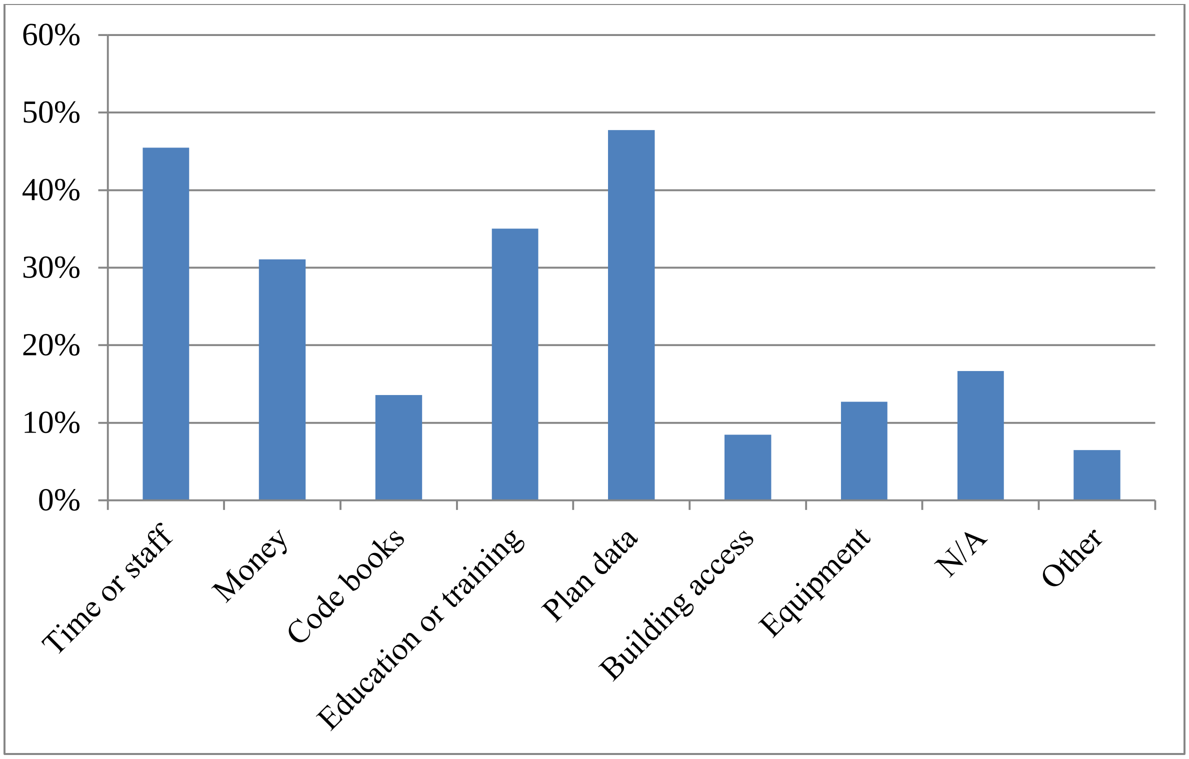


Figure 30: Limitations to residential code enforcement (n=354)

The most prominent barriers to impeding residential energy code compliance surround the availability of resources and information. Nearly half of all respondents (48%) indicated a lack of information provided with building plans and specifications—a severe impediment to the plan review and permitting process. Limited time or staff resources were cited by 45% of respondents, with a lack of education or training following (35%). A general lack of money (31%) rounds out the top impediments to residential energy code compliance and enforcement.

Commercial

Data was also collected for commercial energy code compliance limitations. The same response categories as presented in the previous question were used, allowing for a comparison between residential and commercial trends.

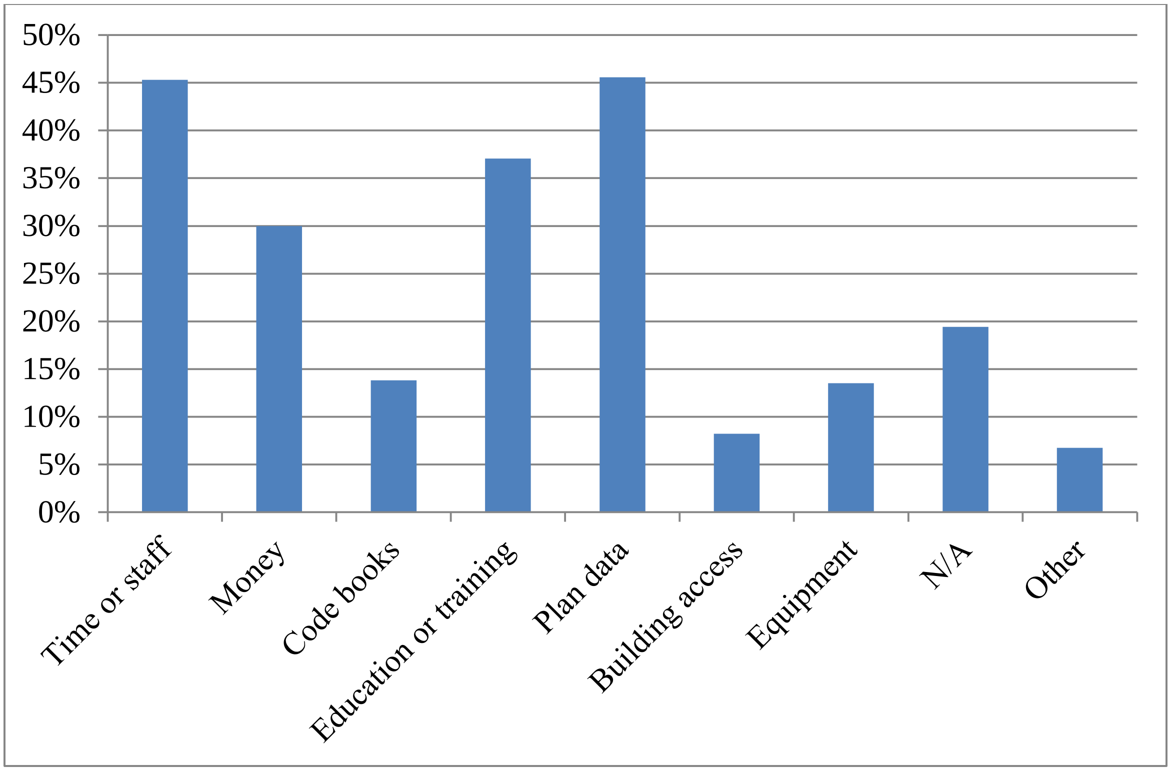


Figure 31: Limitations to commercial code enforcement (n=340)

Limitations to commercial code enforcement follow the same trend across survey states. Insufficient or incomplete data provided with building plans (46%), and a lack of time or staff (45%) were identified most frequently. 37% of responses cited a lack of education or training, while 30% identified money as an impediment.

Observed Trends

The following trends were observed from the individual question analysis:

- Factors limiting energy code enforcement are predominately related to the availability of resources and information
- Primary impediments facing local code enforcement jurisdictions include:
    1. Availability of adequate data with building plans and specifications submitted for permitting
    2. Time and staff
    3. Education or training
    4. Money

Question #12: Residential Code Infractions

Language: *In your jurisdiction, in what plan review and/or inspection items do you generally find do not comply with the **residential** building code? (Check all that apply)*

- *a) Envelope insulation levels*
- *b) Envelope insulation installation*
- *c) Envelop sealing (infiltration)*
- *d) Fenestration*
- *e) Duct insulation*
- *f) Duct sealing*
- *g) Piping insulation*
- *h) Lighting fixtures*
- *i) HVAC sizing*
- *j) Other (please specify)*

Classification: Categorical *(check all applicable responses)*

In addition to general limitations, the survey also sought to identify the most common infractions witnessed by code officials in residential and commercial buildings. Nine residential response options were provided, and can be classified as related to the building envelope, mechanical, or lighting systems. A breakdown of these general categories is presented, followed by the direct analysis of question response options.

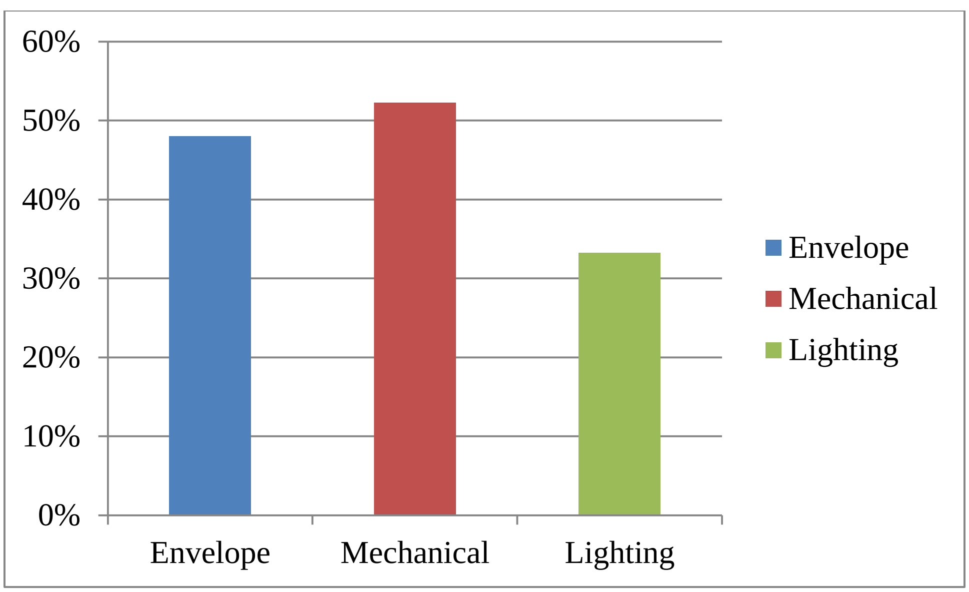


Figure 32: Common residential code infractions (general category) (n=331)

Over half (52%) of survey respondents reported infractions as common within the building mechanical system. These could include both the efficiency of the actual mechanical unit, or installation problems, such as duct sealing. Problems in the building envelope are found almost nearly as often, with 48% of respondents reporting related infractions. Lighting in residential buildings was identified less; however 33% of respondents reported problems with these systems, as well.

From a more detailed perspective, envelope air infiltration was identified as the most frequently occurring residential code infraction (47%), followed by duct sealing (38%) and proper insulation levels (37%). Improper duct and piping insulation was reported in similar frequency. Air sealing, both in the building envelope and duct systems, appear to be a common problem in homes.

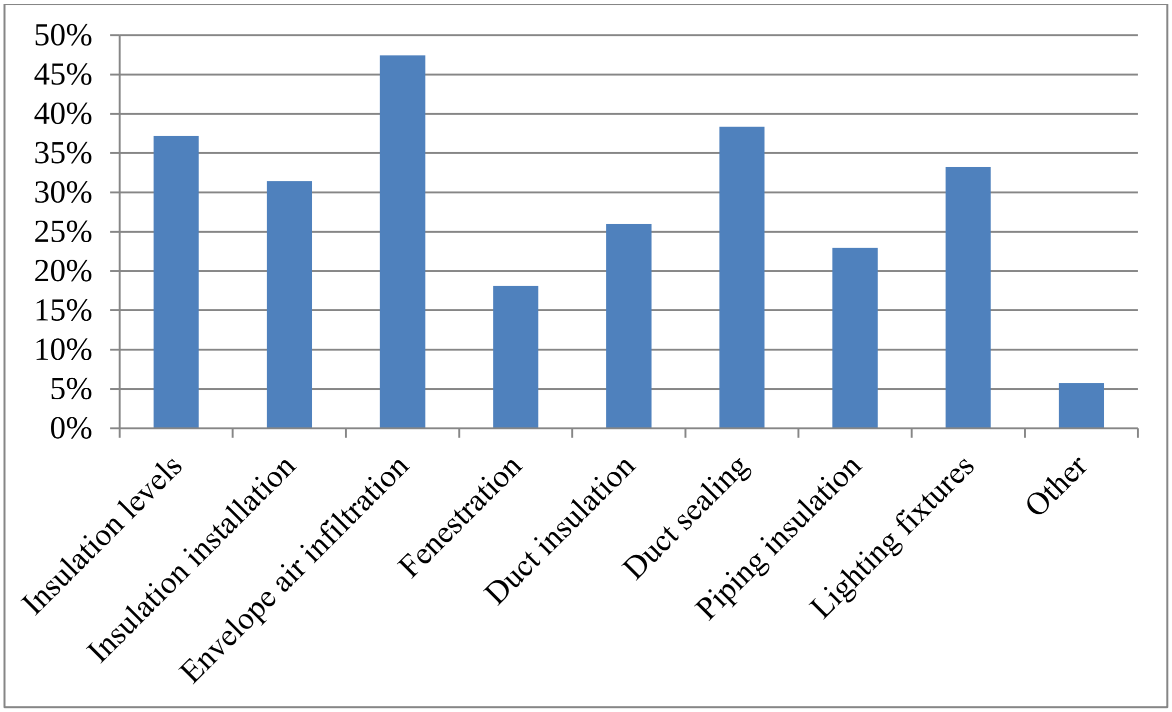


Figure 33: Common residential code infractions (n=331)

Observed Trends

The following trends were observed from the individual question analysis:

- The most common residential code infractions are found in the home mechanical system (52%), followed closely by problems with the envelope (48%)
- Air sealing is specifically identified—envelope air infiltration and sealing of mechanical ducts
- Insulation levels and improper installation was also commonly reported
- Fenestration was reported as having the fewest associated code infractions

Question #13: Commercial Code Infractions

Language: *In your jurisdiction, in what plan review and/or inspection items do you generally find code do not comply with the* ***commercial*** *building code? (Check all that apply)*

- *a) Envelope insulation levels*
- *b) Envelope insulation installation*
- *c) Envelop sealing (infiltration)*
- *d) Fenestration*
- *e) Duct insulation*
- *f) Duct sealing*
- *g) Piping insulation*
- *h) Lighting fixtures*
- *i) Lighting controls*
- *j) HVAC system controls*
- *k) Other (please specify)*

Classification: Categorical *(check all applicable responses)*

A question identifying common commercial energy code infractions follows the previous inquiry. A similar format and set of response options were offered, however; additional options were offered to capture greater specificity in commercial code provisions related to lighting and mechanical system controls.

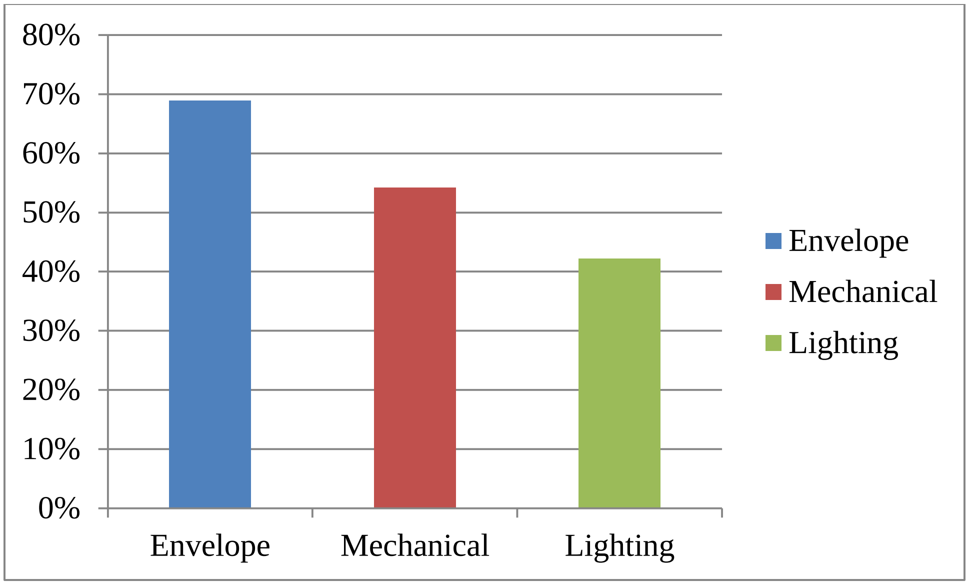


Figure 34: Common commercial code infractions (general category) (n=331)

On the commercial side, the majority (69%) of infractions reported were found within the building envelope. A greater number of respondents indicated problems with the building mechanical and lightings systems, as well. Overall, the frequency of code infractions were observed to be greater in commercial building responses than for residential.

From a more detailed perspective, envelope air infiltration was identified as the most frequently occurring residential code infraction (47%), followed by duct sealing (38%) and proper insulation levels (37%). Improper duct and piping insulation was reported in similar frequency. Air sealing, both in the building envelope and duct systems, appear to be a common problem in commercial buildings.

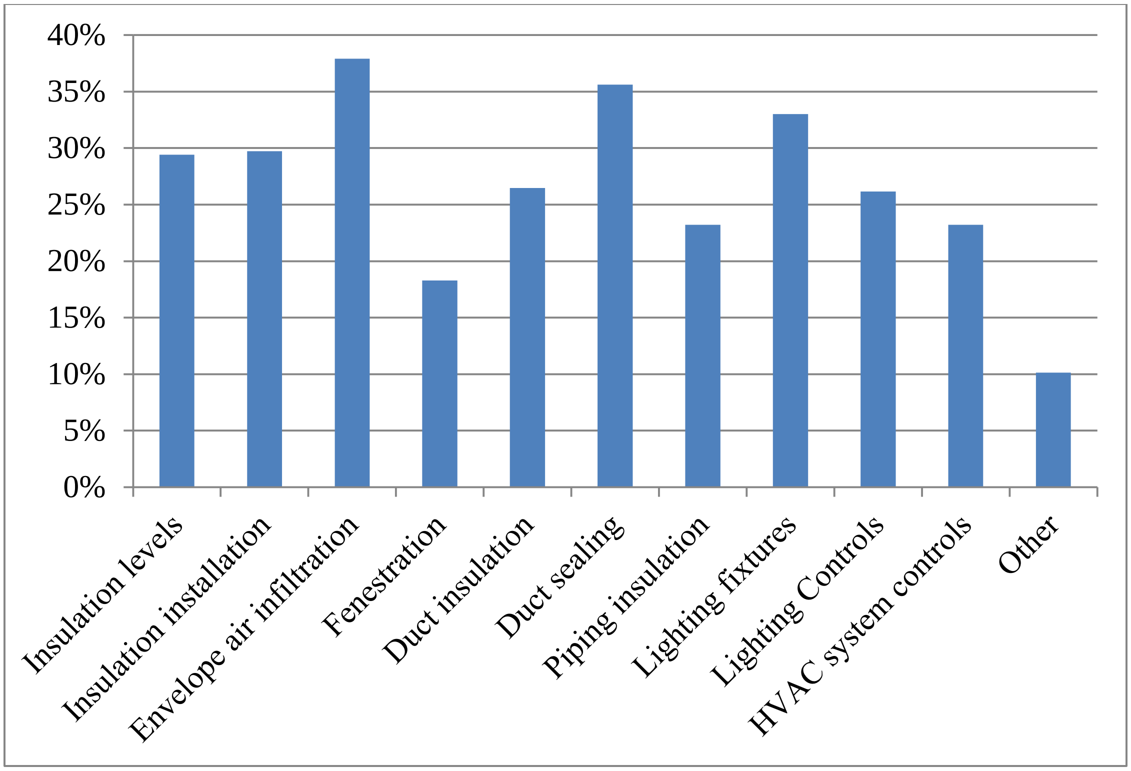


Figure 35: Common commercial code infractions (n=306)

Observed Trends

The following trends were observed from the individual question analysis:

- Energy code infractions observed within commercial projects are most commonly found in the building envelope (69% of respondents)
- Over half (54%) of responses identified the mechanical system as a problem—fewer (42%) citing lighting as an issue
- As seen in residential buildings; fenestration was the least reported infraction

Question #14: Available Information

Language: *What information is available to your staff during field inspection?*
a) Approved plans
b) Energy code compliance checklist(s)
c) Published energy code and/or standard
d) Other (please specify)

Classification: Categorical *(check all applicable responses)*

The survey sought to identify information available to code officials during field inspections.

Several pieces of valuable resources were identified, including approved building plans and specifications, prescriptive checklists, codes/standards, and other guidance. The availability of this information may be correlated with other survey questions, or with best practices and recommendations surrounding energy code compliance.

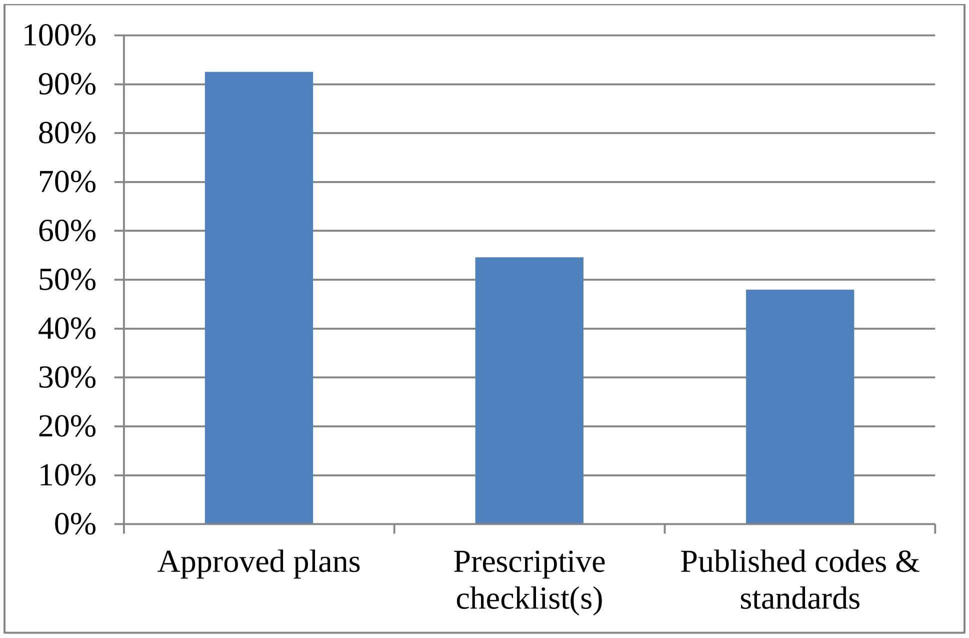


Figure 36: Information available during field inspections (n=348)

Approved plans were by far the most frequently cited source of information available during the field inspection—93% of all respondents indicated having access to them. Only about half of survey respondents reported having prescriptive checklists (55%), or published codes and standards (48%). From the list, it appears specifications and other data was cited as least available, with only 19% of respondents reporting access to this source of information.

Observed Trends

The following trends were observed from the individual question analysis:

- Approved building plans are the resource most commonly available to code officials conducting an energy code field inspection
- Only about half of code officials report having access to prescriptive checklists or the actual energy code or standard being enforced

Question #15: Software Compliance Reports

Language: *Do you accept software compliance reports with permit applications in lieu of a plan review?*

a) Yes
b) No
c) Not applicable

Classification: Categorical *(check all applicable responses)*

Many states accept compliance software reports, such as those generated by RES*check* and COM*check*, in replacement of conducting a formal plan review. These programs are generally considered a desirable option for builders/designers and code officials alike. This question seeks to identify the frequency of this practice.

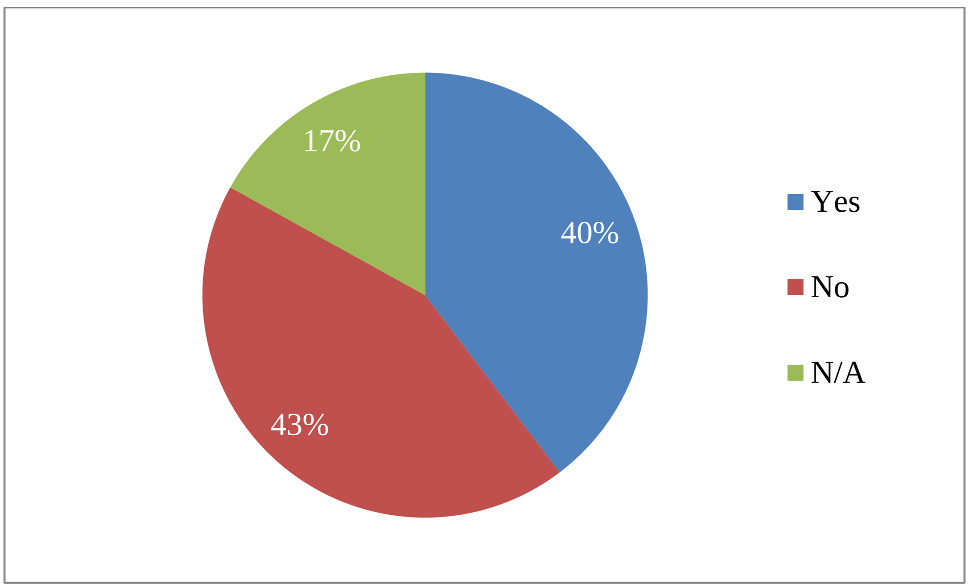


Figure 37: Acceptance of software compliance reports (n=295)

About half of the response distribution reports accepting software compliance reports in lieu of conducting a plan review. This response rate was about as expected prior to analyzing survey data. It is unexpected, however, following the prevalence by which the trade-off compliance path was identified earlier in the survey.

Observed Trends

The following trends were observed from the individual question analysis:

- Less than half of code enforcement jurisdictions report accepting compliance software reports in lieu of conducting a plan review
- An approximately equal number of jurisdictions accept compliance software reports in comparison to those who do not accept the reports

4.3 SUMMARY OF FINDINGS

Response data was analyzed to provide insight on jurisdictional processes and challenges impeding code enforcement at localized stakeholder levels. The original survey was directed towards code officials, who could provide information on building inspection processes, evaluations, and related issues. General findings from the survey analysis are presented in the following sections, and contribute to an understanding of local background and challenges facing 90% Compliance.

Population Sample

Approximately 302 responses were gathered from local code enforcement jurisdictions. The average code official works for a jurisdiction serving 22,617 people. The vast majority of respondents serve comparatively smaller jurisdictions, with 43% coming from a jurisdiction serving a population of less than 10,000 people. The average jurisdiction issued 162 permits in the previous calendar year (105 residential and 57 commercial). Compared to population served, the average code official saw 7.16 residential permits per 1000 people served (4.64 residential and 2.52 commercial).

Funding Sources

Most (79%) of code enforcement jurisdictions obtain their funding from a single source. About 87% of all jurisdictions receive their primary funding through revenue gained from issuing permits. About one-third (31%) also receive funding from a local municipality. Most jurisdictions do not receive funding coming from that state-level.

Responsibilities

The majority (79%) of energy code plan reviews are performed by in-house staff working for the local jurisdiction. Third-party contractors are used about 11% of the time for this service, and 5% of the time no plan review is conducting as part of the process for determining compliance. In a similar trend, jurisdictional staff members also perform 83% of field inspections. Third-party contractors are used for inspection services about 8% of the time, with, again, no energy code field inspection used about 5% of the time.

In performing their duties, code officials spend just over a half hour (0.56) on each residential plan review. The typically more complex commercial plan review process takes significantly longer, averaging 0.92 hours. The residential field inspection takes only slightly longer than the plan review at 0.65 hours. The commercial inspection takes a similar amount of time and less than the average commercial plan review at 0.76 hours.

Compliance processes

Most projects demonstrate compliance with the energy code through the use of the trade-off approach, such as submitting a RES*check* or COM*check* software compliance report. For residential buildings, the trade-off approach is used 54% of the time, and 57% of time in commercial projects. The prescriptive path is the second most preferred compliance path in residential and commercial buildings, and is utilized 38% and 34% of the time, respectively. Compliance via the performance path is chosen at about the same rate (8%) in both residential and commercial buildings.

Permitting data included in the compliance process is generally (74%) maintained in the more traditional paper format. Many (54%) also provide an option to maintain data in a digital format, enabling a greater potential for streamlining processes through technological solutions. However, a link between the maintenance of digital permitting data and the inclusion of technologically advanced processes was not included in the survey. Less than half of enforcement jurisdictions accept software reports in lieu of conducting a formal plan review. Building plans are often approved earlier in the compliance process, and actual conditions are later verified in the field. Approved building plans were found to be the most common resource available to code officials conducting energy code field inspections. However, only about half of code officials are known to have access to compliance checklists or the actual codebook for which they are inspecting and verifying compliance.

Education and Training

Over half (56%) of code officials receive at least periodic formal energy code training, which is often provided by a state-sponsored program or professional association, such as the International Code Council (ICC). Mandatory training is required for 25% of code officials, for example that tied to professional certification or continuing education programs. About 11% of code officials receive no energy code training whatsoever.

4.4 CHAPTER SUMMARY

Chapter Four presents survey response data analyzed to better understand processes and challenges at local levels of code implementation. Data was previously collected in several states based on a survey instrument designed by the Pacific Northwest National Laboratory. Response data is broken down by each survey question, accompanied by trends emerging from the analysis. A summary of findings resulting from the survey analysis is also presented, and contributes to conclusions presented in the final chapter.

CHAPTER 5: QUALITATIVE ANALYSIS

5.1 OVERVIEW

Following the analysis of survey data, the investigation continued in seeking additional information to aid states in addressing compliance requirements. This portion of the investigation relied on recent compliance studies reviewed through a process of qualitative content analysis. Conducted in several states, each report serves as a case study, and provides insight in three primary areas: state and local *background information*, *challenges*, and *recommendations* for states. Reports analyzed provide an effective overview of current conditions and actions taken by states early to address Recovery Act requirements. Findings are used to both further and compliment findings gained through the survey analysis, and can be further leveraged to guide states as they address 90% Compliance.

State Samples

Recent studies have taken a preliminary look at states' ability to accept and meet Recovery Act 90% Compliance requirements. These studies resulted in three series of reports, each providing a glimpse of existing state conditions, issues, and recommendations provided to individual states. Reports are analyzed as state case studies and serve as data sources; including two series produced by the Building Codes Assistance Project (BCAP), as well as the final reports submitted by states to the Pacific Northwest National Laboratory (PNNL) upon conclusion of individual 90% Compliance Pilot Studies.

Table 18: Overview of state samples by data source

PNNL 90% Compliance Pilot Study	Report Publication Date	BCAP Gap Analysis	Report Publication Date	BCAP Compliance Plan	Report Publication Date
Georgia	06/2011	*Alabama*	07/2010	*Colorado*	11/2011
*Idaho**	07/2011	*Arkansas*	12/2010	*Delaware*	11/2011
Iowa	06/2011	*Delaware*	01/2011	*Idaho*	06/2011
Massachusetts	07/2011	*Illinois*	12/2010	*Illinois*	11/2011
*Montana**	07/2011	*Kentucky*	02/2011	*Kentucky*	11/2011
*Oregon**	07/2011	*Michigan*	12/2010	*Michigan*	11/2011
Utah	06/2011	*Nebraska*	11/2011	*Nevada*	05/2011
*Washington**	07/2011	*Nevada*	11/2010	*New Hampshire*	11/2011
Wisconsin	N/A	*New Hampshire*	02/2011	*New Mexico*	11/2011
		New Mexico	01/2011	*South Carolina*	11/2011
		Ohio	02/2011	*Texas*	11/2011
		South Carolina	11/2011	*West Virginia*	11/2011
		South Dakota	12/2010		
		Texas	02/2011		
		West Virginia	02/2011		

**States included in combined Northwest Pilot Study*

Findings were extracted and input to a database. Data was further organized, with a matrix constructed for each source to effectively display information emerging from each unique report series. Observations, themes and extracted information is presented by source in the following sections. A resultant summary of findings across all states is also provided, contributing to an increased understanding of background scenarios, challenges faced by states and local implementers, and recommendations for states to consider as they address compliance requirements.

Coding of Data

The content analysis portion of the study relied upon a coding system to guide the data extraction process. Categories were defined by and allocated between three primary categories: state and local background scenarios, challenges impeding implementation, and recommendations for states. Content was first analyzed and coded for contribution to these three primary categories.

Most categories were coded based upon the organizational scheme observed within each reports series. This led to a natural flow of information from the documents to within the boundaries of the study. As additional categories were coded, sub-categories were also created to provide an increasing level of detail, as well as to aid the organizational process and ensure relevant data remained aligned with targeted knowledge. Data was extracted and allocated by coded categories, and displayed in a matrix format allowing for a comparison of codes across states within a single data set. These matrices form the basis for the data tables presented within the chapter. A more detailed description of the content analysis process is included in the *Methodology* chapter. A comprehensive list of codes applied to each data source is also included in Appendix C.

5.2 90% COMPLIANCE STUDIES

Conducted in several states, the PNNL 90% Compliance Pilot Studies set out to test the recommended methodology for assessing and demonstrating compliance with Recovery Act requirements. Reports analyzed provide an effective overview of state experiences and early actions taken to address Recovery Act requirements. Findings are used to further, as well as compliment knowledge gained through the survey analysis, and can also be generalization to guide states in addressing 90% Compliance.

Overview of State Pilots

PNNL 90% Compliance Pilot Studies were conducted across nine U.S. states, including one conglomerate study combining four Northwest states. Upon completion of each pilot, states submitted a final report outlining their approach, findings, successful practices, challenges, and overall feedback on the methodology. These reports serve as case studies from which state experiences and findings can be analyzed to better understand challenges and successful practices. Each report from the collection of studies was analyzed, with findings complimenting and trends observed in the survey analysis portion of the study.

An overview of the data sources, including states covered and respective report publication dates are provided in the following table:

Table 19: State pilot study final report and publication date

PNNL 90% Compliance Pilot Study	Report Publication Date
Georgia	06/2011
*Idaho**	07/2011
Iowa	06/2011
Massachusetts	07/2011
*Montana**	07/2011
*Oregon**	07/2011
Utah	06/2011
*Washington**	07/2011
Wisconsin	N/A

**States included in combined Northwest Pilot Study*

All 90% Compliance Pilot Studies were completed during the 2010-2011 timeframe (*NOTE*: The Wisconsin report did not indicate a publish date). PNNL issued a Funding Opportunity Announcement advertising the need and criteria by which states would be considered for selection. All pilot studies were required to adhere to the PNNL recommended approach; however, no single state undertook a comprehensive study addressing all building types or all requirements within the methodology.

PNNL attempted to select pilot states from several different climate zones across the country, targeting a diverse population of state compliance scenarios. Regional Energy Efficiency Organizations (REEO) were enlisted to aid the selection process, as well as to support states and subcontractors throughout the process.

The following table lists each pilot study state, the administrative state agency, and partnering REEO, along with the publication date for the final report.

Table 20: Pilot study oversight agency and partner organization by state

Pilot State	Oversight Agency	Partner Organization
Georgia	Department of Community Affairs	Southeast Energy Efficiency Alliance
Iowa	Department of Public Safety	Midwest Energy Efficiency Alliance
Massachusetts	Department of Energy Resources	Northeast Energy Efficiency Partnerships
Montana	N/A	Northwest Energy Efficiency Alliance
Northwest	N/A	Northwest Energy Efficiency Alliance
Utah	N/A	N/A
Wisconsin	Safety & Buildings Division	Midwest Energy Efficiency Alliance

States are observed to have taken multiple approaches in coming to terms with their current scenario and in administering study requirements. Some states sent a contact letter and flyer to open communication channels with local enforcement jurisdictions and inform states of the impending study and requirements. PNNL also created a Jurisdictional Survey designed to collect data on local compliance processes and procedures (this survey was administered in a portion of Pilot Study states, with the data presented in the preceding chapter). Several states also relied upon interviews and focus groups to collect further information on state-specific conditions, and also to strategize ideal approaches for identifying building samples and collecting data. The PNNL recommended approach called for multiple requirements in the building evaluation, involving a review of submitted plans and specifications, as well as several field inspections at varying stages of the construction process. Energy code training and educational programs were also suggested to train evaluation personnel. In some cases, these training sessions were also made available to other interested and affected stakeholders.

Table 21: Pilot study approach by state

Instrument	GA	IA	MA	MT	NW*	UT	WI
Contact letter	Yes	Yes	No	No	No	N/A	N/A
Survey	Yes	No	No	No	Yes	Yes	No
Interviews	N/A	N/A	No	No	Yes	N/A	No
Focus groups	N/A	N/A	No	No	No	N/A	No
Plan review	Yes	Yes	No	Yes	Yes	N/A	Yes
Field inspections	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Evaluator training	Yes	Yes	No	No	N/A	N/A	No

*NW denotes the pilot study comprised of the four northwest states

Pilot study states were also chosen for their ability to provide insight upon unique conditions or areas of uncertainty, such as the inclusion of third-party performance testing, alternative means of compliance demonstration, or the execution of inspections within home rule states or unincorporated jurisdictions. The Iowa study was observed to include both a HERS Rating and RES*check* compliance option. The Massachusetts study also included a HERS option, while also including ENERGY STAR homes within the sample. The Montana study was unique compared to other pilot states, in that it included an option for self-certifying compliance with the energy code. Georgia was observed to be one of the earlier states to form a compliance working group, although other states, both pilot and non-pilot, have since followed suit.

In support of their recommended methodology, PNNL hosts a collection of compliance tools and resources to aid inspection and evaluation processes. The PNNL method outlines specific requirements for assembling a statistically valid sample of buildings for compliance evaluation. This process is automated by the Sample Generator tool. The Jurisdictional Survey is designed to collect information on local building department staff, current practices, and processes for determining energy code compliance. Compliance Checklists aid the plan review and field inspection processes, allowing evaluators to verify checklists requirements and the fulfillment of their respective code provisions. Once an inspection has been completed, the Score + Store tool is designed to digitally house the data obtained. The tool is also designed to track the sampling process, as well as report based upon selected metrics.

Table 22: Compliance tools utilized

Compliance Tool	GA	IA	MA	MT	NW	UT	WI
Sample Generator	Yes	Yes	Yes	No	No	Yes	Yes
Jurisdictional Survey	Yes	N/A	No	No	Yes	Yes	No
Compliance Checklists	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Score + Store	Yes	Yes	No	No	No	Yes	Yes

The Compliance Checklists were found to be the most popular resource relied upon in the Pilot Studies, with all states putting them to use. The Sample Generator was also observed to be widely utilized, with only the Northwest and Montana studies choosing not to rely on the tool as a means of generating a set of sample buildings. The Wisconsin study used a combination of the Sample Generator and Departmental software used by the State Safety and Buildings Division. The Montana and Northwest studies also chose not to upload inspection data to the Score + Store tool, nor did the Massachusetts study. Data was collected via the Jurisdictional Survey in three pilot states, and is analyzed in the previous chapter. The Georgia and Utah studies were found to have utilized the entire suite of compliance tools designed to support the PNNL recommended methodology.

The PNNL method outlines four sample types based on new or renovated residential or commercial buildings. As a general rule, 44 buildings of the same type are required to be considered a statistically valid sample. Buildings could be inspected as a single sample building during multiple stages of construction (the single-building approach), or evaluations could be performed based on a combination of multiple buildings making up the entire progression of required construction stages (multi-building approach). The Recovery Act also identifies targets codes by which these samples should be measured for compliance. These codes are interpreted to be the 2009 International Energy Conservation Code (IECC) for residential buildings, and Standard 90.1—2007 for commercial buildings (or better in each case). Some of the pilot states had not yet adopted the target codes at the time of the study. While many states performed a compliance baseline against the target codes, other states measured against the code enacted in the state at the time of the study.

Table 23: State pilot study characteristics

State	Sample Type	Sample Size (no. bldgs.)	Baseline Code	Compliance Rate	Sample Approach
Georgia	Commercial	44	90.1-2007	80%	Multi
Iowa	Residential	50	2009 IECC	54%	Multi
Massachusetts	Residential	50	2006 IECC	88%	Single
Montana	Residential	125	2009 IECC	N/A	Single
Northwest	Residential	N/A	N/A	N/A	Single
Utah	Commercial	42	2006 IECC	87%	Single
Wisconsin	Commercial	44	2009 IECC & 90.1-2007	95%	Multi

Pilot states included residential and commercial building samples of various sizes. The final samples were found to be predominately new or recently constructed buildings. Some states had committed to include renovated buildings within their sample, however; only a handful of these buildings were obtained, with no specific details presented within state reports. The Georgia study focused on new commercial buildings, however the State's final report indicated an additional pilot following the PNNL approach would specifically evaluate residential and commercial renovations.

The smallest building sample was seen in Utah with 42 new commercial buildings inspected. The State of Montana conducted an expanded pilot study, evaluating 125 newly constructed residential buildings. All pilot states, with the exception of Massachusetts and Utah, evaluated compliance against the specified Recovery Act target codes. The Massachusetts study evaluated

50 homes against the 2006 IECC, with Utah evaluating 42 commercial buildings against the commercial energy chapter of the 2006 IECC. The Wisconsin study was unique, in that commercial buildings were evaluated against both the IECC and Standard 90.1.

All states were found to have contracted third-party services to conduct building evaluations. A combination of single- and multi-building sampling was utilized across states, and in some cases these approaches were mixed in order to generate the necessary number of sample buildings. In some cases, timing of the site visit was also reported difficult, resulting in an inspection conducted after certain components were no longer visible. In some cases, post-construction evaluations of recently completed projects were also used, further limiting the evaluator's ability to verify certain requirements.

Challenges

Each state reported challenges and other experiences as a result of implementing the PNNL methodology. While much of this feedback was found to center specific code requirements or infractions, conclusions could also be drawn upon the value of overall methodology and logistics of performing a compliance evaluation. These findings are presented in the following sections in the order analyzed.

Georgia

The final report following the Georgia pilot study provided a number of issues surrounding not only the overall methodology, but also the ability to verify particular items on the Compliance Checklists. Issues pertaining to the checklist were indicated in relation to checklists items, allowing for cross-referencing with the respective code provision.

The following table includes problems with the checklists as reported by the Georgia study, including the related review or inspection stage and referenced 90.1—2007 provision:

Table 24: Reported checklists issues in Georgia study

Checklist Item(s)	Code Provision(s)	Problem Encountered
PR1	4.2.2	Insufficient information on the plans and specifications, e.g. insulation R values.
FR4 *FR5* *FR6* *FR7* *FR8*	5.5.4.3a 5.5.4.3b 5.5.4.4.1 5.5.4.4.2 5.8.2.1	Fenestration U values and SHGC for windows, doors and skylights were not identified and no NFRC rating certification was available. Product labels are not typically affixed to commercial fenestration products and the majority of the buildings evaluated failed to meet these requirements.
PR3	4.2.2 7.4.1	Mechanical systems were found to be close to full compliance. However, efficiency labels were consistently lacking on mechanical equipment and service hot water systems.
EL2	9.4.3	Tandem electrical wiring was missing and wattages for electrical fixtures were not provided. A simple item, exit signs, rated above the allowable wattage was commonly found.
PR8	6.7.2.1	The biggest concern of the evaluators was the evaluation checklist. For example, some of the items on the checklist were not practical or field verifiable.
PR9	8.4.1.1 8.4.1.2	Construction documents require "as-built" drawings submitted within 90 days of system acceptance' is not a practical requirement. Other items were subjective in nature which resulted in comments being provided by the evaluators rather than having a more definite and clear yes or no answer.
PR9	8.4.1.1 8.4.1.2	Feeder connections and voltage drop are addressed by the electrical code, not the energy code. This requirement which is found in the National Electrical Code seems redundant and cannot be easily verified as compliant without the design engineer's calculations.
PL3	7.4.6	Plumbing installations were mostly compliant but some heat traps were missing.

The study also brought forth challenges related to the general process of conducting compliance evaluations. Some code provisions were not easily verified during the typical field inspection process, such as the checklist requirement calling for submission of as-built drawings within 90 days of acceptance. The Georgia study included the example of equipment load and sizing calculations which allow for verification of a voltage drop. The personal judgment of a particular evaluator was also called into question in performing inspections. Furthermore, although 90.1—2007 had been adopted within the state, the majority of buildings inspected in the Georgia study had actually been permitted and constructed under the previous 90.1—2004 code.

General challenges facing energy code compliance presented in the study include a lack of (not necessarily prioritized, but listed in the order stated):

- Education
- Time
- Money
- Equipment
- Codebooks
- Data provided on plans

According to the report, the Georgia compliance working group and contracted evaluators agreed upon a need for additional statewide energy code training. Audiences identified include designers, building inspectors, the construction industry and related trades. In the past six months, the study also reports having conducted 42 energy code training workshops through the Southface Energy Institute. Workshops were reported to have included training on air leakage testing (duct and envelope) and lessons on new code requirements.

Iowa

The Iowa study reported low energy code compliance resulting from a lack of documentation. Many areas of the state are unregulated (two of these areas were included in the study), and were not available for participation in the study due to a lack of permit information site information and construction activity (the PNNL Sample Generator tool functions based on reported recent construction permitting data). Technical problems were also reported with the Score + Store software early in the process, although these were stated as eventually solved. The study found most enforcement jurisdictions were not inspecting to the adopted state energy code. Many local building departments were reported to not take advantage of free training provided by the state, and see a lack of funding for what is perceived as additional time and effort required to enforce code requirements.

All Iowa evaluations required a RES*check* compliance report or HERS Rating documentation. Only a small number of jurisdictions were described as actively involved with the Iowa study, as many were non-responsive to requests to participate. Additional sample buildings were needed in order to obtain the necessary sample size. Load calculations were reported to have been calculated in only 12 of 50 homes inspected, with a low compliance rate on seemingly simple items; examples given were the posting of the compliance certificate on the electrical panel, or the installation of efficient lighting. The study also highlighted a higher compliance rate observed in Climate Zone 5 (reported as 71%) in comparison to Climate Zone 6 (64%).

Massachusetts

The Massachusetts study was entirely based on post-construction inspections and evaluations. One Compliance Checklists was completed for each home through a single site visit. The typical visit was reported to take between 15 and 60 minutes. The study encountered problems applying the PNNL Compliance Checklists through a post-construction approach. The report specifically identified problems with the sample scoring system, citing the ability of a sample building to comply, even when only a portion of the checklist items are readily observable to the evaluator. According to the study, when ‘N/A’ or ‘Not Observable’ options are checked for a particular requirement, zero points are assigned (possible or received) to those items, resulting in . As many items required by the energy code are not observable post-construction, the study reported this type of use as non-effective.

Montana

The Montana study encountered problems in obtaining sample buildings and gaining access to project sites. Many phone calls were reported as unreturned, necessitating direct visits to project sites. Many of the sample homes chosen for an inspection were found to be inaccessible or based on inaccurate project information. Similar to the Iowa study, the Sample Generator was not an effective tool in identifying building samples, due to the large number of projects in the state which occur outside of code enforcement areas.

Plan reviews as part of the compliance process were reported as rare within smaller enforcement jurisdictions, with energy features generally only checked during site inspections in these areas. Information included in RES*check* compliance reports was also found to be inaccurate in comparison with values observed in the field. Information on building envelope air leakage, mechanical equipment and lighting was also stated as not often included.

Northwest

Many of the local enforcement jurisdictions polled in the Northwest pilot study reported permit revenue as their only source of funding. Third-party inspection was also uncommon. Financial constraints were reported to limit the amount of time code officials were able to spend in the field performing building inspections and evaluations. The study also indicated builders have a particular opposition to assemblies utilizing continuous insulation.

Code officials reported a lack of information provided with buildings plans and specifications. Mechanical load calculations were found to be a rare practice in residential construction, and exterior doors often lacked proper labeling as is typically required of fenestration products. Confusion amongst local enforcement staff was also cited in correctly completing inspection checklists.

Utah

The energy code was reported as less of a priority in Utah compared to other life and safety code inspections. Similar to other studies, many inspected homes were reported as having unobservable features related to particular code requirements. This was stated as a problem of site visit timing between phases of the construction process. A lack of time, money and resources necessary for performing compliance inspections in local jurisdictions was also reported as limiting energy code compliance, along with the need for consistent education and technical support. The Utah report also described confusion among enforcement officials, due to conflicting information on appropriate construction methods or rules, and the lack of a clear authority. The State also identified home builders as resisting compliance, frustrated with inconsistent enforcement between jurisdictions.

Wisconsin

The Wisconsin study also utilized the PNNL Compliance Checklists, and experienced confusion on certain checklists items where responses were interpreted to have multiple meanings. The example given referenced the checklist requirement for code provision 502.2.1, stating, "Insulation intended to meet the roof insulation requirements not installed on top of a suspended ceiling." Documentation submitted with building plans was reported as often missing. Discrepancies between information entered into COM*check* and actual field conditions were also reported. "Judgment calls" on behalf of individual evaluators was also cited as a barrier, due to the number of third-party auditors enlisted for the study.

Reported Conclusions

Several conclusions can also be drawn from the experiences of pilot study states. The following section outlines some of the primary takeaways reported by individual states. Findings are presented by state in the order which they were analyzed.

Georgia

The Georgia Department of Community Affairs (DCA) reported having been able to "strictly" follow the guidelines recommended by PNNL, and relied "exclusively" upon the Compliance Checklists and Score + Store tools. Third-party contractors were also said to have reported results back to the State relatively seamlessly. The State also pledged to continue energy code training, while exploring alternative approaches to evaluating and improving compliance. Overall, Georgia found a compliance rate of 80% within the state, and will use this as a baseline against which to address Recovery Act requirements. The study described the PNNL guidelines as "very instrumental" in framing the compliance evaluation process, and allowing for successful completion of the pilot. The DCA highly recommended use of the PNNL compliance tools and resources.

Iowa

A broken understanding in the overall value of energy codes was reported in Iowa, including a tendency to hide deficiencies within the compliance evaluation process. A call to educate city officials and political leaders on the value of energy codes was stated. The Iowa study concluded a significant need for local enforcement jurisdictions to require adequate documentation to demonstrate code requirements. Although evaluation times were found to be relatively short, they are expected to be up to twice as time consuming once necessary information is obtained for plan review. Many jurisdictions accepting software compliance reports, such as is provided by RES*check*, were described as simply seeking a bottom line pass or fail score. The actual inputs and field conditions were often found to differ from the indicate criteria. The study also concluded the insulation inspection (one of the PNNL-suggested inspection stages) could be conducted during the same visit as the framing/rough-in inspection, further streamlining the inspection process and limiting the necessary number of site visits. One inspector included in the study also suggested checklists be created based on the chosen compliance approach to make the process less confusing in avoiding unnecessary information and checklist items.

Massachusetts

The Massachusetts study concluded the PNNL Compliance Checklists were not a valuable tool for conducting post-construction assessments. In inability to observe several checklist items and verify related code requirements yielded incomplete checklists. However, this condition was found to have no net impact on the compliance score. The study concluded it would take three site visits to complete the entire checklist during the construction process. Compliance was found to be lowest when inspected based on the overall UA approach, due to limited tradeoffs allowed by RES*check*. Compliance was found to be higher when inspected to performance-based paths, allowing more flexibility for tradeoffs. All of the ENERGY STAR homes were found to comply under prescriptive or UA tradeoff approaches.

The study found general training required to become a certified HERS Rater was sufficient for completing the PNNL checklists. A period of adaptation was required for evaluators to become comfortable with the checklists, but the overall learning curve was acceptable. Evaluators did make a few suggestions for improving the checklists, such as removing the need for a compliance certificate or emphasizing allowances within code footnotes.

Montana

The Montana study was not able to gather the data to complete a building evaluation through a single site visit. Approximately 2-4 site visits were concluded necessary to fulfill a checklist. Smaller jurisdictions were reported to seldom conduct a formal plan review, with most information verified during the field inspection. Information included in software compliance reports were also concluded to commonly deviate from actual installation conditions.

Northwest

Compliance rates were reported as satisfactory according to the Northwest pilot study. Certain trades were found to lack sufficient documentation to demonstrate energy code requirements during the plan review stage, with residential mechanical equipment singled-out as difficult to verify prior to the field inspection. The study also describes classroom-based training as the preferred approach to energy code education. The Northwest study report also notes a prevalence of above-code programs in the region, potentially inflating compliance evaluations in comparison to Recovery Act target codes.

Utah

The energy code was found to be a lesser priority in comparison to many other building requirements in Utah. The state reported a need to support building officials in making energy a higher priority. The study also concluded a need for improved consistency between local enforcement jurisdictions, citing many as ignoring energy code requirements. A single, recognized source for technical assistance is proposed as a potential solution to this problem, such as a clearinghouse for energy code information and resources. The Utah study also reported an ability to conduct multiple evaluations within a single development, as opposed to inspecting only single samples.

Wisconsin

The Wisconsin pilot concluded documentation missing from the plan review stage was a primary limitation of energy code compliance. Subjective evaluator judgment was also cited as a source of inconsistency within the study, especially with a significant number of third-party contracted personnel. The state suggested rearranging checklists to include a column throughout for plan review or field-verified observations. Edits were also requested enabling checklists to match the International Building Code and Construction Specifications Institute taxonomies. The Score + Store tool was also recommended to accommodate multiple R value ratings for a single assembly with an automatic calculation of the overall assembly resistance.

5.2.1 Observed Trends

The 90% Compliance Pilot Study reports offer feedback on state experiences and actions taken to address Recovery Act compliance requirements. For the thesis experiment, reports submitted by individual pilot states were analyzed, and resultant data was presented throughout the section. The following represents a summary of findings extracted from the pilots, which allow for a better understanding of state applications, challenges encountered, and recommendations for consideration.

- The overall use of the PNNL recommended methodology was reported positively, with more specific feedback received on various pieces of the suggested approach.
- Georgia reported implementation without significant difficulty, having relied upon the recommended methodology, as well as supporting compliance tools and resources.
- Several improvements to the Compliance Checklists and instructions were presented, suggesting the elimination of non-applicable provisions and clarification of items found confusing by evaluators.
- The Massachusetts pilot utilized the Compliance Checklists to conduct post-construction buildings inspections and evaluations—this application is NOT recommended.
- Several studies cited a lack of information and documentation submitted with permit applications, limiting the ability to assess compliance during plan review stages.
- Plan reviews were reported as rare within smaller enforcement jurisdictions, with most code requirements verified through field inspection in these areas (if at all).
- Unregulated areas within states may lack energy code enforcement.

Observed Trends (continued):

- Building samples relying on recent construction permit data, such as the PNNL Sample Generator tool, may not adequately represent unregulated regions.
- In general, 2-4 site visits are required to complete the Compliance Checklist, as some studies were able to streamline the process by combining field inspections.
- The Massachusetts study field inspection process was based on only one site visit per sample, however; this approach yielded a significant quantity of 'N/A' and 'Non-observable' responses.
- Montana encountered difficulty in securing and accessing project sites for sample buildings.
- Many sample buildings identified through data sources were found to be non-existent or based on inaccurate information.
- The timing of site visits were reported as difficult, due to short time periods to observe certain energy features.
- The Massachusetts study reported a potential scoring problem; no points are counted for or against when 'N/A' or 'Non-observable' is selected, having no impact on the compliance score.
- Studies yielded several common code infractions, including a lack of mechanical load calculations, and low compliance rates for many seemingly simpler checklist items.
- Choice of compliance path (i.e., prescriptive, UA tradeoff, or performance approaches) was found to impact compliance, with higher scores resulting from performance-based approaches.
- Conditions entered into compliance software programs were often found inconsistent with actual conditions as verified in field.
- Many sample buildings were found to have been designed to an earlier version of the energy code than was inspected.
- Primary conditions limiting code officials' ability to enforce the energy code were identified as education, time and money.
- In some states, the energy code was identified as a significant source of confusion amongst code officials, with home builders described as resisting compliance efforts.
- Access to energy code education and training was consistently presented as important
- The Iowa study suggested the need for an increased understanding of the value behind building energy codes, emphasizing the need to educate government officials and policymakers.

5.3 GAP ANALYSIS

The second series of documents analyzed was the Gap Analysis reports published by the Building Codes Assistance Project (BCAP). These documents specifically address shortfalls in relation to 90% Compliance requirements, and issue recommendations for individual states in overcoming these challenges. A significant amount of information is included, providing further understanding of state background conditions, challenges and recommendations for consideration at the state-level.

Overview of State Gap Analysis

A series of underlying assessments lies behind each Gap Analysis report, providing an overview of state-specific compliance scenarios in relation to 90% Compliance requirements. All reports were published between mid-2010 and mid-2011, and were conducted in partnership with state agencies responsible for energy code oversight within the particular state. The Southeast Energy Efficiency Alliance, a regional efficiency organization, was also found to have contributed to the Alabama study.

The following table provides an overview of the 15 states where a Gap Analysis was conducted is provided, along with partnering state agencies and organizations, as well as the respective report publication dates.

Table 25: Gap Analysis partner organization by state

State	Partner Organization or Agency	Publication Date
Alabama	Southeast Energy Efficiency Alliance	July 2010
Arizona	Economic Development Commission: Energy Office	December 2010
Delaware	Energy Office and Department of Natural Resources and Environmental Control	January 2011
Illinois	N/A	December 2010
Kentucky	N/A	February 2011
Michigan	Department of Energy, Labor & Economic Growth (former)	December 2010
Nebraska	Energy Office	June 2011
Nevada	Office of Energy	November 2010
New Hampshire	Office of Energy and Planning	February 2011
New Mexico	Regulation and Licensing Department	January 2011
Ohio	N/A	February 2011
South Carolina	N/A	November 2010
South Dakota	Bureau of Administration	December 2010
Texas	State Energy Conservation Office	February 2011
West Virginia	Division of Energy	February 2011

State Background

The BCAP Gap Analysis included a fairly well-distributed inventory of states. The smallest state (by population) included in the analysis was South Dakota at approximately 800,000 people, with the largest being Texas at over 25 million people. The number of metropolitan population centers and median household income was also included in the reports, helping to size each state in comparison to others in the collection. Recent housing starts (residential permits issued) were also included, indicating high and low numbers for each state. An obvious trend was observed in the year 2009, when all included states issued the least number of residential building permits. The majority of reports also included a description of primary industries contributing to the individual state economy.

Table 26: Summary of state demographics

State	Population (million people)	Metro. Population Centers	Median Income	Permit High (year)	Permit Low (year)	Economy Type
Alabama	4.6	4	$40,489	30,000 (2006)	15,000 (2009)	Manufacturing, fabrication, tourism
Arizona	2.9	5	$48,745	17,932 (2005)	7,056 (2009)	Service, agriculture, manufacturing
Delaware	0.9	4	$56,860	7,977 (2005)	3,140 (2009)	Banking, chemicals, healthcare
Illinois	12.8	8	$53,966	67,000 (2005)	11,000 (2009)	Casting, refining, chemicals, steel
Kentucky	4.3	4	$40,072	22,705 (2004)	6,878 (2009)	Iron, vehicles, furniture, machinery
Michigan	10.0	6	$45,255	53,000 (2005)	6,000 (2009)	N/A
Nebraska	1.8	3	$47,357	10,922 (2005)	5,180 (2009)	Agriculture, chemicals, manufacturing, processing, telecomm.
Nevada	2.5	3	$53,341	45,000 (2005)	6,000 (2009)	Gaming, construction
New Hampshire	1.3	2	$60,567	9,263 (2003)	2,160 (2009)	Machinery, tourism, manufacturing
New Mexico	2.0	5	$43,028	14,200 (2005)	4,600 (2009)	N/A
Ohio	11.5	9	$45,395	53,000 (2003)	13,000 (2009)	N/A
South Carolina	4.7	3	$44,625	54,157 (2005)	15,529 (2009)	N/A
South Dakota	0.8	2	$45,043	5,839 (2004)	3,691 (2009)	Service, agricultural, tourism
Texas	25.0	4	$48,259	215,000 (2006)	75,000 (2009)	Agricultural, energy distribution, technology
West Virginia	1.8	2	$37,435	5,399 (2006)	1,966 (2009)	Manufacturing, fabrication, tourism

The Gap Analysis reports also looked at the cost-effectiveness of the residential energy code. Each state was compared against the 2009 International Energy Conservation Code (IECC) to show increases in upfront constructions costs, balanced against longer term energy savings. These numbers appear tied to a larger BCAP background effort to demonstrate cost-effectiveness of the residential energy code.

Table 27: Potential savings through code implementation

State	**Annual State Energy Savings by 2030** (trillion Btu)	**Annual State Cost Savings by 2030** ($ million)	**Annual State CO_2 Reduction by 2030** (million metric tons)	**First Cost Increase** ($)	**Utility Cost Savings** ($)	**Simple Payback** (years)
Alabama	42.2*	287*	3.0*	668.76*	205.00*	3.3*
Arizona	13.1	81	0.9	559.49*	217.00	2.63*
Delaware	6.6*	51	0.5	N/A	N/A	N/A
Illinois	384.0	307	2.6	818.72	243.37	3.5
Kentucky	9.5*	57	0.7*	773.92	336.00	2.3
Michigan	26.8	202	1.8*	965.19	274.00	3.5
Nebraska	70.0	786	4.0	400.00	236.00	N/A
Nevada	18.4*	130*	1.0*	777.00	228.50	3.5
New Hampshire	3.0	33	0.20*	777.15*	228.5*	3.4*
New Mexico	6.0*	45*	0.3*	666.00*	233.50*	2.85*
Ohio	21.4	177	1.4	803.00	229.00	3.5
South Carolina	47.0*	338*	3.3*	692.74	207.00	3.5
South Dakota	7.1*	50	0.4*	818.72	405.00	3.19*
Texas	213.9*	1600*	15.6*	818.72	243.37	3.3
West Virginia	5.2	32	0.4*	1293.59*	405.00*	3.19*

**Referenced BCAP Incremental Costs Analysis (BCAP, 2012b)*

Based on the BCAP analysis, the 2009 IECC is observed to be cost-effective in all included states when rolled into a typical consumer mortgage. First costs of construction were observed to rise from as low as $400 to as high as approximately $1300, with associated utility costs savings ranging from $205-405. This equates to a simple payback in as little as 2.3 years within included states.

In recent years, the Federal Government has provided three primary sources of funding to support energy efficiency and renewable energy within the states. Much of this funding came by the way of the U.S. Department of Energy (DOE) to support energy codes adoption and implementation. The following graphic provides an overview of funding seen in recent years as distributed to the individual (Gap Analysis) states.

Table 28: Recent federal funding sources

State	EECBG Funding ($ million)	SEP Funding ($ million)	Total ARRA Funds Received ($ billion)
Alabama	10.4	55.5	3.7*
Arizona	9.6*	39.4	7.7*
Delaware	15.9	24.2	1.0*
Illinois	112.2	101.3	12.0*
Kentucky	10.4*	52.5*	3.7*
Michigan	19.6*	82.0*	8.6*
Nebraska	9.6*	31.0	1.3*
Nevada	5.8	34.7	3.0*
New Hampshire	14.5	25.8	1.0*
New Mexico	9.6	31.8	2.8*
Ohio	25.0	96.1*	8.8*
South Carolina	31.1	23.7	4.6*
South Dakota	15.0	23.7	1.4*
Texas	163.1	218.0	16.8*
West Virginia	14.0	32.7	1.8*

**Referenced U.S. Department of Energy Weatherization and Intergovernmental Program (DOE, 2012d)*

Three types of funding are outlined: Energy Efficiency Conservation Block Grant (EECBG), State Energy Program (SEP, and funds spawning from the American Recovery and Reinvestment Act of 2009 (ARRA or Recovery Act). Although these funds are distributed independently, both EECBG and SEP formulaic funding experienced significant increases as a result of Recovery Act stimulus funding. A portion of this funding supported the adoption and implementation activities outlined in the remainder of the section.

Adoption

A primary focus of the BCAP Gap Analysis reports covered issues related to energy code adoption within the states. While model energy codes are produced on the national stage, individual stakeholders participating in this process come from all levels of government and private industry. Furthermore, model codes are adopted by states and local municipalities, leading to a variety of implementation issues and local politics.

Current Status

The following table outlines the energy codes observed within Gap Analysis states in relation to Recovery Act requirements at the time the respective reports were published. (*Note*: As of November 5, 2012 current status of state energy codes can be verified at: www.energycodes.gov/states). The table also includes each state's regulatory framework (statewide or local adoption via *Home Rule*), state agency responsible for administration and oversight of the energy code, and typical adoption cycle, if applicable.

Table 29: Current state regulatory status

State	Regulatory Framework	Residential Code (based on)	Commercial Code (based on)	Satisfies ARRA (YES/NO)	Administering State Agency	Update Cycle (years)
Alabama	Home Rule	2006 IECC	90.1--2007	NO	Alabama Energy & Residential Codes Board*	N/A
Arkansas	Statewide	2003 IECC	90.1--2001	NO	Arkansas Energy Office	N/A
Delaware	Statewide	2009 IECC	90.1--2007	YES	Delaware Energy Office	3*
Illinois	Statewide	2009 IECC	90.1--2007	YES	Illinois Capital Development Board*	3*
Kentucky	Statewide	2006 IRC	2006 IBC	NO	Department of Housing, Buildings & Construction	3*
Michigan	Statewide	2009 IECC*	90.1--2007*	YES	Bureau of Construction Codes	3*
Nebraska	Statewide	2009 IECC	90.1--2007	YES	Nebraska Energy Office	N/A
Nevada	Statewide	2006 IECC	90.1--2004*	NO	Renewable Energy & Energy Efficiency Authority	3*
New Hampshire	Statewide	2009 IECC	90.1--2007	YES	Bureau of Building Construction & Safety	N/A
New Mexico	Statewide	2006 IECC	90.1--2004	NO	Construction Industry Division	3*
Ohio	Statewide	2009 IBC*	90.1--2007*	NO	Board of Building Standards*	N/A
South Carolina	Statewide	2006 IECC	2009 IBC*	NO	Building Codes Council	N/A
South Dakota	Home Rule	2006 IECC	2006 IBC	NO	(none)	N/A
Texas	Home Rule	2009 IRC	2009 IECC	NO	State Energy Conservation Office	3*
West Virginia	Statewide*	2003 IECC	2003 IECC	NO	State Fire Commission*	N/A

**Referenced BCAP (2012c) Code Status*

Three of the fifteen states included in the Gap Analysis were observed to be Home Rule states, and therefore; adopt the energy code localized levels, such as by city, township or otherwise local municipality. The remaining states were observed to adopt the energy code on a statewide basis, requiring all local jurisdictions within the state to enforce the current state energy code. A variety of codes were found present within the included states, ranging from several variations of the IECC to the International Residential Code (IRC) and International Building Code (IBC) for commercial projects. The state agency found to hold administrative responsibility over the energy code is often the State Energy Office, but may also be a fire commission, designated board, or otherwise assigned regulatory agency. Only five of the states analyzed were observed to be in compliance with the energy codes targeted by the Recovery Act. All included states, when reported, were also observed to adopt codes on a three year cycle; the same on which the model codes are developed.

Codes for State Facilities

Government owned buildings are often subject to additional requirements to promote increased efficiency. States may use specific energy savings targets or rely on green building programs to set minimum requirements for overall energy savings, building components, or sustainable practices. A specific threshold usually accompanies such requirements, setting a specific level (i.e. size or cost) at which such requirements go into effect.

Table 30: State code requirements for government buildings

State	Benchmark	Designated Threshold (>)
Delaware	10% less energy than 90.1—2007	N/A
Illinois	LEED Silver	10,000 ft.^{2}
Kentucky	LEED Certification (base level)	N/A
Michigan	LEED Certification (Silver)	$ 1,000,000
Nevada	LEED Certification	N/A
New Hampshire	20% energy savings	$1,000,000 or 25,000 ft.^{2}
New Mexico	LEED (Silver) and 50% energy savings	15,000 ft.^{2}
Ohio	Reduce energy use by 15% in 4 years	N/A
South Carolina	LEED (Silver)	10,000 ft.^{2}
South Dakota	LEED (Silver)	All state buildings

Gap Analysis states where requirements for state-owned facilities were observed are summarized in the above table, along with respective designated thresholds. While some states, such as Delaware, New Hampshire and Ohio, were observed to have specific energy savings targets for government buildings, most states who have these requirements rely on the LEED green building rating system produced by the U.S. Green Building Council (USGBC). While states may use a specified rating as a design threshold, many do not necessarily require government-owned facilities to complete the application and rating process.

Of states observed to reference LEED requirements, none were found to exceed a LEED Silver rating. The LEED system relies on point thresholds to determine which rating is earned. Points can be gained across several categories, one of which focuses on building energy consumption (Energy & Atmosphere). To achieve a Silver rating under LEED 2009, a project must earn at least 50 points across all categories. As a minimum prerequisite, LEED projects must exceed the Standard 90.1—2007 commercial standard by 10% (based on simulated cost of energy). Projects wishing to avoid energy simulation may also meet the perquisite and earn points through adherence to guidance prescribed by the ASHRAE Advanced Energy Design Guides or the New Buildings Institute Core Performance Guide. However, these prescriptive options offer the opportunity for lesser points (up to three points) in comparison to the simulated approach. Building simulation models can earn additional points, with the first point awarded for 12% savings, and up to 19 points awarded for 48% savings over the target commercial code. Constituting nearly half the points required for the Silver rating threshold, the LEED system places a specific emphasis on the value of above-code energy savings as a core part of green and high-performance buildings.

Statewide Climate Change Initiatives

In addition to efficiency requirements for state-owned buildings, many states were also observed to have specified or joined greater climate change initiatives. A variety of programs are elected by individual states, ranging from regional efforts, such as the Midwest Greenhouse Gas Accord, to the installation of state advisory groups, or even joint interstate partnerships with neighboring states.

Table 31: Climate change initiatives

State	State Climate Change Initiative(s)
Alabama	University of Alabama State Climate Change Mitigation Study
Arizona	Governor's Commission on Global Warming Climate Action Plan
Delaware	Climate Change Consortium
Illinois	Climate Change Advisory Group Midwest Greenhouse Gas Reduction Accord
Kentucky	Intelligent Energy Choice for Kentucky's Future
Michigan	Climate Action Council Midwest Greenhouse Gas Reduction Accord
Nevada	State Energy Plan and State Energy Conservation Plan Advisory Board Committee on Climate Change
New Hampshire	Department of Environmental Services Climate Action Plan Member of Regional Greenhouse Gas Initiative
New Mexico	Climate Master Program Southwest Climate Change Initiative (joint with Arizona)

Green and Above-code Programs

Gap Analysis reports also provided a glimpse of high-performance and green building activities within states. Programs covered include LEED and ENERGY STAR projects, Accredited Professionals (AP), as well as the prevalence of ENERGY STAR builders and HERS Raters. An overview of these projects and professionals are broken down by individual state in the following table.

Table 32: Inventory of above-code buildings

State	LEED Certified Buildings	LEED Registered Projects	LEED APs	ENERGY STAR Homes	ENERGY STAR Builders	HERS Raters
Alabama	22	124	1119*	3236	55	11
Arizona	37	90	436	704	59	8
Delaware	10	49	218*	6456	42*	5
Illinois	288	666*	7623*	6307	181	36*
Kentucky	38	179	910*	7162	171	46
Michigan	199	343	3221*	5853	246	35
Nebraska	25	64	804*	2900	72	9*
Nevada	41	156	1000	88848*	21*	13
New Hampshire	27	84	431*	4870	60*	24*
New Mexico	46	310	556*	6079	66*	17*
Ohio	259*	868	4372*	31346	160*	37
South Carolina	60	270	1342*	2861	289	29
South Dakota	7	58	189*	464	27	7*
Texas	301	1240	8566*	320397	822	79
West Virginia	7	33	113*	169	12*	23

**Referenced LEED Project Directory (USGBC, 2012), ENERGY STAR Project Directory (EPA, 2012), and HERS Rater Directory (RESNET, 2012)*

Other Programs

A variety of additional programs were also observed within Gap Analysis states. Alabama and Nebraska were reported to rely on efficiency loan programs through the State. Six of the fifteen states reported the presence of an appliance rebate program, and three states with a similar utility rebate program. The State of Delaware also utilizes a rebate program providing incentives for the construction of green homes, including a requirement for ENERGY STAR appliances and equipment products. Five states reported involvement with ICLEI, a sustainability organization for local governments.

Illinois reported obtaining funding to support green jobs through the U.S. Department of Labor. Nebraska supports energy efficiency goals set by the Western Governors Association, and has implemented an Energy Codes Ambassadors program to support compliance. Five states were also reported to have entered into the U.S. Conference of Mayors Climate Protection Agreement. Some West Virginia cities participate in the Cool Cities program, with Texas cities reporting participation in the Clean Cities program. New Mexico has adopted codes specifically addressing earthen building materials, further enabling green construction practices in the state. Kentucky reports programs supporting green schools, and energy efficient jobs training. Nebraska and Illinois also operate energy efficiency programs for low-income housing. Southface Energy Institute of Atlanta produces their EnergyKey and Earthcraft programs on a regional basis (southeast). Delaware also has a goal for all newly constructed buildings to be net-zero energy capable by the year 2030.

Implementation

The second primary focus of the BCAP Gap Analysis documents relate to the implementation of building energy codes. Codes are adopted by the state or local jurisdiction, and true energy savings are only realized through compliance with those codes. The following provides additional background information pertaining to the implementation of building energy codes.

Key Organizations

Energy codes affect a wide range of stakeholder groups, including builders, designers, manufacturers, and the eventual end consumer. Several of these organizations are identified, and presented in the reports. An overview of key organizations reported by individual state is covered in the following table in the order extracted.

Table 33: Key stakeholder organizations

State	Key Organizations
Alabama	University of Alabama
Arizona	Pulaski Technical College Phillips Community College of the University of Arkansas Northwest Arkansas Community College at Bentonville
Delaware	University of Delaware Center for Energy and Environmental Policy Sustainable Energy Utility Energize Delaware
Illinois	Midwest Energy Efficiency Alliance Illinois utilities (several) Metropolitan Mayors Caucus Clean Energy Community Foundation
Kentucky	Kentucky Sustainable Energy Alliance Midwest Energy Efficiency Alliance Southeast Energy Efficiency Alliance
Michigan	Midwest Energy Efficiency Alliance Michigan State University Responsible Energy Codes Alliance Dow Chemical Company
Nebraska	Nebraska Association of Code Officials Energy Assistance Network League of Municipalities
Nevada	Southwest Energy Efficiency Partnership
New Hampshire	Home Builders and Remodelers Association Northeast Energy Efficiency Partnership Lake Region Community College
New Mexico	Southwest Energy Efficiency Partnership
Ohio	Department of Development Better Buildings Coalition State Extension Service
South Carolina	Energy Office
South Dakota	Midwest Energy Efficiency Alliance Responsible Energy Codes Alliance

Stakeholder groups are observed to represent a cross-section of energy efficiency advocates, industry, and institutional interests. Regional partnerships, such as the Regional Energy

Efficiency Organizations, include groups such as the Midwest Energy Efficiency Alliance and Northeast Energy Efficiency Partnership. In some states, the Energy Office may take on a role of energy efficiency advocacy more so than a regulatory function. Universities, such as Michigan State University and the University of Delaware are also observed as active within energy codes issues, often in the form of technical assistance, educational and outreach efforts. National organizations, such as the Responsible Energy Codes Alliance and corporate industry, such as Dow Chemical, are also observed as present.

Training programs

All states included in the Gap Analysis were observed to have at least general access to energy code training programs. These were often indicated as provided by national organizations, such as the International Code Council (ICC), or funded by DOE through a state energy office. Alabama cited Earthcraft and EnergyKey training provided by the Southface Institute. The State of Michigan has exercised a training partnership with Michigan State University, which has also drawn support from Dow Chemical, Guardian Industries, and the Midwest Energy Efficiency Alliance. The annual EduCode conference is hosted in Nevada, where there is also a training partnership with the University of Nevada. New Hampshire exhibits a state-sponsored training series covered under the New Hampshire Building Code Compliance Project. Texas A&M University also operates a state-sponsored training program in Texas.

Table 34: Professional licensing and certification programs

State	Professional Licensing or Certification Requirement
Alabama	Local only
Arizona	Local only
Delaware	Local only
Illinois	Local only
Kentucky	YES
Michigan	YES
Nevada	YES
New Hampshire	NO
New Mexico	YES
Ohio	YES
South Carolina	YES
South Dakota	NO
Texas	YES
West Virginia	YES

Licensing and Certification

Several states were also observed to have professional licensing and certification programs for code officials and inspectors. Some states were found to have statewide programs, while others exhibited requirements only at localized levels. State reports highlighted the value of professional licensing and certification programs, but often stressed the need for these programs to incorporate requirements specific to energy code training. Overall, eight states were observed to have some sort of licensing or certification requirements pertaining to code officials.

Third-party Rating and Enforcement

The PNNL method called for the use of third-party inspection and evaluation of sample buildings. Several states were observed to currently utilize contracted third-party services, although through a variety of functions. Third-party services are often used to inspect for code requirements or to test building performance. Although the use of third-party services was observed, the prevalence of these options cannot be interpreted and it should not be assumed to be a primary method of enforcement.

Table 35: Third-part testing and enforcement

State	Use of Third-party Enforcement	Acceptance of HERS Rating
Alabama	NO	NO
Illinois	YES	N/A
Kentucky	YES	YES
Michigan	YES	YES
Nevada	N/A	YES
New Mexico	NO	N/A
South Carolina	YES	YES
South Dakota	YES	YES
Texas	YES	YES
West Virginia	YES	YES

Seven of the included states were found to contract third-party services for enforcement of energy code provisions. Many of these states were also found to accept a HERS Rating as a means of demonstrating compliance with energy code requirements. The State of Kentucky accepts an ENERGY STAR rating as a means of demonstrating compliance with the energy code. Some states, such as New Hampshire, do not accept a HERS Rating or ENERGY STAR on a statewide basis, but make allowances for these options within some local enforcement jurisdictions. The majority of states did not report use of third-party services and were not included in the table.

5.3.1 Observed Trends

The BCAP Gap Analysis reports provide an overview of current scenarios and conditions impacting a state's ability to meet 90% Compliance requirements. Data gathered through the analysis is presented throughout the section, and are summarized based on contribution to the study. These findings allow for a better understanding of state background information, and are considered for further generalization towards the final deliverable.

- Based on a referenced analysis conducted by BCAP, the 2009 IECC is cost-effective in all states included in the Gap Analysis when rolled into a typical consumer mortgage.
- States have received recent funding from the U.S. Department of Energy to support energy code adoption and implementation programs through three primary sources:
    1. Energy Efficiency Conservation Block Grants (EECBG)
    2. State Energy Program (SEP)
    3. American Recovery and Reinvestment Act of 2009 (ARRA)
- Three of the fifteen Gap Analysis states were observed to be Home Rule states, and therefore; adopt the energy code at localized levels, such as by city, township, or municipality.
- A variety of energy codes were observed present within states, including several variations of the IECC, IRC and IBC.
- The state agency with administrative oversight over the energy code is often the State Energy Office, but may also be an alternate state regulatory agency or appointed body.
- States may set energy savings targets or rely on green building programs to set minimum efficiency requirements. A specific building size or cost threshold was observed to accompany these requirements in several states.
- Many states have implemented climate change initiatives, or joined partnerships with neighboring states within the same geographic region.
- Many unique green building programs exist within individual states
- A variety of stakeholder groups exist, including energy efficiency advocates, government officials, industry, and institutional interests.
- Eight of fifteen states were observed to have professional licensing and certification programs for code officials, however these often do not include requirements specific to the energy code.
- All fifteen states have at least general access to energy code training programs, which are often provided by professional organizations or funded by DOE.
- Seven states were found to contract third-party services for energy code enforcement and building performance testing. Some states may accept a HERS or ENERGY STAR rating as a means of demonstrating energy code compliance.

5.4 STRATEGIC COMPLIANCE PLANS

The third series of documents analyzed in the study was the Strategic Compliance Plans, also published by the Building Codes Assistance Project (BCAP). These documents further address individual state scenarios and highlight many components required to support compliance with building energy codes. Each state plan contains further background and a variety of recommendations directed at states as they address 90% Compliance requirements.

Overview of State Compliance Plans

The Strategic Compliance Plans were written for 10 states, with all reports published in November 2011. A portion of the states where a compliance plan was conducted were also included in BCAP's Gap Analysis. Each plan acknowledges a state regulatory or administrative agency as a partner in the effort, with all reports also recognizing the U.S. Department of Energy and the American Recovery and Reinvestment Act of 2009. Some state plans also provide recognition to the respective Regional Energy Efficiency Organization (REEO). The following table provides a list of states for which a plan was written, as well as the corresponding state agency acknowledged in each report.

Table 36: Strategic Compliance Plan acknowledgements by state

State	Acknowledgements
Colorado	Department of Local Affairs and Governor's Energy Office
Delaware	Department of Natural Resources and Environmental Control
Illinois	Department of Commerce and Economic Opportunity
Kentucky	Department of Housing, Buildings and Construction
Michigan	Bureau of Construction Codes
New Hampshire	Office of Energy and Planning and Energy Code Challenge
New Mexico	Regulations and Licensing Department
South Carolina	State Energy Office
Texas	State Energy Conservation Office
West Virginia	Department of Commerce Division of Energy

REEOs were recognized as contributing to the majority of state compliance plans. The state of Kentucky actually credited two REEOs, the Midwest Energy Efficiency Alliance and the Southeast Energy Efficiency Partnership, with having been involved with the project. New Hampshire was the only state compliance plan found to credit a contracted organization, identifying GDS Associates within the final report.

Table 37: Partnering Regional Energy Efficiency Organization

State	Regional Energy Efficiency Organization
Colorado	Southwest Energy Efficiency Partnership
Delaware	Northeast Energy Efficiency Partnership
Illinois	Midwest Energy Efficiency Alliance
Kentucky	Midwest Energy Efficiency Alliance and Southeast Energy Efficiency Alliance
Michigan	Midwest Energy Efficiency Alliance
New Hampshire	Northeast Energy Efficiency Partnership

As a source of data, the Strategic Compliance Plans provide an overview of state scenarios, and recommendations for state action in several key areas. Each state plan was observed to cover 4-5 of the following topics to which suggested actions were allocated:

- Secure Funding
- State and Local Policy
- Training
- Outreach
- Compliance Evaluation

All report documents were found to be broken down into these general areas, providing an overview of background conditions with associated actions intended to drive states towards 90% Compliance. In all reports, suggested actions initiated and focused on the *Energy Code Compliance Collaborative*. This group is often referred to by a variety of names, but is generally understood as equating to the compliance working group suggested in the PNNL recommended model. While many states have not established such a group, several state compliance plans identified existing groups. The Colorado report was unique, in that it was the only report to specifically name 'state agencies' as an intended audience.

Table 38: States compliance working groups identified

State	Working Group
Delaware	Energy Codes Coalition
Michigan	Energy Code Ad Hoc Committee
New Mexico	Energy Codes Advisory Group
West Virginia	Building Energy Collaborative

State Background

The Strategic Compliance Plans began with a general overview of state compliance scenarios, placing codes at the center of energy challenging facings states and the nation. The need for code and compliance was demonstrated in highlighting the percentage of energy consumed within residential and commercial buildings. Figures were extracted from individual reports and are presented in the following table.

Table 39: Energy consumption in residential and commercial buildings

State	Percent of Total Energy Used in Buildings
Colorado	43%
Delaware	49%
Michigan	49%
New Hampshire	52%
New Mexico	36%
South Carolina	38%
Texas	28%
West Virginia	45%

Model building codes are generally adopted statewide or by local municipality, which is known as *home rule*. Compliance plans were developed for states exhibiting both types of regulatory infrastructure. The majority of states were found to adopt a statewide energy code, however Colorado and Texas adopt by city or local jurisdiction.

Table 40: Regulatory framework by state

State	Regulatory Framework
Colorado	Home Rule
Delaware	Statewide
Illinois	Statewide
Michigan	Statewide
New Hampshire	Statewide
New Mexico	Statewide
South Carolina	Statewide
Texas	Home Rule
West Virginia	Statewide

Critical Tasks

The compliance plans continued in identifying *critical tasks.* Each state was assigned a series of tasks, which was observed to often vary from state-to-state. The primary critical tasks identified for states were:

1. Energy Code Compliance Collaborative
2. Training Program
3. Consumer and Professional Outreach
4. Energy Code Ambassadors Program
5. Compliance Evaluation Study

These were found to be quite consistent between states, with many of the same tasks assigned in multiple states. Some states included all of the above tasks, with additional tasks found to be directly related or an off-shoot set of activities under a similar name. The South Carolina and West Virginia reports contained the fewest number of tasks with only four assigned, while New Mexico was assigned a total of nine critical tasks.

Energy Code Compliance Collaborative

This collaborative is understood to serve as the compliance working group recommended by the PNNL methodology. In states where such a group has been established, several variations have been observed. Overall, six of the states for which a compliance plan was written contained a critical task of the same or similar name.

Training Program

Six compliance plan states included a critical task referencing an energy code training program. The New Mexico plan contained two similar tasks; recommending the state maintain the energy code training program, as well as provide advanced training opportunities. The Michigan plan contained two tasks providing the same instructions, and the Delaware plan suggested implementing an advanced statewide training program.

Consumer and Professional Outreach

All state compliance plans were found to include this task. Some tasks were described as outreach to raise consumer awareness, sometimes targeting a specific stakeholder group (e.g. Colorado real estate, appraisal and lending outreach). Delaware and Texas included a task instructing the states to create and disseminate factsheets and checklists. The state of Michigan was instructed to achieve support for the Michigan Uniform Energy Code and to develop a coordinated outreach strategy. The New Mexico plan also called for achieving support for the state's energy code.

Energy Code Ambassadors

All ten states also called for the creation of an Energy Code Ambassadors program. This program is a collaborative partnership between BCAP and the International Code Council, where code officials are enlisted to champion the energy code within their state, region or community.

These individuals are typically well-versed in code requirements, and also familiar with many relevant resources and training opportunities surrounding the energy code. Aside from the Ambassadors program, others states were also observed to have initiated a program of a similar name and purpose. For example, the Illinois and Kentucky plans recommend creation of an energy code delegates program.

Compliance Evaluation Study

Five of the compliance plans outlined the need for an evaluation study within the set of assigned critical tasks. While some states do not call for execution of a specific study, many plans recommend strategic planning for an eventual study, or preparation through related activities. The Michigan and New Mexico plans ask states to develop a protocol for conducting a compliance evaluation, while the South Carolina and West Virginia plans recommend states pursue an evaluation structure and survey. The New Mexico plan also suggests developing tools and resource for conducting a compliance evaluation.

Other Critical Tasks Identified

Other critical tasks assigned to states were found to include:

- *Colorado*: Make the argument for state-level support
- *Kentucky*: New energy subcommittee within the State Board of Housing
- *Michigan and New Mexico*: Expand the value of the website homepage
- *Michigan*: Create a centralized online portal for energy codes
- *New Hampshire*: Implement PNNL guidelines

Stakeholder Outcomes

In addition to outlining critical tasks for individual states, each plan also included a list of four desired stakeholder outcomes. An identical set of outcomes was identified for each state:

1. Policymakers support the code
2. Consumers expect and demand the code
3. Professionals build to the code
4. Officials enforce the code

The same end goal was also presented in each state report: *Full Compliance.*

Energy Codes Coalition

The remainder of each state report was broken down into key areas upon which the state should focus, the first of which was the formation and mission of the compliance working group. State compliance plans identified several tasks and responsibilities for each working group. Tasks assigned to state working groups include:

- Make the economic case for codes
- Serve as a clearinghouse for code information
    - Source of information for policymakers
    - Collective voice on code issues
    - A shared forum
- Provide targeted outreach
    - Build support by utilizing connections
- Secure funding for projects
- Support energy code implementation programs
    - Provide oversight of implementation programs
    - Manage programs

Secure Funding

The next key area surrounds funding for energy code compliance efforts. Each compliance report outlined general options for states to consider in generating financial support for energy code compliance and supporting efforts. Options presented to states are as follows:

- Establish an Energy Efficiency Resource Standard
    - Some reports use Energy Efficiency Portfolio Standard terminology
    - Similar to renewable portfolio standards (%)
    - Standard put into place to support long-term energy efficiency benefits
- State appropriations
    - Include resources for local jurisdictions to ease financial burdens
    - SEP funding for compliance
- Trust or public benefit funds
    - Trusts to support energy efficiency
- Raise permit and re-inspection fees
- Subsidize training fees
    - Nominal training fees
- System Benefits Charge
    - Fund placed through utility surcharges
- Utility support
    - Other utility funding
- Direct benefit from private companies

Funding is often identified as one of the key factors limiting compliance with the energy code. This can be considered a primary area of interest to states, especially in times of constrained budgets and the passing of the economic stimulus. Nine of the Strategic Compliance Plans name state appropriations as a potential funding source. Eight of the plans call for the placement of an energy efficiency resource or portfolio standard. Seven states recommended pursuing additional funding through increased construction permit fees, spreading the burden across the industry and downstream to project owners or other funding agencies. Seven states plans also recommend the placement of a public benefit fund, with six states instructed to finance compliance efforts through increased training and certification fees.

State and Local Policy

Compliance plans continue in recommended strategies surrounding state and local policies. These tend to focus on the adoption of energy codes, but are also observed to relate to other efficiency or green building programs affecting building energy use within states. This portion of the state compliance plans were found to be less consistently prescribed in comparison to other sections of the reports. Recommendations ranged from straight-forward statements calling for adoption of target codes to more specific state instructions.

States having not yet adopted the target codes prescribed by the Recovery Act of 2009 were instructed to adopt the 2009 International Energy Conservation Code (IECC) and Standard 90.1—2007. In addition, several plans suggested the adoption of a stretch code or otherwise above-code program statewide or through enabling local jurisdictions. Home Rule states, such as Colorado, are instructed to adopt a statewide energy code, and promulgate procedures to certify compliance.

States are advised to incorporate third-party testing and inspection services into their compliance efforts. Retrofit programs should be enhanced through the use of energy service companies (ESCO), and housing grant recipients are asked to meet ENERGY STAR program requirements. States are also instructed to implement an energy code continuing education and certification program, while amplifying their plan for code enforcement.

The plans also call for additional resources to be allocated to support energy code compliance. Suggested steps include dedicated funding for free training. States with limited resources or unincorporated regions are encouraged to utilize state inspectors for rural areas, or possibly apply funding to borrow inspectors from neighboring building departments. The state of West Virginia is referenced of having incorporated this practice.

Other state-specific policy goals and activities are also referenced in the plans. Compliance activities are suggested to support Delaware's net zero goal by the year 2025. The state of Illinois is asked to install a new energy subcommittee with the State Board of Housing. Kentucky is given the recommendation to post best practices for stakeholders, such as through a state website. Increased enforcement within unincorporated areas of the state is suggested for Texas, while allowing third-party testing and further encouraging localities to reach for net zero targets.

Outreach

Consumer and professional outreach was a primary focus of the Strategic Compliance Plans. The reports outline activities currently seen across states, and provide recommendations for continued outreach efforts. A brief sampling of current programs reported within states include Colorado's RechargeColorado.org program and website, the Energize Delaware campaign, an Illinois pilot outreach program at big box retail stores, and a Texas State Energy Conservation Office centralized online portal, offering updates on compliance tools and training events.

Methods of Communications

The compliance plans also outline several suggested forms of communication, including:

- Maintaining a state energy codes website
- Energy code compliance checklists
- A press kit for generating earned media
- Public service announcements
- Policymaker factsheets
- Attending conferences and trade shows
- Energy code field guides
- Coordination with real estate agents, appraisers and lenders
- Print media campaigns
- TV and radio spots
- Producing news story B-rolls (ready-packaged news stories)
- Interaction with professional editorial boards
- Pod casting code information

Several state compliance plans also reference a public service announcement created for the state of New Hampshire, and available for use in other interested states.

Recommended Messages

The reports also detail specific messages to be communicated through public and professional outreach efforts. Many of these focus on the benefits associated with energy codes, many of which are often portrayed from a consumer perspective. Messages suggested for state outreach efforts include:

- Energy codes reduce utility bills for citizens and businesses
- Compliance yields full savings potential
- Energy codes ensure lower building operating costs
- Energy codes create reduced financial risk for lenders
- Codes increase a building's selling potential
- If your home or business does not meet code, it will cost you every month
- Energy codes reduce utility bills and protect consumers
- Front end costs are more affordable and cheaper than later costs to fix
- Energy codes increase electric grid reliability
- Codes protect citizens from substandard construction
- Energy code compliant homes are less likely to default on payments
- Compliant homes are a significant selling point

Stakeholder Groups

In conducting outreach activities, the plans name a variety of potential stakeholders. These range from state agencies advocating for or administering the energy code, to private organizations providing goodwill support. A list of stakeholders recommended for inclusion in outreach efforts is as follows:

- State agencies and housing authorities
- General assembly
- Local governments
- International Code Council (ICC) chapters
- Regional Energy Efficiency Organizations (REEO)
- Regional USGBC chapters
- State Home Builders Associations

List of stakeholders recommended for outreach efforts (continued):

- Regional chapters of the American Institute of Architects (AIA)
- ASHRAE chapters
- Utility companies
- Fire Marshal office
- Municipal associations
- Environmental groups
- Product manufacturers
- Private organizations
- Consumer protection agencies
- Real estate, appraisal and lending organizations
- Educational institutions
- Cool Cities programs
- Chamber of Commerce

Advocacy Resources

Compliance plans also identify several resources for use across multiple states. Many of these are in relation to particular activities, ranging from code advocacy to specific technical requirements inspected during compliance evaluations. Several of the general items are also available for customization, and can be tailored to the needs of specific states. Resources identified within state plans include:

- *ACEEE reports on the impact of energy efficiency programs*: www.aceee.org/blog/2011/11/how-does-energy-efficiency-create-job (accessed: November 5, 2012)

- *BCAP Cost-savings Calculator*: http://energycodesocean.org/resource/energy-code-calculator (accessed: November 5, 2012)

- *BCAP fact sheets*: http://energycodesocean.org/consumers-take-action (accessed November 5, 2012)

- *BCAP incremental costs information*: http://energycodesocean.org/incremental-cost-analysis (accessed November 5, 2012)

List of advocacy resources (continued):

- *IMT Policymaker Factsheet*: http://www.imt.org/uploads/resources/files/PolicymakerFactsheet-EnergyCodeCompliance.pdf (accessed November 5, 2012)

- *NEEP Energy Efficiency at Home video*: www.vimeo.com/16891099 (accessed November 5, 2012)

- *New Hampshire fact sheets and energy code presentations*: www.nhenergycode.com (accessed November 5, 2012)

- *U.S. DOE Resource Guide for State and Local Policymakers*: http://www.energycodes.gov/building-energy-codes-resource-guide-policy-makers (accessed November 5, 2012)

Training

The importance of energy code training and education programs was also stressed identified repeatedly within the Strategic Compliance Plans. A number of general training strategies were provided in each report, along with an example of a training program breakdown. An overview of recent state-funded training efforts was provided, with a summary of such efforts provided in the table below.

Table 41: Summary of state training programs

State	Program Description	Recent Attendance
Colorado	Statewide supported by the Department of Local Affairs with Recovery Act funds	50 sessions
Delaware	NEEP provided commercial and residential training	6 sessions
Illinois	Contracted with International Energy Conservation Consultants	30 sessions (scheduled)
Kentucky	Partnership with state HBA and the University of Kentucky	“several”
Michigan	Partnership with Michigan State University	5000+ attendees
New Hampshire	Conducted through New Hampshire Building Codes Compliance (NHBCC) project	29 sessions 1100+ attendees

A sample training program was also estimated within plans for several states. Costs of these sample programs ranged from as little as $16,000 in South Carolina up to about $49,000 in the state of Illinois. Several general strategies were also recommended, encouraging states to maintain current programs or install additional energy code training opportunities.

Recommended strategies were observed to include:

- Empower energy codes at the community level
- Continue with state energy code delegate program
    - Provide phone and email support to peers
    - Participate in local government meetings
- Continue and expand the state energy code training program
- Include training on special topics
- Develop a centralized energy codes website
- Implement the Energy Code Ambassadors program

Compliance Evaluation

Several of the state Strategic Compliance Plans concluded in encouraging the execution of a formal compliance evaluation. In all cases, these evaluations referenced the PNNL methodology. In addition, one unique state, Colorado, also referenced a compliance study conducted in the Fort Collins area during the 1990s.

A consistent set of goals was observed across all states where a compliance evaluation was recommended. These goals are as follows:

1. Establish energy code compliance baseline
2. Track progress toward state goals
3. Monitor energy savings attributed to building energy codes
4. Document cost-effectiveness of compliance activities

The structure of the formal compliance study was also presented, again referencing the PNNL methodology.

Compliance evaluations were recommended to include:

- BCAP or PNNL (original or state-specific) survey
- Funding allocation ranging from $75,000-750,000 (references PNNL pilot studies)
- PNNL State Sample Generator
- Local (first-party), state (second-party) and contracted private sector firms (third-party)
- Approach based on the PNNL methodology

5.4.1 Observed Trends

The Strategic Compliance Plans offer an overview of state compliance scenarios and a package of recommendations for individual states to consider in addressing 90% Compliance requirements. Plans were analyzed for each included state, with extracted data included throughout the section.

The following list of findings summarizes key takeaways for further consideration in additional states.

- A portion of states were found to have established an energy codes compliance working group, including Delaware, New Mexico, and West Virginia.
- State compliance plans encourage the creation of an energy codes coalition to provide key functions, such as directing targeted outreach efforts, serving as a clearinghouse for codes information, and providing oversight for implementation programs.
- Several sources of funding are recommended, including Energy Efficiency Resource Standards, state appropriations, trusts or public benefit funds, construction permitting and inspection fees, subsidized training fees, a System Benefits Charge, and other funding from utilities or private organizations.
- All states, including those with a Home Rule regulatory infrastructure, are directed to adopt a statewide energy code, while also allowing for above-code programs.
- Compliance plans encourage states to incorporate third-party testing and evaluation services.
- States are encouraged to implement professional licensing and certification programs, including energy code education in continuing education requirements.
- States are directed to allocate additional funding to support compliance requirements, including free energy code training courses.
- Unincorporated or rural regions of a state are encouraged to leverage inspection services from neighboring jurisdictions, or employ roaming statewide officials.
- Several outreach activities are recommended, including maintenance of a state energy codes website, factsheets and field guides for policymakers, marketing through media sources, and coordination with professional organizations.
- Outreach materials are encouraged to build on specific messaging to highlight the benefits of energy codes in relation to energy and cost savings, building quality, consumer protection, and as a selling point to potential homebuyers.
- Several key stakeholder groups are identified, including state and local government agencies, national professional organizations (and regional chapters), environmental groups, consumer protection agencies and educational institutions.
- Resources are identified to assist in advocating for the energy code, which, in many cases, may be customized by states seeking code adoption or addressing compliance requirements.
- Compliance plans outlined training programs in many states, including recent sessions Colorado, Delaware, Illinois, Kentucky, Michigan, and New Hampshire—totaling over 100 unique training sessions and upwards of 6000 attendees.
- Characteristics of successful training programs are suggested for states, typically including community energy code ‘champions’, code delegate programs, expansion of state training programs, training on special topics, a centralized energy codes website, and the implementation of an energy code ambassadors program.
- State compliance evaluations are recommended based on the PNNL methodology.
- Evaluations should also include local, state and private sector contracted personnel.

5.5 SUMMARY OF FINDINGS

The qualitative portion of the study analyzed state case studies from three unique collections of reports, with identified phenomena extracted and input to a database. A database was constructed for each source, with information displayed in a matrix format. The following represents a summary of findings obtained from each collection of reports, helping to better understand state and local scenarios, challenges faced, and potential resolutions for states to consider as they address compliance requirements.

5.5.1 Pilot Studies

Pilot studies were conducted in several states to test the methodology recommended by the Pacific Northwest National Laboratory (PNNL) and assist states in addressing 90% Compliance requirements. Reports submitted by individual pilot states shed light on unique compliance scenarios, challenges faced by states and enforcement officials, and provide an effective outline of experiences reported by early-adopting states. The resulting findings are summarized below, helping to understand state needs, as well as challenges and takeaways from previous state experiences.

Application of PNNL Methodology

The pilot studies offered mixed feedback on a number of the pieces of the PNNL methodology, but the use of this approach was found to be positive overall. The Georgia study reported having been able to implement the method without significant difficulty, having been able to follow the recommended approach using each of the supplementary compliance tools and resources. Third-party contractors were also described as having been able to apply and report results easily in the Georgia study, with the state highly recommending the PNNL approach.

A handful of studies offered suggestions to improve the checklists. These requests surrounded improvement of the checklists and accompanying instructions, elimination of non-applicable conditions, or clarification of confusing items. The Massachusetts study relied on the checklists in conducting post-construction building evaluations. This application was not recommended, due to the inability to observe many checklist items after completion of the construction process.

Plan Review

Several pilot studies cited a lack of information submitted with permit applications, limiting the plan review stage of the compliance evaluation process. Documentation demonstrating satisfaction of many code requirements was often found to be missing from plans and specifications. The Iowa study specifically called upon a need for local enforcement jurisdictions to require adequate documentation during this stage of the process. Energy code plan reviews were also reported as rare within smaller enforcement jurisdictions, with code requirements verified through the field inspection, if at all.

Identifying Sample Buildings

Some pilot study states were found to contain areas unregulated for energy code enforcement. Without a responsible building department, it was difficult to solicit participating samples in these areas. Furthermore, the PNNL Sample Generator functions based on recent construction permitting data reported by local building departments. As unregulated areas have no way of collecting or reporting such data, they are overlooked in the prescribed process for generating a building sample.

Required Site Visits

Pilot studies reported varying numbers of site visits required to complete the Compliance Checklists. The Massachusetts study gathered all information to complete the checklist in a single site visit, but reported encountering many non-observable items due to the post-construction approach utilized in the study. Other studies reported multiple required visits to effectively observe checklists items, generally ranging from 2-4 visits to the project site. Pilots reporting fewer site visits were observed to have combined some of the inspection stages recommended in the PNNL methodology. For example, the Iowa study combined the insulation and rough-in inspections to streamline the process and limit the number of required site visits.

Site Access

Access to sample project sites was also found to be a problem in conducting compliance evaluations. The Montana study had difficulty gaining access to sites identified as sample buildings. Many phone calls to local jurisdictions and project contacts went unreturned, resulting in attempts to visit sites directly. These projects were sometimes locked or otherwise inaccessible. Several building samples chosen for evaluation were also found to be non-existent or based on inaccurate permitting data. Site access contributed to difficulty in completing the checklists, as well, due to difficulty in timing the field inspection after desired items were installed, but while still visible to the evaluator.

Evaluation Times

The amount of time required to evaluate a building sample was found to be relatively short. However, this time period is reported to significantly increase when proper documentation is obtained with permit applications. Shorter evaluation times were also reported as a result of the single inspection, post-construction approach, and in the Iowa study where multiple stages were sometimes combined to streamline the process.

Sample Scoring

The Massachusetts pilot study called attention to potential issues with the scoring system used by the PNNL methodology and related Score + Store tool. According to the study, the compliance score assigned to a single sample building is not negatively impacted when a significant quantity of checklists items are marked as not applicable or non-observable. In such instances, no points are given for the particular checklists item, however no possible points are scored either. The net result is an apparently neutral impact on sample scoring.

Code Infractions

Individual state pilot study reports indicated a number of common code infractions. Mechanical load calculations were found rarely completed in residential evaluations. A low compliance rate was also observed on many seemingly simple checklists items, such as the posting of compliance certificates on the home electrical panel, the presence of labels on doors and fenestration products, and the installation of high efficacy lighting. The Georgia study also addressed a number of checklists items that were not applicable under the energy code, and suggested as better-suited for inspection under other building codes (e.g. electrical or mechanical codes).

Compliance Paths

Evaluations were found to differ based on which compliance path the building was scored against. Compliance was found to be lowest when evaluated against the overall UA, or tradeoff, approach. RES*check* was cited as allowing a limited amount of tradeoffs. Compliance was reported as higher when inspected against performance-based paths, or when the selected project was constructed to a standard required by ENERGY STAR or designated HERS Rating.

Use of Compliance Software

Several studies encountered problems with compliance software options and submitted reports. Discrepancies were observed between information entered into the software and conditions seen in the field. A tendency to seek a bottom line pass or fail score was also described, hiding many of the conditions actually installed within the building.

Evaluation against Target Codes

A complication was encountered in evaluating buildings against a targeted energy code. Studies inspected and scored buildings against a designated residential or commercial code, but many sample buildings were found to have actually been constructed based on a previous code. While most states had implemented the desired code, a portion of sample buildings had originally been permitted under an earlier code version, allowing these buildings to be constructed and inspected against a code other than was currently adopted within the state.

Reported Limitations

Conditions reported as limiting enforcement officials' ability to uphold the energy code often surrounded education, time and money. Many states found enforcement jurisdictions to perceive 90% Compliance requirements as an unfunded effort beyond their typical job description and responsibility. Most jurisdictions were found to receive only one source of funding, typically based on revenue gained from permit applications. Financial restraints were reported to limit the amount of time code officials were able to spend performing compliance inspections.

Understanding of Code Requirements

Pilot studies suggest a learning curve associated with energy code requirements, and, in some cases, the energy code as a significant source of confusion. The Utah study reported confusion amongst enforcement officials, described as conflicting information on appropriate construction methods, rules, and lack of a single clear authority. The state also specifically reported home builders as resisting compliance efforts, presenting the group as frustrated with inconsistent enforcement between jurisdictions.

Education and Training

Access to energy code education and training programs was identified as important in several pilot studies. This need was often cited as a result of confusion in applying code requirements. The Iowa study stated reluctance for code officials to take advantage of educational opportunities, even free training programs recently offered by the state. For completing the PNNL Compliance Checklists, the training generally required to become a HERS Rater was referenced as sufficient. Classroom-based programs were also cited as the preferred training method.

Value of Energy Codes

State pilots also suggested the need for an increased understanding of the value behind energy codes. The Iowa study reported this understanding as lacking, including an observed tendency to hide deficiencies. The study also stated a need to educate city officials and political decision makers on the value of energy codes. The energy code was also reported as lacking value in Utah, where the code was described as lacking priority in comparison to other safety-oriented building codes.

Cost of Conducting a Compliance Evaluation

The pilot studies provide a better understanding of many logistical questions surrounding a state compliance evaluation. While the studies provided an average number of site visits and time required to complete various stages of the process, the presence of federal funding did not allow for a direct glimpse of the cost a state faces in conducting a formal compliance evaluation.

Outside of the prescribed methodology, the researcher engaged in follow-up communication with PNNL staff in an attempt to assign an approximate cost to a 90% Compliance Pilot Study. DOE administered the state pilot studies by way of PNNL, who then contracted with four Regional Energy Efficiency Partnerships and one state directly. Contracts awarded displayed a range of costs, depending on the designated building type, supplemental funding sources, and the overall scope of the study. Overall, a figure of $100,000 to 150,000 is estimated as necessary to conduct a formal compliance evaluation based on the federal model. (PNNL, personal communication, July, 19, 2012) This figure is based on the measurement of a single building type using federal funding, and does not include any supplemental activities necessary to raise compliance rates. This figure is expected to be reduced, however, if states funded from within, and directly contracted evaluators or leveraged existing building department personnel.

5.5.2 Gap Analyses

A second series of reports published by the Building Codes Assistance Project (BCAP) was evaluated for further insight on individual state compliance scenarios. Several themes have been identified to better outline the needs of states and local enforcement jurisdictions. Findings are summarized in the following section, and provide a better understanding of existing conditions within individual state scenarios.

Costs of Adopting Energy Codes

The Gap Analysis reports reference a cost-effectiveness analysis of the 2009 International Energy Conservation Code (IECC) in a variety of states. When rolled into an average mortgage, the Building Codes Assistance Project (BCAP) defines the 2009 IECC as cost-effective in all evaluated states. This assessment is performed from consumer perspective, analyzing consumer cash flows for initial costs and longer term energy and cost savings.

Funding Sources

The sources of funding to support building efficiency, energy codes, and related compliance efforts were found identified as flowing to states from the federal government. Three primary sources of funding were observed, primarily attributed to the U.S. Department of Energy. These include Energy Efficiency and Conservation Block Grants, State Energy Program funding, and stimulus funds attributed to the American Recovery and Reinvestment Act of 2009 (Recovery Act).

State Regulatory Infrastructure

A minority of states evaluated in the Gap Analysis were found to be Home Rule states, and therefore; adopt building codes by municipalities or otherwise locality. States were found to have adopted a variety of codes, such as the IECC, IRC, and IBC. In addition, a range of codes with the potential to impact building energy consumptions were also observed, such as electrical, plumbing, mechanical and existing building codes. The state agency typically responsible for oversight of the energy code was found in many cases to be a State Energy Office, however other state regulatory agencies or appointed bodies were also observed.

Beyond Code Programs

Many states were found to have adopted statewide energy savings targets or goals. A percentage savings target or specific green building program rating is often used as a threshold for government-owned facilities. The majority of states evaluated were also found to have adopted the goals of greater climate change initiatives, or have joined partnerships with nearby states. Many state-specific high-performance or green building initiatives were also found within individual states.

Stakeholder Groups

A variety of stakeholder groups were found in relation to energy code adoption and implementation. These groups typically include energy efficiency advocates, government officials, private industry, or institutional interests, such as university or extension programs.

Professional Licensing and Certification

Over half of the states evaluated were found to have professional licensing and certification programs for code officials. While many of these programs were observed to include training opportunities and continuing education requirements, they often do not include requirements specific to the energy code, and may focus predominately on building safety or other industry-related topics.

Education and Training

All evaluated states were found to have at least general access to energy code training programs. These opportunities are often state-sponsored, with funding spawning from DOE. Additional training programs are also provided by professional organizations, such as the International Code Council (ICC) or regional Home Builders Association chapters.

Third-party Enforcement

Contracted third-party services were found in less than half of the states evaluated. These services include both enforcement and performance testing, such as that performed by a HERS Rater.

Alternative Compliance Paths

A handful of states were found to accept alternative means of complying with the energy code, in lieu of the more traditional approaches specifically identified within the IECC. Some states allow for design and eventual verification through a HERS Rating. Other states also deem homes designed and constructed to ENERGY STAR criteria as meeting energy code requirements.

5.5.3 Strategic Compliance Plans

The third series of case study reports included plans written for individual states in relation to Recovery Act compliance requirements. These reports provide some additional insight on individual states scenarios, and offer a packaged set of recommendations for states to consider as they address compliance requirements. The following list provides a summary of findings, and supports a greater understanding of guidance directed to states to meet 90% Compliance.

Energy Code Working Group

Compliance plans for individual states called for the creation of a coalition to serve several key functions in relation to compliance requirement implementation. This group is identified by a variety of titles, but is called upon to provide relatively consistent functions, including oversight of targeted outreach, serving as a source of codes information and interpretation, and direction of compliance implementation programs.

Funding Sources

Several general strategies for securing funding to support compliance requirements are offered to states. These include Energy Efficiency Resource Standards, state appropriations, trusts, public benefits funds, revenue construction permitting and inspections fees, subsidized training fees, a Systems Benefits Charge, and additional options provided by utilities or private organizations with similar interests. State governments are directed to allocate additional funding to support compliance requirements. The inclusion of free training courses is also recommended within such allocations.

Regulatory Infrastructure

All state plans, including those states lacking statewide authority, are to adopt a statewide energy code. Furthermore, states are encouraged to allow above-code requirements and programs within cities and local municipalities.

Third-party Enforcement

State compliance plans encourage states to incorporate third-party testing and building evaluation services. Plans reference the protocol and approach recommended within the methodology proposed by the Pacific Northwest National Laboratory (PNNL).

Unincorporated or Rural Enforcement Regions

Many states have rural or unincorporated areas where the energy code is not inspected or adequately enforced. In these areas, states are recommended to rely upon roaming state-employed officials. Building departments without the proper enforcement staff are also encouraged to contract services from nearby enforcement jurisdictions.

Stakeholder Groups

State plans present key stakeholder groups impacted by compliance requirements. These include state and local government agencies, professional organizations (national, state and regional chapters), environmental groups, consumer protection agencies, and educational institutions.

Outreach

Several outreach activities are encouraged within states, including the maintenance of a state energy code website, policymaker factsheets, field guides for code officials, and media marketing. These efforts are suggested in coordination with a variety of professional stakeholder organizations. Outreach materials should build on a number of sample messages, many of which are focused on consumer savings, protection, and building quality. A number of resources are also identified to assist in advocating for energy code adoption and compliance, and most can be customized for use within individual states.

Education and Training

Compliance plans outline several state training programs, and provide recommendations for additional training efforts. Recent efforts in several states have presented over 100 individual training sessions, covering over 6000 attendees. States are directed to continue their training programs, and encouraged to offer additional advanced opportunities free of charge. Several characteristics of successful training programs are provided, including the installation of community-level energy code delegates, training on special topics, inclusion of a state training website, and implementation of an energy code ambassadors program.

Professional Licensing and Certification

Many state compliance plans direct states to implement professional licensing and certification programs for code officials. These programs are recommended to include training and continuing education requirements specific to the energy code.

Compliance Evaluation

All states are directed to investigate, plan, or execute a formal compliance evaluation based on the PNNL methodology for addressing 90% Compliance. Evaluations are suggested to include local, state and private sector personnel. A supplementary training program should also be included to increase knowledge of and familiarity with the energy code, as well as a means to train evaluators conducting audits and gathering data for compliance measurement.

5.6 CHAPTER SUMMARY

This section presents data gathered from multiple sources through a process of qualitative content analysis. Three collections of reports were utilized as state case studies, providing insight on state-specific scenarios, challenges, and recommendations for further consideration in other states working to address 90% Compliance. Data is presented by source, followed by a synopsis of trends observed from each unique set of documents. The chapter closes through a summary of findings for each data source, which are further synthesized in Chapter Six to draw guidance for states addressing Recovery Act requirements.

CHAPTER 6: DELIVERABLE

6.1 GUIDANCE FOR STATES

The *American Recovery and Reinvestment Act of 2009* ("Recovery Act") established requirements for states to adopt and demonstrate compliance with building energy codes. In response to these requirements, the Federal Government issued a methodology to further define expectations, and put forth an approach by which states may satisfy Recovery Act obligations. Based on the federal model, the following guidance is presented for states to consider as they strive to demonstrate *90% Compliance* with Section 410 of the Recovery Act.

6.1.1 Background

The Recovery Act provided states with funding aimed at stimulating the economy, job creation, and a transition to clean energy technologies. Part of this funding included support for energy efficiency programs, specifically requiring the adoption and implementation of energy codes for residential and commercial buildings. The U.S. Department of Energy (DOE) published a methodology elaborating on Recovery Act language, and further outlining state expectations in pursuit of the legislative mandate.

State Expectations

Section 410 of the Recovery Act includes the following requirements for building energy codes:

- Adoption of *target energy codes* for residential and commercial buildings.
- A plan to achieve compliance with target codes within eight years, including active training and enforcement programs and annual compliance measurement.

These requirements are applicable to states, as well as local code-adopting and enforcing jurisdictions, covering both statewide and Home Rule regulatory infrastructures. Target energy codes are defined for residential and commercial buildings, and are based on model codes produced by the International Code Council and ASHRAE. For residential buildings, states are instructed to adopt into law the most recently published version of the International Energy Conservation Code (IECC). As of the publish date of the Recovery Act, this was the 2009 version of the IECC. For commercial buildings, states are specifically instructed to adopt Standard 90.1—2007. Together, the IECC and Standard 90.1 are typically known as 'model' energy codes for residential and commercial buildings. States have the option of adopting these codes independently, or states may choose to adopt only the IECC, which incorporates the most recent version of Standard 90.1 by reference.

Further requirements of the Recovery Act include a plan to achieve 90% Compliance with target energy codes within eight years, placing the deadline for compliance demonstration in early 2017. Energy code training and educational programs are specified to support the process. Active measurement and enforcement is also referenced, placing an emphasis on the process leading to 90% Compliance, as opposed to a simple deadline.

The original language from the Recovery Act of 2009 is available at the following:

- *American Recovery and Reinvestment Act of 2009 (Section 410)*: http://www.gpo.gov/fdsys/pkg/BILLS-111hr1enr/pdf/BILLS-111hr1enr.pdf (accessed: November 5, 2012)

A Snapshot of Current Conditions

The following list represents current conditions gathered through a survey of code officials, providing insight on practices and processes relied upon within local enforcement jurisdictions:

- Implementation of 90% Compliance requirements depends on local stakeholders, many of which are code officials serving smaller jurisdictions.
- Most projects demonstrate compliance with the energy code through the *Tradeoff* approach, often through use of DOE RES*check* or COM*check* software.
- Permit documentation is most often maintained in a paper format, with many jurisdictions moving toward digital application and documentation processes.

Current conditions provided by code officials (continued):

- Plans and specifications are often approved as a first step, with conditions later verified through a field inspection. However, adequate documentation to support permit applications is often lacking.
- Only about half of code officials have access to compliance checklists or actual codebooks, with approved building plans serving as the most common resource available during field inspections.

The most common code infractions reported within residential buildings are generally within the mechanical or envelope systems. Infractions are often found related to requirements for air sealing for envelope infiltration and mechanical duct systems. Proper mechanical system load and sizing calculations are often lacking for residential projects. Issues surrounding insulation and its installation are also commonly reported. Fenestration exhibits the fewest number of infractions within residential buildings. Within commercial buildings, the envelope is also identified as a common source of code infractions, with over half of code officials reporting problems in this portion of the building. Lighting is referenced as the least common infraction within commercial projects. (Survey findings)

A Model Approach

The expectations of the Recovery Act are further defined through a methodology published by DOE, developed with the assistance of Pacific Northwest National Laboratory (PNNL). The federal method elaborates upon the basic requirements of the Recovery Act, and provides a comprehensive model for states to follow in measuring building energy code compliance rates. The approach recommends the formation of a compliance working group within each state, and outlines requirements for approaching local jurisdictions, establishing a baseline of current practices, developing a valid building sample, evaluating compliance, and reporting eventual findings. Additional topics, such as general funding sources, as well as supplemental training programs are also addressed.

States have initiated compliance measurement activities, including several 90% Compliance Pilot Studies administered in several states. Pilots were commissioned by the Federal Government to test the recommended approach, and gather feedback on the process through state experiences. Overall, the federal model was found successful, with specific feedback offered on portions of the methodology and supporting compliance tools.

For more information on the federal methodology and state compliance activities, visit the DOE Building Energy Codes website:

- *Measuring State Energy Code Compliance Report*: www.energycodes.gov/sites/default/files/documents/MeasuringStateCompliance.pdf (accessed: November 5, 2012)

6.1.2 Recommendations

The following sections provide guidance for states addressing Recovery Act 90% Compliance requirements. A general approach overlaying the Federal model is presented, outlining requirements against issues identified within states, as well as local levels of energy code enforcement. Recommendations are provided for states to consider as they implement supporting policies and take action to meet compliance requirements. The source of each recommendation as it emerged through the study is also provided. Finally, related tools and valuable resources are presented to assist states and support each step of the process.

Figure 38: Recommended approach to 90% Compliance demonstration

Establish a Compliance Working Group

Source: Federal methodology, Strategic Compliance Plans

The federal model for demonstrating 90% Compliance with Section 410 of the Recovery Act suggests the formation of a *Compliance Working Group* within each state. This group is intended to work with state agencies and provide oversight for many of the compliance activities within a state. The federal approach does not outline specific requirements that apply to the working group, however; states are directed to establish this group prior to performing self-assessments, building evaluations, or executing training and education programs.

Issues and Findings

Several states have already established a compliance working group, typically recognized as a coalition, collaborative, or otherwise advisory group. These groups are often observed to include government officials, environmental or energy efficiency advocates, private corporations, institutional personnel, and members of the construction industry. A compliance working group can serve several key functions in relation to Recovery Act compliance requirements, such as oversight of training programs, targeted outreach efforts, a source for code information and interpretations, as well as providing general direction for compliance implementation programs. A variety of outreach materials are available to states, ranging from policymaker factsheets to field guides for code officials. These efforts are suggested in coordination with professional stakeholder organizations. (Strategic Compliance Plans) State pilots also suggest the need for an increased understanding of the value behind energy codes, including their use, implementation and enforcement, with a specific focus on government officials and political decision-makers.

Recommendations

States should establish a compliance working group to assist with 90% Compliance planning and implementation. Such a group should include a diverse group of representatives with the ability to provide multiple perspectives on compliance issues, as well as connect compliance activities to interested and affected stakeholder populations. A compliance working group can rely on volunteer members, and function in a committee format under the oversight of a state regulatory (or otherwise assigned) agency. A charter should be established by the responsible agency, with clear goals put in-place to align work efforts and support compliance requirements. Compliance groups consisting of professional stakeholders will be amply qualified to guide state training efforts, as well as recommend potential funding options. Technical assistance and a variety of outreach materials are available from the federal government and many national organizations. These materials can be customized for state-specific applications, and technical assistance is highly valuable to states initiating compliance activities. (Strategic Compliance Plans) As energy codes are often chosen as a mechanism to support greater energy savings, climate change, or sustainability policies, it becomes all the more important to engage the appropriate policy and decision-makers beyond simply code officials, including lawmakers, governmental officials, city council members, designers, builders, and manufacturers.

Resources

- *U.S. Department of Energy Building Energy Codes Program*: http://www.energycodes.gov (accessed: November 5, 2012)
- *National Association of State Energy Officials (NASEO) Webinar: Energy Code Best Practices: How to Establish an Energy Codes Compliance Collaborative*: http://www.naseo.org/codes/events/2012-04-17/NASEO-BCAP_Codes_Collaborative_Webinar-2012-04-17.pdf (accessed: November 5, 2012)
- *Idaho Energy Code Collaborative*: http://idahoenergycollaborative.weebly.com/1/post/2011/02/feb-11-idaho-energy-update.html (accessed: November 5, 2012)
- *Nevada Energy Codes Collaborative*: http://renewableenergy.state.nv.us/resources-forms/necc.html (accessed: November 5, 2012)
- *Online Code Environment and Advocacy Network (OCEAN)*: http://energycodesocean.org/research-topics/outreach (accessed: November 5, 2012)
- I*nstitute for Market Transformation Building Energy Code Compliance Resources*: http://www.imt.org/codecompliance.html (accessed: November 5, 2012)

Secure Financial Support

Source: Federal methodology, Gap Analyses, Strategic Compliance Plans

A variety of general funding options to support Recovery Act compliance requirements are outlined within federal guidance, however, many of these are tied to associated stimulus funding, and will soon no longer be available for states to support ongoing programs. Options include a handful of federal sources designed to support energy efficiency in buildings, including DOE Energy Efficiency and Conservation Block Grants (EECBG) and State Energy Program (SEP) funding. States are encouraged to allocate support within their budgets for energy code training programs. Remaining stimulus funding input to revolving loan programs are suggested as an option in some states, as well as the potential to leverage utility efficiency programs. Local governments are also encouraged to pursue options, such as increased permit and inspection fees, or training fees to subsidize overhead costs. However, it is recognized that when construction activity is down, the potential for many of these options is reduced.

Issues and Findings

The Federal model and recent compliance studies identify funding as a primary impediment to compliance with building energy codes, and specifically to the implementation of Recovery Act compliance requirements. Based on the survey of local code enforcement officials, jurisdictions are found to be severely limited in the number of functions they can perform, especially those over and above current workloads. Most local jurisdictions obtain funding from a single source, which is most often a product of permit revenue. Only about one-third of jurisdictions are supported by a municipal budget. In addition, other top limitations reported by local code enforcement jurisdictions center around the availability of time, knowledge, and resources—arguably also linked to financial stability. (Survey)

Several general strategies for securing funding are available to support state compliance efforts. Solutions currently exercised within states include Energy Efficiency Resource (or Portfolio) Standards, state appropriations, public trusts or benefits funds, and Systems Benefits Charges. Some states have also established relationships with utility companies or private organizations with overlapping interests in energy efficiency. Some local governments have been successful in finding revenue for general training; however most are limited in funding options to support compliance specific to the energy code. (Gap Analyses and Strategic Compliance Plans)

Recommendations

States need to take action early to develop a funding model to financially support efforts to demonstrate 90% Compliance. This step is included early in the process, as it has the ability to severely limit progress, if not impede state compliance efforts altogether. Several options do exist, but none is as attainable as they have been in recent years, and traditional funding sources are tight following the passing of the Recovery Act. Realistic and sustainable funding sources will require adequate buy-in from state policy makers and officials, further emphasizing the need to communicate the value of energy codes and compliance efforts to the appropriate decision-makers. At the present time, accurate estimates for performing baseline compliance studies and increasing compliance rates are largely unknown. States having initiated activities may be able to provide further insight on necessary funding allocations, however no states have yet to complete a full study or fully meet the 90% Compliance requirements. The organization of the study and current conditions are expected to significantly impact required funding, but may vary significantly from state-to-state. Members of a compliance working group may also be able to provide additional insight on state-specific sources of funding, or localized organizations with similar interests. (Strategic Compliance Plans)

Resources

- *U.S. Department of Energy Energy Efficiency and Conservation Block Grant Program*: http://www1.eere.energy.gov/wip/eecbg.html (accessed: November 5, 2012)
- *U.S. Department of Energy State Energy Program*: http://www1.eere.energy.gov/wip/sep.html (accessed: November 5, 2012)

Resources (continued):

- *Environmental Protection Agency Green Building Funding Opportunities*:
  http://www.epa.gov/greenbuilding/tools/funding.htm
  (accessed: November 5, 2012)

- *U.S. Department of Energy: Building Energy Codes Technical Assistance*:
  https://www.energycodes.gov/resource-center/state-assistance-request
  (accessed: November 5, 2012)

- *U.S. Department of Energy Database of State Incentives for Renewables and Efficiency (DSIRE)*:
  http://www.dsireusa.org/
  (accessed: November 5, 2012)

- *National Association of State Energy Officials (NASEO) State Member Directory*:
  http://www.naseo.org/members/states/
  (accessed: November 5, 2012)

- *Energy Foundation*:
  http://www.ef.org/home.cfm
  (accessed: November 5, 2012)

- *New York State Energy Research and Development Authority*:
  http://www.nyserda.ny.gov/en/Funding-Opportunities.aspx
  (accessed: November 5, 2012)

- *New York State Energy Efficiency Portfolio Standard*:
  http://www3.dps.ny.gov/W/PSCWeb.nsf/All/06F2FEE55575BD8A852576E4006F9AF7?OpenDocument
  (accessed: November 5, 2012)

- *Bonneville Power Administration Energy Efficiency Utility Summits*:
  http://www.bpa.gov/Energy/N/Utilities_Sharing_EE/Utility_Summit/
  (accessed: November 5, 2012)

- *Oak Ridge National Lab: Electric Utilities and Energy Efficiency*:
  http://www.ornl.gov/info/ornlreview/rev28_2/text/uti.htm
  (accessed: November 5, 2012)

- *U.S. Green Building Council: Financing and Encouraging Community Green Building*:
  http://www.usgbc.org/ShowFile.aspx?DocumentID=6247
  (accessed: November 5, 2012)

Install Education and Training programs

Source: Federal methodology, Pilot studies, Gap Analyses, Strategic Compliance Plans

The original language of the Recovery Act specifically calls for inclusion of education and training programs to support target energy codes and 90% Compliance requirements. The federal model echoes a need for these programs, and encourages states to establish ongoing training programs throughout the process of benchmarking current processes and conducting measurement activities. Programs are intended to focus on evaluators and enforcement officials, but may also be extended to include practitioners and other affected stakeholders.

Issues and Findings

The importance of energy code training programs was highlighted by several states in 90% Compliance pilot study findings. Over half of code officials are known to have at least general access to training, however; many programs do not include courses specific to the energy code. Only about a quarter of local enforcement jurisdictions require energy code training as part of a mandatory program, and many code officials report receiving no training at all. Training is also reported as one of the most prominent limitation to compliance. (Survey)

Some states have implemented professional training and certification programs for code officials, however, many of these programs focus on building safety or other industry-related topics without specifically targeting the energy code. Training programs are most often performed through state-sponsored programs, or commissioned through a professional organization, such as the International Code Council (ICC) or regional Home Builders Association chapter.

Successful state training programs are also found to include attributes such as community-level energy code delegates, state or specialized training websites, and training on advanced code topics. (Gap Analyses and Strategic Compliance Plans)

Recommendations

Training and educational programs are core to improving compliance with building energy codes. It is important that code implementers receive training to learn practices yielding higher compliance rates, but also to have access to general educational programs and resources to better understand the intent and principles behind specific code provisions. States should make every effort to ensure continuity of these programs to increase general compliance, as well as to support Recovery Act requirements. Energy code training programs are most often recommended to be offered on a no-cost basis; however, states where such training is in demand may consider charging a prudent fee to cover program costs. (Federal methodology) States might also consider tying professional certification requirements to licensing programs in order to ensure prerequisite knowledge. (Gap Analyses) Adequate training and educational resources are paramount in generating a state energy code compliance rate above the 90% threshold.

Resources

- *U.S. Department of Energy Building Energy Codes Program*:
  www.energycodes.gov
  (accessed: November 5, 2012)

- *Building Codes Assistance Project*:
  http://bcap-energy.org/
  (accessed: November 5, 2012)

- *Online Code Environment and Advocacy Network: Training*:
  http://energycodesocean.org/research-topic/training
  (accessed: November 5, 2012)

- *Georgia Department of Community Affairs:*
  http://www.dca.state.ga.us/development/ConstructionCodes/programs/EnergyCodeTrainingWorkshops.asp
  (accessed: November 5, 2012)

Resources (continued):

- *Texas State Energy Conservation Office*:
  http://www.seco.cpa.state.tx.us/tbec/
  (accessed: November 5, 2012)

- *Michigan State University Energy Code Training and Implementation Program*:
  http://energycodes.spdc.msu.edu/
  (accessed: November 5, 2012)

- *Washington State University Extension Energy Program*:
  http://www.energy.wsu.edu/buildingefficiency/energycode.aspx
  (accessed: November 5, 2012)

- *Efficiency Vermont*:
  http://efficiencyvermont.com/for_our_partners/res_nc_partners/training_opportunities
  (accessed: November 5, 2012)

- *Code College Network*:
  http://www.codecollegenetwork.com/
  (accessed: November 5, 2012)

- *Southface Energy Institute:*
  http://www.southface.org/learning-center/trainings/
  (accessed: November 5, 2012)

Adopt Target Energy Codes

Source: Federal methodology, Gap Analyses, Strategic Compliance Plans

A crucial legislative step for states in satisfying Recovery Act requirements is the adoption of target energy codes for residential and commercial buildings.

The federal model, in combination with the original Recovery Act language, establishes these targets as:

- 2009 IECC for residential buildings
- Standard 90.1—2007 for commercial buildings

States may adopt these codes directly, or must establish a state code that offers equivalent or better energy savings. (ARRA Section 410)

Issues and Findings

The majority of existing guidance encourages the adoption of energy codes on a statewide basis. This creates a complication for states which adopt codes by individual locality, called Home Rule, as this regulatory infrastructure extends beyond energy codes alone. States are also found to adopt a variety of building codes which may impact the energy code, such as those establishing requirements for mechanical, plumbing, electrical, or specialized building systems. Currently, it is difficult for Home Rule states to comply with legislative requirements for energy code adoption. Although some cities within these states have adopted quite progressive codes and standards, conditions tend to vary between localities within those states. (Gap Analyses) Code adoption is often challenged due to uncertainties surrounding potential energy savings and increased construction costs. The Building Codes Assistance Project recently conducted a series of cost assessments analyzing the effect of code adoption in a variety of U.S. states. The analysis is presented from a consumer cash flows perspective, with increased costs rolled into a typical homeowner mortgage, and balanced against energy savings. (Gap Analyses) A similar analysis has been conducted by the U.S. Department of Energy on a national scale, in addition to state-by-state analyses. The National Association of Home Builders also published a national cost analysis for the 2009 and 2012 IECC.

Recommendations

To satisfy Recovery Act requirements, states must adopt at least the 2009 IECC for residential buildings and Standard 90.1—2007 for commercial buildings. (Federal methodology) Many states have adopted both options by way of solely adopting the 2009 IECC, which incorporates 90.1—2007 by reference. A portion of states have gone the route of establishing their own state-specific code, however; these codes must be analyzed and demonstrate equivalent or greater levels of energy savings than the Recovery Act target codes. To meet the legislative mandate, Home Rule states will need to allow for an exception and incorporate a minimum statewide energy code, or will need to seek an alternative method. (Gap Analyses)

Several organizations support increased energy efficiency through code adoption. Many of these can be leveraged to create and support legislative proposals, provide technical guidance, and in identifying applicable resources. States should also consider adoption of the more recent 2012 IECC and 90.1—2010. These model codes have been determined to be more efficient than the target codes, therefore meeting the requirements of the Recovery Act. In addition, these more recent versions achieve significant energy savings, which have been shown to be cost-effective by the referenced analyses. (Gap Analyses)

Resources

- *U.S. Department of Energy Status of State Code Adoption*: http://www.energycodes.gov/states/ (accessed: November 5, 2012)
- *U.S. Department of Energy Model Adoption and Compliance Policies*: http://www.energycodes.gov/resource-center/model-policies (accessed: November 5, 2012)
- *Regional Energy Efficiency Organizations*: http://energycodesocean.org/regional-energy-efficiency-groups (accessed: November 5, 2012)

Resources (continued):

- *Responsible Energy Codes Alliance*: http://www.reca-codes.org/ (accessed: November 5, 2012)

Conduct a Compliance Evaluation

Source: Federal methodology, Strategic Compliance Plans

Once Recovery Act target codes have been adopted and supporting activities have been selected, states are expected to conduct a compliance evaluation. This is intended to be an ongoing process, starting with the establishment of a baseline compliance rate, and continuing with subsequent training and evaluations until a rate of 90% energy code compliance has been achieved. The evaluation is the last stage in the Recovery Act compliance process, but is the primary undertaking and should not be underestimated. (Federal methodology) The following graphic outlines a more detailed view of compliance evaluation stage.

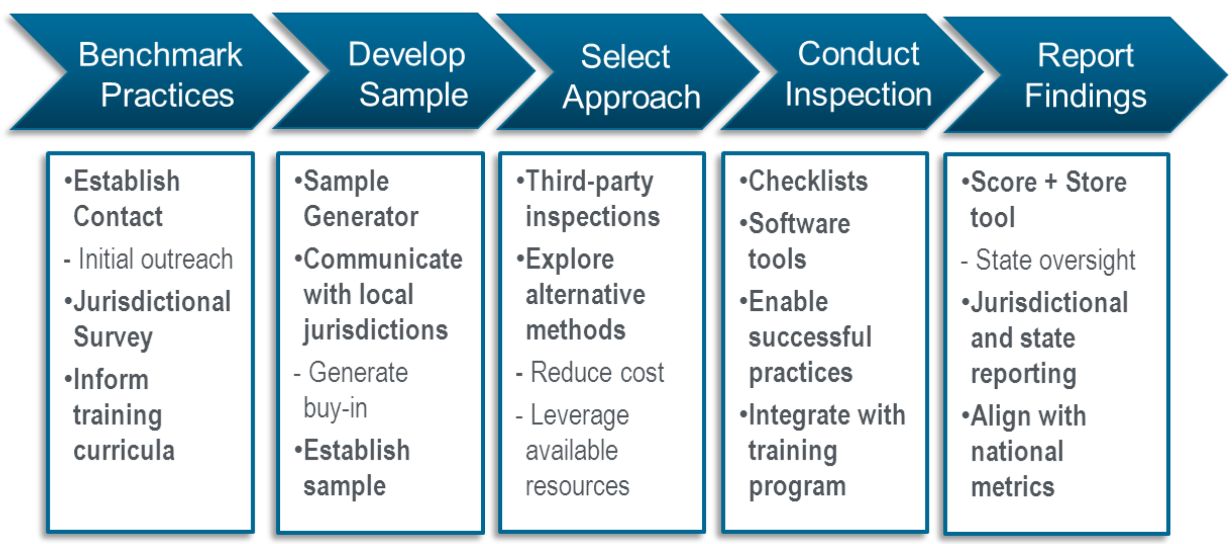


Figure 39: Compliance evaluation steps

Benchmark Practices

The federal model outlines methods for states to benchmark current practices used within local code enforcement jurisdictions. As a first step in preparation for the actual compliance evaluation, it is recommended that states survey stakeholders to better understand conditions and processes used within local code enforcement jurisdictions. The Pacific Northwest National Laboratory developed an instrument known as the *Jurisdictional Survey* to assist states in benchmarking current practices and conditions. The survey includes a variety of questions characterizing local building departments, their staff, and inquiring upon the processes by which the energy code compliance is determined. The survey is recommended in preparation for the compliance evaluation, as well as to supplement the inspection of individual buildings. These benchmarking activities can also be continued until 90% Compliance is achieved, allowing a state to spot-check progress or provide feedback to accompanying training programs. (Federal methodology)

Issues and Findings

Pilot studies found the survey to be a successful method of benchmarking current scenarios and gathering early compliance data. Several pilot states administered the survey to varying degrees, with additional non-pilot states gathering survey data. Response data indicates nearly half of code officials serve smaller jurisdictions of less than ten thousand people. (Survey) This would indicate states require a means of coordinating with a large number of local implementation actors. A portion of pilot study states also conducted stakeholder interviews and focus groups to augment or in replacement of the survey approach.

Recommendations

States should consider surveying stakeholders early in the evaluation stage. As a less-expensive part of the process, states can gather valuable data in programming training curricula, communicating with local building departments, and in developing an eventual building sample. (Pilot studies) The survey may also help to establish first contact with local enforcement jurisdictions, or to further recruit participants. Accompanying letters and supplemental information should also be included to explain the overall process. (Strategic Compliance Plans)

Resources

- *DOE Compliance Evaluation Procedures Overview*:
  http://www.energycodes.gov/compliance/evaluation
  (accessed: November 5, 2012)

- *PNNL Jurisdictional Survey*:
  https://survey.pnl.gov/se.ashx?s=4D1929A5207AB413
  (accessed: November 5, 2012)

- *North Carolina Energy Code Compliance Survey*:
  http://www.mathisconsulting.com/storage/NC%20Code%20Compliance%20Survey%20Report%20electronic.pdf
  (accessed: November 5, 2012)

- *International Code Council (ICC) Chapter Directory*:
  http://www.iccsafe.org/Chapters/Pages/default.aspx
  (accessed: November 5, 2012)

- *American Institute of Architects (AIA) Chapter Directory*:
  http://www.aia.org/about/structure/components/AIAS078541
  (accessed: November 5, 2012)

- *ASHRAE Chapter Directory*:
  http://www.ashrae.org/society-groups/chapters
  (accessed: November 5, 2012)

- *National Association of Home Builders Chapter Directory*:
  http://www.nahb.org/local_association_search_form.aspx
  (accessed: November 5, 2012)

Develop Sample

The next step in the compliance evaluation process is to develop a building sample from which energy code compliance measurements can be gathered. The federal model requires a statistically valid sample from both new and existing residential and commercial buildings. State samples must include at least 44 buildings from each of the following construction types:

- New residential
- New commercial
- Residential renovations
- Commercial renovations

Some states may require a smaller or larger building sample, depending on the amount of recent construction activity within the state. The federal model also calls for further consideration within the designated categories, such as multifamily projects, modular housing, and large or specialty commercial projects. The building sample also needs to draw a weighted sample across all state climate zones. (Federal methodology)

Issues and Findings

The majority of pilot study states relied upon the PNNL Sample Generator tool to calculate and define the building sample. (Pilot studies) This web-based tool creates a statistically valid sample across all state climate zones based on recent construction permitting data. Projects are generated by county, directing evaluators where to focus their efforts and work with local jurisdictions to identify specific projects.

Some pilot studies did encounter some difficulty in establishing a building sample of adequate size. Unregulated areas within a state (without an assigned building department or agency responsible for energy code enforcement) were found to be under-reported within recent permitting data, and therefore not fully represented by the Sample Generator. Many states also had difficulty in identifying specific projects within designated areas, and had to expand their original sample to secure the necessary number of inspections. (Pilot studies)

Recommendations

The PNNL Sample Generator was created specifically to create state building samples for 90% Compliance evaluations. States should use the tool to establish a starting sample, and then expand the sample as needed to secure adequate buildings for each construction type. States should not overlook the importance of communicating with and generating buy-in from local stakeholders and enforcement jurisdictions. Identifying local partners and working with cooperative jurisdictions early in the process is recommended. States should also plan to establish a larger sample than necessary, as some projects may not work out due to timing, availability of necessary data, and factors beyond control of the evaluation. (Pilot studies)

Resources

- *PNNL Sample Generator Tool*:
  http://energycode.pnl.gov/SampleGen/
  (accessed: November 5, 2012)

- *U.S. Census Bureau Building Permits Survey*:
  http://www.census.gov/construction/bps/
  (accessed: November 5, 2012)

Select Approach

The federal model for measuring 90% Compliance recommends the use of third-party evaluators to conduct building inspections. The methodology suggests hiring private sector testing and verification professionals, such as a Home Energy Rater. Personnel from a non-local inspection agency may be used to fulfill the third-party approach. States are encouraged to support these industries by establishing credentials for professional certification.

Several compliance approaches are also outlined in the federal model, often referenced as *compliance paths*. Compliance may be demonstrated by any of the options typically included within the model codes; prescriptive, tradeoff, or performance paths. Evaluators are encouraged to select the path as indicated on compliance documents, as appropriate, to match the path to which the building was designed.

Issues and Findings

The approach by which samples were evaluated was found to impact pilot study findings in several ways. Individual evaluations were found to differ based on which path the building was scored against. Compliance was found to be highest when buildings were evaluated through the performance-based path. In states where software reports are accepted, pilots reported discrepancies between information contained on the compliance report and actual field conditions. States should note which code a building was designed and constructed to satisfy, as buildings currently under construction may not necessarily have been permitted to meet the currently adopted energy code. Pilots also concluded the PNNL Compliance Checklists were not a valuable approach when applied in a post-construction format, due to the inability to observe a large portion of required provisions.

The use of contracted third-party services was found in less than half of the pilot states. Performance rating and verification professionals are observed in several states, however; not on a widespread basis. Some states have also experimented with alternative means of demonstrating compliance with the energy code, such as design and verification through a HERS Rating. Other states may also recognize ENERGY STAR homes as code-compliant. (Pilot studies)

Recommendations

States should select one or more approaches to 90% Compliance evaluations, as is suitable for their particular scenario. States where alternative means of demonstrating compliance are in-place should leverage these methods in gathering data. The Federal model provides the most comprehensive approach to evaluating compliance rates in relation to 90% Compliance requirements. Third-party services are a viable approach; however, limited funding may prohibit use of contracted services in some states. Although the federal model specifically recommends the third-party approach, alternative approaches are not removed and should be considered, if advantageous. (Pilot studies) In particular, states with limited funding might further consider a self-evaluation model relying on existing jurisdictional staff.

Resources

- *Compliance Verification Paths for Residential and Commercial Buildings*: http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-20822.pdf (accessed: November 5, 2012)

- *Residential Energy Services Network:* Find a HERS Rater: http://www.resnet.us/directory/search/searchtype/auditor (accessed: November 5, 2012)

- *U.S. Environmental Protection Agency: Find an ENERGY STAR Builder:* http://www.energystar.gov/index.cfm?fuseaction=new_homes_partners.locator (accessed: November 5, 2012)

Conduct Inspections

The Federal model outlines the evaluation of a single building over two stages: review of building plans and specifications submitted with the permit application, followed by a series of field inspections performed on the project site. These inspections strategically target specific stages of the building construction process in hopes of observing all features required by the energy code, including placement of the building foundation, framing or rough-in stages, installation of insulation, and a final inspection. The federal model allows for the inspection of a single building through each designated stage of construction, or the creation of a single sample through the evaluation of each stage via separate buildings, or a combination thereof.

Issues and Findings

Several state 90% Compliance pilot studies reported a lack of information submitted with building permit applications, severely limiting the plan review stage of the compliance evaluation process. Plan reviews were cited as rare within smaller jurisdictions. In-house staff was found to perform the vast majority of plan reviews and field inspections for energy code compliance.

State pilots reported varying numbers of site visits required to gather the necessary compliance data. This was often dependent on the chosen approach, or how thoroughly checklists were completed. Access to projects was reported as challenging, due to timing issues or inaccurate project information. The amount of time necessary to evaluate a single building sample was found to be relatively short, however; this process may take longer when adequate documentation is obtained with building permit applications.

Recommendations

Establishing a robust building sample and understanding unique conditions within a state is paramount to obtaining adequate compliance data. (Pilot studies) States should first become familiar with current practices and the financial capability of their study. While all portions of the federal model are encouraged as an ideal target, states may wish to consider alternatives to gather necessary information.

The depth of plan review and field inspections efforts depends upon the ability of local jurisdictions to require and enforce necessary practices. Efforts should focus on installing successful practices for evaluation longer-term and on a permanent basis, enabling local jurisdictions to uphold energy code requirements. These efforts should also be integrated with state training programs to increase understanding and the underlying need for proper enforcement. (Federal methodology and Strategic Compliance Plans)

Resources

- *PNNL Compliance Checklists*: http://www.energycodes.gov/compliance/evaluation/checklists (accessed: November 5, 2012)
- *REScheck and COMcheck Software Tools*: http://www.energycodes.gov/compliance/tools (accessed: November 5, 2012)

Report Findings

Following the evaluation of building samples, the federal model calls for the reporting of findings to establish a state compliance rate. States are directed to establish separate reporting for each building type, as compliance may vary between samples. Individual buildings are assigned a compliance rating of 0-100%, based on the proportion of code requirements satisfied. A tiered system is incorporated to set the importance of individual code provisions. Data gathered within a state is reported at multiple levels, allowing for a comparison of compliance between local jurisdictions, as well as for an overall state rate. Data is also intended to eventually be aggregated across states to establish a glimpse of national energy code compliance rates. (Federal methodology)

Issues and Findings

State 90% Compliance pilot studies reported an overall positive experience with the process of reporting evaluation data on energy code compliance rates. Final inspection data was reported through the PNNL Score + Store tool, which is designed to electronically capture data entered into the Compliance Checklists. A variety of reports can then be run to establish baseline rates, eventually leading to a final state compliance rate to demonstrate 90% Compliance based on Section 410 of the Recovery Act. In addition, use of the Score + Store tool also ensures alignment with national metrics.

One pilot study reported early technical problems in using the Score + Store tool, but these were indicated as resolved as the study progressed. The study also noted a problem states should be aware of pertaining to the scoring system. Items marked non-applicable or non-observable have no effect on the scoring of an individual building. (Pilot studies)

Recommendations

States should plan to use the Score + Store tool to report 90% Compliance evaluation data, as it has the ability to streamline data storage, handling and reporting processes. In addition, the tool is programmed to run many of the report types which will be desirable to states, as well as serving as a means to report a final compliance rate comparable with other states. A single account can be created for overseeing state personnel, with data submitted for entry by a responsible party. States should also address scoring issues early in the process, to ensure expectations are met and adequate data is gathered and reported for individual sample buildings. (Pilot studies)

Resources

- *PNNL Score + Store tool*:
  https://energycode.pnl.gov/ScoreStore/login
  (accessed: November 5, 2012)

- *Building Codes Assistance Project (BCAP) Compliance Planning Assistance Program*:
  http://energycodesocean.org/compliance-planning-assistance-program
  (accessed: November 5, 2012)

Resources (continued):

- *BCAP State Gap Analysis Reports*:
  http://energycodesocean.org/gap-analysis-reports
  (accessed: November 5, 2012)

- *BCAP State Strategic Compliance Plans*:
  http://energycodesocean.org/strategic-compliance-plans
  (accessed: November 5, 2012)

6.2 STAKEHOLDER REVIEW

In order to substantiate study findings, the guidance for states was extracted and distributed to interested professionals familiar with energy codes and Recovery Act compliance requirements. These stakeholders were asked to provide feedback on a voluntary basis in accordance with Institutional Review Board requirements (see Appendix E for more information on Michigan State University IRB requirements).

Commenters were provided content for review, as well as a list of guiding questions (see Section 3.3.1). Feedback was secured from six independent reviewers, with comments incorporated into the final thesis document as deemed appropriate by the researcher and faculty advisor. Overall feedback indicated that the recommended guidance was useful in addressing a complex issue, aligned with Recovery Act compliance requirements, and backed by the findings of state pilot studies. The shorter and concise nature of the document was well-received, and considered straight-forward, yet flexible enough for state officials to implement. Other commenters appreciated the inclusion of specific topic areas, such as the ability of states to secure funding, as well as linkages to existing resources and training materials. Several modifications were also made based on stakeholder feedback. The majority of these focused on editorial changes and clarifications. A discussion on technical assistance options and the need for increased awareness amongst policymakers was also added. Transcripts of stakeholder feedback are included in Appendix D.

6.3 CHAPTER SUMMARY

This chapter presented the study deliverable; guidance for states to consider as they address 90% Compliance requirements. An overview of Recovery Act requirements is provided, with portions of the federal model balanced against study findings, including challenges and realities faced within states and local enforcement jurisdictions. Guidance is provided for state consideration in the form of recommended actions paired with valuable tools and resources. The chapter also includes a brief summary of the stakeholder review process utilized to substantiate study recommendations.

CHAPTER 7: CONCLUSION

7.1 CONCLUSIONS

The Recovery Act of 2009 put forth requirements for states to adopt target energy codes, and then demonstrate 90% Compliance with those codes by the year 2017. In response to these requirements, the Federal Government issued a methodology further defining expectations and approaches states should apply in preparing for new requirements, and eventually in measuring actual state compliance rates. Unfortunately, uncertainties remain, and many states have been complacent to establish supporting policies and initiate activities to pursue the 90% Compliance goal.

The present study set out to better understand existing conditions and compliance scenarios within U.S. states, while analyzing barriers and potential resolutions for states to consider in addressing compliance requirements. Issues facing states and local enforcement jurisdictions were identified and considered against the components of the federal methodology. Recommendations and experiences present in earlier studies are also drawn upon and generalized to provide guidance to states preparing to address Recovery Act requirements.

Conclusions resulting from the study are presented below. Findings have been synthesized based on contributions from multiple data sources across several states, poising federal requirements against both state and local perspectives. A summary of general assumptions and limitations, the expected contribution to the existing knowledge base, and potential for future research in this area is also discussed later in the chapter.

Some uncertainty remains surrounding the recommended 90% Compliance methodology.

A number of problems and uncertainties were discovered surrounding use of the suggested approach, as well as the collection of supplemental tools and resources. Many of these were uncovered through pilot studies designed to test the methodology conducted in several states. Pilot states offered specific feedback identifying uncertainties encountered while applying the method, and suggested areas for clarification. States may wish to proceed using the methodology as a guiding model, but should be aware of issues experienced in preceding applications.

Feedback from pilot states was clear in ruling the Compliance Checklists ineffective when applied through a single, post-construction inspection. Other states conducted up to four site inspections on a single project, while others were able to streamline the process through 2-3 site inspections. It can be concluded; the prescribed inspections will require more than a single site visit to gather adequate information, but may not require all visits suggested for a single sample building.

The scoring system behind the web-based Score + Store tool was also reported as unclear. Checklist items not observed or marked ‘N/A’ by evaluators had no impact on the overall scoring of a building sample. Therefore, this begs the question; how much of the checklist needs to be completed for a sample score to be considered valid? Validity rules governing the overall sample size could be applied on a provision-by-provision level, but this approach would likely require a much larger overall sample size in order to acquire statistically valid samples for every provision. It should also be noted; pilot states reported difficulty in generating a sample of the current size, let alone moving towards yet a larger sample. States may want to seek clarification on this issue to assure sample validity.

States may encounter difficulty in generating an unbiased, statistically valid sample.

Pilot study states reported difficulty in generating a statistically valid sample of buildings upon which to conduct a compliance evaluation. Many of these difficulties were encountered after sample buildings were identified, at the point where evaluators attempted to establish contact or gain entry to the project sites. Other states encountered samples based on inaccurate data, with some sample buildings found to be non-existent. This problem may be further amplified due to a recent decline in construction activity. Several states were forced to expand their original sample, due to an inability to access a portion of sample buildings, a lack of cooperation from local jurisdictions, or problems in gathering adequate information to complete the Compliance Checklists.

The PNNL methodology includes an approach to generating a statistically valid sample, and suggests ways to avoid bias in doing so. However, survey responses indicate the majority of code officials serve jurisdictions of lesser population; a potential bias towards experiences and perceptions in these smaller jurisdictions or more rural areas. At the same time, the PNNL Sample Generator was used by most states to identify their building sample. This tool bases its random selection of buildings on recent construction permit data. Rural or unincorporated areas of a state may often not have a local building department or fall under regulation. As construction permit data is typically reported by local building departments, the Sample Generator may not adequately represent projects in rural areas.

States need not only understand the timing of conducting building inspections, but also of conducting a compliance evaluation against target codes, in general. Many states have only adopted the Recovery Act target codes within the past couple years, or more recently. Other states have yet to adopt target codes, but are required to demonstrate compliance by 2017.

Construction of a building takes time—in many cases up to several years. Many sample buildings are likely to have been permitted to an older, less stringent version of the energy code. In short, inspections could be seeking code provisions and features which were not required by the code to which the building was designed and constructed. Furthermore, the energy code allows for multiple means of demonstrating compliance (i.e. prescriptive, UA tradeoff, and performance-based approaches). In evaluating sample buildings solely on a prescriptive, checklist-based approach, code-compliant buildings could be scored as if less than 100% in compliance with the energy code, even if they do indeed comply via another path.

90% Compliance depends on policy implementers detached from federal requirements.

The PNNL recommended methodology and 90% Compliance requirements are largely based on a top-down implementation structure. However, the implementation of these requirements depends on a vast collection of localized actors nationwide, including code officials, designers, builders, and product manufacturers working for a significant number of independent organizations. This creates a potential problem for states, in that any improvements on the road to compliance will apply to a great number of people spread across many smaller municipalities. The PNNL method calls for a uniform approach across states and jurisdictions, which has benefits in avoiding duplicative efforts and in reporting eventual compliance data. While this may represent an ideal situation from a national perspective, malfunction may occur within states, as there is no guarantee implementers will empathize with federal goals. This may reinforce the need for a bottom-up approach, adding value and generating support at local levels.

Few jurisdictions utilize third-party inspection services.

The PNNL 90% Compliance methodology recommends the use of third-party contractors for performing building sample evaluations, however; in-house jurisdictional staff currently perform the majority of plan review and field inspections. This presents a conflict between what states have been directed to do, and the means by which enforcement is currently conducted. With rare use of third-party contracted services and limitations surrounding human and financial resources, the ability of local jurisdictions to rely on this option is unlikely.

The building performance and testing industry is also more developed in some states compared to others, leaving states dependent on professionals who may not sufficiently exist in certain areas of the country. States saturated with HERS Raters, or those which accept a HERS or ENERGY STAR rating as a means to demonstrating energy code compliance, may be better poised to entertain a third-party inspection approach. This option may be less feasible in some states.

Jurisdictions do not have adequate resources

Factors limiting proper energy code enforcement are often equated to the availability of information and resources. In this context, these are classified as financial or human resources for performing regular enforcement-related activities. The PNNL methodology provides several suggestions for generating increased manpower, such as contracting third-party services, hiring state or neighboring enforcement agents to conduct inspections in less populated areas, cross-training the current workforce, or even recruiting volunteers. The second most prevalent limitation to energy code enforcement is due to time and staff constraints, followed by education and training, and finally money. As most jurisdictions are smaller in size, these limitations are expected to have significant impacts on available resources.

Furthermore, many rural or unincorporated areas within states were found to be unregulated by energy code enforcement. In these areas, states are recommended to provide traveling state officials or contract nearby jurisdictions to conduct plan review and field inspections. In either case, this requires action even in areas where no resources presently exist for this purpose.

Funding for energy code compliance is becoming increasingly limited.

Most code enforcement jurisdictions receive funding from a single source, most of which typically comes from permit revenue. The PNNL methodology recommends the use of contracted third-party services to perform compliance evaluations. This creates a problem for local jurisdictions, in that any new requirements or activities to support 90% Compliance will need to be administered within traditionally limited, often formulaic budgets. Any additional expense above and beyond that which is performed by the average code enforcement jurisdiction is assumed to require additional revenue or new funding sources. Unfortunately, many of the recommended federal sources have now dissipated, and traditional state formula funding has been cut significantly with the passing of the Recovery Act.

In addition, construction activity has declined heavily due to overall economic circumstances. Financial constraints were reported to result in less time spent by code officials in the field performing inspection duties. Fewer construction projects equate to reduced permit applications, reducing the amount of income generated from permit revenue at the local level. Money was also cited as the fourth most common limitation facing local code enforcement jurisdictions. Time and the availability of resources are also cited as primary limitations; these situations arguably tired directly to funding availability.

State compliance plans suggest a number of ways states might address the need for additional funding. Recommended options are directed at states, many of which have been applied through previous compliance measurement activities, including: Energy Efficiency Resource (or Portfolio) Standards, state appropriations, trust or public benefit funds. States might also work with utility providers to establish a System Benefits Charge, or other programs to offset current consumption levels with energy efficiency targets. Localities might consider increasing construction permit and inspection fees or subsidized training to provide an increased emphasis on the energy code, while attempting to leverage the interests of affected stakeholder organizations.

Funding was found to be a primary limitation to both states and local enforcement jurisdictions. Many states initiated compliance measurement activities and boosted energy code training programs on a wave of Recovery Act stimulus funding. Much of this funding was provided by the U.S. Department of Energy, and directed specifically at energy efficiency and job-creation. States have observed high demand for energy code training, however; many of these programs were provided free of charge. With the economic stimulus now in the past, it is unclear if demand will continue to yield participation in paid training sessions. States may encounter problems maintaining existing programs, let alone advancing these efforts amongst a host of other challenges.

There exists a lack of clear responsibility for demonstrating 90% Compliance.

One of the key remaining questions surrounding compliance requirements is focused on who is actually responsible for meeting the mandate. The Recovery Act was created through federal legislation tied to the economic stimulus. In order to obtain stimulus funds, governors from each U.S. state certified a commitment to meet the terms of the Recovery Act, which included energy code adoption and compliance requirements. Building energy code compliance, however, is most often determined through local permitting processes within code enforcement jurisdictions. This is typically handled through a municipal building department. This creates a tension between an intent created on the national state, compliance infrastructure which has historically existed (if existing within a state at all) at localized levels, and state agencies left in the middle. Although the commitment to demonstrate 90% Compliance was made at the state level, it will require significant coordination with local enforcement actors, as well as guidance from the national level to further clarify expectations and streamline the process. The federal government has created a methodology and several supporting tools for approaching the problem. A variety of organizations also provide compliance resources to states and interested parties. Several strategies can be taken in conducting compliance evaluations, but it is the responsibility of the state to lead this process. State agencies or appointed parties may wish to work with groups of affected stakeholders to establish expectations, as well as assign roles and responsibilities. Data collection and measurement activities will need to be conducted within actual building projects. Depending on the designated evaluation approach, many states will find it necessary to work through the existing compliance infrastructure provided by local enforcement jurisdictions.

Energy code training is available but not typically required

Section 410 of the Recovery Act specifically identifies the need for energy code training and educational programs to supplement 90% Compliance requirements. The PNNL methodology echoes the need for these programs, but does not spell-out specific characteristics. Over half of code officials report receiving training surrounding the energy code, however, only a quarter of those surveyed indicated energy code training as part of a mandatory program, such as is sometimes required for many professional certification or continuing education requirements. A significant amount of training was delivered as a result of the Recovery Act stimulus, however; over 10% of code officials still report having received no energy code training at all. Furthermore, model energy codes are developed on a three year cycle and have increased in stringency to become far more progressive in the last few years. This means the most advanced code requirements have not even been enacted yet. Energy code training and education is also reported as the third most prominent limitation to compliance, emphasizing a need for these programs to remain available.

Pilot studies indicate a knowledge base similar to that required for a home performance rater is generally sufficient for application of the PNNL methodology and completion of the associated checklists. Further examination of evaluator feedback, however, might indicate they fall subject to many of the common fallacies and misunderstandings experienced by code officials, in general. Some areas of confusion reported on the Compliance Checklists seemed to indicate a greater misunderstanding of the requirements of the code, as opposed to problems with the checklist alone. Suggestions included the removal of elements required within the code, such as the posting of a compliance certificate on the electrical panel. This was an item described in another pilot as a simpler code requirement with a surprisingly low rate of compliance, perhaps indicating low awareness. Others suggested emphasizing code footnotes within the checklists to provide further clarity on exceptions and allowances embedded within the code itself. These findings may suggest evaluators are prone to many of the same problems, errors and areas of confusion as the typical code official or building inspector.

Lastly, pilot studies described a lack of understanding of the value behind energy codes. Some state educational programs extend beyond the technical requirements of the code and cross-cut general public awareness, energy efficiency, and green building initiatives. All three series of reports analyzed in the present study suggested the need for additional education and outreach to government officials and policymakers.

Commonly Reported Code Infractions

The majority of residential code infractions reported by surveyed code officials are within the home mechanical system. These infractions are followed closely by problems seen in the building envelope. Infractions related to proper air sealing for envelope infiltration and mechanical ducts are specifically referenced, with insulation levels and installation issues also reported. Pilot studies also emphasized a lack of mechanical system sizing and load calculations. Of those specified, fenestration was found to exhibit the fewest infractions.

Within commercial buildings, the envelope was pointed to as the primary culprit, with over two-thirds of code officials reporting problems in that area. Over half also identified commercial mechanical systems as exhibiting common infractions. Fewer code officials, although still almost half of those surveyed, reference lighting as a common code infraction.

Compliance Software may ease the process, but actual conditions require verification

The PNNL Jurisdictional Survey, as well as customized state surveys, inquired about the use of compliance software within local jurisdictions. According to survey respondents, this is the most common means of demonstrating compliance with the energy code. This compliance path is typically preferred, due to its simpler, bottom-line pass/fail score. Pilot studies, however, reported common discrepancies between information displayed in software compliance reports and the installation conditions actually observed within the following field inspection. While software reporting has the ability to significantly streamline the compliance process, verification of the design remains important, especially when considering a common lack of information submitted when applying for a construction permit.

Inspectors need to require adequate information and documentation

The most commonly cited limitation to energy code enforcement stated by survey respondents is the availability of adequate information submitted with buildings plans and specifications for permitting approvals. This creates a problem, in that approved building plans are the most commonly stated resource available, and are used for conducting later field inspections. Although only 14% of code officials indicated the availability of code books as a limitation, only about half reported even having access to prescriptive checklists or the actual codebook or standard being enforced. This condition is somewhat perplexing in relation to other findings, such as the need for additional training, and the overall perceived value of energy codes. Several pilot studies found a lack of information submitted with permit applications, which limits the ability to identify compliance issues during plan review stages. Some states described the plan review process as falsely short, due to a lack of information obtained within plans and specifications. If not documented and identified in the earlier stages, code infractions may go undetected until caught in the field inspection, if detected at all. This not only places more responsibility on the building inspector, but pushes resultant modifications downstream at a point where products have been purchased, labor has been conducted, and rework is likely required. Further standardization of the information required within permit application documents, combined with strict enforcement by local jurisdictions could perhaps avoid a significant portion these negative repercussions entirely.

A state compliance working group may assist in meeting compliance requirements

One of the first steps suggested by the PNNL methodology is the formation of a compliance working group within a state. Several variations of these groups were observed within pilot states testing the recommended methodology, as well as non-pilot state conducting their own compliance measurement activities. These groups were found to perform several functions, ranging from stewarding the review and adoption of target energy codes, to assistance of following compliance activities. Many of the stakeholders required to staff such a group are already present within states, and active participation is often garnished on a voluntary basis. States can utilize such a group in managing their own unique scenario, and may choose to have a group work closely with a designated oversight agency, or empowered more openly to address issues as they see fit. States may be able to leverage such a group to assist with more traditional energy code issues, as well as receive new requirements, such as those surrounding 90% Compliance.

7.2 ASSUMPTIONS AND LIMITATIONS

The reader should be aware of several assumptions and limitations identified within the study. Challenges and recommendations for states were sought in relation to energy code requirements within the Recovery Act of 2009. Both quantitative and qualitative methods were applied, drawing upon data generated across several U.S. states. Limitations inherent within the specific methods applied in the study are discussed earlier within the *Influential Works* section of Chapter Three: *Research Methods* (found under *Methodology*). The following assumptions and limitations range from surrounding the overall research topic, to specific characteristics of the researcher's decisions and included data sources.

Firstly, the methodology formulated and recommended by the Pacific Northwest National Laboratory (PNNL) is taken as the model by which states will need to demonstrate 90% Compliance. The original language of the Recovery Act includes some specifics, but leaves many questions surrounding how states will fulfill the overall requirements. In response to the Recovery Act, the U.S. Department of Energy charged PNNL with installing further detail and establishing state expectations. Many questions remain, providing states some flexibility, but also uncertainty as they form their own plan to address compliance requirements.

Behind the recommended methodology, there is an assumption that feedback offered through state pilot studies and other data sources represent some level of truth that is not understood, achievable, or acted upon by the regularly commissioned code officials. This assumes evaluators will find a hidden reality behind code enforcement, building design, construction, and the general industry. This condition somewhat ignores the possibility that evaluators will be subject to the same or similar set of problems and limitations facing professional compliance officials, such as a lack of or difficulty in obtaining certain information, working with fewer resources than truly needed, and while not always getting full cooperation from builders, contractors, and other involved parties who want to see projects moved to completion.

Survey response data analyzed in the experiment was the result of an instrument designed for and directed at code officials serving local enforcement jurisdictions. This can be considered both an assumption and limitation. It is assumed the perspectives gained from the statistical analysis can be extrapolated to the general population of these individuals. At the same time, study conclusions generalized from the survey are limited to this same perspective. All findings are based on the inherent quality of the previous studies and resulting data sets.

Individual state survey samples varied significantly in size. Many state samples were small enough where they cannot be considered a statistically valid sample in comparing the state sample to the overall population of code officials within a state. More advanced statistical testing to compare phenomena within state samples did not meet common statistical tests of significance. For most survey questions, state samples were combined, with the aggregate sample used to generalize findings and draw conclusions. The overall sample was not weighted, and is therefore heavily influenced by the larger state samples. The study was also subject to existing and available survey response sets, and did not have the ability to return to subject populations in seek of additional data. First and foremost, findings and conclusions should be considered the result of an educational exercise.

Reports analyzed in the study are also subject to a set of assumptions and limitations. States reports are assumed to have adequately and accurately captured the conditions and realities present within the particular state. In the case of pilot study reports, states and their contractors reported their own findings through a report submitted upon completion of the pilot. State Gap Analysis reports and Strategic Compliance Plans were often conducted in correspondence with a state regulatory or oversight agency, but are taken to represent the realities and unique conditions within the particular state. No issues or discrepancies with the information included in these reports were known at the time the present study was completed.

Lastly, the topic of energy code compliance in relation to the Recovery Act can be considered recently and continually changing. The topic is, and will be, affected by the release of further information from the federal government, and further molded by the experiences of states addressing compliance requirements. While the researcher made every effort to accommodate all changes during the course of the study, the final document can be considered to best represent the period starting with the issuance of the Recovery Act and culminating with the completion of the 90% Compliance Pilot Studies. Furthermore, state experiences are expected to change over time as conditions change and new codes replace previous versions. For example, recent code versions include unprecedented requirements, such as air leakage testing and additional scope. Current survey responses are based on more traditional provisions and associated infractions and limitations. The existing set of challenges will likely change when more advanced requirements go into effect.

7.3 EXPECTED CONTRIBUTION

The Recovery Act of 2009 set forth requirements for states to demonstrate 90% Compliance with target energy codes by the year 2017. The primary goal of the study is to provide states with guidance and options to address compliance requirements. A methodology recommended by the federal government is compared against conditions within states and enforcement jurisdictions to better understand the realities facing prospective policy actors at state and local levels of implementation.

Background information gathered within states provides a baseline understanding of the practices and processes utilized to implement and enforce energy codes. These implementation issues can be considered within broader environmental legislation, such as the issues and political mechanisms discovered through the study *Literature Review*. An increased understanding may lead to a better alignment between top-down policies, bottom-up needs, and recommended solutions. States can take this information and the experiences of early adopting states into consideration when formulating their own plans to address compliance requirements. A primary need is for states to understand what is expected, and what they can do about it. Taking the methodology recommended by the Federal government, the study deliverable breaks down the primary components of the method. The expectations coming with the Recovery Act are discussed and clearly defined. Challenges are presented as identified at the state and local levels of implementation. These influence a simple set of recommendations designed with states in mind, supplemented with available solutions and resources for states to leverage in implementing policies to support 90% Compliance.

7.4 SUGGESTIONS FOR FURTHER RESEARCH

The present study presents a general inquiry into 90% Compliance requirements, and builds upon an existing knowledge base within the general topic of energy code compliance. The study seeks to connect local realities with federal requirements in an effort to provide guidance to states. Existing knowledge specific to the Recovery Act are also centralized, with resources to be drawn upon by states seeking to address compliance requirements. As additional states take action, future research potential is expected to present itself. Several inquiries can also be suggested in furthering the present study.

Many of the 90% Compliance Pilot Studies administered a state compliance survey and followed with actual building inspections. Within the survey, common code infractions and limitations impeding 90% Compliance are explored. A future study could take these perceived conditions, and compare them against observations obtained from independent field inspections and sample building evaluations. This approach may better indicate if reported barriers indeed show up within the findings of a third-party. Subject to the availability of a full data set, such a comparison could further establish or delineate earlier studies where the perspectives of survey respondents, such as enforcement officials, are heavily and solely relied upon.

Attainment of additional state survey responses would allow for a comparison of unique conditions between individual state samples. Data analyzed in the present study was gathered across several states of significantly varying sample size, with the largest sample outweighing the smallest by a factor of ten. Gathering additional data within the smaller sample states, or adding further states to the analysis would allow for a better understanding of conditions within individual states, as well as a more event distributed aggregate sample.

A future study could also focus more specifically on the present survey response data set. While the present study sought a general descriptive analysis, a more advanced statistical analysis, such as a linear regression, could correlate individual responses across multiple survey questions, allowing for a more detailed understanding of specific perspectives within the sample.

Additional phenomena may also be present beyond the scope of a descriptive analysis. As the original survey instrument included mostly categorical response questions, a more advanced analysis could include correlation between individual response choices, and a comparison between categorical and numerical response questions.

Data reviewed within the study suggested the inclusions of technological advancements within code enforcement processes. Web-based permitting, digital checklists completed through tablet devices, and software packages could dramatically improve and streamline traditional inspection and compliance demonstration processes. Future research could further investigate this potential, as well as explore solutions for specific portions of the compliance process.

Aside from technical advancements in energy code compliance and enforcement processes, there may also be room for further evaluation of political mechanisms to support energy code compliance. Chapter Two provides a thorough review of related legislation and over-arching environmental policy. Compliance is a tall order, and many of the primary impediments identified at the state and local levels are centered on a lack of resources. There may be more of an opportunity to address compliance issues through larger policies at the federal and state levels, especially in aligning needs with adequate sources of funding.

Finally, limited funding and uncertain state expectations surrounding 90% Compliance suggest a need to more adequately explore alternative means of demonstrating energy code compliance. The PNNL methodology included a brief introduction to some alternatives, but settled on the more prescriptive, checklist-driven approach performed by third-party contractors. Although arguably more comprehensive, limited funding and support for energy code compliance within states may threaten the potential of this approach. Alternative methods with the ability to better leverage existing resources and encourage participation by local stakeholders may remove significant burden from the process, and allow for a more sustainable evaluation of state compliance rates.

7.5 CLOSING THOUGHTS

When it comes to compliance with building energy codes, states have unique needs and practices. Building construction is a very traditional and method-driven field, with an immense variety of skill sets and players needed to bring a project from concept to occupancy. While the energy code is looked toward as an efficiency solution, it remains far from the single priority of enforcement officials. We are not going to get there with 90% Compliance alone.

Building energy codes have become an important topic within the industry. At first glance, there have been many changes in the past few years. Following the Recovery Act, many states made a decision to adopt target codes. The high profile nature of the Recovery Act and associated stimulus funding made the directive clear, and generated buy-in from the often absent higher levels of decision-making within state and local governments. Although expectations surrounding compliance requirements may be unclear, energy gains through increased code adoption cannot be disputed, especially considering the additional savings the targeted (and newer) codes contain compared to previous versions. Savings relative to this action will have an impact for years to come. Back in the present tense, the passing of the economic stimulus, changing political winds, and remaining uncertainty surrounding the country's economy have left budgets at all levels of government without clear direction. If funding for energy efficiency continues to dissipate, one must assume energy code compliance will follow suit. Without funding and proper governmental support, compliance requirements could become a significant burden on already strained stakeholders crucial for successful implementation. We then simply have to ask; where is the value, what actually helps, and what pieces result in true savings?

The implementation of 90% Compliance policy reminds me personally of issues I formerly experienced as a high school science teacher. In the field of Education, No Child Left Behind (NCLB) brought new requirements in the name of a social wellness—a fair public education for all students. Similar to energy savings, the burden of a very necessary social need falls squarely upon the professionals who are left to implement it. To teachers, new requirements meant more work and increased risk in a time of heavy competition and perpetual cuts. Many argued funding was inadequate to address such a large-scale problem, and many even classified NCLB as an unfunded mandate imposed upon an already faltering public educational system. Although the Federal Government further developed the program and supplemental resources, many within the field of Education still question NCLB's impact on the greater social problem it was intended to remedy. Time will better inform us on how code construction industry stakeholders will receive compliance requirements in the long-run.

To address 90% Compliance requirements in the Recovery Act, the federal government recommended a methodology which would yield a fairly robust glimpse into energy code compliance rates both within and across U.S. states. Unfortunately, successful policy implementation depends on more than this direction alone, and states may not be eager to jump on the compliance bandwagon after the stimulus money runs dry. At a point in time where many recommendations surrounding 90% Compliance are pushing full steam ahead, states may want to first check the financial sustainability of their existing and core efficiency programs.

Furthermore, the recommended approach assumes that a re-evaluation of buildings will find a hidden truth in the form of lower than ideal compliance rates. While previous compliance studies indicate this is likely the case, new evaluators are still subject to the same problems, limitations, and may hold roughly the same background as the traditional code official. There may be a logical fallacy in measuring a so-called reality by proceeding through the same challenges and limitations which led to the original problem.

Several portions of the compliance process come to mind when considering what is good for energy efficiency through building codes. Energy code training seems to be the base piece to the equation, providing a solid platform for educational and outreach efforts. Clear code requirements also go a long way. Right now, the game seems often to see what you can get approved by your local code official and less about complying with the actual requirements—let alone the larger picture social needs and building science applications.

Let the design and construction professionals do their job, and let there be heightened accountability to go with it. Let code officials do their job, as well, but not with the unreasonable expectation that one individual can possibly catch every requirement for every code in every building. We regulate safety in other industries through intermittent inspections, and it’s probably good enough for the energy code, too, but not without adequate penalties for non-compliance. There is also a growing rating and verification industry which can add another level of accountability and transparency. These individuals have the ability to substantiate good work, can label the less-than-good work, and hand a final report to the increasingly interested, and arguably most important, driver of the entire process—the consumer.

In terms of 90% Compliance, I would recommend states further explore alternative paths to demonstrating energy code compliance, as well as options for reducing the costs of performing a compliance evaluation. The recommended methodology serves as a valuable model, but third-party evaluation is not the prevalent method for enforcing the energy code. Depending on the relationship between ongoing code enforcement and efforts related to 90% Compliance, existing building departmental staff, or even student assistance, could be garnished in gathering compliance data. States without adequate funding or political support will face challenges in implementing the full methodology or recommendations offered by many national organizations. This approach also puts additional cost and workload upon an already weakened system. Simultaneously, builders and code officials voluntarily enter compliance information into software programs every day. This represents a large, untapped source of data aimed at a similar end goal. In addition, many states already use and recognize this approach, and buildings have yet to see the effects of the data revolution.

Before taking 90% Compliance requirements as-is, some states may also consider a re-think of the intent behind the original policy. The policy was aimed at energy savings through the implementation of building energy codes, and there is general agreement that the responsibility for continued action falls primarily upon states. As presented earlier in the Literature Review (Chapter Two), Section 410 of the Recovery Act is based on a top-down approach, through which a national or social desire is imposed upon states and lower levels of government through a Federalist perspective.

Building energy codes have historically been developed and implemented through gradual incremental advancement. The Recovery Act and associated stimulus changed all that, and led to previously unrealized code adoption rates—hence now all this talk of compliance. A clear agenda combined with ample funding created immediate state motivation and buy-in all the way up to the Governor's office. This left little opportunity or time for complex political systems and complicated regulatory processes to weigh-in. Although Recovery Act legislation focused on clean energy sources and efficiency, the primary intent was aimed at job-creation and the injection of funds back into the American economy. Beyond current implementation issues, this resulted in additional common fallacies of basic policy creation. Codes are associated with many common political mechanisms: regulation, incentives, education, research spending, and, in some cases, self-regulation. I would propose building energy code policy at the Federal level is often spread too thinly and caught between carrot and stick identities. This is exemplified by significantly reduced current funding levels in comparison to the stimulus funds which initiated compliance efforts. At the same time, the Federal government lacks a clear regulatory role in developing and enforcing building energy codes. Unlike most federal standards, building energy codes are not developed through a Federal rulemaking process. Although several existing federal statutes require the adoption and implementation of energy codes, certain states regularly find loopholes and ignore these laws, slowing adoption and compliance rates, and leaving some areas of the country yet without clear building energy efficiency requirements. Combine limited funding with a regulatory infrastructure dependent on state and local implementers, and any such policy has the potential to lose its way.

While there may be more scientific value in the federal methodology, alternative approaches may yield better economics or more sensible solutions for individual states. It is also important for energy code *compliance* not to be overtaken by *Compliance* (of the 90% variety). While Recovery Act requirements are expected to increase compliance rates, it is important for states to avoid losing sight of the intent behind the original policy. Many of the issues that first brought national attention to energy codes come down to practitioner application and social education. Regardless of how states choose to approach compliance requirements, ensuring follow-through to actually save energy in buildings is undoubtedly a good thing. As is often the case with policy implementation, the result will probably fall somewhere in the middle.

APPENDIX

APPENDIX A: SURVEY INSTRUMENTS

The following section contains the original survey instruments administered within states referenced in the study. The Pacific Northwest National Laboratory (PNNL) designed the *Jurisdictional Survey* to help benchmark current practices and processes utilized within states and local enforcement jurisdictions. The instrument is preceded by an informational flier designed to introduce the 90% Compliance effort to recipients, and assist in establishing ongoing communications between the study and its stakeholders. The survey administered in Michigan, which is based on the PNNL survey, is also included for review.

A.1 PNNL JURISDICTIONAL FLYER

Measuring Energy Code Compliance Jurisdictional Assistance

Buildings account for roughly 40 percent of the nation's energy consumption. Enhancing their efficiency will lead to a stronger economy, a cleaner environment, and decreased dependence on imported oil. With this goal in mind, the <State organization>, with support from the U.S. Department of Energy's Building Energy Codes Program (BECP), is asking local jurisdictions to participate in a statewide study to measure compliance rates with building energy codes. This letter is meant to familiarize you with the study and to solicit your support for this important activity.

The study is part of a major national effort to support and improve vital efficiency measures that will help us address our energy and environmental challenges. As carefully as our energy codes are written, they don't save energy unless buildings actually comply. Further, knowing on-the-ground code implementation and compliance challenges can foster improvements in the codes, increase educational and support activities, and reinforce the continuing need to support code enforcement efforts. While informative and helpful, the compliance data collected from individual buildings and jurisdictions will not be made public. Our aggregated state compliance rate will be the study's only public result.

For our local jurisdictions, your participation is crucial, and it comes with key benefits: energy code training for local personnel, the chance to identify areas for code compliance improvement, and the availability of data to document the need for additional resources to support code compliance initiatives.

The overall benefit, of course, is to help increase energy savings for your citizens. As documented by FEMA, every dollar spent on building safety codes saves four dollars in post-disaster mitigation costs. This activity will help develop a similar message for energy codes.

State and Jurisdictional Roles

BECP has released a protocol for conducting the statewide study in a technical report and a brief "*Step-by-Step Companion Guide*". If interested, you can find these and other related resources at www.energycodes.gov/arra/compliance_evaluation.stm.

Our state is conducting the study in partnership with building evaluators from <evaluator contracting agency, if applicable> We will begin in <month, year> and continue for <X months>. In total, we will evaluate a randomly generated sample of approximately (X) building projects. This number includes <new construction and renovations of both residential and commercial, if applicable> buildings. <If known, add the number and type of samples needed in this jurisdiction.>

What to Expect

Prior to the Visit. <Contact name/affiliation> will contact you to set up a date and time for a visit with your building department, and to request information on your plan review, inspection, and permitting process. This will help create a plan for the onsite visit and assess the time it will take to collect data in your jurisdiction. You will learn the number, types, and construction phases of the projects needed for the study. Ideally, jurisdictions would then randomly select the projects prior to the evaluator's visit. However, if there are questions or concerns, the evaluator can help select projects upon arrival.

During the Visit. On the day of the visit, the evaluator will perform the following tasks:

- Conduct a short interview on plan review and inspection processes associated with the energy code
- Answer questions about the study
- Review the data collection forms for residential and commercial projects
- Collect energy-related information from plans, specifications, and related project documentation
- Determine a contact person for each of the projects selected in order to arrange onsite visits to projects

In the Field. Over a few visits, evaluators will collect data on a building's energy-relevant features, using checklists that follow a typical jurisdictional inspection process. Data will be gathered at these stages:

- Foundation
- Rough-in (electrical, mechanical, plumbing, framing)
- Insulation
- Final

Building inspectors are encouraged to join the evaluator on site to gain valuable energy codes-related experience, noting that the same forms used for the study can also be used on a daily basis for code enforcement efforts in your jurisdiction.

Thank you very much for your consideration—we hope to collaborate with you for the sake of saving energy.

Contact name

State Organization

<name@state.gov>

A.2 PNNL JURISDICTIONAL SURVEY

PNNL Survey

The following sample survey questions were designed for use by states wishing to conduct a survey of their building jurisdictions as one method of better understanding energy code compliance rates in their state. The use of surveys for this purpose is discussed in Measuring State Energy Code Compliance (DOE, 2010b), which was recently released by DOE's Building Energy Codes Program (BECP). As stated in this document, jurisdictional surveys alone are not a statistically valid method for deriving a state code compliance rate, but are valuable for informing the state of practices in their jurisdictions and for identifying specific training needs by location.

There are many alternative ways to administer the jurisdictional surveys:

1. Where states choose to do onsite evaluations of buildings, the evaluators are encouraged to complete a jurisdictional survey as part of their visit to each jurisdiction. Conducting the survey in person is the preferred approach, and will secure the highest response rate.
2. The state may choose to send the surveys by mail. In this case, the state will want to develop some introductory information to accompany the survey which provides a compelling reason why the survey should be completed.
3. The BECP will also provide an online survey tool. The tool will also provide information about the value of the survey and how the results will be used.

The online survey tool will by default contain the following set of standard questions. States will have the option to remove and add questions. States are encouraged, however, to use the standard questions as provided in order to have consistent and comparable results across states. Results from the online survey will be stored in a centralized database where they can be aggregated to provide various views of state, regional, and national results. Regardless of which approach is used, the BECP can assist states in adding their survey results into this same centralized database.

All survey data contributed to this effort will further become part of a study attempting to correlate jurisdictional best practices with measured code compliance rates. The results of such a study will be made publically available, but the individual jurisdictional survey results will be considered confidential and will not be distributed.

Questions About Your Jurisdiction:

Agency name: _____

Jurisdiction served _____

Estimate of the population served: _____

Name, title, and contact for person completing this survey:

Name: _____

Title: _____

Email address: _____

Telephone number: _____

During the previous year, how many building permits were issued by your agency?
Residential building permits: _____
Commercial building permit: _____

How is your agency funded? (Check all that apply)
☐ Permitting revenue
☐ Jurisdictional budget
☐ State funded
☐ Other _____

Questions About Your Staff:

Who conducts plan reviews for energy code compliance? (Check all that apply)
☐ In-house staff
☐ 3rd party entities
☐ Other jurisdictions or government agencies
☐ Not done
☐ Other _____

Who conducts field inspections for energy code compliance? (Check all that apply)
☐ In-house staff
☐ 3rd party entities
☐ Other jurisdictions or government agencies
☐ Not done
☐ Other _____

What level of education and training does your agency staff receive specifically for energy codes?

Residential energy codes training (Choose one)

☐ Professional certification and annual training
☐ Periodic formal training
☐ On-the-job training, but seldom formal training
☐ Training not provided

Commercial energy codes training (Choose one)

☐ Professional certification and annual training
☐ Periodic formal training
☐ On-the-job training, but seldom formal training
☐ Training not provided

How would you prefer to receive training? (Check all that apply)

☐ Webinar / Online
☐ Classroom
☐ In the field
☐ Other _____

Questions About Your Processes

What methods are used as a basis for documenting energy code compliance and in what percentages? REScheck and COMcheck are considered trade-off methods. Use whole numbers only.

Residential Buildings	Commercial Buildings
Prescriptive: ______%	Prescriptive: _____ %
Trade-off: _____ %	Trade-off: _____ %
Performance: _____ %	Performance: _____ %

How many hours are devoted to the average plan review for energy codes? If energy plan reviews are performed in conjunction with reviews for other code provisions, please estimate the time for the energy-related reviews only.

Residential Buildings: _____ hours
Commercial Buildings: _____ hours

How many hours are devoted to the average field inspection for energy codes? If energy field inspections are performed in conjunction with inspections for other code provisions, please estimate the time for the energy-related field inspections only.

Residential Buildings: _____ hours
Commercial Buildings: _____ hours

What format does your agency use to maintain permitting data?

☐ Paper
☐ Digital
☐ Other _____

How many years does your agency maintain permitting data? (Choose one)

☐ 1-2 years
☐ 3-5 years
☐ 6-7 years
☐ More than 7 years

What limitations impede your ability to enforce the energy code? (Check all that apply)

Residential Buildings

☐ Time or staff
☐ Money
☐ Code books
☐ Education or training
☐ Data provided with the plans
☐ Building access
☐ Equipment
☐ Not applicable
☐ Other _____

Commercial Buildings

☐ Time or staff
☐ Money
☐ Code books
☐ Education or training
☐ Data provided with the plans
☐ Building access
☐ Equipment
☐ Not applicable
☐ Other _____

In your jurisdiction, what plan review and/or inspection items do you generally find do not comply with the code? (Check all that apply)

Residential Buildings

☐ Envelope insulation levels
☐ Envelope insulation installation
☐ Envelope sealing (infiltration)
☐ Fenestration
☐ Duct insulation
☐ Duct sealing
☐ Piping insulation
☐ Lighting fixtures
☐ Other _____

Commercial Buildings

☐ Envelope insulation levels
☐ Envelope insulation installation
☐ Envelope sealing (infiltration)
☐ Fenestration
☐ Duct insulation
☐ Duct sealing
☐ Piping insulation
☐ Lighting fixtures
☐ Lighting controls
☐ HVAC system controls
☐ Other _____

Does the energy plan review and inspection cover all aspects of the energy code?

Choose One

☐ Yes
☐ No

If No, what aspects are not covered? _____

What information is available to your staff during field inspection? (Check all that apply)

☐ Approved plans
☐ Energy code compliance checklist(s)
☐ Published energy codes and/or standards
☐ Other _____

Do you accept software compliance reports with permit applications in lieu of a plan review?
Choose One
☐ Yes
☐ No
☐ Not applicable

What information is typically missing from plans, specifications and/or actual construction that prevents you from determining compliance?
Residential Buildings: _____
Commercial Buildings: _____

What software and/or other information technologies do you use to facilitate the plan reviews, inspection processes, record keeping, and communications with permittees?

_____

A.3 MICHIGAN SURVEY

Michigan Uniform Energy Code (MUEC) Survey Instrument:

The capacity of jurisdictions to enforce the Michigan Uniform Energy Code (MUEC) varies greatly due to differences in available resources. This survey will help the Michigan State Housing Development Authority (MSHDA) and other agencies to understand what obstacles jurisdictions face as they try to enforce the recently adopted revisions to the MUEC. The state intends to use the data collected in this survey, as well as surveys of other stakeholder groups, to develop a plan to help local jurisdictions to meet a 90% compliance rate with the new code by 2017.

Your answers to these questions will be kept strictly confidential. Your survey code is used only for administration of the survey, and will not be associated in any way with your response. This survey is being administered by Public Sector Consultants Inc. and the Michigan State University School of Planning, Construction and Design through a grant from the Michigan State Housing Development Authority.

Please take about ten minutes to answer this survey. We appreciate your response.

Questions about Your Jurisdiction

1. **Survey Code: _______________** (This code is on the letter you received informing you of the survey, in the subject heading under the address.)

2. **Region of Michigan:** (Check **one**.)

   ☐ Southeast ☐ Central ☐ Western ☐ Northern Lower Peninsula ☐ Upper Peninsula

3. **Estimate of the population served: _______________**

4. **Do you serve or have you recently served as any of the following?** (Check **all** that apply.)

☐ Building Code Official	☐ Mechanical Inspector
☐ Building Inspector	☐ Plumbing Inspector
☐ Plan Reviewer	☐ Electrical Inspector

5. **During the previous year, how many building permits were issued by your agency?**

   Residential building permits: _______________________

   Commercial building permits: _______________________

6. **How is your agency funded?** (Check **all** that apply.)

☐ Permitting revenue	☐ State funded
☐ Jurisdictional budget	☐ Other ______________________

Questions about Your Staff

7. **Who conducts plan reviews for energy code compliance?** (Check **all** that apply.)

☐ In-house staff
☐ Third-party entities
☐ Other jurisdictions or government agencies
☐ Not done
☐ Other ______________________

8. **Who conducts field inspections for energy code compliance?** (Check **all** that apply.)

☐ In-house staff
☐ Third-party entities
☐ Other jurisdictions or government agencies
☐ Not done
☐ Other ______________________

9. **What level of education and training does your agency staff receive specifically for energy codes?**

Residential energy codes training (Choose **one**.)	**Commercial energy codes training** (Choose **one**.)
☐ Professional certification and annual training (mandatory)	☐ Professional certification and annual training (mandatory)
☐ Periodic formal training from International Code Council, state-sponsored entity, or code officials association	☐ Periodic formal training from International Code Council, state-sponsored entity, or code officials association
☐ Periodic formal training from another source	☐ Periodic formal training from another source
☐ On-the-job training, but seldom formal training	☐ On-the-job training, but seldom formal training
☐ Training not provided	☐ Training not provided

10. **Please rank training method in order of preference:**

	Rank
Online conference – scheduled, live sessions	__
Online – presentations, recorded video, and other prepared media	__
Classroom	__
In the field	__
Other ____	__

Questions about Your Processes

11. **Can you estimate the percentage of residential buildings in your jurisdiction that are in compliance with the Michigan Uniform Energy Code? _____** %

12. **Can you estimate the percentage of commercial buildings in your jurisdiction that are in compliance with the Michigan Uniform Energy Code? ___** %

13. **What methods are used as a basis for documenting energy code compliance and in what percentages?** RES*check* and COM*check* are considered trade-off methods. Use whole numbers only.

Residential Buildings	
Prescriptive	______%
REScheck (trade-off)	______%
Performance (i.e., RESNET HERS Rater)	______%

Commercial Buildings	
Prescriptive	_______%
COMcheck (trade-off)	_______%
Performance (i.e., Energy Cost Budget)	_______%

14. **How much time is devoted to the average plan review for energy codes?** If energy plan reviews are performed in conjunction with reviews for other code provisions, please estimate the time for the energy-related reviews only. Note partial hours as decimals (i.e., 30 minutes is 0.5 hours). Note 0 hours if staff time is insufficient to allow for energy code review.

Residential Buildings:	________ hours
Commercial Buildings:	________ hours

15. **How much time is devoted to the average field inspection for energy codes?** If energy field inspections are performed in conjunction with inspections for other code provisions, please estimate the time for the energy-related field inspections only. Note partial hours as decimals (i.e., 30 minutes is 0.5 hours). Note 0 hours if staff time is insufficient to allow for site inspection dedicated to energy codes.

Residential Buildings:	________ hours
Commercial Buildings:	________ hours

16. **During site inspections, does the installation of drywall often prohibit inspections for wall insulation?**

☐ Yes ☐ No

If yes, is an insulation certificate required?

☐ Yes ☐ No

17. **Do you mandate a second review in the case of an energy code violation?**

☐ Yes ☐ No

18. **Do you issue stop-work orders for energy code violations?**

☐ Yes ☐ No

19. **What format does your agency use to maintain permitting data?**

☐ Paper
☐ Digital
☐ Other ________________________________

20. **What limitations impede your ability to enforce the energy code?** (Check **all** that apply.)

Residential Buildings
☐ Time or staff
☐ Money
☐ Code books
☐ Education or training
☐ Data provided with the plans
☐ Building access
☐ Equipment
☐ Not applicable
☐ Other ______________________

Commercial Buildings
☐ Time or staff
☐ Money
☐ Code books
☐ Education or training
☐ Data provided with the plans
☐ Building access
☐ Equipment
☐ Not applicable
☐ Other ______________________

21. **In your jurisdiction, in what plan review/inspection items do you generally find code violations?** (Check **all** that apply.)

Residential Buildings
☐ Envelope insulation levels
☐ Envelope insulation installation
☐ Envelope sealing (infiltration)
☐ Fenestration
☐ Duct insulation
☐ Duct sealing
☐ Piping insulation
☐ Lighting fixtures
☐ Other ______________________

Commercial Buildings
☐ Envelope insulation levels
☐ Envelope insulation installation
☐ Envelope sealing (infiltration)
☐ Fenestration
☐ Duct insulation
☐ Duct sealing
☐ Piping insulation
☐ Lighting fixtures
☐ Lighting controls
☐ HVAC system controls
☐ Other ______________________

22. **In your view, roughly how much of the MUEC is covered by the energy plan review and inspection?** (Choose **one**.)

	0–25%	**26–50%**	**51–75%**	**76–100%**
Residential	☐	☐	☐	☐
Commercial	☐	☐	☐	☐

23. **What information is available to your staff during field inspection?** (Check **all** that apply.)

- ☐ Approved plans
- ☐ Energy code compliance checklist(s)
- ☐ Published energy codes and/or standards
- ☐ Product and equipment specifications and other data
- ☐ Insulation certification sheets
- ☐ Other

24. **Do you require energy code compliance documents to be submitted with the permit application?**

☐ Yes ☐ No

25. **What information is typically missing from plans, specifications, and/or actual construction that prevents you from determining compliance?**

Residential Buildings: ______________________________________

Commercial Buildings: ______________________________________

26. **What software and/or other information technologies do you use to facilitate plan reviews, inspection processes, record keeping, and communications with permittees?**

____

27. **Do you accept software compliance reports with permit applications in lieu of a plan review?** (Choose **one**.)

☐ Yes ☐ No ☐ Not applicable

Questions about Your Familiarity with Regulatory Tools

28. **Do you possess a current copy of the MUEC?**

☐ Yes ☐ No

29. **If asked, could you instantly list any of the following?** (Check **all** that apply.)

- ☐ R-value requirements in the MUEC
- ☐ U-value requirements of the MUEC?
- ☐ The different energy zones of the MUEC?
- ☐ The two methods for compliance for air sealing in the current MUEC

30. **Would you describe yourself as fairly or very familiar with any of the following programs?** (Check **all** that apply.)

- ☐ Energy Star
- ☐ Home Energy Rating System (HERS)
- ☐ International Energy Conservation Code (IECC)
- ☐ MUEC-prescriptive
- ☐ Component Modeling Approach for commercial glazing from the National Fenestration Rating Council

31. **Have you had any formal training on the following programs?** (Check **all** that apply.)

- ☐ Energy Star
- ☐ Home Energy Rating System (HERS)
- ☐ International Energy Conservation Code (IECC)
- ☐ MUEC-prescriptive
- ☐ NFRC's Component Modeling Approach for commercial glazing

32. **What types of code support and information would help increase energy code compliance in your community? ____**

APPENDIX B: COMPARATIVE STATE SURVEY ANALYSIS

The descriptive analysis of survey data performed in the study focused primarily on characteristics of the aggregate sample gathered across states. Overall, six state samples gathered through previous independent studies were analyzed in the present research. Although some individual state samples are not of adequate size to be considered statistically comparable, a basic analysis was performed to compare trends observed between individual states. This analysis is presented in the following sections, referencing the questions and language included in the original survey instrument.

The following survey samples were acquired for each state:

Table 42: Overview of state survey samples

Survey State	No. of Respondents
Michigan	283
Oregon	50
Utah	26
Idaho	15
Montana	10
Washington	6
TOTAL	**390**

B.1 QUESTIONS ABOUT YOUR JURISDICTION

These questions gather limited background information and contact information on the agency completing the survey. The following questions were included in the data analysis.

Question: *Estimate of the population served.*

Classification: Numerical (number of people)

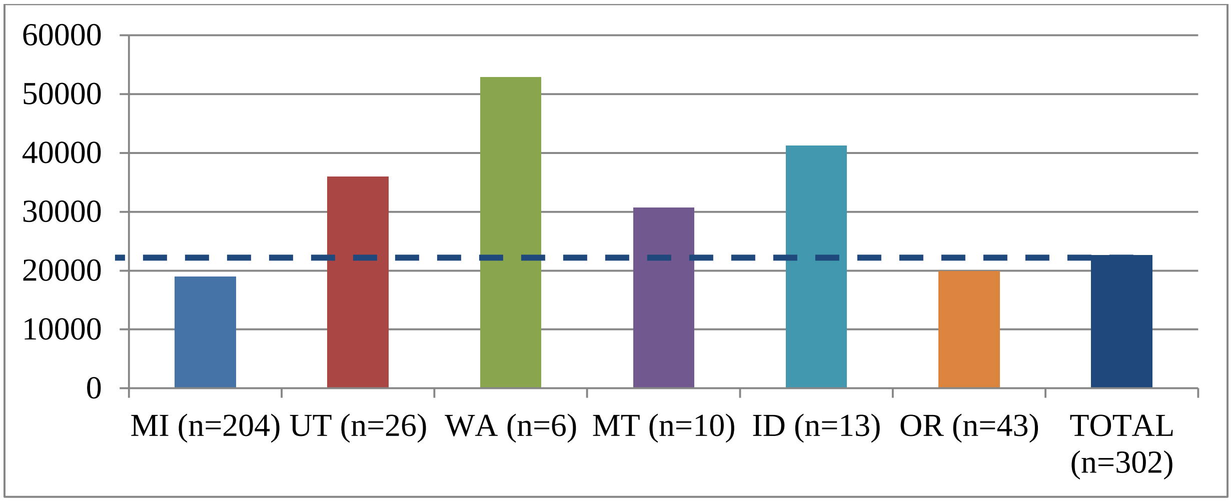


Figure 40: Average jurisdiction population by state (number of people)

Table 43: Jurisdiction population by state (number of people)

SAMPLE	MI	UT	WA	MT	ID	OR	TOTAL
n=	204	26	6	10	13	43	**302**
Min.	100	2900	8700	864	1500	1440	**100**
Q1 (25%)	5000	9750	24675	3125	19900	8900	**6000**
Q2 (50%)	10725	25000	49500	17750	47068.5	16500	**14000**
Q3 (75%)	25000	57000	75000	61250	58000	26500	**30000**
Max.	90173	110000	120000	105000	83500	65000	**120000**
Mean	19003	35996	52950	30686	41260	19929	**22617**
Median	10725	23500	49500	17750	44137	16000	**14000**
St. Dev.	21030.64	32359.93	34723.85	33489.84	22636.44	15269.44	**23789.13**
Var.	4.42E+08	1.05E+09	1.21E+09	1.12E+09	5.12E+08	2.33E+08	**5.66E+08**

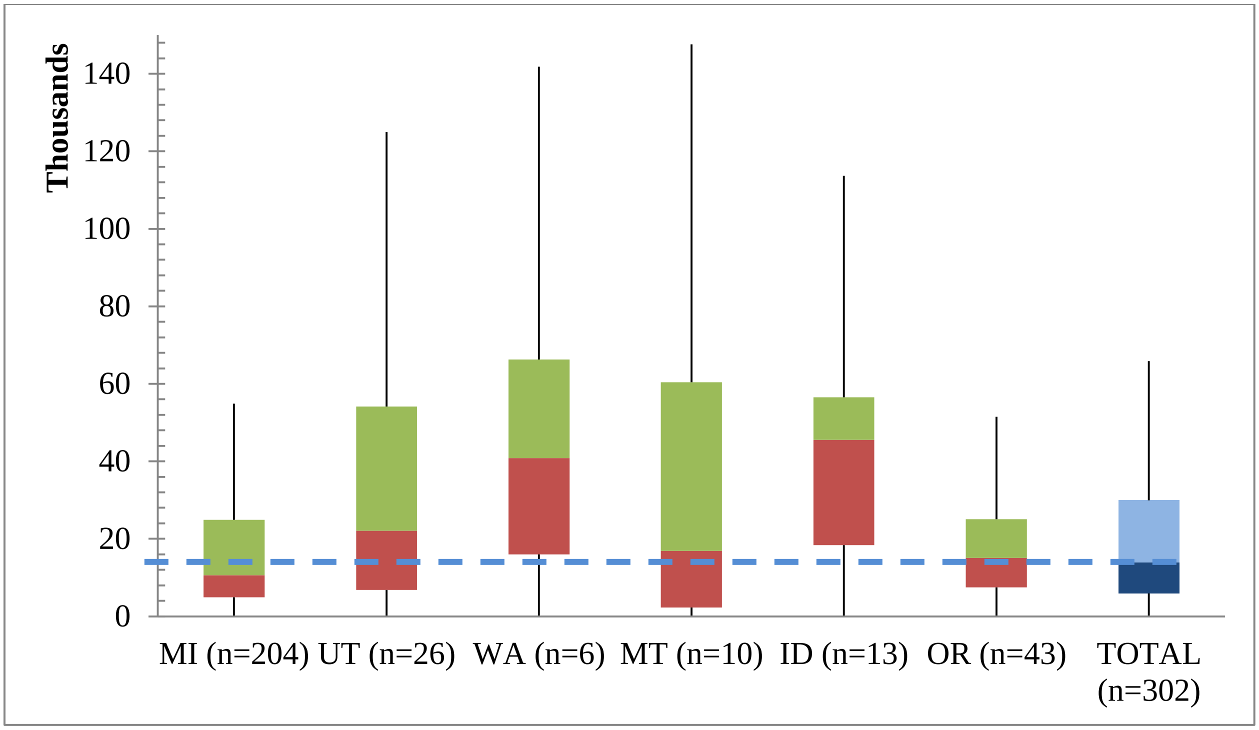


Figure 41: Population samples by state (thousand people)

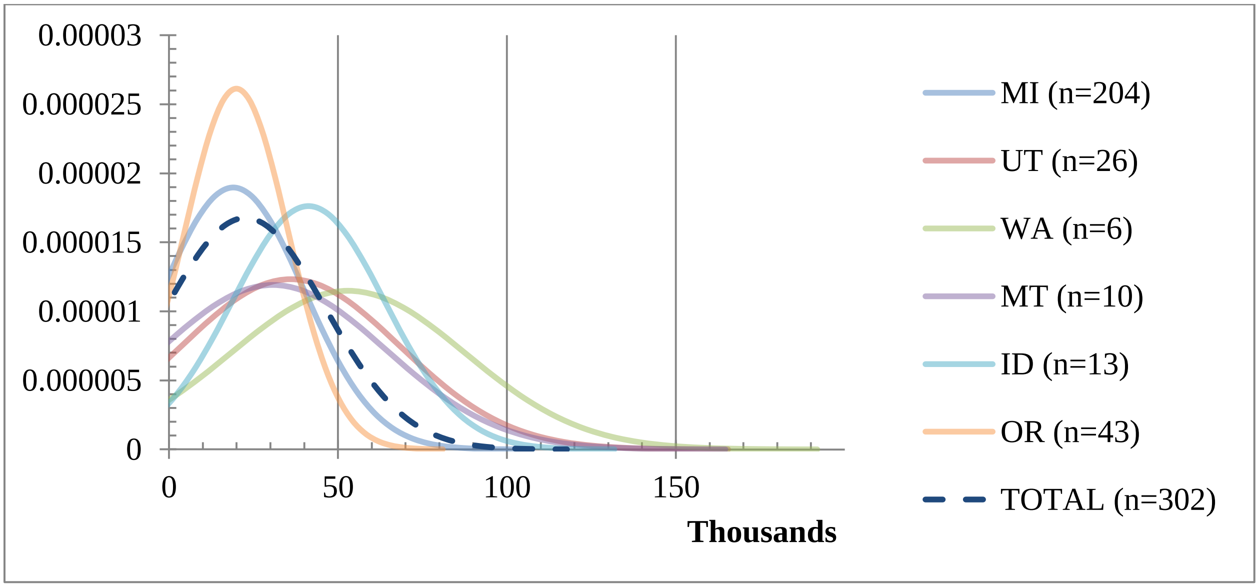
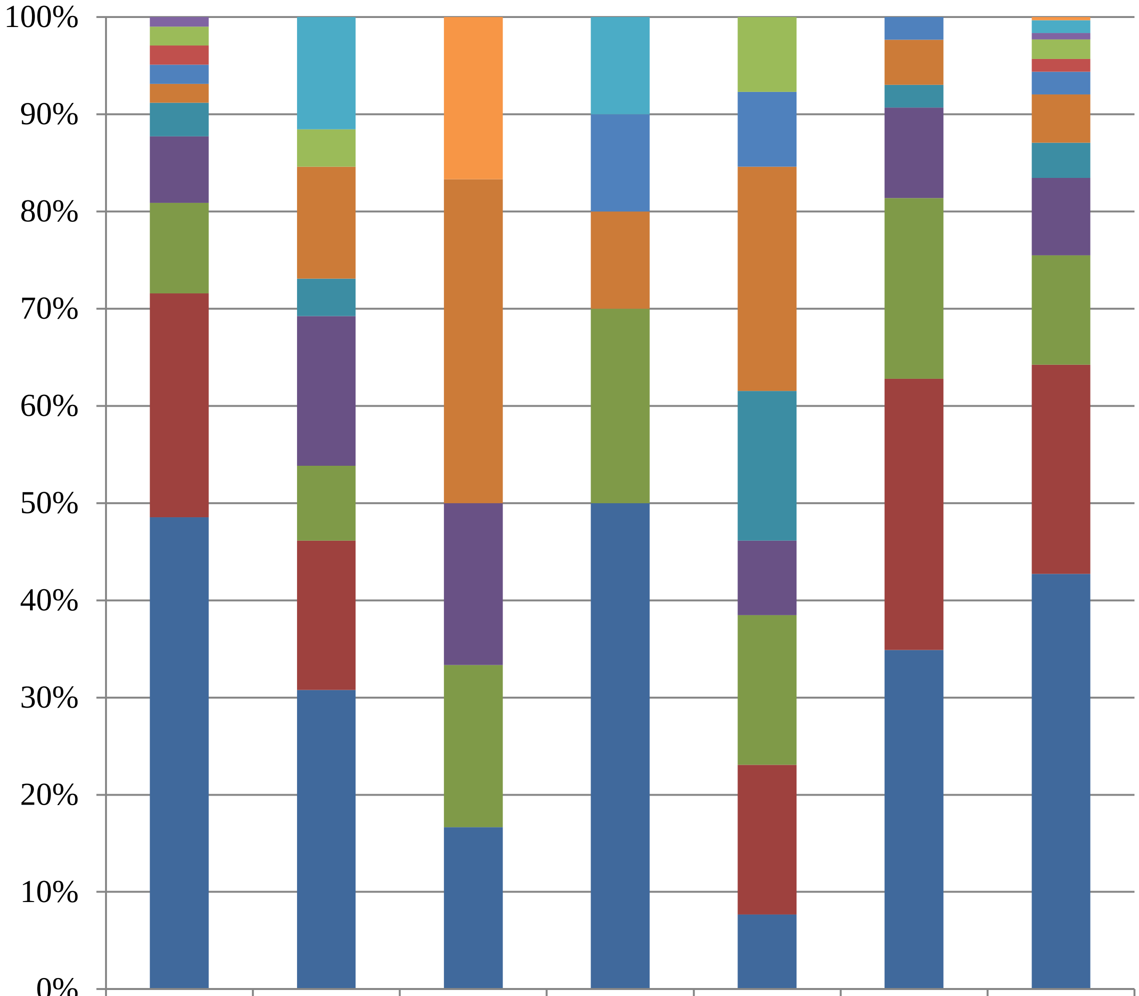


Figure 42: Population distribution by state (thousand people)



	MI (n=204)	UT (n=26)	WA (n=6)	MT (n=10)	ID (n=13)	OR (n=43)	TOTAL (n=302)
110-120	0%	0%	17%	0%	0%	0%	0%
100-110	0%	12%	0%	10%	0%	0%	1%
90-100	1%	0%	0%	0%	0%	0%	1%
80-90	2%	4%	0%	0%	8%	0%	2%
70-80	2%	0%	0%	0%	0%	0%	1%
60-70	2%	0%	0%	10%	8%	2%	2%
50-60	2%	12%	33%	10%	23%	5%	5%
40-50	3%	4%	0%	0%	15%	2%	4%
30-40	7%	15%	17%	0%	8%	9%	8%
20-30	9%	8%	17%	20%	15%	19%	11%
10-20	23%	15%	0%	0%	15%	28%	22%
<10	49%	31%	17%	50%	8%	35%	43%

Figure 43: Incremental population distribution by state (thousand people)

Question: *In the previous calendar year, how many building permits were issued by your agency?*

a) Residential building permits
b) Commercial building permits

Classification: Numerical (number of permits)

Table 44: Number of permits per population by state

SAMPLE	MI	UT	WA	MT	ID	OR	TOTAL
Average Population	19003	35996	52950	30686	41260	19929	**22617**
No. Permits Issued:							
Residential	102	26	426	161	124	92	**105**
Commercial	21	181	318	216	38	54	**57**
Total	**123**	**207**	**744**	**377**	**162**	**146**	**162**
No. Permits per 1000 People	*6.47*	*5.76*	*14.05*	*12.29*	*3.93*	*7.33*	*7.16*

Table 45: Number of permits issued by state

SAMPLE	MI	UT	WA	MT	ID	OR	TOTAL
n=	167	21	6	8	12	42	**256**
min.	0	0	26	7	27	5	**0**
Q1 (25%)	25	6	39.5	13.25	65	29.75	**24**
Q2 (50%)	62	15	353	54	136.5	70.5	**60**
Q3 (75%)	150	40	782.75	181.5	158.25	143.25	**147.25**
Max.	400	100	1100	829	213	285	**1100**
Mean	102	26	426	161	124	92	**105**
Median	62	15	353	54	136.5	70.5	**60**
St. Dev.	104.78	28.64	382.33	260.26	56.19	74.06	**129.95**
Var.	1.10E+04	8.20E+02	1.46E+05	6.77E+04	3.16E+03	5.49E+03	**1.69E+04**

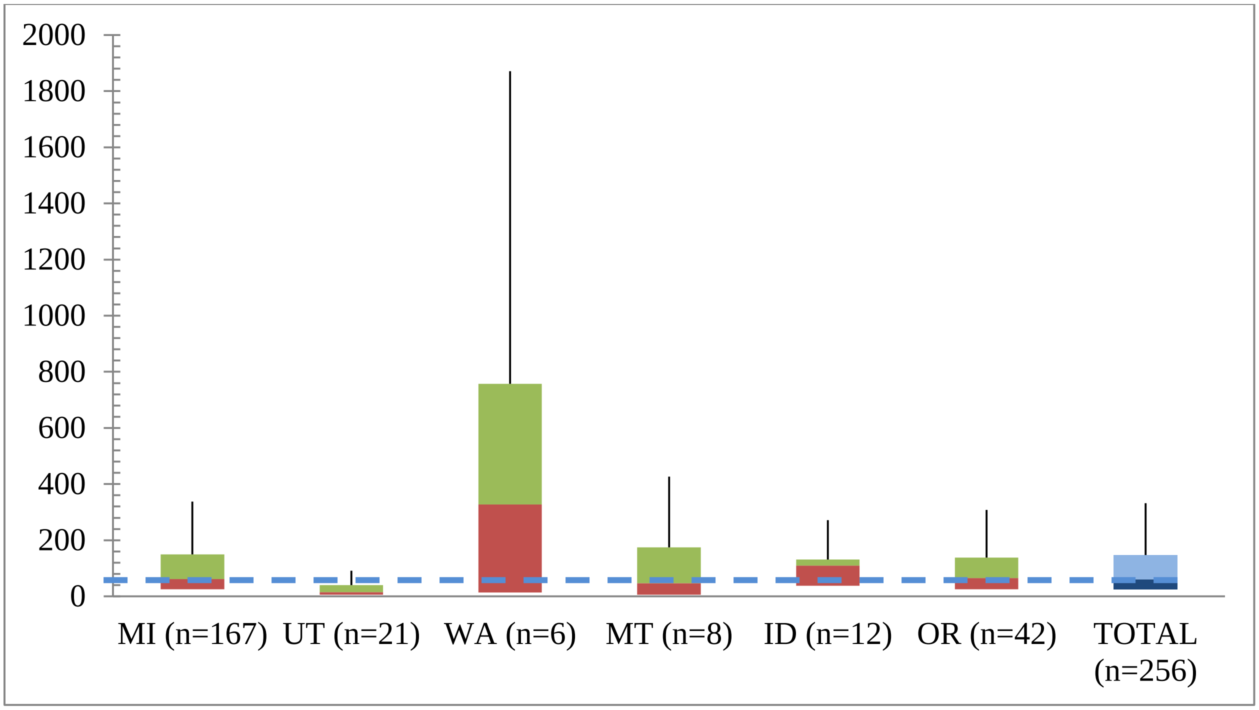


Figure 44: Residential building permits by state (number of permits)

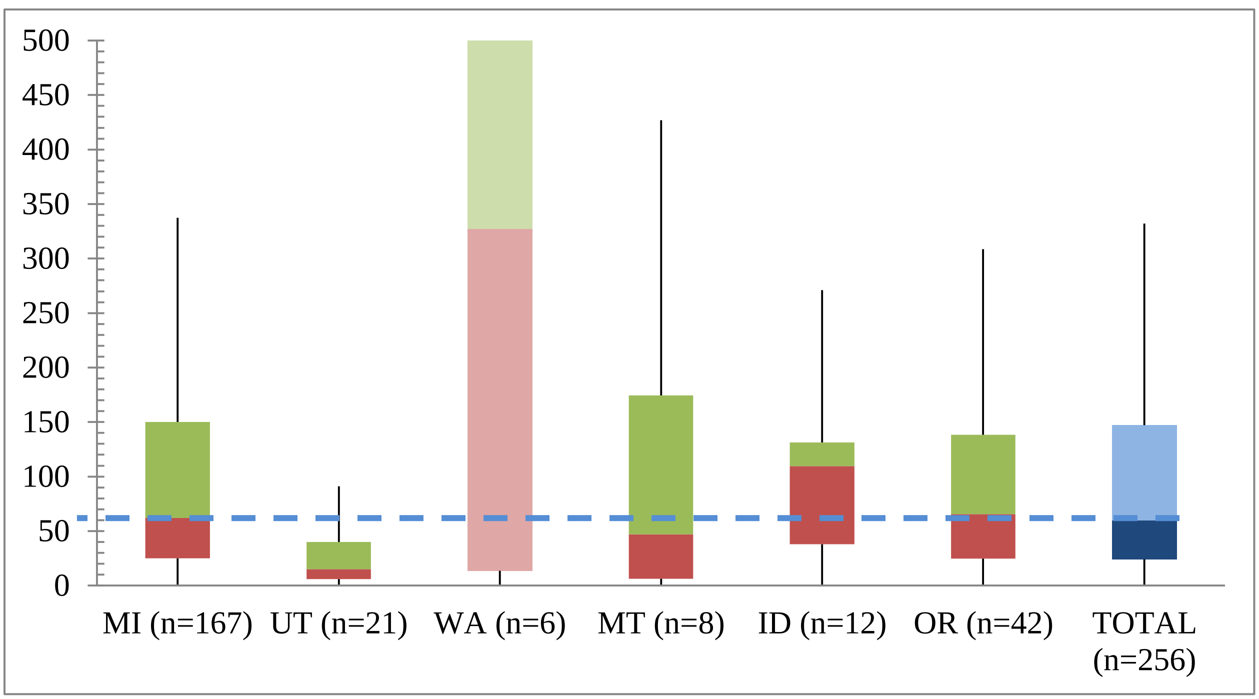


Figure 45: Residential permits by state (magnified view)

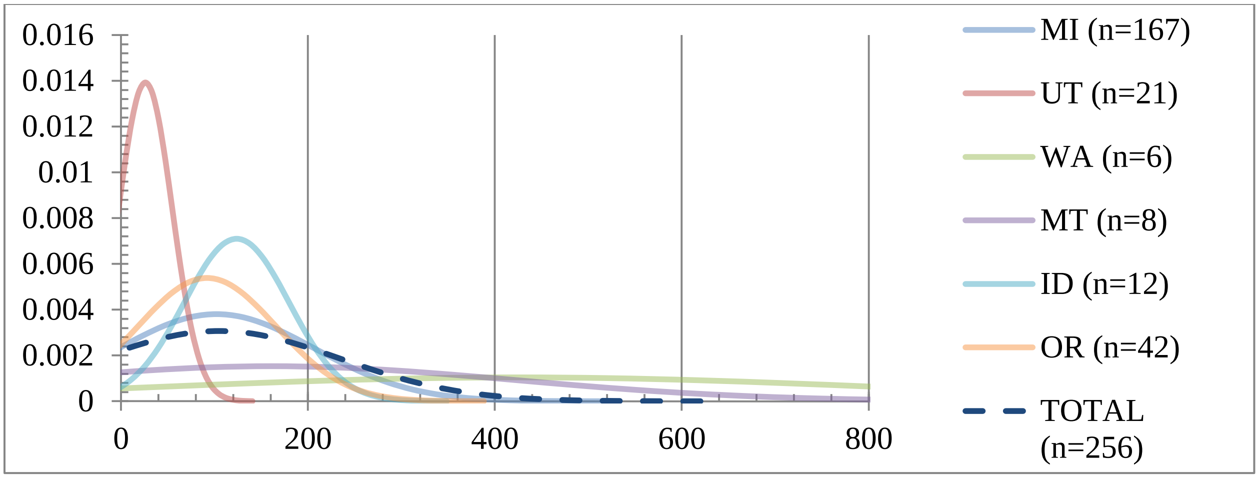
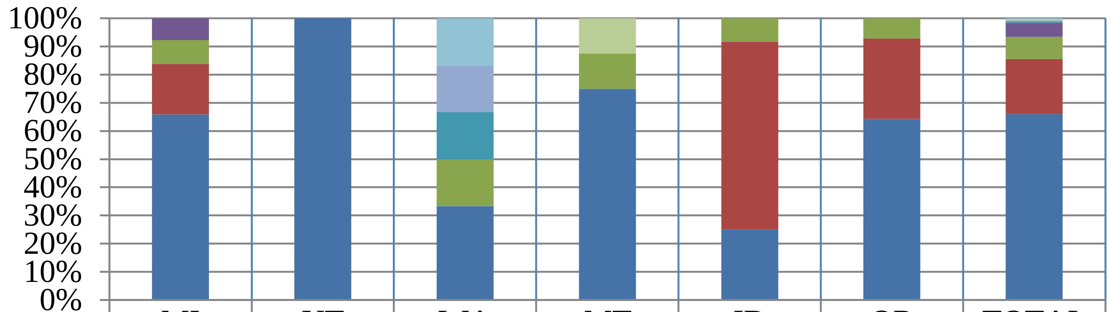


Figure 46: Residential permit sample distribution by state



	MI (n=167)	UT (n=21)	WA (n=6)	MT (n=8)	ID (n=12)	OR (n=42)	TOTAL (n=256)
1000-1100	0%	0%	17%	0%	0%	0%	0%
900-1000	0%	0%	0%	0%	0%	0%	0%
800-900	0%	0%	0%	13%	0%	0%	0%
700-800	0%	0%	0%	0%	0%	0%	0%
600-700	0%	0%	17%	0%	0%	0%	0%
500-600	0%	0%	0%	0%	0%	0%	0%
400-500	0%	0%	17%	0%	0%	0%	0%
300-400	8%	0%	0%	0%	0%	0%	5%
200-300	8%	0%	17%	13%	8%	7%	8%
100-200	18%	0%	0%	0%	67%	29%	20%
<100	66%	100%	33%	75%	25%	64%	66%

Figure 47: Incremental residential permit distribution

Table 46: Number of residential permits issued by state

SAMPLE	MI	UT	WA	MT	ID	OR	TOTAL
n=	161	25	6	9	13	42	**256**
min.	0	0	3	6	0	1	**0**
Q1 (25%)	1	46.5	5.25	10.5	0	12	**2**
Q2 (50%)	5	97	145	146	22	29.5	**12**
Q3 (75%)	26	248.5	708.25	456	74	73.25	**60**
Max.	130	685	1000	684	109	212	**1000**
Mean	21	181	318	216	38	54	**57**
Median	5	97	145	146	22	29.5	**12**
St. Dev.	32.11	197.21	366.84	253.24	37.40	56.35	**123.67**
Var.	1.03E+03	3.89E+04	1.35E+05	6.41E+04	1.40E+03	3.17E+03	**1.53E+04**

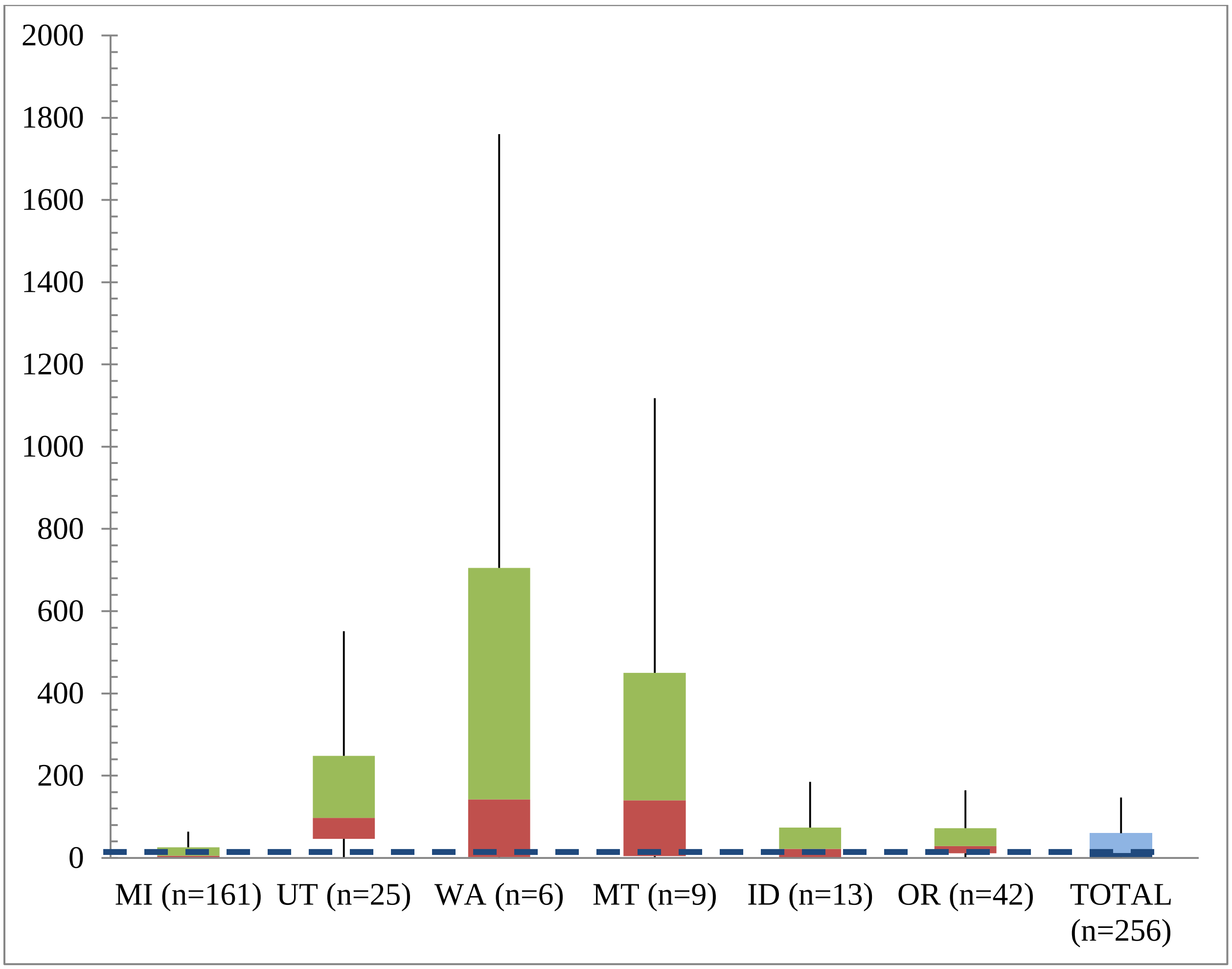


Figure 48: Number of commercial building permits issued by state

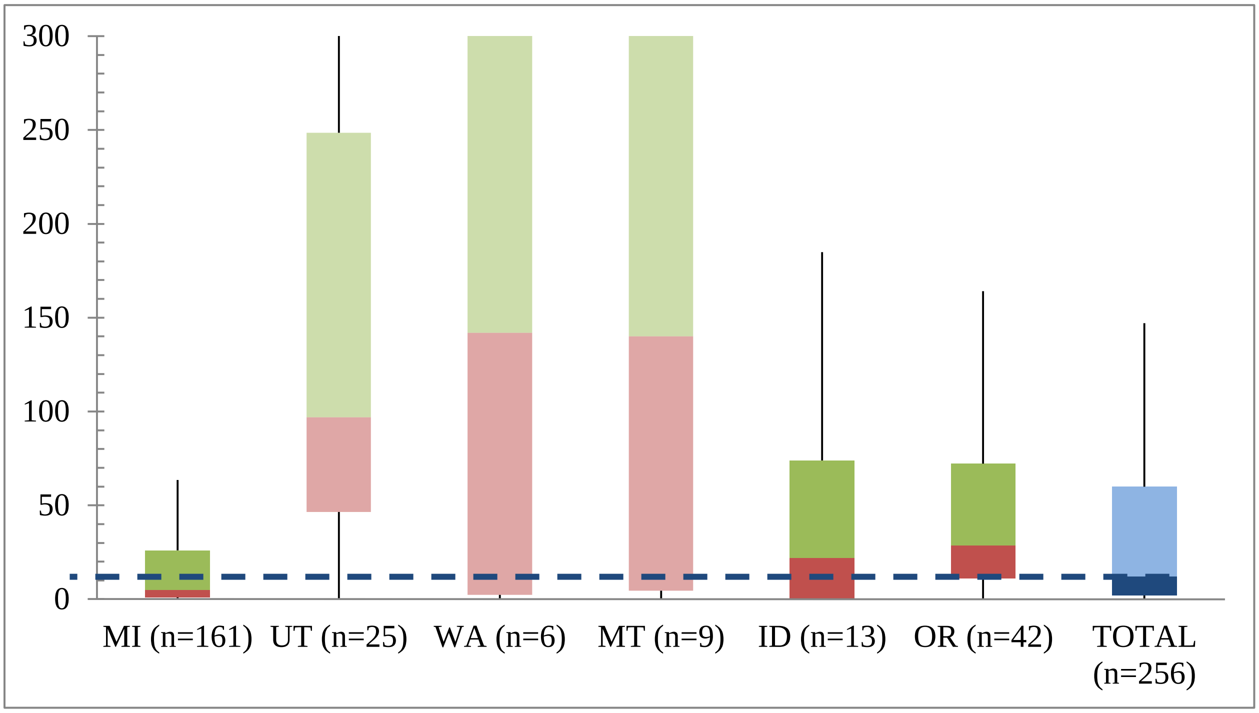


Figure 49: Number of commercial permits by state (magnified view)

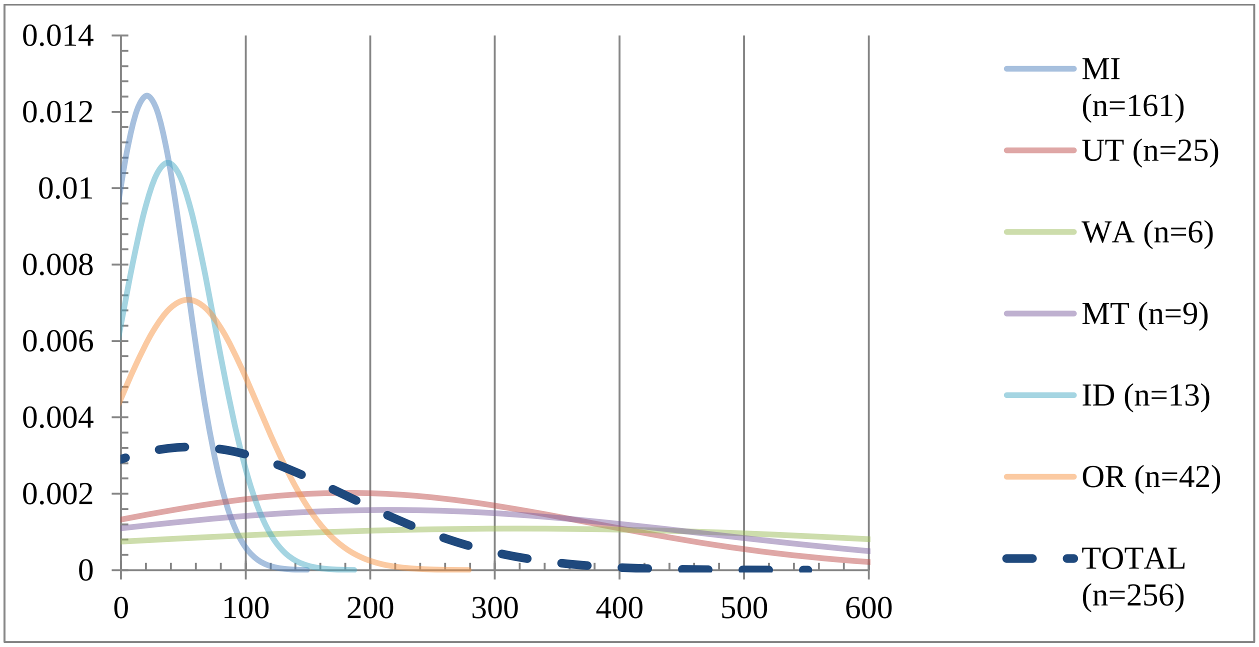
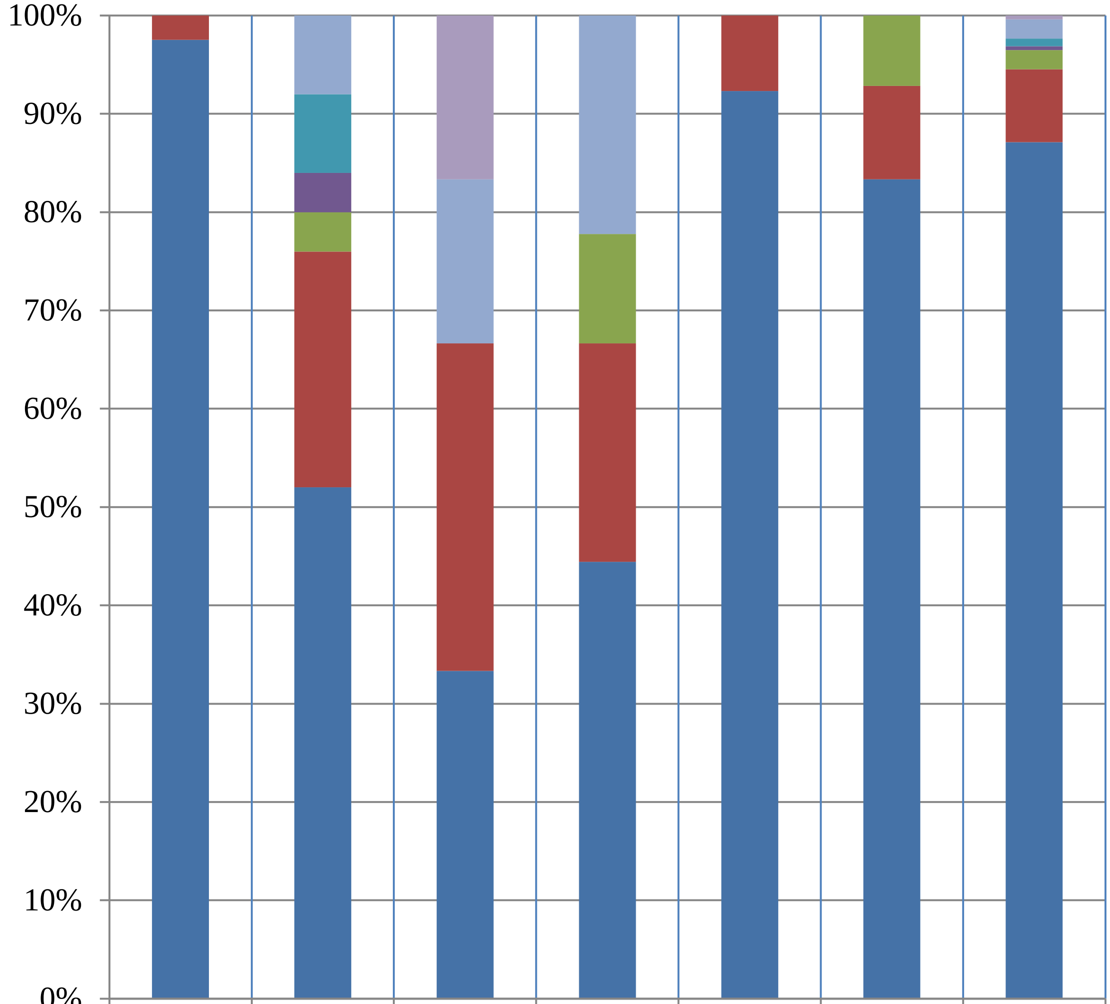


Figure 50: Commercial permit sample distribution by state



	MI (n=161)	UT (n=25)	WA (n=6)	MT (n=9)	ID (n=13)	OR (n=42)	TOTAL (n=256)
1000-1100	0%	0%	0%	0%	0%	0%	0%
900-1000	0%	0%	17%	0%	0%	0%	0%
800-900	0%	0%	0%	0%	0%	0%	0%
700-800	0%	0%	0%	0%	0%	0%	0%
600-700	0%	8%	17%	22%	0%	0%	2%
500-600	0%	0%	0%	0%	0%	0%	0%
400-500	0%	8%	0%	0%	0%	0%	1%
300-400	0%	4%	0%	0%	0%	0%	0%
200-300	0%	4%	0%	11%	0%	7%	2%
100-200	2%	24%	33%	22%	8%	10%	7%
<100	98%	52%	33%	44%	92%	83%	87%

Figure 51: Incremental commercial permit distribution by state

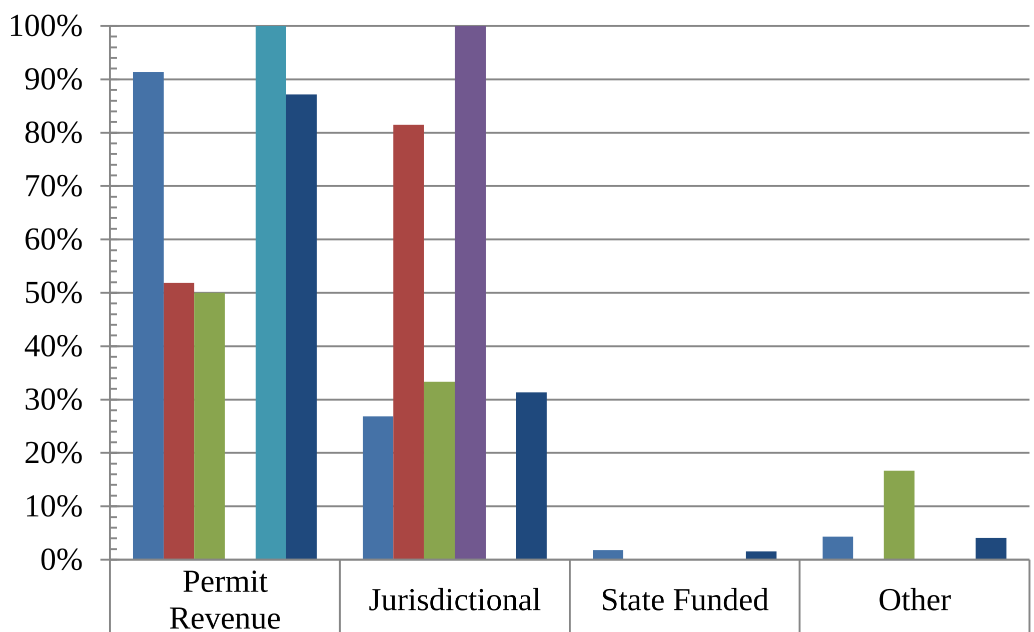
Question: *How is your agency funded? (check all that apply)*

a) Permitting revenue
b) Jurisdictional budget
c) State funded
d) Other (please specify)

Classification: Categorical *(check all applicable responses)*

Table 47: Jurisdictional funding source by state

SAMPLE	MI (n=279)	UT (n=27)	WA (n=6)	MT (n=1)	ID (n=6)	TOTAL (n=319)
Permit Revenue	91%	52%	50%	0%	100%	**87%**
Jurisdictional	27%	81%	33%	100%	0%	**31%**
State Funded	2%	0%	0%	0%	0%	**2%**
Other	4%	0%	17%	0%	0%	**4%**



	Permit Revenue	Jurisdictional	State Funded	Other
MI (n=279)	91%	27%	2%	4%
UT (n=27)	52%	81%	0%	0%
WA (n=6)	50%	33%	0%	17%
MT (n=1)	0%	100%	0%	0%
ID (n=6)	100%	0%	0%	0%
TOTAL (n=319)	87%	31%	2%	4%

Figure 52: Jurisdictional funding source by state

B.2 QUESTIONS ABOUT YOUR STAFF

These questions inquire about characteristics of staff employed for the purpose of energy code enforcement. The following questions were included in the data analysis.

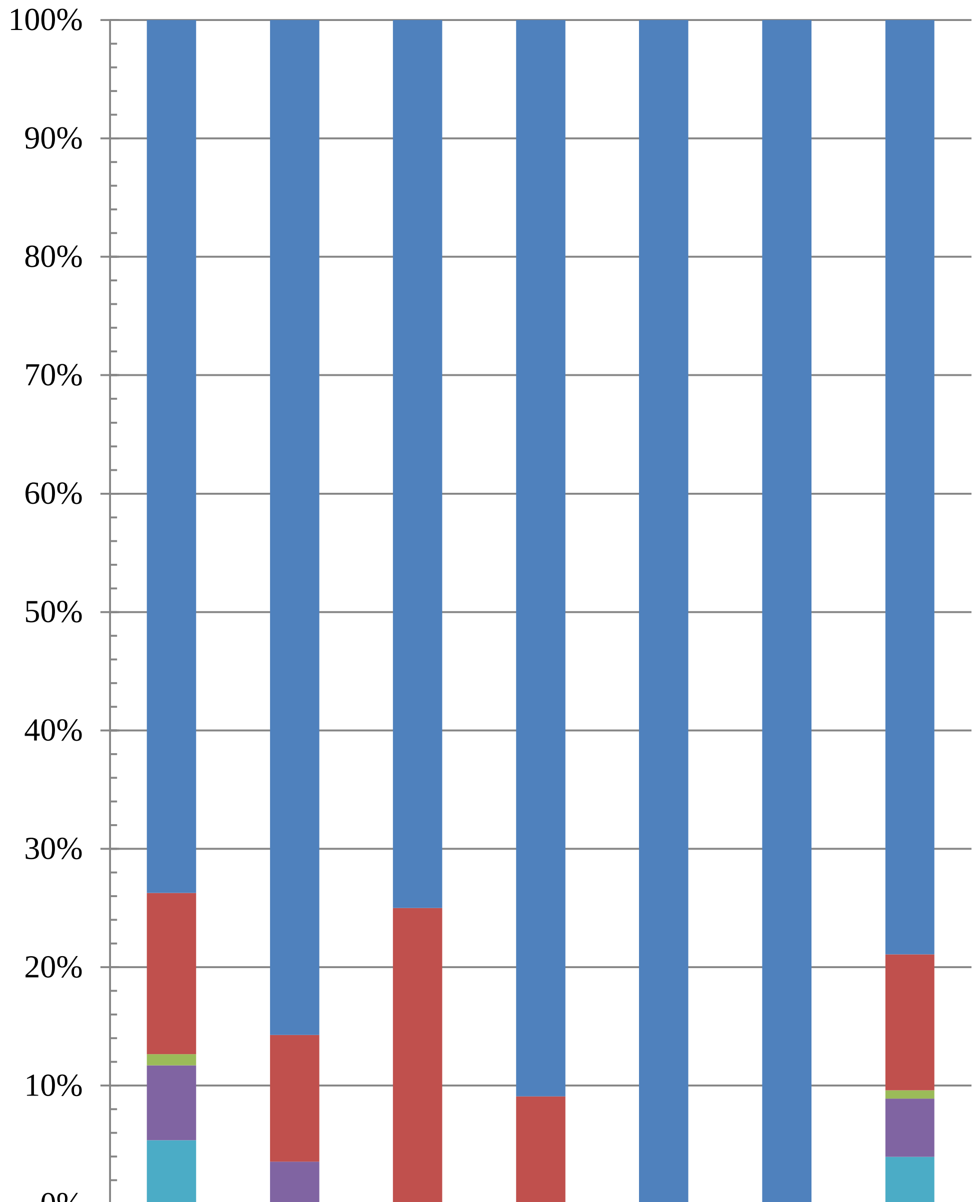
Question: *Who conducts plan reviews for energy code compliance? (check all that apply)*

- *a) In-house staff*
- *b) 3rd party staff*
- *c) Other jurisdictions or government agencies*
- *d) Not done*
- *e) Other (please specify)*

Classification: Categorical *(check all applicable responses)*

Table 48: Party responsible for conducting plan review by state

SAMPLE	**MI** (n=277)	**UT** (n=25)	**WA** (n=6)	**MT** (n=10)	**ID** (n=15)	**OR** (n=48)	**TOTAL** (n=382)
In-house staff	74%	86%	75%	91%	100%	100%	**79%**
3rd party entities	14%	11%	25%	9%	0%	0%	**11%**
Other jurisdictions or agencies	1%	0%	0%	0%	0%	0%	**1%**
Not done	6%	4%	0%	0%	0%	0%	**5%**
Other	5%	0%	0%	0%	0%	0%	**4%**



	MI (n=277)	UT (n=25)	WA (n=6)	MT (n=10)	ID (n=15)	OR (n=48)	TOTAL (n=382)
In-house staff	74%	86%	75%	91%	100%	100%	79%
3rd party entities	14%	11%	25%	9%	0%	0%	11%
Other jurisdictions or agencies	1%	0%	0%	0%	0%	0%	1%
Not done	6%	4%	0%	0%	0%	0%	5%
Other	5%	0%	0%	0%	0%	0%	4%

Figure 53: Party conducting plan review by state

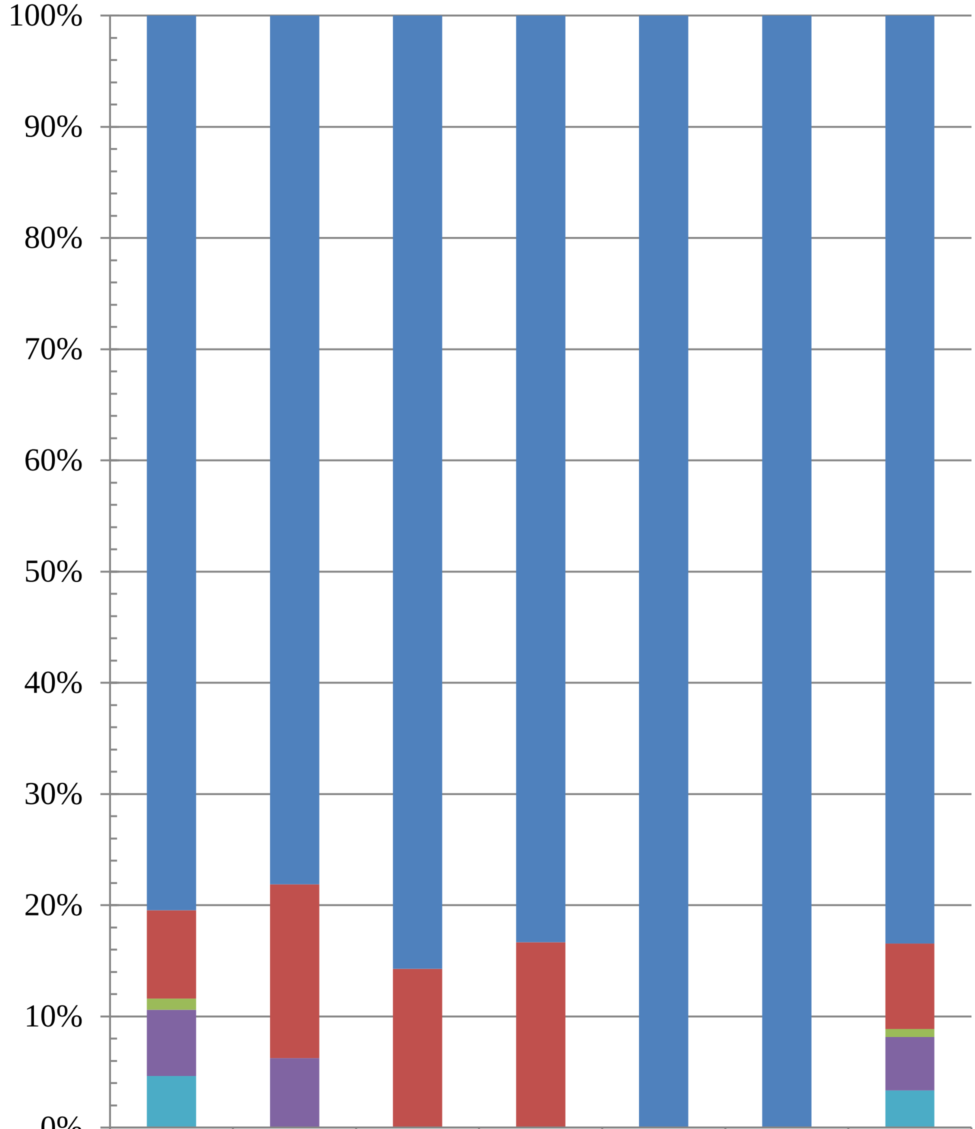
Question: *Who conducts field inspections for energy code compliance? (check all that apply)*

a) *In-house staff*
b) *3rd party staff*
c) *Other jurisdictions or government agencies*
d) *Not done*
e) *Other (please specify)*

Classification: Categorical *(check all applicable responses)*

Table 49: Party responsible for conducting field inspection by state

SAMPLE	MI (n=276)	UT (n=27)	WA (n=6)	MT (n=10)	ID (n=15)	OR (n=48)	TOTAL (n=382)
In-house staff	80%	78%	86%	83%	100%	100%	**83%**
3rd party entities	8%	16%	14%	17%	0%	0%	**8%**
Other jurisdictions or agencies	1%	0%	0%	0%	0%	0%	**1%**
Not done	6%	6%	0%	0%	0%	0%	**5%**
Other	5%	0%	0%	0%	0%	0%	**3%**



	MI (n=276)	UT (n=27)	WA (n=6)	MT (n=10)	ID (n=15)	OR (n=48)	TOTAL (n=382)
In-house staff	80%	78%	86%	83%	100%	100%	83%
3rd party entities	8%	16%	14%	17%	0%	0%	8%
Other jurisdictions or agencies	1%	0%	0%	0%	0%	0%	1%
Not done	6%	6%	0%	0%	0%	0%	5%
Other	5%	0%	0%	0%	0%	0%	3%

Figure 54: Party conducting field inspection by state

Question: *What level of education and training does your agency staff receive specifically for energy codes?*

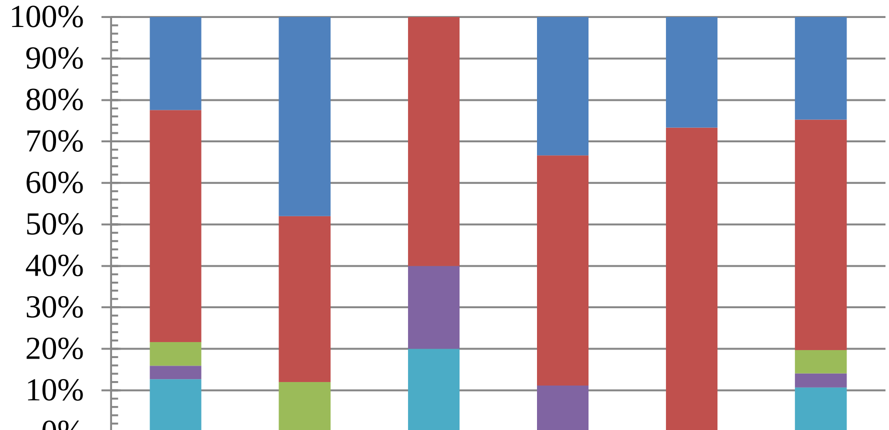
a) Residential energy codes training

b) Commercial energy codes training

Classification: Categorical (Choose only one rating 1-4)

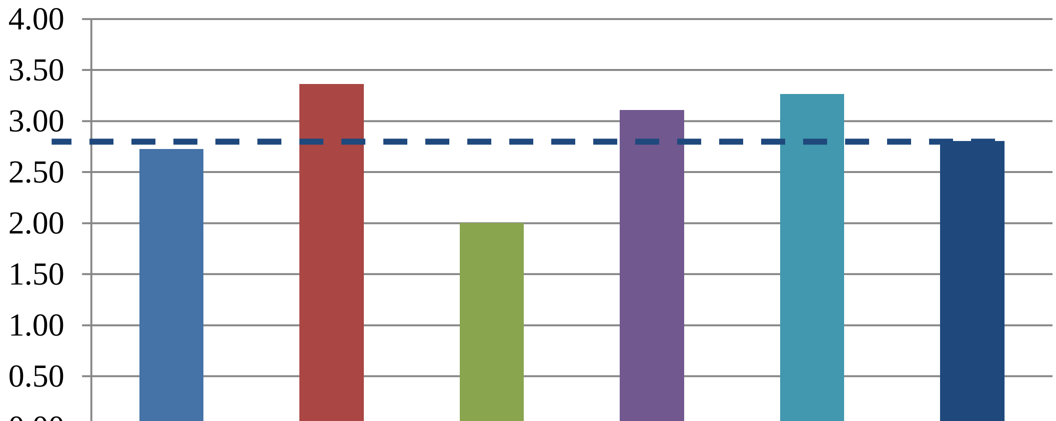
Table 50: Level of education and training for jurisdictional staff by state

Rating	SAMPLE	MI (n=245)	UT (n=25)	WA (n=5)	MT (n=9)	ID (n=15)	OR (N=0)	TOTAL (n=299)
4	*Professional certification and annual training (mandatory)*	22%	48%	0%	33%	27%	N/A	**25%**
3	*Periodic formal training from International Code Council, state-sponsored entity, or code officials association*	56%	40%	60%	56%	73%	N/A	**56%**
2	*Periodic formal training from another source*	6%	12%	0%	0%	0%	N/A	**6%**
1	*On-the-job training, but seldom formal training*	3%	0%	20%	11%	0%	N/A	**3%**
0	*Training not provided*	13%	0%	20%	0%	0%	N/A	**11%**
Average Rating		**2.72**	**3.36**	**2.00**	**3.11**	**3.27**	**N/A**	**2.80**



	MI (n=245)	UT (n=25)	WA (n=5)	MT (n=9)	ID (n=15)	TOTAL (n=299)
Professional Certification & Training	22%	48%	0%	33%	27%	25%
Periodic training (professional association)	56%	40%	60%	56%	73%	56%
Periodic training (other source)	6%	12%	0%	0%	0%	6%
Informal training	3%	0%	20%	11%	0%	3%
Not provided	13%	0%	20%	0%	0%	11%

Figure 55: Energy code training delivery by state



	MI (n=245)	UT (n=25)	WA (n=5)	MT (n=9)	ID (n=15)	TOTAL (n=299)
Average Rating	2.72	3.36	2.00	3.11	3.27	2.80

Figure 56: Rating of energy code training by state

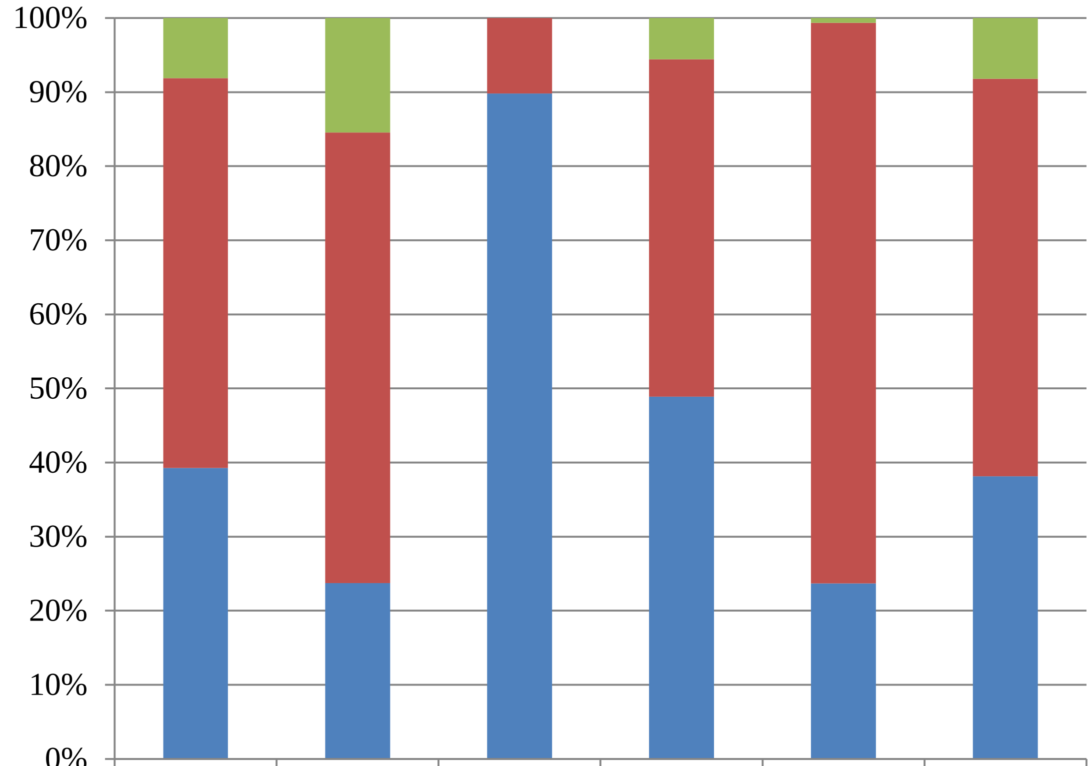
B.3 QUESTIONS ABOUT YOUR PROCESSES

These questions gather information on processes for assessing compliance with energy codes. The following questions were included in the data analysis.

Question: *What methods are used as a basis for documenting energy code compliance and in what percentages? REScheck and COMcheck are considered trade-off methods. Use whole numbers without a % sign to complete the question.*

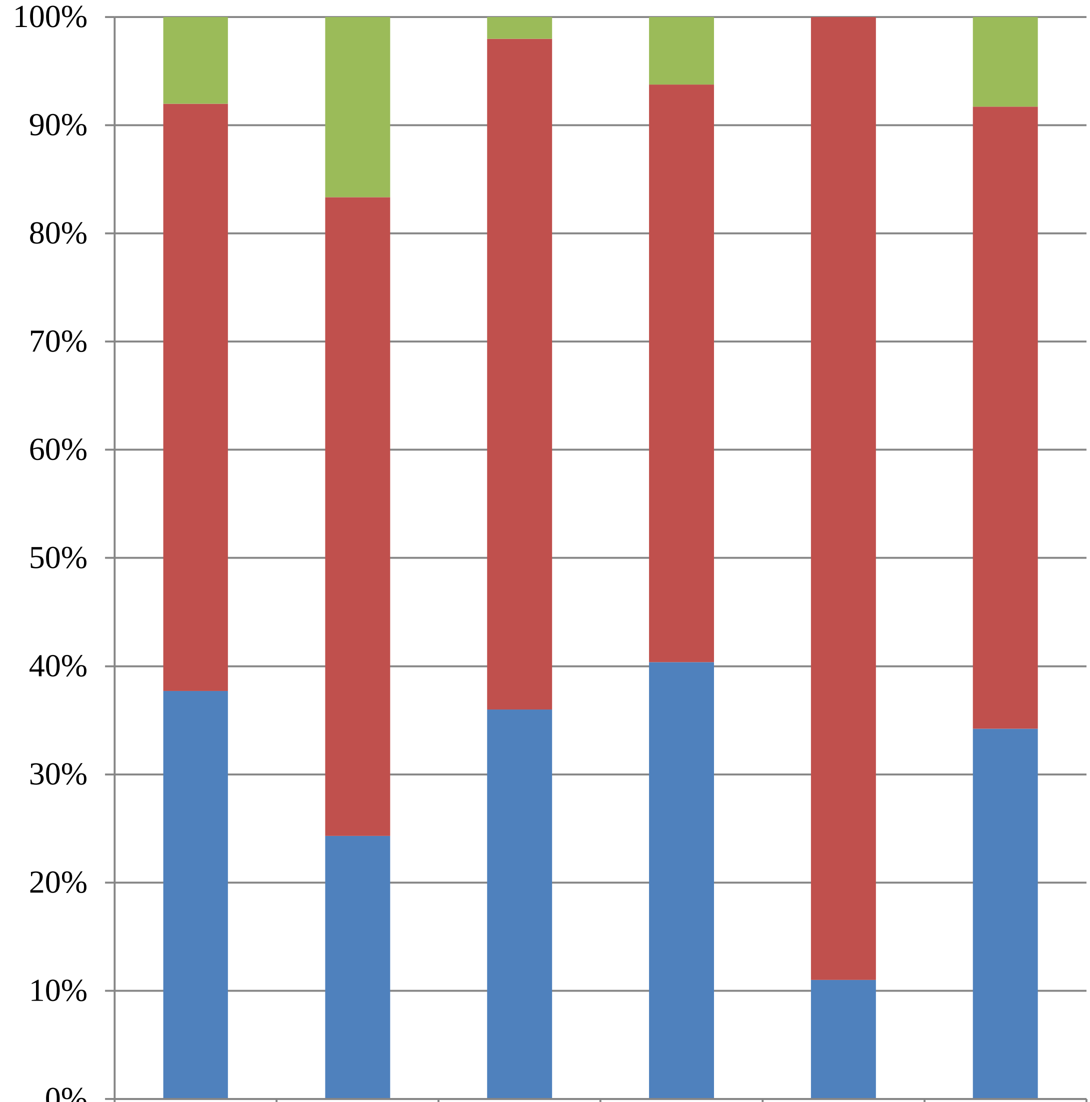
a) Prescriptive
b) Trade-off
c) Performance

Classification: Numerical (separate percentage entries for residential and commercial)



	MI (n=157)	UT (n=26)	WA (n=5)	MT (n=8)	ID (n=15)	TOTAL
Performance	8%	15%	0%	6%	1%	8%
REScheck	53%	61%	10%	46%	76%	54%
Prescriptive	39%	24%	90%	49%	24%	38%

Figure 57: Residential compliance path by state (n=211)



	MI (n=157)	UT (n=26)	WA (n=5)	MT (n=8)	ID (n=15)	TOTAL
Performance	8%	17%	2%	6%	0%	8%
REScheck	54%	59%	62%	53%	89%	57%
Prescriptive	38%	24%	36%	40%	11%	34%

Figure 58: Commercial compliance path by state (n=211)

Question: *How many hours are devoted to the average* ***plan review*** *for energy codes? If energy plan reviews are performed in conjunction with reviews for other code provisions, estimate the time for the energy-related reviews only.*

a) Residential buildings

b) Commercial buildings

Classification: Numerical (hours of time)

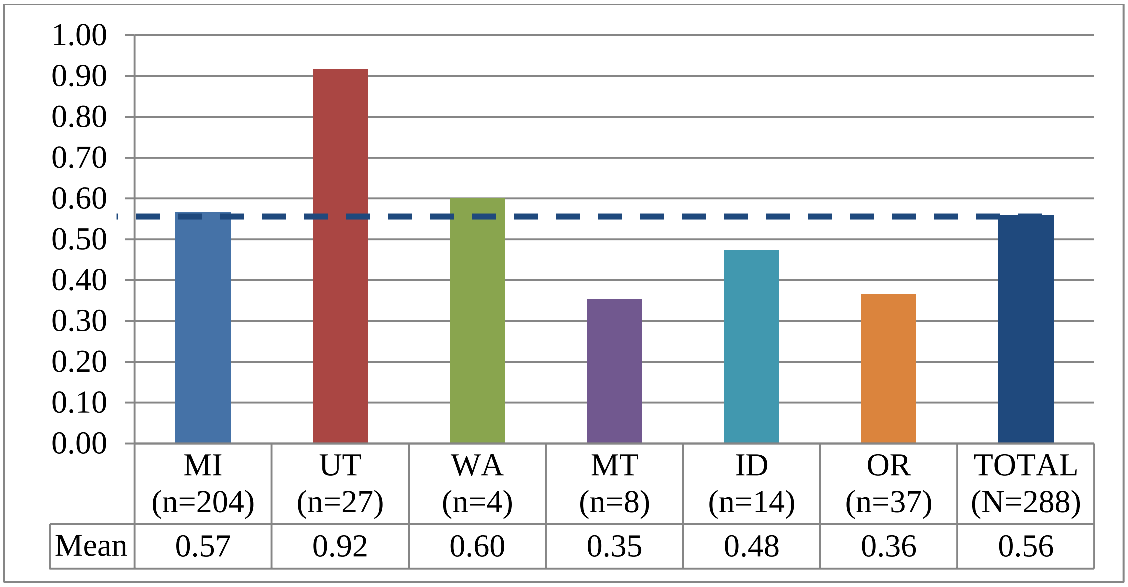


Figure 59: Average time spent on residential plan review by state (hours)

Table 51: Average time spent on residential plan review by state (hours)

SAMPLE	MI	UT	WA	MT	ID	OR	TOTAL
n=	204	24	4	8	14	37	**288**
min.	0	0	0.5	0.25	0.08	0.25	**0**
Q2 (25%)	0.425	1		0.25	0.25	0.25	**0.25**
Q3 (50%)	0.5	1		0.29	0.5	0.25	**0.5**
Q4 (75%)	1	1		0.5	0.54	0.5	**1**
Max.	1.5	1	1	0.5	1	0.5	**1.5**
Mean	0.57	0.92	0.60	0.35	0.48	0.36	**0.56**
Median	0.5	1	0.5	0.29	0.5	0.25	**0.5**
Mode	0.5	1		0.25	0.5	0.25	**0.5**
St. Dev.	0.36	0.28	0.20	0.12	0.27	0.12	**0.35**
Var.	1.28E-02	7.64E-02		1.35E-02	7.12E-02	1.55E-02	**1.21E-01**

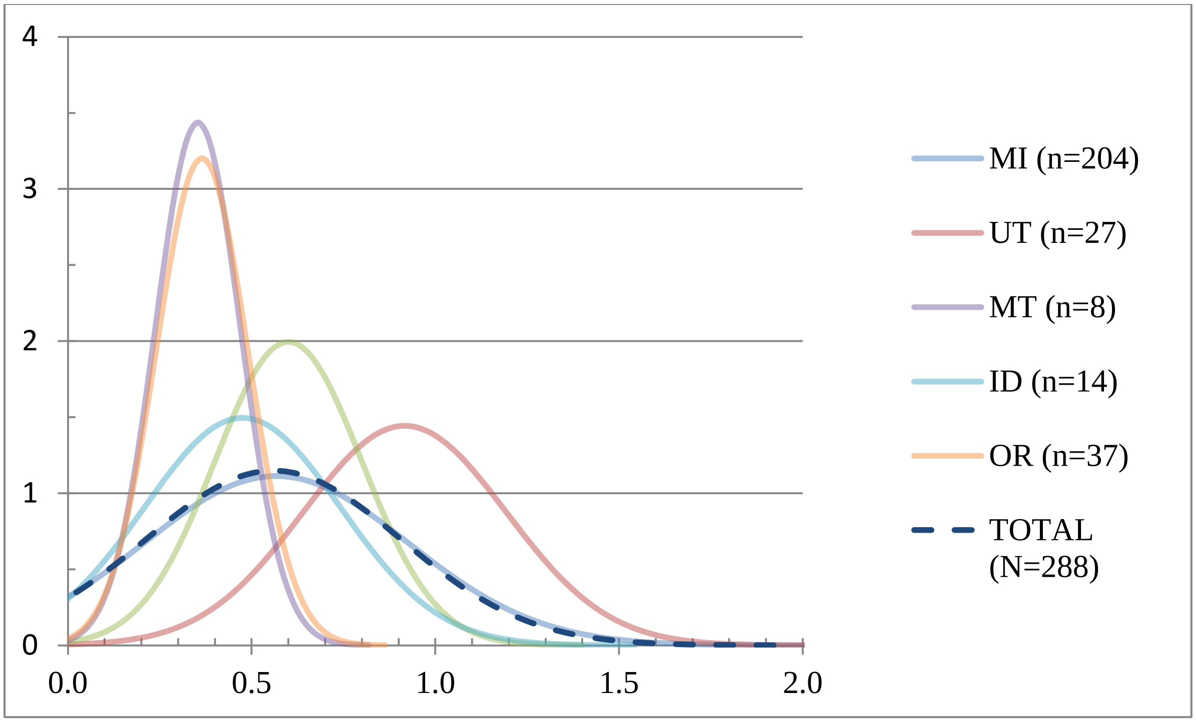
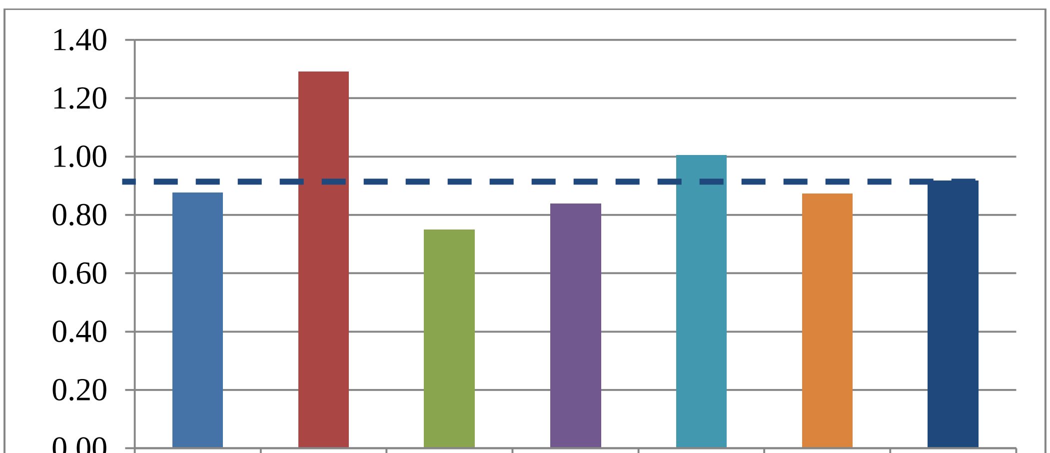


Figure 60: Time spent on residential plan review by state (hours)



	MI (n=203)	UT (n=27)	WA (n=3)	MT (n=8)	ID (n=15)	OR (n=47)	TOTAL
Mean	0.88	1.29	0.75	0.84	1.01	0.87	0.92

Figure 61: Time spent on commercial plan review by state (hours)

Table 52: Time spent on commercial plan review by state (hours)

SAMPLE	MI	UT	WA	MT	ID	OR	TOTAL
n=	188	24	4	9	15	47	**283**
min.	0	0	0.5	0.415	0.08	0.5	**0**
Q2 (25%)	0.5	1		0.5625	0.495	0.5	**0.5**
Q3 (50%)	0.775	1		0.75	1	1	**1**
Q4 (75%)	1	2		1.125	1.5	1	**1**
Max.	3	3	1	1.5	2.25	1	**3**
Mean	0.88	1.29	0.75	0.84	1.01	0.87	**0.92**
Median	0.775	1	1	0.75	1	1	**1**
Mode	1	1		0.75	0.75	1	**1**
St. Dev.	0.70	0.68	0.25	0.33	0.60	0.22	**0.64**
Var.	4.94E-01	4.57E-01		1.11E-01	3.55E-01	4.75E-02	**4.11E-01**

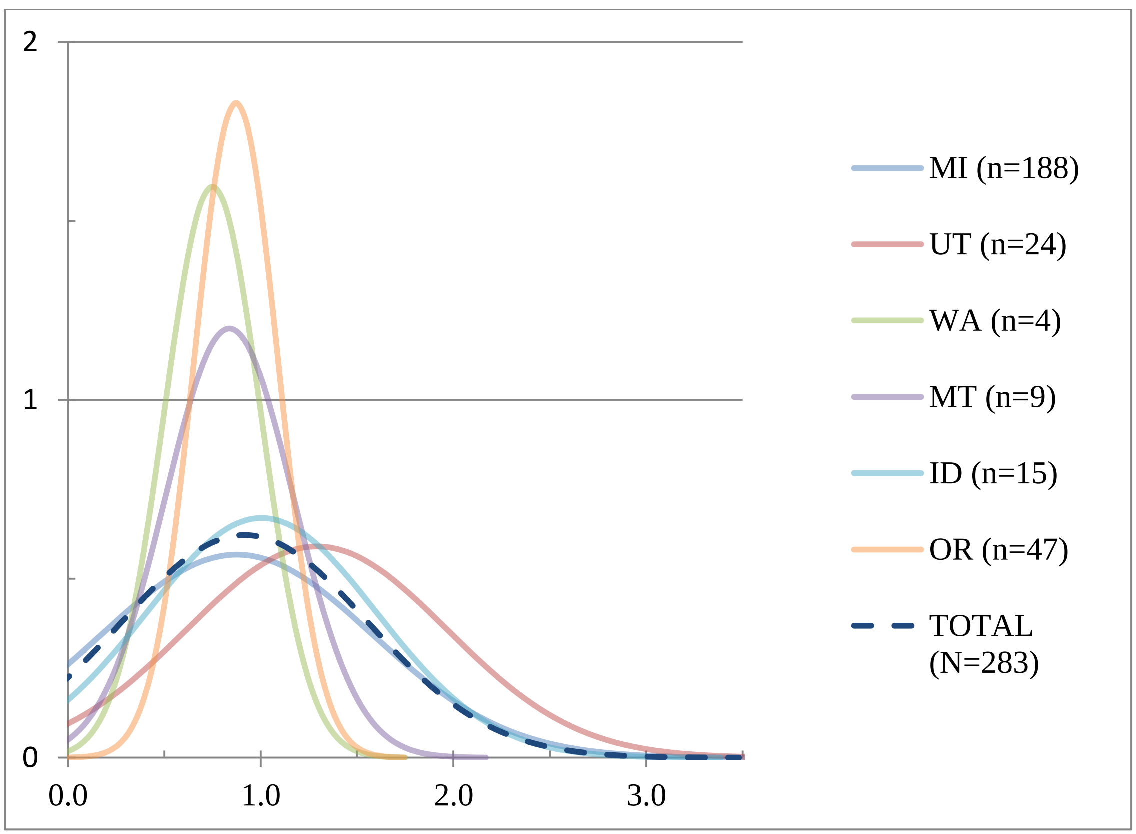


Figure 62: Time spent on commercial plan review by state (hours)

Question: *How many hours are devoted to the average* ***field inspection*** *for energy codes? If energy field inspections are performed in conjunction with inspections for other code provisions, please estimate the time for the energy-related field inspections only.*

a) Residential buildings
b) Commercial buildings

Classification: Numerical (hours of time)

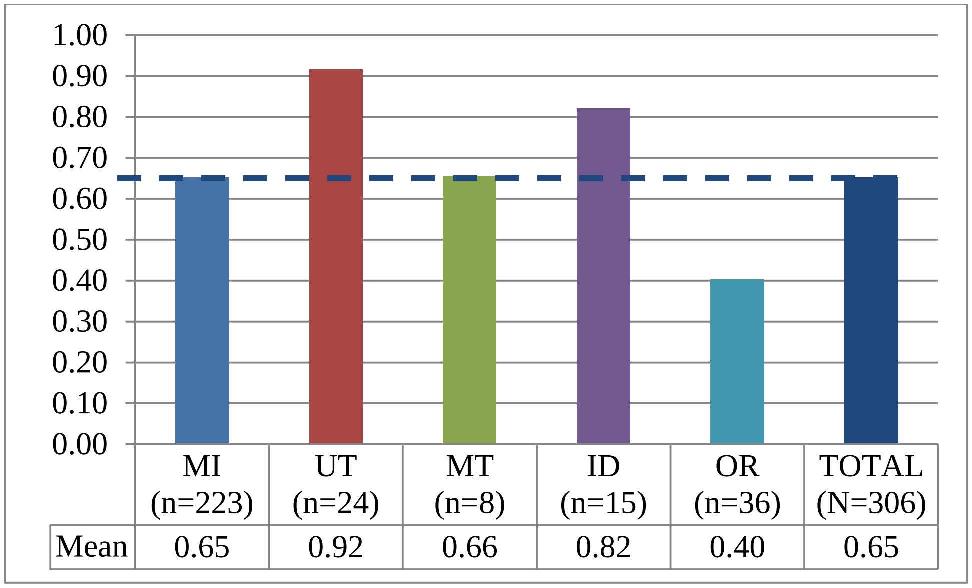


Figure 63: Time spent on residential field inspection by state (hours)

Table 53: Time spent on residential field inspection by state (hours)

SAMPLE	MI	UT	WA	MT	ID	OR	TOTAL
n=	223	24	5	8	15	36	**306**
min.	0	0	0.1	0.25	0.25	0.25	**0**
Q2 (25%)	0.25	1		0.5	0.5	0.25	**0.25**
Q3 (50%)	0.5	1		0.5	0.66	0.5	**0.5**
Q4 (75%)	1	1		1	1.5	0.5	**1**
max.	2	1	1.5	1	1.5	0.5	**2**
Mean	0.65	0.92	1.17	0.66	0.82	0.40	**0.65**
Median	0.5	1	1	0.5	0.66	0.5	**0.5**
Mode	0.5	1		0.5	0.5	0.5	**0.5**
St. Dev.	0.49	0.28	0.48	0.28	0.46	0.12	**0.46**
Var.	2.39E-01	7.64E-02		7.71E-02	2.11E-01	1.49E-02	**2.08E-01**

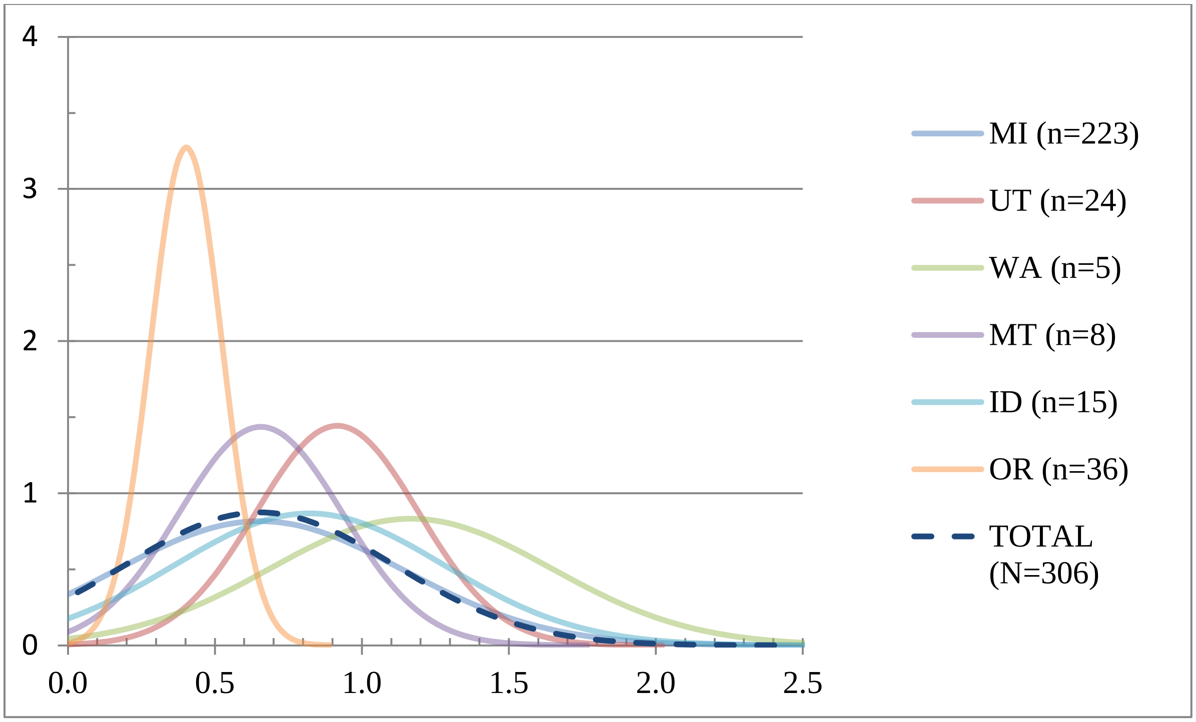


Figure 64: Time spent on residential field inspection by state (hours)

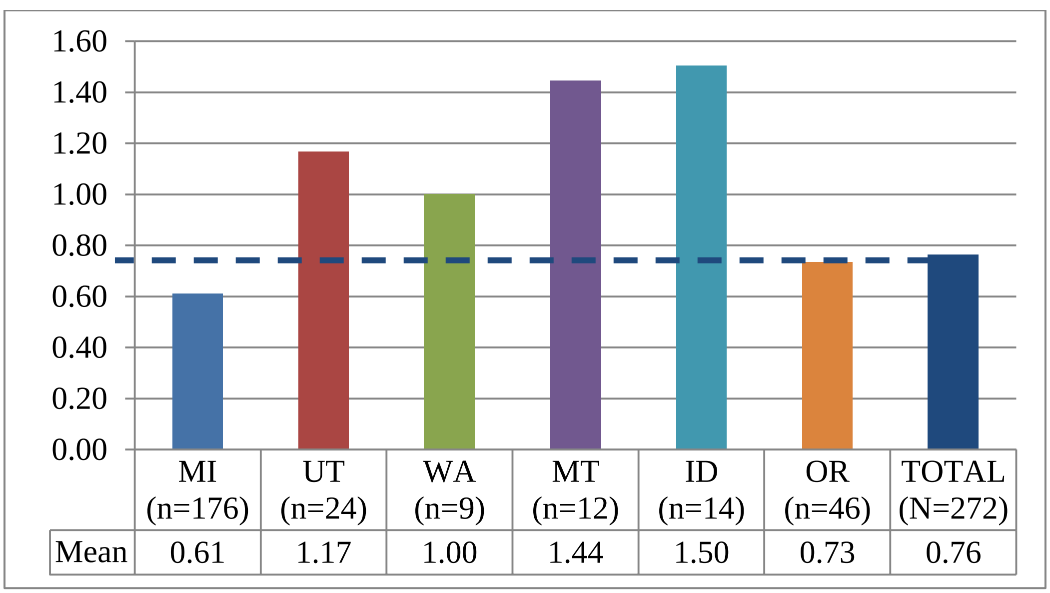


Figure 65: Time spent on commercial field inspection by state (hours)

Table 54: Time spent on commercial field inspection by state (hours)

SAMPLE	MI	UT	WA	MT	ID	OR	TOTAL
n=	176	24	9	12	14	46	**272**
min.	0	0	0.25	0.33	0.25	0.25	**0**
Q2 (25%)	0.25	1		0.625	0.57	0.5	**0.5**
Q3 (50%)	0.5	1		1	1.25	1	**0.5**
Q4 (75%)	1	1.75		2.375	2	1	**1**
max.	1.75	2	1	3.5	5.25	1	**5.25**
Mean	0.61	1.17	1.00	1.44	1.50	0.73	**0.76**
Median	0.5	1	1	1	1.25	1	**0.5**
Mode	0.5	1		0.625	1.25	1	**1**
St. Dev.	0.41	0.55	4.02	0.98	1.29	0.29	**0.60**
Var.	1.72E-01	3.06E-01		9.63E-01	1.67E+00	8.26E-02	**3.59E-01**

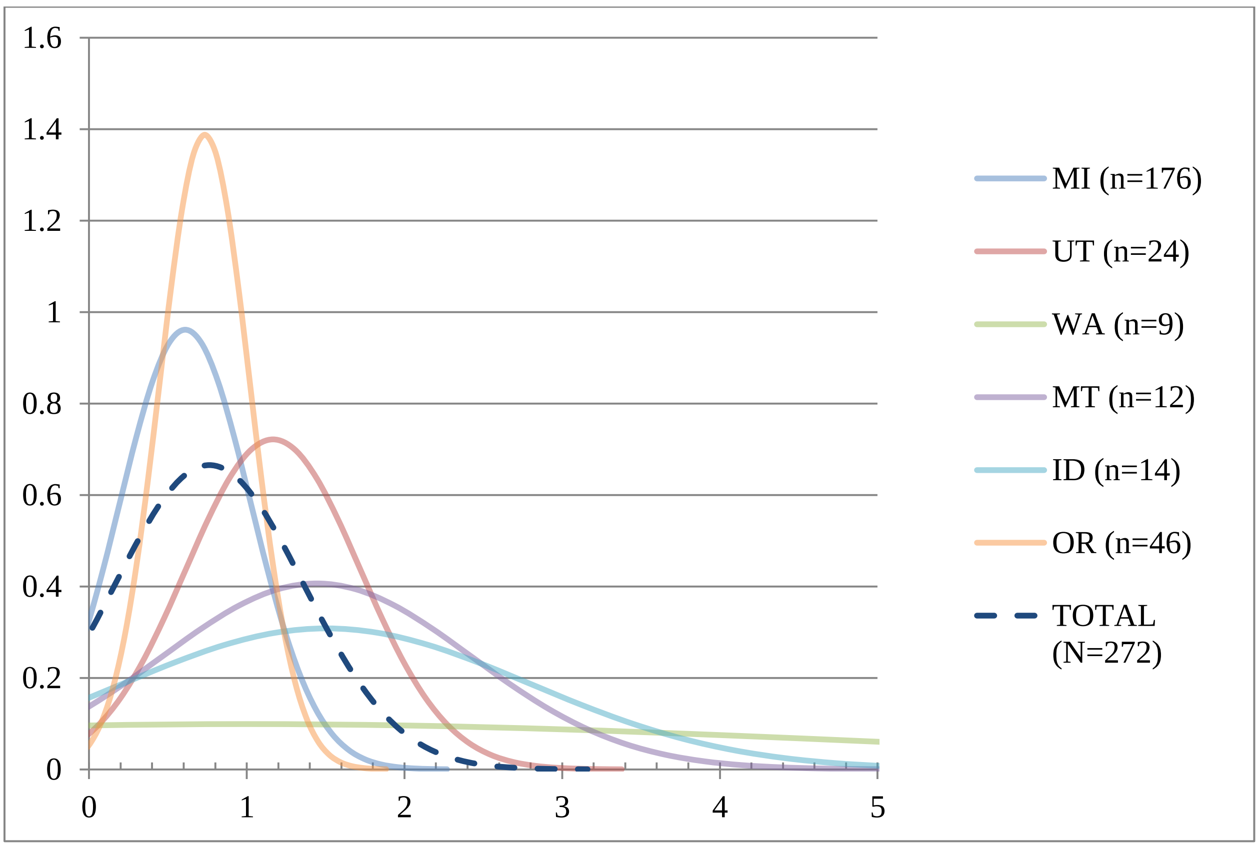
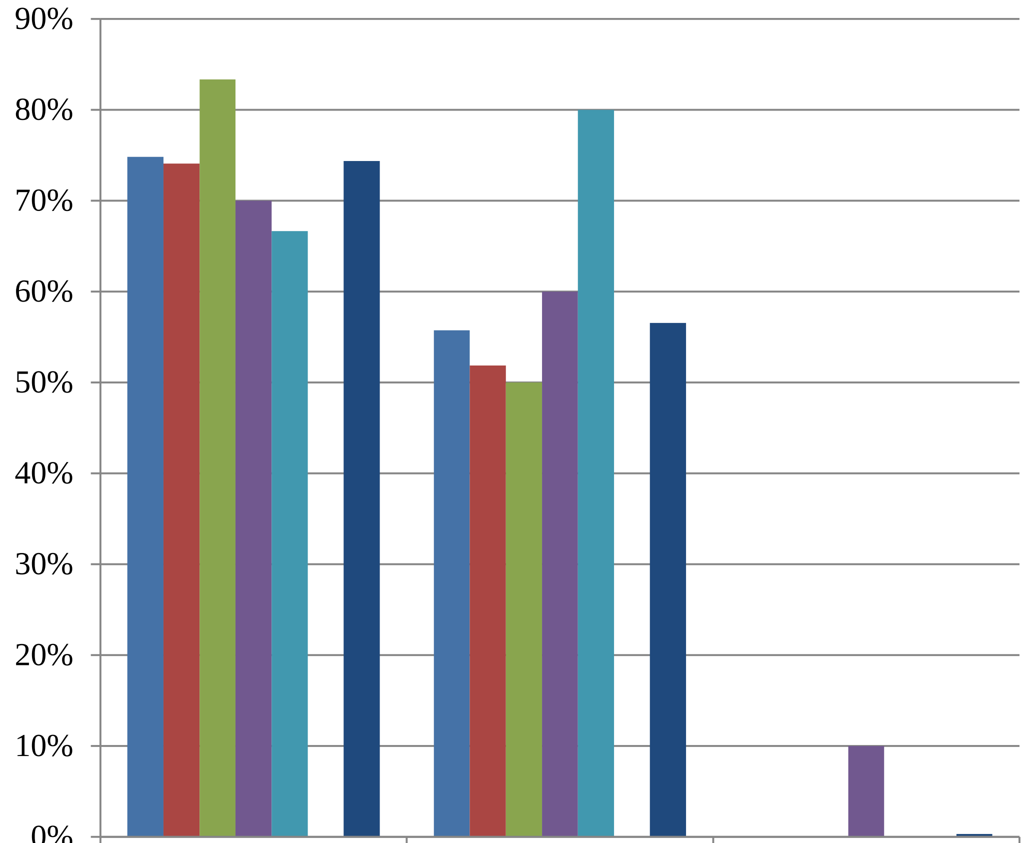


Figure 66: Time spent on commercial field inspection by state (hours)

Question: *What format does your agency use to maintain permitting data?*

a) Paper
b) Digital
c) Other (please specify)

Classification: Categorical *(check all applicable responses)*



	Paper	Digital	Other
MI (n=262)	75%	56%	0%
UT (n=27)	74%	52%	0%
WA (n=6)	83%	50%	0%
MT (n=10)	70%	60%	10%
ID (n=15)	67%	80%	0%
OR (n=0)	0%	0%	0%
TOTAL (n=320)	74%	57%	0%

Figure 67: Format used to maintain permit data by state

Question: *What limitations impede your ability to enforce the energy code? (check all that apply)*

a) Time or staff
b) Money
c) Code books
d) Education or training
e) Data provided with plans
f) Building access
g) Equipment
h) Not applicable
i) Other

(if responded other, text entry box is included for description of this condition)

Classification: Categorical (check all applicable responses—separate classification for residential and commercial buildings)

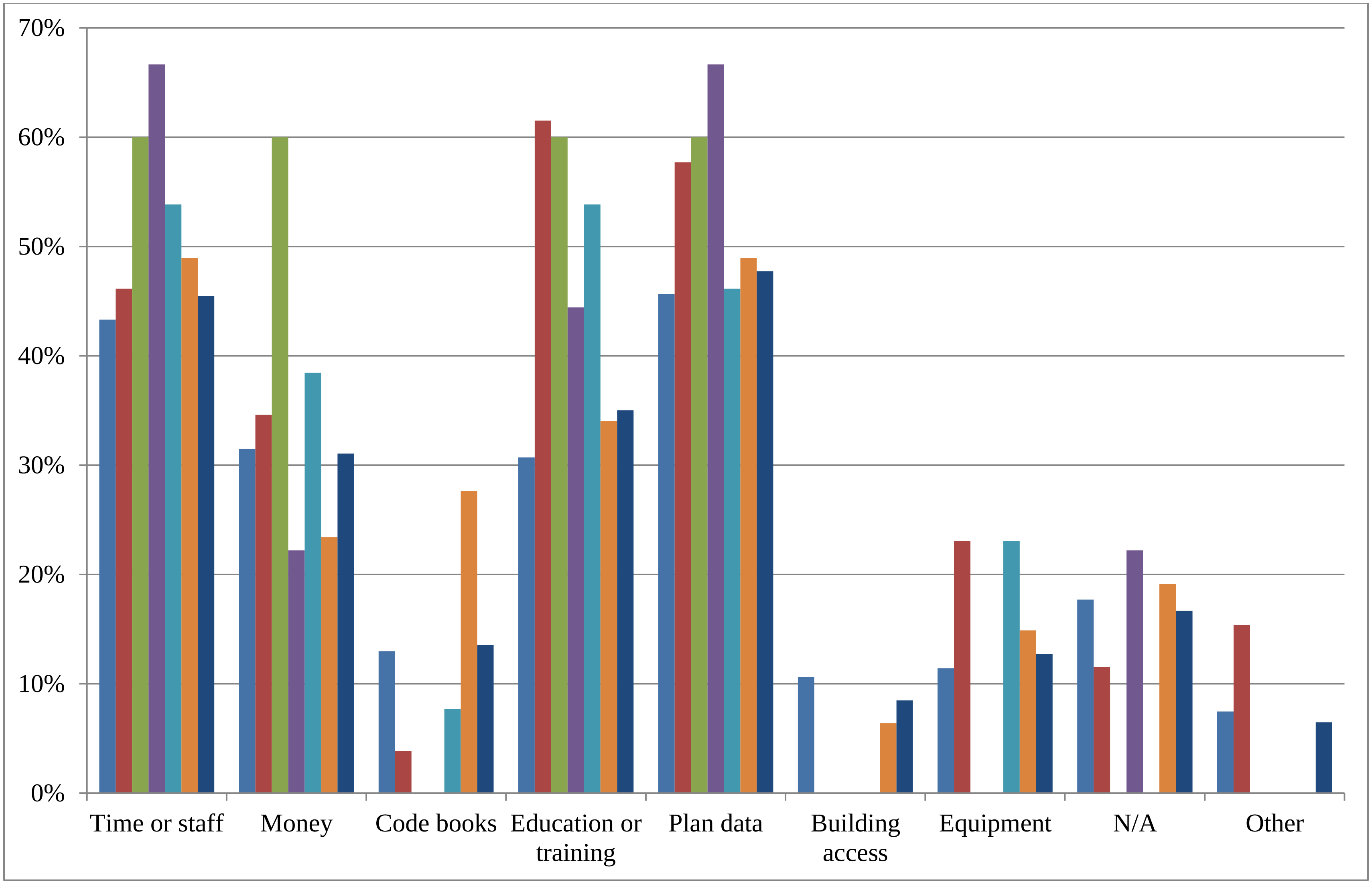


Figure 68: Limitations to residential code enforcement by state

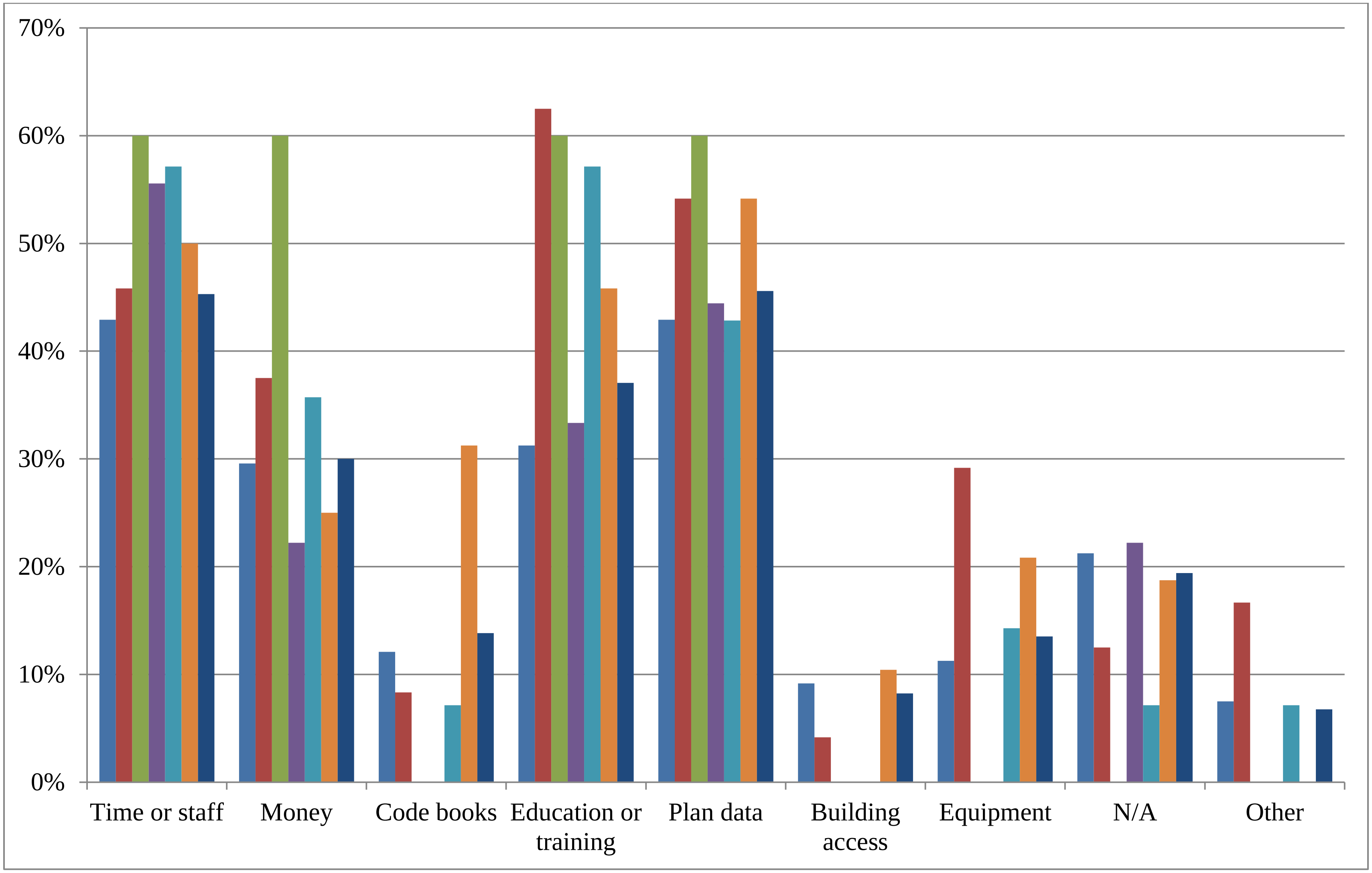


Figure 69: Limitations to commercial code enforcement by state

Question: *In your jurisdiction, in what plan review and/or inspection items do you generally find code do not comply with the* ***residential*** *building code? (Check all that apply)*

- *a) Envelope insulation levels*
- *b) Envelope insulation installation*
- *c) Envelop sealing (infiltration)*
- *d) Fenestration*
- *e) Duct insulation*
- *f) Duct sealing*
- *g) Piping insulation*
- *h) Lighting fixtures*
- *i) HVAC sizing*
- *j) Other (please specify)*

Classification: Categorical *(check all applicable responses)*

Table 55: Common residential code infractions by state

SAMPLE	MI (n=238)	UT (n=23)	WA (n=5)	MT (n=10)	ID (n=11)	OR (n=44)	TOTAL (n=331)
Envelope	33%	100%	80%	100%	55%	86%	**48%**
Mechanical	44%	83%	100%	60%	55%	73%	**52%**
Lighting	34%	13%	60%	30%	27%	41%	**33%**

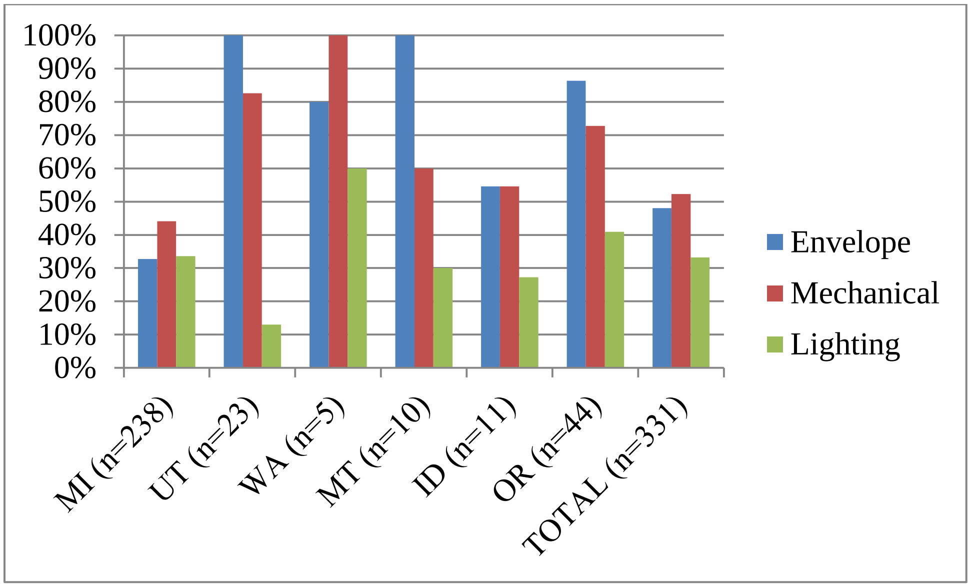


Figure 70: Common residential code infractions by state

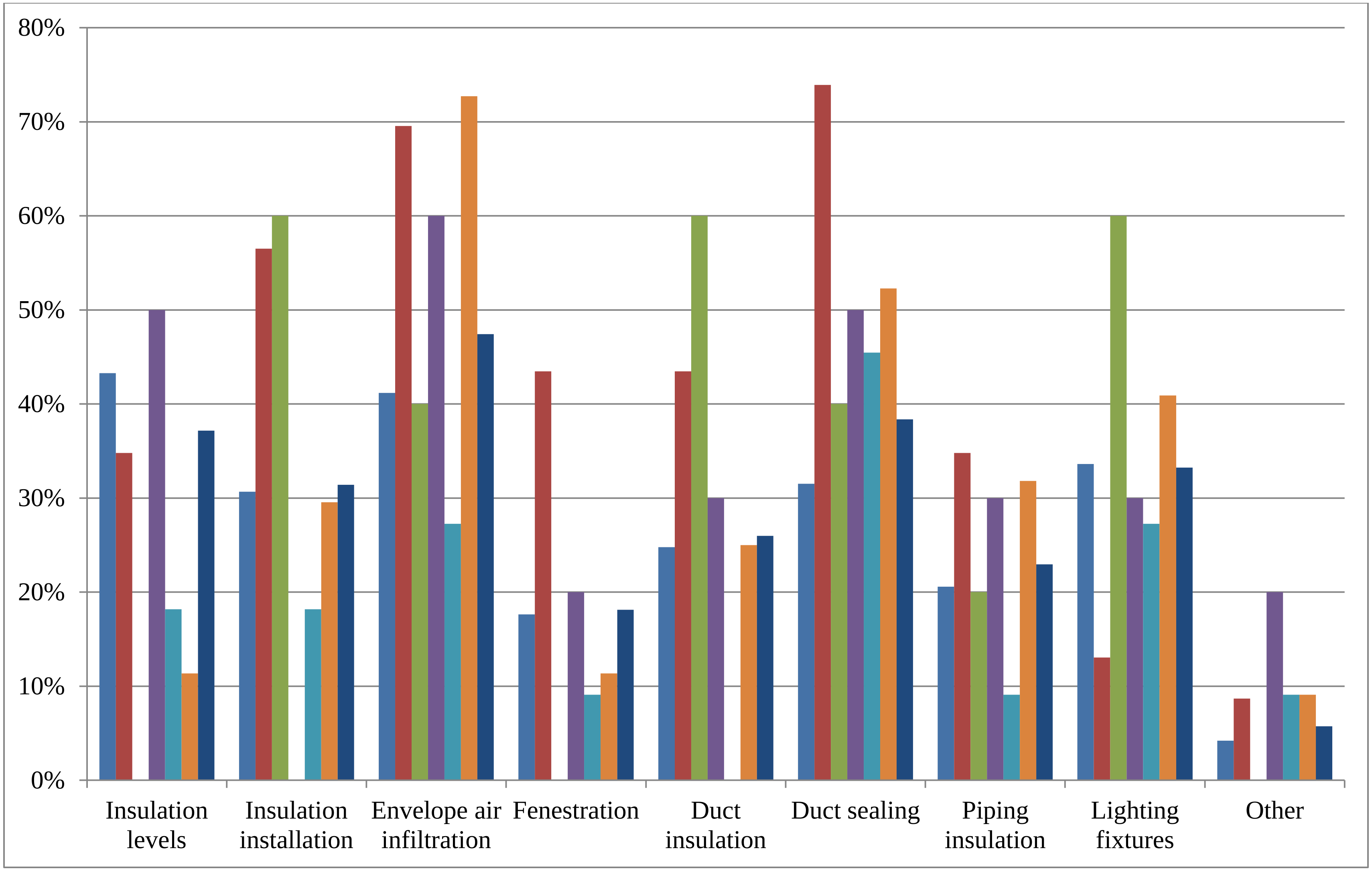


Figure 71: Common residential code infractions by state

Question: *In your jurisdiction, in what plan review and/or inspection items do you generally find code do not comply with the **commercial** building code? (Check all that apply)*

1. *Envelope insulation levels*
2. *Envelope insulation installation*
3. *Envelop sealing (infiltration)*
4. *Fenestration*
5. *Duct insulation*
6. *Duct sealing*
7. *Piping insulation*
8. *Lighting fixtures*
9. *Lighting controls*
10. *HVAC system controls*
11. *Other (please specify)*

Classification: Categorical *(check all applicable responses)*

Table 56: Common commercial code infractions by state

SAMPLE	MI (n=238)	UT (n=23)	WA (n=5)	MT (n=10)	ID (n=11)	OR (n=44)	TOTAL (n=331)
Envelope	66%	92%	60%	78%	46%	76%	**69%**
Mechanical	49%	73%	100%	56%	54%	63%	**54%**
Lighting	36%	69%	80%	22%	62%	49%	**42%**

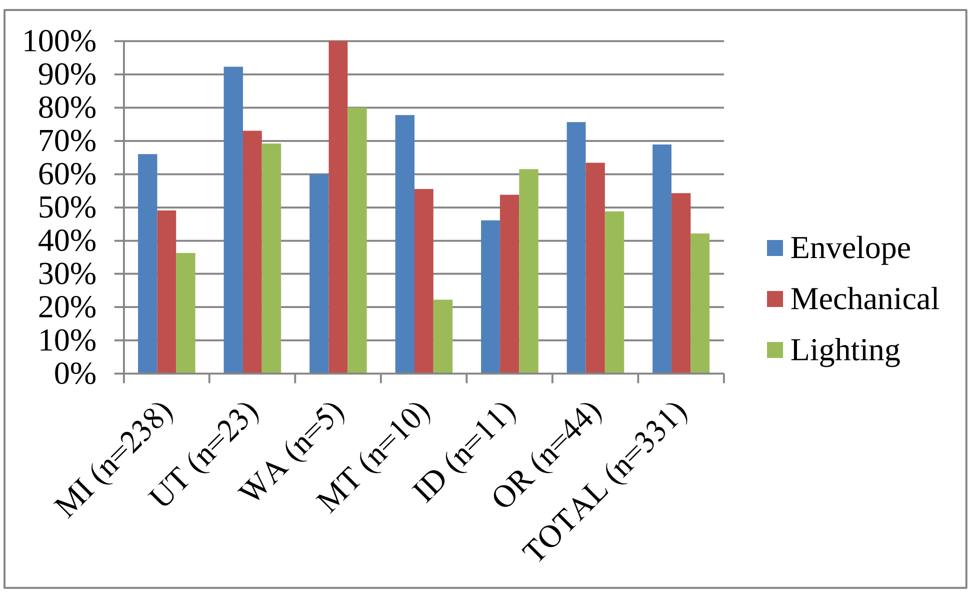


Figure 72: Common commercial code infractions by state

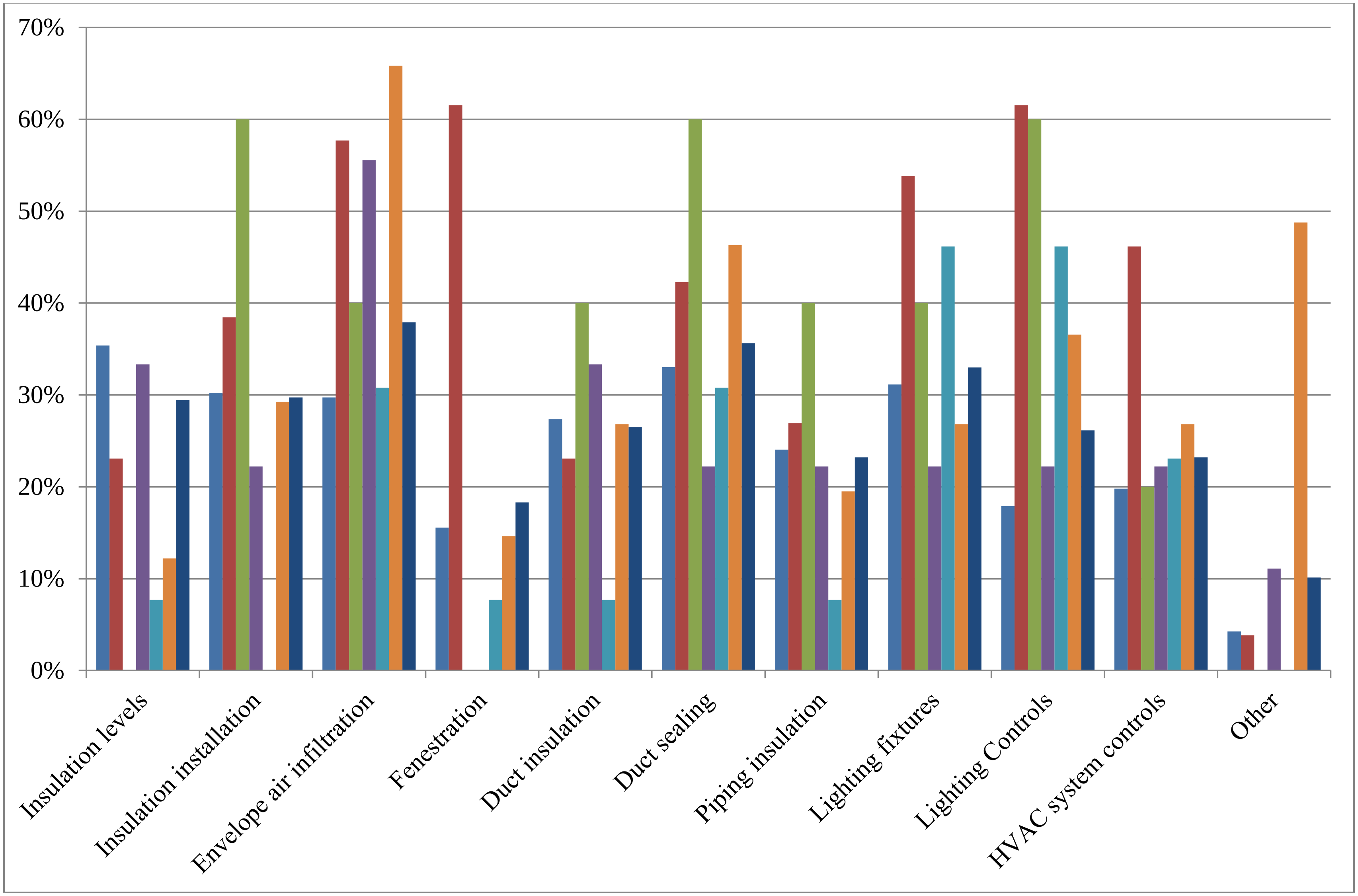
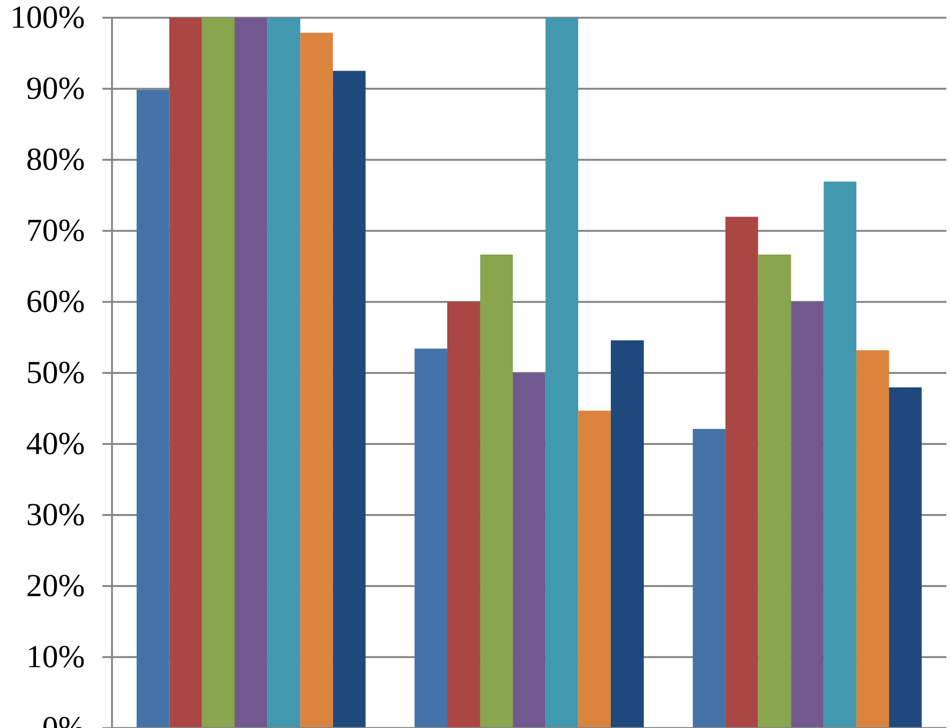


Figure 73: Common commercial code infractions by state

Question: *What information is available to your staff during field inspection?*

a) Approved plans
b) Energy code compliance checklist(s)
c) Published energy code and/or standard
d) Other (please specify)

Classification: Categorical *(check all applicable responses)*



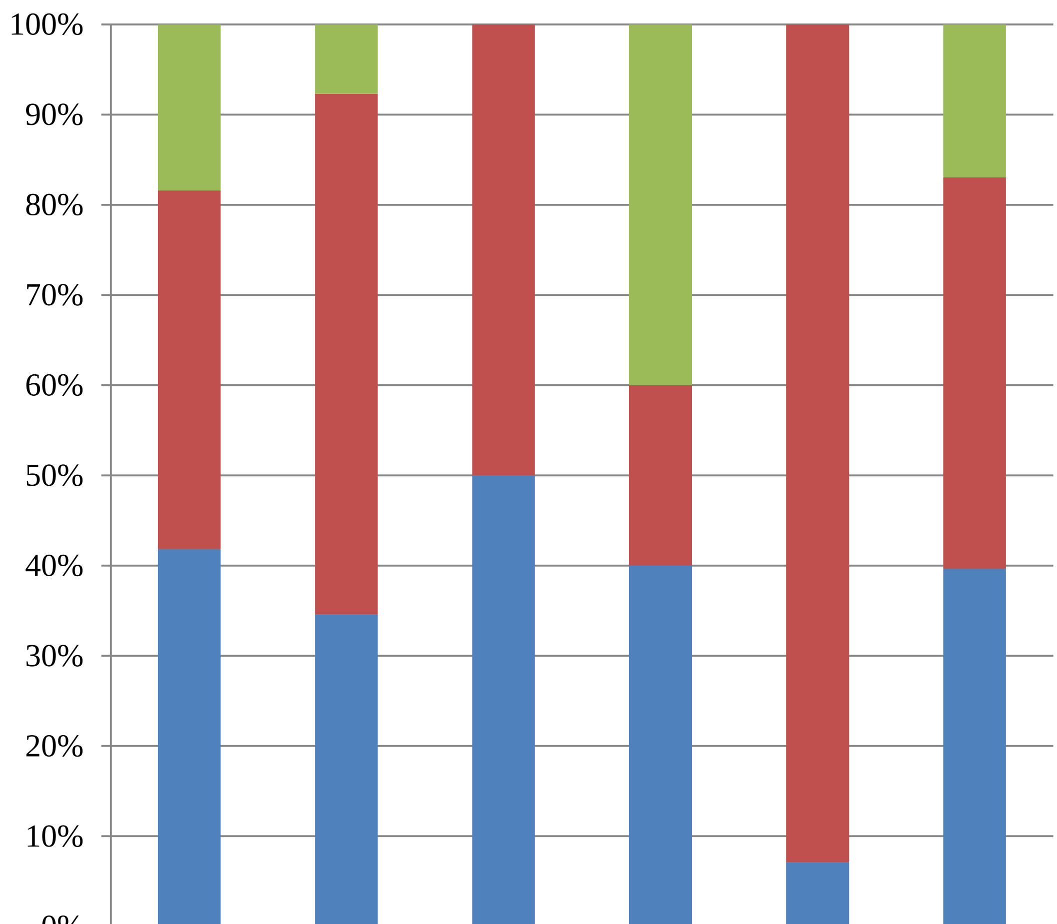
	Approved plans	Prescriptive checklist(s)	Published codes & standards
MI (n=247)	90%	53%	42%
UT (n=25)	100%	60%	72%
WA (n=6)	100%	67%	67%
MT (n=10)	100%	50%	60%
ID (n=13)	100%	100%	77%
OR (n=47)	98%	45%	53%
TOTAL (n=348)	93%	55%	48%

Figure 74: Information available during field inspections by state

Question: *Do you accept software compliance reports with permit applications in lieu of a plan review?*

- *Yes*
- *No*
- *Not applicable*

Classification: Categorical *(check all applicable responses)*



	MI (n=239)	UT (n=26)	WA (n=6)	MT (n=10)	ID (n=14)	TOTAL (n=295)
N/A	18%	8%	0%	40%	0%	17%
No	40%	58%	50%	20%	93%	43%
Yes	42%	35%	50%	40%	7%	40%

Figure 75: Acceptance of compliance software reports by state

APPENDIX C: CONTENT CODING SYSTEM

Based on existing qualitative methods for content analysis, a coding system was used to extract data from three series of case study reports. The study sought information on existing state scenarios, challenges, and recommendations offered to states as they address 90% Compliance requirements. After becoming familiar with the documents, a categorized coding system was developed to identify and extract phenomena emerging from qualitative data sources. Series of categories and sub-categories were developed based on consistent formatting schemes observed within each set of reports. These were employed until all relevant data was captured within created categories.

As more reports were analyzed, the coding system was organized, consolidated, and transformed into a database comparing coded categories across states.   This information was then displayed as a matrix, with portions extracted from the database and displayed in the Qualitative Data Analysis chapter. Eventual findings were allocated as contributing to an increased understanding of existing conditions within states and localities, challenges faced, and potential recommendations for states to consider in addressing Recovery Act compliance requirements. The following sections present the coding system employed for each report series.

NOTE: Coded data categories and sub-categories presented below represent the full list. Only those which were able to be consistently populated and were found to contribute to study findings were applied towards the final project.

Table 57: Overview of state samples by data source

PNNL 90% Compliance Pilot Study	Report Publication Date	BCAP Gap Analysis	Report Publication Date	BCAP Compliance Plan	Report Publication Date
Georgia	06/2011	*Alabama*	07/2010	*Colorado*	11/2011
*Idaho**	07/2011	*Arkansas*	12/2010	*Delaware*	11/2011
Iowa	06/2011	*Delaware*	01/2011	*Idaho*	06/2011
Massachusetts	07/2011	*Illinois*	12/2010	*Illinois*	11/2011
*Montana**	07/2011	*Kentucky*	02/2011	*Kentucky*	11/2011
*Oregon**	07/2011	*Michigan*	12/2010	*Michigan*	11/2011
Utah	06/2011	*Nebraska*	11/2011	*Nevada*	05/2011
*Washington**	07/2011	*Nevada*	11/2010	*New Hampshire*	11/2011
Wisconsin	N/A	*New Hampshire*	02/2011	*New Mexico*	11/2011
		New Mexico	01/2011	*South Carolina*	11/2011
		Ohio	02/2011	*Texas*	11/2011
		South Carolina	11/2011	*West Virginia*	11/2011
		South Dakota	12/2010		
		Texas	02/2011		
		West Virginia	02/2011		

**States included in combined Northwest Pilot Study*

C.1 90% COMPLIANCE PILOT STUDY FINAL REPORTS

- **General**:
  - State agency
  - Partner organization
  - Publication date

- **Methods**:
  - Contact letter
  - Survey
  - Interviews
  - Focus groups
  - Plan review
  - Field inspections
  - Evaluator training
  - Compliance working group
  - Other

- **Compliance Tools:**
    - Sample Generator
    - Jurisdictional Survey
    - Compliance Checklists
    - Score + Store

- **Methodology**:
    - Sample type
    - Sample size (number of buildings or surveys)
    - Code evaluated
    - Reported compliance rate
    - Inspection approach
    - Sample approach
    - Number of state climate zones covered
    - Number of total state code enforcement jurisdictions
    - Evaluator training description

- **Compliance Approach:**
    - Prescriptive
    - Trade-off
    - Performance

- **Barriers Identified:**
    - (list)
- **Accomplishments Reported:**
    - (list)

C.2 BCAP GAP ANALYSIS REPORTS

- **General**:
    - Report publish date
    - Partner organization(s)(list)

- **State Overview:**
    - Population
    - National population rank
    - Number of metropolitan population centers
    - Median household income
    - National income rank
    - Residential permit high (number)
    - Residential permit high (year)
    - Residential permit low (number)
    - Residential permit low (year)
    - Economy type (major sectors)

- **State Energy Portfolio:**
    - Energy produced (%)
    - Energy imported (%)

      By Source:
    - Petroleum (%)
    - Natural gas (%)
    - Nuclear (%)
    - (% of national)
    - Coal (%)
    - Renewables (%)
    - (% of national)
    - Renewable portfolio requirement
    - Residential electricity cost (cents per kWh)
    - Commercial electricity costs (cents per kWh)

- **Potential Savings from Code Implementation:**
    - Annual statewide energy savings by 2030 (trillion Btu)
    - Annual statewide cost savings by 2030 (based on 2006 prices)($)
    - Annual carbon emissions reduction by 2030 (million metric tons)
    - Residential additional first costs
    - Residential cost savings (annual)
    - Simple payback (years)
    - *Rolled into mortgage (30 years):*
    - Down payment increase (monthly)
    - Mortgage payment increase (monthly)
    - Utility bill savings (monthly)
    - Payback period (months)
    - EECBG funding (million $)
    - SEP funding (million $)
    - Total ARRA funds (billion $)

- **Adoption**:
    - Regulatory framework
    - Model code basis for residential code
    - Model code basis for commercial code
    - Satisfies ARRA target codes (Y/N)
    - Administering agency
    - Update cycle (years)

      Other state codes:
    - International Building Code (IBC)
    - International Mechanical Code (IMC)
    - International Code for Existing Buildings (IEBC)
    - International Residential Code (IRC)
    - International Fire Code (IFC)
    - International Plumbing Code (IPC)
    - International Fuel Gas Code (IFGC)

- NFPA National Electric Code (NEC)
  - ASME Boiler and Vessel Pressure Code
  - NFPA Life Safety Code

- **Codes for State Facilities:**
  - Benchmark reference
  - Required threshold

- **Statewide Climate Change Initiatives:**
  - Initiative name(s)

- **Green & Above-code Programs:**
  - LEED Certified Buildings (number)
  - LEED Registered Buildings (number)
  - LEED APs (number)
  - Energy Star Homes (number)
  - Energy Star Builders (number)
  - HERS Raters (number)

- **Implementation**:
  - Key organizations (list)
  - Training program (Y/N)
  - (Description)
  - Building Officials (number)
  - General inspector licensing/certification requirement (Y/N)
  - Energy code specialization (Y/N)
  - Use of third-party enforcement (Y/N)
  - Acceptance of HERS rating (Y/N)

C.3 BCAP STRATEGIC COMPLIANCE PLANS

- **General**:
  - Report publish date
  - Acknowledgements (list)
  - Special thanks to REEO (list)

- **Introduction**:
  - Energy consumption in buildings (% of state total)
  - Code regulatory framework (Home Rule or Statewide)
  - (if Home Rule, % of jurisdictions having adopted the IECC (any version))
  - (% of state population above number represents)
  - Primary actors identified (list)
  - Focus areas identified (list)

- **Critical Tasks:**
  - Critical Tasks Identified (list)

    - Stakeholder outcomes identified (list)
    - End goal identified (cite)

- **Energy Codes Coalition:**
    - *Secure funding:*
        - Funding mechanisms recommended (list)
        - Spotlight state example referenced
        - (spotlight state regulatory framework)
    - *State and local policy:*
        - Recommended adoption strategies (list)
        - Current residential code(s)
        - Parties named to carry-out strategies
    - *Outreach*:
        - Current outreach efforts (list)
        - Suggested forms of communication (list)
        - Recommended activities (list)
        - Recommended audience (list)
        - Recommended messages (list)
        - Recommended partners (list)
            - State agencies
            - State Energy Office
            - State Housing Authority
            - General Assembly
            - Local governments
            - State ICC chapter(s)
            - Regional Energy Efficiency Organization
            - State and regional USGBC chapters
            - State and regional Home Builders Associations
            - State and regional American Institute of Architects (AIA) organizations
            - Regional ASHRAE organizations
            - State and regional professional organizations
            - Third-party firms
            - Utility companies
            - Fire Marshall Office
            - Municipal associations
            - Environmental groups
            - Manufacturers
            - Private organizations
            - Consumer protection organizations
            - Real estate organizations
            - Appraisal organizations
            - Lending organizations
            - Educational Institutions
            - Cool Cities programs

            - Chamber of Commerce
            - Other
        - Suggested meeting location
        - Recommended dissemination strategies (list)
    - *Training*:
        - Recent training programs (name)
        - (Description)
        - Number of recent sessions
        - Recommended strategies (list)
        - Estimate for program ($)
    - *Compliance Evaluation:*
        - ARRA funds received
        - Current activities (list)
        - Referenced study (list)
        - State compliance evaluation goals (list)
        - Total buildings constructed 2008-10 (number)
        - Recommended structure of study:
            - Survey
            - Cost
            - Sample size
            - Evaluation approach
            - Buildings

- State contact information (list)

APPENDIX D: SUMMARY OF REVIEWER FEEDBACK

This section contains transcripts of feedback submitted by reviewers of the study deliverable. Several stakeholders were recruited on a voluntary basis, and provided commentary on the guidance for states contained in Chapter Six. This review helped to substantiate study findings, and was conducted in accordance with Michigan State University Institutional Review Board (IRB) requirements. The required IRB Approval can be viewed in Appendix E.

Commenters were provided content for review, as well as a list of guiding validation questions (see Section 3.3.1). Feedback is presented by reviewer, with an indication of the response type; hardcopy mark-up, digital mark-up (via Tracked Changes in MS Word), or responses to guiding validation questions. The identity of each reviewer is withheld to protect participant privacy. Overall, feedback was secured from six independent reviewers. Comments received were incorporated into the final thesis document as deemed appropriate by the researcher and faculty advisor. The following section provides a summary of comments and feedback received as a result of the stakeholder review.

Commenter #1: Hardcopy mark-up

- Remove discussion of stimulus when referencing Recovery Act—not included consistently throughout and generally understood within the document.
- Remove redundancy within training section—no need to reference 'training trend' when already within the education and training programs section.
- Avoid phrases like 'can be considered'—make a definitive statement.
- Use of the word 'placed' when describing state activities seems odd.
- A larger sample is suggested as a buffer. How much larger? 5%? 10%?
- Could possibly reword, clean-up and shorten parts of the Select Approach section.

Commenter #2: Validation question responses

1. *Will the presented guidance empower states to pursue 90% Compliance? (why or why not)*

   Yes. Mr. Williams provides a comprehensive guide of addressing 90% compliance. The issues are clearly identified. The recommendations are concise enough for state officials to put them into action.

2. *Does the document accurately portray barriers impeding the adoption and implementation of building energy codes? (please explain)*

   The document captures the critical barriers for implementation and includes a section on securing final support which is typically ignored in studies of this nature.

3. *Is there missing information which should be included in the guidance? (please explain)*

   no

4. *Do you have any concerns with the guidance provided?*
   no

5. *Please include any additional questions or comments you may have (feedback may be written or provided via tracked changes)*

   (no response provided)

Commenter #3: Validation question responses

1. *Will the presented guidance empower states to pursue 90% Compliance? (why or why not)*

   I think that you summarized the problems that the states are having trying to implement the 90% compliance evaluation. The section on funding was a good addition to the paper. One thing that I was looking for was a discussion on options for evaluating 90% compliance that were less expensive but would still work. You alluded to other options in one section but it might be worth a discussion on self-evaluation (first party) from a jurisdictional standpoint. I think that this is where evaluation could go just from an affordability standpoint.

2. *Does the document accurately portray barriers impeding the adoption and implementation of building energy codes? (please explain)*

   Yes. Your portrayal of the barriers were right on. Unfortunately this all comes down to funding – funding for training and support and evaluation. Even if the code is adopted it is difficult to gain any traction of you don't have the mechanisms in place in the state.

3. *Is there missing information which should be included in the guidance? (please explain)*

   Your section on training was good but the missing element in this section was a discussion on technical assistance. Effective training programs are often accompanied by follow-up technical assistance (e.g. BECP User Support) so that builders, designers, etc. can get their questions answered fairly quickly.

4. *Do you have any concerns with the guidance provided?*

   No. The guidance is consistent with the DOE BECP Guidance and is backed by information gleaned from the pilot studies.

5. *Please include any additional questions or comments you may have (feedback may be written or provided via tracked changes)*

   (no response provided)

Commenter #4: Validation question responses

1. *Will the presented guidance empower states to pursue 90% Compliance? (why or why not)*

   It certainly will inform states, but it is hard to predict how empowered they will become. There is no indication of "the force of the mandate requiring states to adopt codes and show compliance", so therefore it seems uncertain that states will treat this as a mandate and therefore respond with priority action.

2. *Does the document accurately portray barriers impeding the adoption and implementation of building energy codes? (please explain)*

   Yes, I think that the first part of the document does a nice job addressing the barriers.

3. *Is there missing information which should be included in the guidance? (please explain)*

   One of the things that could be emphasized is the need for policy makers to increase **<u>their</u>** level of awareness and concern regarding this issue. In order for the other activities to take place (additional education for stakeholders as well as allocating funding for compliance focused strategies in the states), policy makers need to make this a priority for policy action.

4. *Do you have any concerns with the guidance provided?*

   Under PDF pg. 7 (document pg. 6) in the "Secure Financial Support" section, you state *"States are encouraged to allocate support within their budgets for energy code training programs"*. My comment for #3 above directly applies to this statement. When policy makers are choosing financial priorities, I feel that energy code enhancement will not make the grade as a focused priority unless there is a dedicated effort to educate and persuade policy makers about the need for this action as well as the financial benefits to the state's economy.

   I agree with the suggestions in this paragraph from PDF pg. 7 (document pg. 6): "Several general strategies for securing funding are available to support state compliance efforts. Solutions currently exercised within states include Energy Efficiency Resource (or Portfolio) Standards, state appropriations, public trusts or benefits funds, and Systems Benefits Charges. Some states have also established relationships with utility companies or private organizations with overlapping interests in energy efficiency. Some local governments have been successful in finding revenue for general training; however most are limited in funding options to support compliance specific to the energy code." However, I see difficulties with establishing system benefit charges or other related policy driven revenue solutions without complete buy-in from policy makers ahead of time.

5. *Please include any additional questions or comments you may have (feedback may be written or provided via tracked changes)*

   Overall, I think the document is reader friendly and guides the reader through the issues while providing the web links for resources should the reader choose to investigate those resources. The document also addresses all the main issues surrounding this code establishment & compliance challenge.

   The document could use another "once-over" as I noticed there were some words and/or phrases that needed some attention (sorry I did not specifically identify these words and/or phrases, but another editing look will surely catch them).

Commenter #5: Validation question responses

1. *Will the presented guidance empower states to pursue 90% Compliance? (why or why not)*

   The guidance report provides a strong framework for how states could approach indicating 90% compliance. If a state had adequate resources, expertise, and staff time, the guidance would certainly be helpful. My sense is that the purpose was to provide an overview of the issues and approaches, and refer states to the resources for more detailed information. The ability to thoroughly indicate 90% Compliance will likely depend on a given states' resources and ability to execute the details of the approach (e.g., forming and coordinating a compliance working group, conducting a compliance evaluation, etc.).

2. *Does the document accurately portray barriers impeding the adoption and implementation of building energy codes? (please explain)*

   The document effectively identifies the main barriers (concerns about cost). Other barriers, including general political resistance to perceived regulations, lack of education about building energy codes among state and local lawmakers, and difficulty in creating uniform code implementation within a given state, could also be mentioned.

3. *Is there missing information which should be included in the guidance? (please explain)*

   One thing that could be helpful to states is some range of costs/resources needed to conduct compliance assessments or organize other phases of the process that is described. I know that some of the states that were a part of the pilot studies, or did some studies on their own, probably have this information. It's tough because it's very state-specific (and depends on how the process is organized), but I know this is a concern of states, so having some information on other states' experiences might be helpful.

   In terms of education and training programs, one thing I've definitely heard from states is that it is important to make sure to reach a broad range of audiences with those programs, beyond code officials. This would include lawmakers, city council members, architects, builders, designers, etc. This could be something to highlight in the report.

4. *Do you have any concerns with the guidance provided?*

   No.

5. *Please include any additional questions or comments you may have (feedback may be written or provided via tracked changes)*

   NA

Commenter #6: Digital tracked changes within document

- Portions of the document need additional context for reader understanding.
- Certain terminology, such as '90% Compliance' may not be clear to some readers—suggest stating as '90% Compliance requirement in Section 410 of the Recovery Act.'
- In case it's worth seeing or referencing: (redacted to protect reviewer identity)
- It might be helpful to clarify that Section 410 is not mandatory unless states accepted SEP money. As you know, all states accepted the money, but not all states are taking the requirements seriously.
- You might consider briefly explaining "adoption" below, as it may not be clear to all readers. "Adopt into law the building energy efficiency and code administration requirements of the International Energy Conservation Code" might be helpful for more of a lay-person to understand. On more recent reads of the requirements, and in talking to a few people, I believe the actual adoption of the commercial code is required, but a

plan for adoption and compliance is only required for residential buildings. I haven't re-checked any of my sources since that conversation, but just wanted to flag for you…

- While I don't think they choose to spell out their name anymore, it may be helpful to say, "Formerly known as the American Society of…."
- To be extra clear for any reader, you might choose to say "the 2009 version of the IECC (2009 IECC), so as not to launch too quickly into industry lingo.
- Explain what (Standard 90.1) is.
- A lot of my audiences don't understand when we talk about the "model codes" as codes. You might consider being a bit more deliberate in delineating the two.
- I always think it's helpful, when writing dense material, to re-introduce what you're talking about. "Further requirements of Section 410 include…" or something like that…
- I don't think (90% Compliance) needs to be capitalized.
- Not sure if it's helpful to call out that Sec. 410 appears on PDF page 32… See also clarifying statement linked above.
- Current local conditions of what? Seems like an additional explanatory clause/sentence would be helpful here.
- I think that this may also need some defining – partly because the term "compliance" can be difficult for even industry folk to understand… also because you're using it as a proper noun which, without context, will not mean much to most readers.
- Not sure if you're trying to project resource constraints/capacity challenges here, but if so, I don't think it's clear enough.
- How are you doing citations? You might find the paper I co-authored (redacted to protect reviewer identity) to be helpful. It was released at (redacted). We cite a number of energy code compliance studies… but nothing that specifically touches on where most infractions occur. (URL redacted)
- It's not 100% clear what the blame is for…. i.e. "building system that fails to comply with the energy code…"
- If you choose to talk about them again, add (PNNL).
- Does the methodology "discuss" these things? Maybe it addresses them?
- Most people don't know what these are. The next sentence does not clearly modify this. I would recommend explaining what these are…. Probably by replacing this specific reference in the first sentence with more of an explanation, then clearly name it in the second.
- "Found to be successful" - once again, what's the citation?
- (Recovery Act 90% Compliance requirements) could be clearer.
- Feels like something's missing… maybe "to support"…?
- Do you want to spend any real estate mentioning "compliance with what?" I think this way because it's easy for folks to just skim to a graphic or a different section of a paper and it's typically a good rule of thumb not to assume that your audience knows too much… !
- Since we're now a page or two away from it, I would recommend restating what it is… i.e. "the federal model for demonstrating compliance with Section 410 of ARRA…"
- In the last sentence you said model. Not sure if this is intentional.
- Might consider avoiding the passive voice. i.e. "In research presented by the National Labs in 2011, PNNL found…" (I made that up, btw.)

- ‘Value’ of energy codes—and their proper use/enforcement, no?
- How are states encouraged… through Section 410 of ARRA?
- ‘Remaining stimulus funding input to revolving loan programs are suggested…’ Not sure I understand.
- ‘Importance of energy code training programs…’ Would be good to substantiate.
- ‘Third most prominent limitation…’ Behind which and which?
- ‘Some states have initiated…’ Notably X and Y.
- Remove weak statements that take a passive position.
- ‘A first step for states…’ Feels funny to say “a first step” this far in the paper… but I get it. Just an observation.
- ‘*Home Rule…*’ Is there a reason to italicize?
- ‘…beyond simply energy codes alone.’ Simply and alone are redundant. I would remove one or the other.
- In other sections you pointed to AIA, despite it being a code administrator, but instead because they are a network of interested stakeholders. (organization redacted to protect reviewer identity) manages a (title redacted) campaign… not sure if it’s helpful. Alternatively, you can find any (redacted) chapter here: (URL redacted) Also might be useful/interesting to list other energy code advocates here…?

- What does it mean to place an activity?
- ‘Response data indicates nearly half of code officials serve smaller jurisdictions of less than ten thousand people’ Interesting!
- ‘…were also found…’ Consider active voice, i.e. the study found that a portion of pilot study states conducted…
- ‘…to develop a building sample.’ Seems to me like it should be clear to the reader what exactly the sample is for…
- ‘The Sample Generator…’ PNNL Sample Generator.
- ‘…use of third-party evaluators…’ To evaluate the sample data set, to evaluate the buildings, ?. Should be clear in this first sentence.
- Not clear why (Compliance Checklists) is capitalized?
- ‘…however, not in all states on a widespread basis.’ Awkward.
- ‘…to follow in conducting the actual building evaluations…’ Consider rephrasing for simpler construction.
- Colon or double dash instead?
- ‘…installing successful practices…’ Word choice?
- As a general comment, it’s not always obvious to me why resources are listed underneath each of the sections. You might consider a quick, half sentence about what each one is and/or why it matters in the context that you’ve provided.
- Since this is the last section, this is one of the sections more likely to be read, even if the rest of the document was mostly skimmed. To prepare for that, consider making the language very clear, not assuming that your audience actually read a lot of the paper…
- ‘…reporting evaluation data…’ …on energy code compliance rates.
- ‘…demonstrate 90% Compliance’ The 90% Compliance requirement in Section 410 of ARRA.

APPENDIX E: IRB APPROVAL

The design of the thesis project was submitted for review by the Michigan State University Institutional Review Board (IRB) to ensure protection for any human subjects involved with or impacted by the research project. Primary data sources referenced in the thesis project were collected during separate, independent and pre-existing research efforts. For this reason, the majority of the methodology was classified as non-human subjects research. In order to validate study findings, the final set of recommendations was submitted to industry professionals for review and comment. Reviewer feedback was collected and incorporated into the final thesis document in attempt to further substantiate guidance intended for states. The addition of reviewers can be classified as interaction with human research subjects.

The application for MSU IRB *Exempt* project approval was submitted by Professor Tim Mrozowski (Principal Investigator) and Jeremiah Williams (Graduate Research Assistant and Master's Candidate). Approval for the project was granted by the IRB under Exempt status. Information allowing for reference of the MSU IRB approval is:

- *Application*: IRB# x12-618e Category: Exempt 2
- *Approval Date*: July 30, 2012
- *Title*: Jeremiah Williams Thesis Project: Energy Code Compliance

The following figures represent the MSU IRB Approval Letter and Consent Form sent to reviewers contributing to the validation of project recommendations.

Michigan State University
School of Planning, Design and Construction
Construction Management Program

PARTICIPANT CONSENT FORM
Energy Code Professionals

ENERGY CODES AND THE RECOVERY ACT:
GUIDANCE FOR STATES ADDRESSING 90% COMPLIANCE REQUIREMENTS

Principal Investigator: Tim Mrozowski
Secondary Investigator: Jeremiah Williams

Reviewer Comments

The School of Planning, Design and Construction at Michigan State University is conducting research to evaluate the impact of energy code compliance requirements in relation to the Recovery Act of 2009. The Recovery Act establishes several requirements for the adoption and implementation of building energy codes, and calls for states to demonstrate a 90% compliance rate with specific codes. This research aims to improve understanding of those requirements, and provides recommendations for states to consider as they address compliance requirements.

As a participant in this research, you are being asked to answer questions related to your experience with building energy codes and compliance issues. You must be at least 18 years old to participate in this research. Your participation in this research project is completely voluntary. You have the right to say no. If you are uncomfortable, you may change your mind at any time and withdraw from the questionnaire. You may choose not to answer specific questions, or to stop participating at any time. Whether you choose to participate or not will result in no negative effect. Your privacy will be protected to the maximum extent allowable by law. Your name and title will not be used in any publication. The estimated time to complete this questionnaire is approximately 20-30 minutes. As a participant, you may request a copy of this consent letter for your records.

This research project is not funded. The research is conducted by Michigan State University and the data collected will be used for a graduate Master's thesis.

If you have concerns or questions about this study, such as scientific issues, how to do any part of it, or to report an injury, please contact:

Tim Mrozowski*, A.I.A., LEED® AP*
Professor of Construction Management, School of Planning, Design and Construction, Michigan State University, 102B H.E. Bldg., East Lansing, MI 48824, USA, Email: mrozowsk@egr.msu.edu, Phone number : +1 517.353.0781.

Participant Consent Form (continued):

Jeremiah Williams
Graduate Student, Construction Management Program
School of Planning, Design and Construction, Michigan State University, 520 John Carlyle St. #320, Alexandria, VA 22314, USA. Email:remylee@msu.edu, Phone number: +1 231.468.9441

If you have any questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this research study, you may contact, anonymously if you wish, the ***Michigan State University Human Research Protection Program*** *at 517-355-2180, FAX 517-432-4503, or e-mail irb@msu.edu, or mail at: 207 Olds Hall, MSU, East Lansing, MI 48824.*

You indicate your voluntary agreement to participate by submitting your responses. Responses may be submitted to the email contact information presented above.

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REFERENCES

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