Building Energy Code Advancement through Utility Support and Engagement

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Abstract

Several developments came together in the last few years that make a strong case for the involvement of utilities in advancing adoption, implementation, and compliance verification of building energy codes. First, every state that received funding from the American Recovery and Reinvestment Act (ARRA) of 2009 committed to adopting national model codes[1] along with agreeing to implement a plan to reach at least 90% compliance by 2017. Second, many states have established Energy Efficiency Resource Standards (EERS), which provide a clear and tangible energy efficiency target to utilities and other stakeholders. And third, recent advances in building energy codes have made the latest versions much more efficient than even the ones that came out six to eight years ago. Hence the potential for energy savings from increasing compliance to building energy codes is tremendous.

We highlight one recent energy code compliance study in New York for residential and commercial properties (Harper et al. 2012) that quantifies the potential. Given assumptions of the annual construction volumes and useful life of buildings, the researchers estimated lost energy code savings at $300 million in the residential sector and $960 million in the commercial sector, for a total of $1.3 billion in cumulative lost savings over a 5-year construction cycle. Clearly, lost benefits of this magnitude are a legitimate public policy concern.

At the same time, there are several barriers and regulatory challenges that have to be overcome in order to mainstream building energy codes into utility programs. Chief amongst these is the question of quantification of a) compliance to the provisions of the energy codes and b) measurement of savings from this compliance. In this report, we discuss a way around some of the barriers and devote considerable thought to possible solutions for Evaluation, Measurement, and Verification (EM&V) of savings from energy code compliance. We also summarize related activity across different states. Based on best practices in the leading states, we identify appropriate activities for utilities in the energy code cycle and conclude by suggesting pilot program concepts for utilities that are interested in pursuing these further.

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[1] Model codes referred to here are 2009 IECC for residential buildings and Standard 90.1–2007 for commercial buildings as specified in ARRA requirements. Some states adopted these codes without any amendments and some chose to customize them.

Introduction and Background

Building energy codes determine the minimum efficiency level for the design and construction of new buildings and significant additions and renovations to existing buildings. The earliest impetus for building energy codes can be traced back to the emphasis on energy security emerging from the oil embargo of the 1970s. Gradually, by the 1990s, most states or local governments had some version of a building energy codes in place. In the last decade, building energy codes have gained prominence as a market transformation mechanism for making buildings more energy efficient.

The building energy codes discussed in this report are largely national model energy codes published by private nonprofit organizations.[2] These codes are to some extent regulated and managed by the U.S. Department of Energy under federal statutory authority. They are usually adopted by governmental jurisdictions such as states, counties, and cities. Building codes are usually enforced at the local level by building inspectors and code officials, and provide the mandatory minimum requirements for energy efficiency in buildings. These model energy codes are:

- ASHRAE Standard 90.1, *Energy Standard for Buildings Except Low-Rise Residential Buildings*, published by the American Society of Heating, Refrigerating and Air-Conditioning Engineers in Atlanta, Georgia. Standard 90.1 is the national energy efficiency standard for commercial buildings and high-rise residential buildings. It was first published in 1975. While this document is technically a "standard," it is adopted by states and localities and functions as an energy code.
- International Energy Conservation Code (IECC) published by the International Code Council (ICC) in Country Club Hills, Illinois. It was first published in 1998 and is the successor to the Model Energy Code (MEC) published by the Council of American Building Officials. This widely used energy codes is the national energy code for single-family residential buildings and low-rise multifamily buildings.

Both ASHRAE Standard 90.1 and the IECC are recognized under federal law as the minimum requirements for energy efficiency for buildings under their respective scopes.[3] We also refer to these as "basic[4]" energy codes in contrast to advanced energy codes or requirements of "beyond-code" programs. The focus of this report is examining how utility energy efficiency programs can incorporate support for basic energy codes and energy code compliance into their program portfolios.

Electric and gas utilities, whether investor-owned, public power, or cooperatives, have been pursuing energy efficiency strategies for the past 30 years through a variety of incentive programs. Many of the

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[2] A brief history of building energy codes in the U.S. is available from the Building Codes Assistance Project. See http://energycodesocean.org/sites/default/files/resources/The%20History%20of%20Energy%20Codes%20in%20the%20United%20States.pdf.

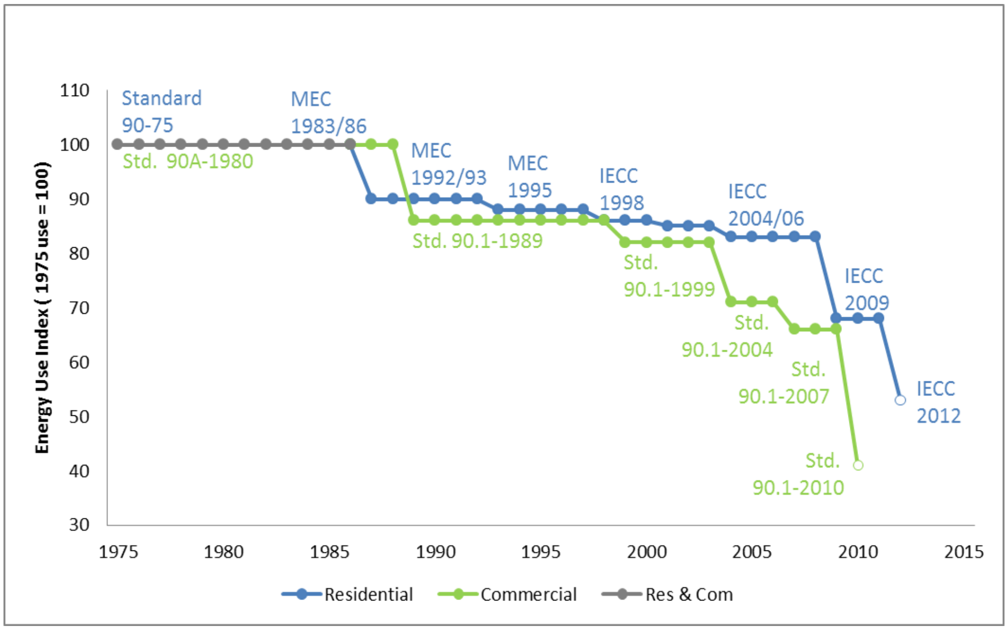
[3] A discussion of the federal legislative history and statutory requirements pertaining to U.S. model energy codes is provided at the DOE Building Energy Codes Program website. See http://www.energycodes.gov/about/statutory-requirements.

[4] We make a distinction between 'basic' codes that are the mandatory minimum building energy codes required by law of the jurisdiction and 'beyond code' initiatives or 'stretch' codes that are more efficient or advanced than basic but compliance to these is only voluntary.

incentive programs have been targeted to advance energy-efficient new construction design and construction. However, utility efficiency programs have generally not focused on providing explicit support for basic or minimum building energy codes. In recent years this situation has changed as energy efficiency Program Administrators (PAs) seek additional energy savings opportunities, often to meet mandated energy reduction targets set by state regulators. The American Recovery and Reinvestment Act (ARRA) of 2009 required states to commit to adopting national model codes as a condition for receiving federal funds, along with agreeing to implement a plan to reach at least 90% compliance by 2017. In order to receive $3 billion in supplemental State Energy Program stimulus funding, all 50 states and the District of Columbia pledged in Governors' letters of assurance to the Department of Energy not only to meet code stringency requirements but also to create plans to achieve and measure the ARRA code compliance level within eight years (Misuriello et al. 2010).

While ARRA funding has provided the stimulus, significant efficiency advances in energy codes in the corresponding period presents an unmatched opportunity for energy savings. As shown in Figure 1, a building complying with ASHRAE standard 90.1-2010 (90.1-10) is expected to be 30% more efficient than one complying with the 90.1-2004 standard. Similarly, the 2012 International Energy Conservation Code (2012 IECC) for residential buildings also offers a 30% efficiency improvement compared to 2006 IECC. With these high efficiency energy codes, the potential for savings is comparable to traditional utility-sponsored incentive programs like lighting and equipment upgrades, which is one of the reasons why utilities are getting increasingly interested in promoting energy codes.

Figure 1. Efficiency Advancement in Residential and Commercial Codes[5] in Recent Years Presents a Significant Opportunity for Savings



Source: ACEEE

As can be seen from the figure, significant reductions in energy use through building energy codes are fairly recent, with the graphs showing the steepest decline within the last eight years. While the technical literature on historical building energy code saving impacts is sparse, one study in 2004 found that energy codes in place in the year 2000 were responsible for reducing about 0.54 quads[6] of annual U.S. primary energy consumption (Nadel 2004). Improved residential and commercial building codes increase energy savings potential even more. The Energy Efficient Codes Coalition estimates (ASE 2011) that in 2030, savings from national implementation of the 2012 IECC or equivalent in residential and commercial buildings will total:[7]

- More than 3.5 quadrillion Btu of source energy saved annually—about 9% of current building sector energy use
- At least $40 billion (real 2008 dollars) saved in energy costs to consumers and businesses
- About 200 million metric tons of carbon dioxide emissions avoided annually by 2030

With potential impacts of this magnitude, energy efficiency PAs have placed renewed emphasis on understanding and supporting energy code development, adoption, and enforcement processes. The building energy efficiency community has also identified improving energy code compliance as a high

[5] Although there is a clear distinction between residential and commercial building energy codes, for the purpose of this study we refer to both as building energy codes since the intent is to focus on compliance and not specific technical details of the codes per se. MEC in the figure refers to Model Energy Codes, an early precursor of the current versions.

[6] 1 Quadrillion British Thermal Unit (or quad) equals 1.055 exajoules (EJ) of energy.

[7] See http://www.thirtypercentsolution.org/modules/news/article.php?storyid=35

priority in order to fully capture potential energy, economic, and environmental benefits associated with the more current editions of these codes. At the same time, policy-makers are examining how utility-sponsored efficiency programs could contribute appropriately and effectively to meeting these basic energy codes objectives. Early efforts by utilities have targeted voluntary or beyond code initiatives. However given the fact that even the minimum mandatory codes do not have high compliance levels, there is a need to broaden utility efforts to include these in the program portfolio. One clear advantage in driving basic energy codes is that they capture a far bigger percentage of the construction market than beyond code programs that are applicable to only select projects. New methods and programs for evaluating code compliance are providing greater insight into the extent of non-compliance and the most common deficiencies in new construction practice. This report offers a number of observations and recommendations on how utilities can most successfully pursue savings opportunities through advancement of adoption, implementation, and compliance verification of building energy codes.

Benefits of Building Codes for Utilities and Energy Efficiency Portfolios

Energy code compliance is important to efficiency program administrators for a number of reasons. The basic energy code is generally assumed to be complied with in new construction and is expected to deliver a certain level of energy saving. This assumption is often used in beyond code program savings estimates and sometimes in resource planning. However, actual compliance rates with even basic codes are often unknown, and the few baseline measurements point to low compliance in most jurisdictions, substantially below 100%.[8] It is widely believed that new construction is underperforming with respect to minimum energy code requirements. While this has implications for understanding true baseline conditions, it also provides a good opportunity for utilities to lend their expertise for an attractive return on investment.

There is a good argument to be made that efforts to increase energy code compliance will yield valid energy savings for which credit should be given. Falling short on insulation, window, and air leakage reduction code requirements is costly or impractical to correct as the building nears completion and even harder after the building is constructed. Thus for non-compliant buildings, expected energy savings can potentially be lost for the entire life of the building. The key is for utilities to help capture a portion of these savings by improving implementation and compliance. This not only has a positive impact on energy, economy, and the environment but also provides a financial incentive for the utility.

The primary benefits to utilities and energy efficiency program administrators for supporting building energy codes include the following:

- Building energy code support programs should enjoy high participation rates. Energy codes are intended to be mandatory and universally applied to buildings within their scope—this

[8] For instance, see Figure 3 and the accompanying discussion in the Evaluation, Measurement, and Verification section of this report.

provides an advantage over traditional incentive programs for energy-efficient new construction that are voluntary in nature and may often have small rates of participation. Thus the potential for energy savings towards achieving regulatory goals is high.

- Potential energy savings from newer versions of energy codes are substantial, as shown earlier in Figure 1. Recent energy efficiency advances in the 2009 and 2012 IECC as well as with the ASHRAE Standards 90.1-2007 and 90.1-2010 now require an approximate 30% increase in building energy performance over the baseline years of 2004 and 2006. Program administrators have an opportunity to assist the local building community with achieving this higher energy performance by improving energy code compliance levels.
- Utilities can also better understand whether their load forecasts and/or conservation forecasts are at risk for any shortfall in code compliance. Some limited energy code compliance evaluation case studies, discussed in a later chapter on Evaluation, Measurement, and Verification (EM&V), suggest that the savings shortfall can be substantial, perhaps 5%-8% in residential and commercial buildings. If not corrected, this shortfall will accumulate over time as new construction from today accounts for a larger share of the building stock. A baseline study of building energy code compliance can determine if compliance shortfall could be a system planning concern.

OBSTACLES AND BARRIERS

Implementation of utility programs for basic building energy codes is subject to approval from regulators and support from policy-makers and other diverse stakeholders. The primary efficiency program approval may come from utility regulators who may be carrying out policies set by a state legislature. Interviews with individuals involved in state regulatory proceedings on this topic have identified a number of persistent criticisms and concerns related to utility program support for energy codes.

Free Riders

A primary objection is that code compliance is not a legitimate activity for utility program administrators. This is because the developer is required by law (state or local) to meet the minimum requirements to obtain a permit to construct and, subsequent to validation that the construction is per the approved plans and specifications, to get an occupancy permit. Since this requirement has to be met anyway, why should ratepayer funds be used to assist a private effort?

"Code Police"

Utilities are very concerned about customer service and customer relations. They do not want to be in the position of requiring energy code compliance or holding up issuance of occupancy permits: that is the responsibility of local government.

Skepticism over Reliable Energy Savings

Some regulators have questioned the reliability of claimed energy savings from energy codes, which are sometimes viewed as "soft" since there are not too many studies that have rigorously measured actual savings from compliance. In contrast, energy savings from programs like lighting replacement are well documented.

Impact of Codes on Achieving Energy Savings Targets

A higher mandatory code for new construction can reduce or eliminate the energy savings available to program administrators from their traditional efficiency programs, which measure savings against the energy code baseline. For example, when codes are upgraded utilities will often lose savings from components that are more efficient in the current version such as more efficient windows or higher insulation levels. This may serve as a disincentive for program administrators to support the development or adoption of more stringent energy codes unless they are assured of getting credit for the savings.

POLICY JUSTIFICATION

From a utility regulator's perspective, there are two critical concerns that must be addressed before a utility can receive energy savings credit for building energy code-related activities. The first is a conceptual/legal question: does the regulatory commission feel that building energy codes are a legitimate area of activity for utilities? Moreover, is it a legitimate area of regulatory authority for utility commission involvement? Traditionally, in most states, building energy codes are handled under an entirely separate legislative and/or regulatory framework. These are not simple questions to answer, and the presence of these obstacles helps account for why the movement toward granting utilities energy savings credit for building energy code-related efforts is a still evolving.

Assuming that threshold hurdle is successfully passed, then the second critical concern is: how can the commission "measure" the energy savings impact of any improvement in building energy codes (e.g., in the code itself, in compliance verification means, etc.), and how much of any such improvement can be attributed to the utility company's activities?

There are two fundamental components to the task regulators face in crediting utilities for energy savings from their building code-related efforts:

1. *Measurement*. Quantifying the amount of energy savings resulting from the building energy code "improvement" (e.g., a stronger code, better compliance, etc.).

2. *Attribution*. Determining how much of that improvement to "attribute" to a particular utility's efforts.

As is often the case in the world of Evaluation, Measurement and Verification (EM&V), the technical challenges underlying those simple concepts are substantial. To begin, measurement (estimation)[9] of the energy savings from an improvement in a building energy code (and/or in code deployment) is

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[9] As is typical in the evaluation of energy efficiency programs, one must compare "what happened" with the energy efficiency program in place to a counterfactual case: "what would have happened" in the absence of the program—which cannot be directly measured, and can never be known with certainty. Hence evaluators tend to refer to evaluation as "estimating" rather than "measuring" program savings.

not simply a matter of calculating the difference in energy consumption from a building constructed under the old code vs. a building constructed to a new code. One must also take into account factors such as noncompliance that affect actual as-built conditions in the market.[10] The ultimate objective of this phase is to derive an estimate of savings compared to what would have happened in the absence of the new code.

Once one arrives at a technical estimate of the net energy savings, the next step is the challenge of attributing some portion of the overall energy savings to the utility or responsible party.[11] Conventional wisdom in the industry has tended to recognize that this attribution function is inherently subjective, and leading efforts have focused on utilizing methods such as employing industry experts to review collected documentation to make those allocations (Elnecave 2012). In some cases (e.g., in Arizona and proposed in Massachusetts), states have simply negotiated a round number attribution to avoid the cost and time that might surround a more rigorous attempt to estimate attribution.

Much effort is being devoted to developing and educating regulators about improved and defensible methods for measuring and attributing savings from building codes-related efforts. NEEP's Evaluation, Measurement and Verification (EM&V) Forum,[12] a multi-state collaborative, this year launched a project to develop state-level estimates of savings potential from codes and standards, as well as guidance and recommendations on attributing savings to such program involvement. The study report is expected to be published in early 2013.

Conceptual Concerns about "Free-Ridership." Rather than a "measurement" problem, the heart of this issue is more of a philosophical concern, not altogether irrational, that utilities are trying to claim savings for building energy code improvements that would happen anyway without their involvement. After all, energy code compliance is secured pursuant to laws and regulations that must be satisfied, and there are other organizations and agencies that are statutorily responsible for ensuring their adoption and compliance. Wouldn't they be doing this work anyway? Why should utilities be able to "ride along" and claim savings for themselves?

Response to the "Free-Ridership" Issue. The strategy for responding to this concern is a two-step process. First, it is necessary to demonstrate that the process associated with building energy code adoption, implementation, and compliance verification is not, in fact, capturing all of the theoretical savings, and that there are opportunities to cost-effectively capture what is being lost due to non-compliance. Second, there is a need to identify a well-defined role for utilities to provide services to advance code deployment that other entities would not be providing or could not provide as well. For the first step, there is substantial available evidence that compliance rates with building energy codes

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[10] One of the virtually universal observations in the building energy code field is that there is always some percentage of buildings that fail to meet the code. Thus it is necessary to adjust the theoretical potential savings from moving from one code to another.

[11] Presumably other entities were involved in improving the building energy code and/or implementation process, so it would be unrealistic to credit the utility with ALL of the savings.

[12] For details, see http://neep.org/uploads/EMV%20Forum/EMV%20Forum%202012%20Project%20Descriptions%20for%20Web.pdf.

routinely fall below 100% (Misuriello 2010). In addition, advocates have noted the often lengthy period of delay between the time of new model codes publication and the ultimate adoption and implementation by states, and that efforts to encourage and enable early adoption could achieve substantial additional savings that would otherwise be lost. This appears to provide considerable room for improving actual savings associated with building energy codes that would not be "free-ridership." To make a more convincing case with the regulators, a state can conduct its own code compliance study.

Lack of Well-Established Methods for Evaluation of Utility Code Interventions. The inclusion of building energy code interventions in utility energy efficiency program portfolios is a relatively new concept, and methods for evaluating and estimating energy savings from these efforts remains a "work in progress." This lack of a well-established and accepted evaluation and measurement framework contributes to the hesitancy of regulators to sanction ratepayer-funded interventions in the building energy code area.

Timing Issues. Another practical obstacle to the inclusion of building energy code intervention as an approved utility energy efficiency program is the issue of timing. Planning and regulatory oversight of utility energy efficiency program portfolios tends to follow short-term, one- to three-year cycles, with energy savings being calculated and filed on an annual basis. A building energy codes initiative may require a longer-term commitment to come to fruition. The end result may be large lifetime benefits but, in the interim, there may be years of activity and expenditures with no measurable energy savings effects. This presents a challenge to the regulatory system that can be an additional impediment to including building energy code-related initiatives in the utility energy efficiency program portfolio.

Response to Timing Issues. The issue of multi-year timeframes needed for certain types of energy efficiency programs has received increasing attention within the industry. In particular, it has been noted that this is an important issue for programs targeting industrial process improvements, where customers often have to work with multi-year implementation schedules. It is also true of programs oriented toward market transformation, where efforts can take many years to accomplish desired effects. The need for flexibility in this regard is becoming more widely recognized in the utility efficiency community, and programs targeting building energy code improvements could be similarly accommodated.

In summary, despite some legitimate initial concerns by regulators, many states are now moving forward with utility-funded energy efficiency programs targeting building energy code savings. In the next section of this report, we present a review of the current landscape in that regard.

State Experience with Energy Codes in Efficiency Program Portfolios

There has been remarkable progress in the last few years in the adoption of building energy codes. Analysis by IMT and others (Stellberg et al. 2012) estimates that states and cities representing nearly three-quarters of the nation's building stock have adopted or will soon adopt model energy codes and standards that meet or exceed the requirements of the model energy codes. While adoption has picked up, actual code compliance has not caught up yet; by some estimates, compliance rates average just 16% to 90% for new construction (Elnecave et al. 2012; Stellberg et al. 2012) (also see Figure 3) and much lower for alterations to existing buildings (Heinemeier 2012). However, these numbers vary widely from state to state, and in many states utilities are leading the charge of increasing compliance with building energy codes.

Many recent studies have reviewed in detail the state-level efforts in this area. The National Association of State Energy Officials report (Wagner and Lin 2012) provides a snapshot of utility involvement in building energy codes in 13 states. A Midwest Energy Efficiency Alliance (Elnecave 2012) paper on the relationship between utility programs and building energy codes has case studies on California, Massachusetts and Minnesota. An Institute for Electric Efficiency (Cooper and Wood 2011) white paper compares three different approaches adopted by (1) California, Massachusetts, and Minnesota; (2) Arizona; and (3) the Pacific Northwest. Papers by the Cadmus Group (Lee et al. 2012) and IMT (Stellberg et al. 2012) provide a brief summary of the status of codes and standards support programs across the nation, with a particular focus on the role played by utilities and program administrators. The reader interested in greater detail is referred to these for case studies and best practices. We aim to present here only a brief summary of the latest energy code development for each state and, wherever information is available, examples of utility participation in driving the codes agenda.

Twenty-five states have established Energy Efficiency Resource Standards (EERS) (Foster et al. 2012) that program administrators, including utilities, are required to meet. To achieve these targets, each PA has its own energy efficiency program portfolio. This includes a mix of direct consumer incentives, education and training programs, and market transformation initiatives like energy codes. The annual state energy efficiency scorecard (Foster et al. 2012) published recently by ACEEE reveals that the EERS targets vary widely in their stringency. These scores, reproduced in Table 1 below, indicate the overall focus of the state on energy efficiency and provide a background for the state's performance on building energy codes. On an empirical observation basis, a case can be made that states that have a higher EERS score, and hence more stringent and urgent efficiency targets, tend to have more advanced energy code programs as well. This is certainly true for states like Massachusetts, Arizona, Minnesota, and Rhode Island. California, which is one of the leading states on utility code activity but has a relatively moderate EERS score, proves that the corollary is not true. The Northwest region has been a pioneer in utility-funded building energy code initiatives. Utilities and other partners in these leading states are creating new frameworks for measurement and attribution of savings from energy codes.

The U.S. Department of Energy-funded Building Codes Assistance Project (BCAP)—a joint initiative of the Alliance to Save Energy, the American Council for an Energy-Efficient Economy, and the Natural Resources Defense Council—runs a Compliance Planning Assistance (CPA) program that works with states to take practical steps towards achieving full energy code compliance. Many of these states have formed their own Compliance Collaborative, a joint forum for all stakeholders impacted by energy codes to come together to work toward common interests. Typically these Compliance Collaboratives comprise state builders associations, regional energy efficiency partnerships, advocacy organizations, leading electric and gas utilities, local community groups, and building and energy departments of the state.

In 2010 and 2011, the Building Energy Codes Program conducted pilot studies in nine states with a focus on measuring the effectiveness of state energy code compliance processes. A few other states—New York, Nebraska, Illinois, Indiana, Massachusetts, and Rhode Island—have conducted their own self-funded pilot studies. Figure 2 summarizes state initiatives and depicts that a majority of states are already pursuing codes-related activity. The pilot studies have provided insights into the effectiveness of compliance initiatives and will guide future efforts in this area.

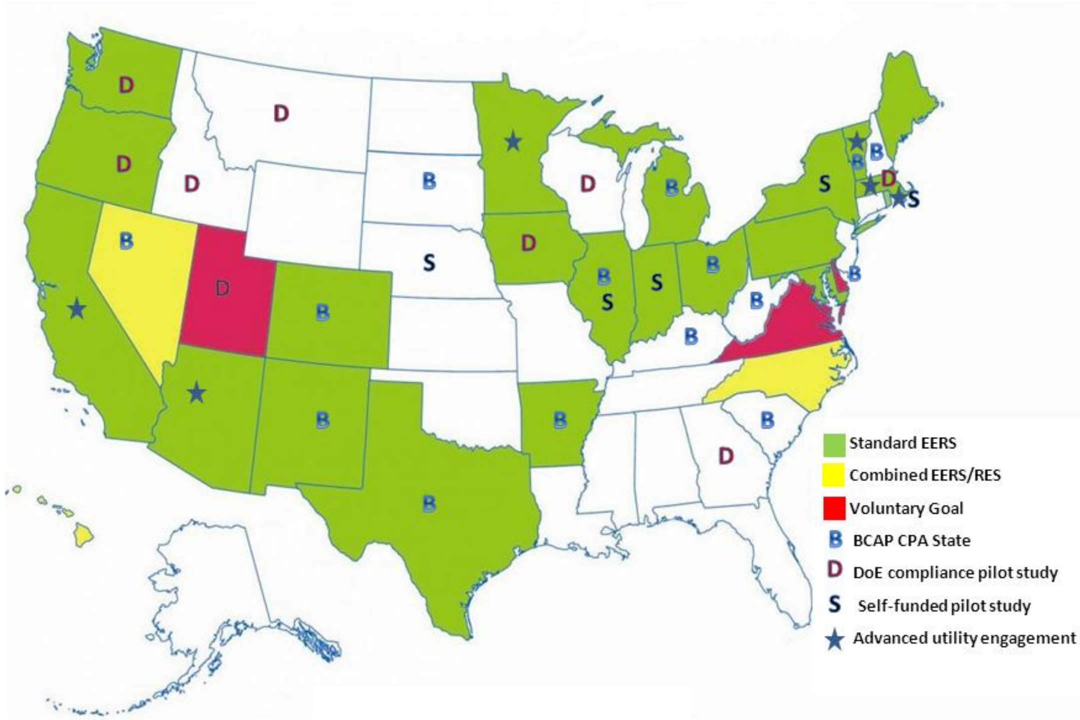
Utilities that have a multi-state presence are often agents for cross-pollination of best practices across the borders. For instance, National Grid is leading the codes agenda in Rhode Island and Massachusetts; similarly, Xcel Energy, which is a part of the Compliance Collaborative in Colorado, is also active in Minnesota. As more accurate evaluation and attribution mechanisms evolve, utilities across states will see opportunities in financial gains from advancing energy codes, thus spreading the footprint of efficient codes over the entire nation.

Table 1 and the corresponding Figure 2 summarize the status of the states on building energy codes.

- ‘Regulatory developments’ captures new advances in regulation related to building energy codes and specifically in the utility context.
- ‘Utility participation’ lists publically reported instances of utility actions on energy codes.
- ‘Number of utilities active’ is a metric derived from the CEE Residential New Homes Program Summary (CEE 2011), which summarizes the new construction activities of CEE member utilities across 27 U.S. states. These program activities generally include training, education, and marketing initiatives for builders, raters, and contractors.
- ‘Level of utility EE activity’ is a qualitative assessment of relative involvement of utilities in the codes cycle. States where utilities efforts are focused on preparatory code activities like participation in stakeholder collaboratives are classified as ‘exploratory’ while states where utility involvement is at the higher end of the code cycle (like developing an attribution framework) are considered as ‘advanced’ for this analysis. The states with advanced utility engagement with building energy codes are also highlighted on the map.
- ‘EERS Score’ is the state score on Energy Efficiency Resource Standards as assessed by the ACEEE State Scorecard (Foster 2012).
- The table also gives the current building energy code adopted[13] by the state (or local jurisdictions in case of a home rule state).

[13] See http://www.energycodes.gov/adoption/states.

Figure 2. Overlay of EERS and Energy Code Efforts in Different States



Sources:

- American Council for an Energy-Efficient Economy
- Online Code Environment & Advocacy Network

Table 1. Overview of Utility-Code Related Developments across States

State	Regulatory Developments	Utility Participation	# of Util. Active	Level of Utility EE Activity	Energy Code	EERS Score
Alabama	Code adopted from Oct 1, 2012	Alabama Power in discussion with the SEO to support building codes		Exploratory	IECC 2009	0
Arizona	Up to 1/3 credit of savings from building energy code initiatives can be claimed by utilities	Home rule state, 1/3 of municipalities have adopted IECC IOUs must demonstrate and evaluate savings that they claim Savings from appliances go to gas utilities so electric utilities focusing on buildings	4	Advanced	Home rule state IECC different versions at local level	4
California	California has a clearly articulated state policy that advancing energy codes is a priority, and that utilities are authorized and encouraged to develop programs in that area (e.g., Decision 12-05-015, May 10, 2012	IOUs support code development, advocacy and compliance efforts PG&E has developed a compliance enhancement program	7	Advanced	CA Title 24	2.5
Colorado		Xcel Energy is a part of the Compliance Collaborative and has selected six local jurisdictions (cities or counties) to help either adopt a stronger code or do a better job with code enforcement and compliance.	1	Exploratory	Home rule state IECC different versions at local level	3
Connecticut	Connecticut Department of Public Utility Control (DPUC) included language in their utility efficiency program orders to work on	Utilities providing training to building practitioners on energy code compliance		Intermediate	IECC 2009	

State	Regulatory Developments	Utility Participation	# of Util. Active	Level of Utility EE Activity	Energy Code	EERS Score
	codes and standards[14]					
Delaware	Stakeholder group of builders, architects, contractors formed	Working with legislature to encourage ratepayer funded building energy code programs	0	Exploratory	2009 IECC with Amendments	0
Georgia	First state to mandate the testing of air leakage and duct tightness	Training, technical and financial support	0	Intermediate	IECC 2009	0
Illinois	Utilities required by the EEPS to present specific proposals to implement building codes	Utilities to provide support for a special plans examiner and inspector program	3	Exploratory	IECC 2009	3.5
Iowa	Focus on Above Code Program	Utility rebates for new homes to meet IECC 2012 requirements	3	Exploratory	IECC 2009	3.5
Massachusetts	State to adopt updated building codes every three years	A code adoption and compliance study to be released in late 2012	8	Advanced	IECC 2012	4
	Framework of attribution being developed	Research by MIT proposes utility-supported financial model for public utilities and other utility-to-community programs				
Maine	Recent legislation proposes the abolishment of the Bureau of Building Codes and Standards[15]		1	Exploratory	None Statewide, 2009 IECC	3
Michigan		Ongoing training programs	3	Exploratory	2009 IECC with Amendments and 90.1-2007	2.5
Maryland	Codes Working Group formed under EMPOWER	Utilities organize training programs	3	Exploratory	20212 IECC	4

[14] See NEEP comments at http://neep.org/uploads/policy/NEEP%20Comments%202012%20CT%20C&LM%20-%205.11.pdf.
[15] See http://www.mainelegislature.org/legis/bills/bills_125th/billtexts/HP131201.asp .

State	Regulatory Developments	Utility Participation	# of Util. Active	Level of Utility EE Activity	Energy Code	EERS Score
	Maryland Plan by the Maryland Energy Administration					
Minnesota	Savings from building codes and appliance standards count towards annual energy efficiency targets of the utilities	Utilities training and certifying inspectors and providing rebates for inspections to claim code savings	6	Advanced	2009 IECC	4
Nebraska	Wholly public power therefore high involvement	Utilities organize training workshops and provide funding for events	2	Exploratory	90.1-2007 and 2009 IECC	0
New York	In October, 2011, the New York State Public Service Commission issued an Order regarding Systems Benefit Charge which includes over $16 million in funding for Advanced Energy Codes and Energy Standards as part of NYSERDA's Technology and Marketing Development Program Operating Plan for 2012—2016[16]	Long Island Power Authority has developed HERS infrastructure to promote codes and provides financial support for towns that adopt ENERGY STAR specifications as the local code NYSERDA conducts trainings, plan reviews and provides energy code advice to municipalities and runs an Energy Code Training and Support dedicated website NYSERDA has also funded compliance studies	5	Intermediate	State specific Energy Conservation Construction Code (ECCCNYS) 2010	4
N Carolina		Advanced Energy, a program administrator, to create a set of training and energy code support materials that complement the implementation of the stretch code and the new construction guaranteed energy savings program	1	Exploratory	2012 North Carolina Energy Conservation Code (more efficient than 2009 IECC)	1
Oregon		The bulk of energy code training, benefit cost analysis,	8		2010 Oregon Energy	2

[16] See http://www.nyserda.ny.gov/en/Programs/System-Benefits-Charge/System-Benefits-Charge.aspx.

State	Regulatory Developments	Utility Participation	# of Util. Active	Level of Utility EE Activity	Energy Code	EERS Score
		compliance studies, evaluation and stakeholder group support work is funded by state IOUs through the Northwest Energy Efficiency Alliance (NEEA)			Efficiency Specialty Code (meets or exceeds 2009 IECC)	
Rhode Island	National Grid allowed to claim savings from code programs; SEO not engaged in codes effort	National Grid is leading the building codes program and have proposed a third party inspection program	1	Advanced	2009 IECC	4
Texas	Responsible Energy Codes Alliance submitted comments in response to the Public Utility Commission's Rulemaking Proceeding to Amend Energy Efficiency Rules, as it relates to building energy codes[17]	Austin Energy supports the city's third-party compliance verification program and provides budget support and a part-time staff member to the local building department	2	Intermediate	2009 IECC	1
Vermont	Established Vermont's Commercial Building Energy Standards and RBES Adjusting goals in lieu of attributing savings to PAs	Efficiency Vermont's Energy Code Assistance Center provides technical assistance and training materials and also operates an energy code hotline for codes-related queries	3	Intermediate	2011 Vermont Commercial Building Energy Standards (CBES)—based on the 2009 IECC.	4
Washington	Rules for public utilities to comply with Washington's energy portfolio standard, the Energy Independence Act (Initiative 937) specifically allows utilities to count savings from newly	Seattle City Light has funded three to four professional staff in the City's building department for energy code development, plans review and enforcement. Other utilities too are active in compliance studies, code development and training	8	Intermediate	State Specific, equivalent to 90.1-2007 and 2009 IECC	3

[17] For detailed comments, see http://interchange.puc.state.tx.us/WebApp/Interchange/Documents/39674_72_728214.PDF.

State	Regulatory Developments	Utility Participation	# of Util. Active	Level of Utility EE Activity	Energy Code	EERS Score
	adopted efficiency standards and energy code toward meeting conservation targets	activities				
	One of the first in the country 'Utility Code Group' formed in 1993 as a forum of utilities					

Evaluation, Measurement, and Verification (EM&V)

Energy code compliance programs sponsored by utilities using ratepayer finds will almost always be subject to some type of EM&V requirements, as are other building energy efficiency programs. The procedures and rigor of EM&V efforts will vary by jurisdiction and available resources but will have the purpose of understanding the energy impacts and cost-effectiveness of the program, as well as program deployment and operational effectiveness. In applications where there are utility rewards or incentives involved, EM&V studies can support energy savings allocation and attribution calculations. Utilities, regulators, and interested stakeholders have a long history of evaluating energy efficiency programs[18] including those involving aspects of building energy codes. Moving to the more narrow evaluation topic of basic building energy code compliance is well within the capabilities of the program evaluation community.

However, there are two technical areas where utility program evaluators should achieve a consensus on approach. The first area is identifying a uniform protocol for measuring, reporting, and evaluating building energy code compliance (while meeting ARRA reporting requirements). The second area is identifying agreed-upon methods of estimating lost energy savings due to any measured shortfalls in building energy code compliance. Both of these areas are addressed below along with recommendations for consideration.

EM&V Protocols for Energy Code Compliance Evaluations

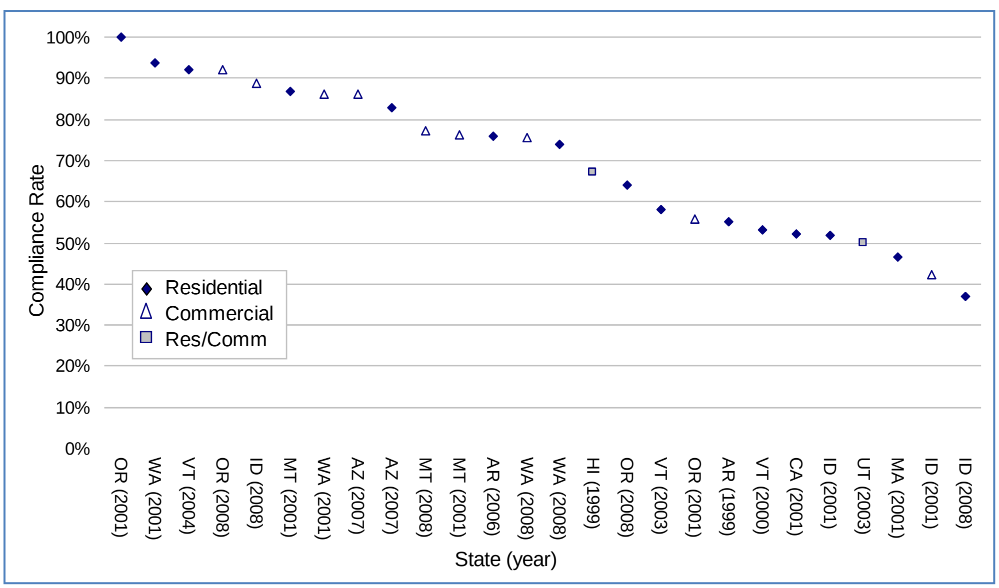
States have never before faced building energy code compliance requirements from the federal government. Given these new national ARRA requirements plus a need for uniformity in results, it is worthwhile to review recent efforts to measure building energy code compliance, assess applicability of various approaches, and develop a specialized, uniform methodology. Over the last two years, two separate research efforts have taken on these tasks.

[18] More general information on EM&V topics can be found on the International Energy Program Evaluation Conference web page, and its Evaluator's Resources page. See http://www.iepec.org/?page_id=32.

Recent ACEEE research (Misuriello 2010) reviews past energy code compliance efforts. It updates and expands work by BCAP. In 2005, BCAP compiled and analyzed 16 state-level residential code compliance studies. BCAP added several additional state and regional studies from both the residential and commercial sectors to its review in 2008. In this recent paper, ACEEE broadened the scope of the literature review by including new construction baseline studies and program evaluation papers. The total of 68 studies cover residential and commercial code compliance measurement issues at the local, state, regional, and national levels.

A majority of past compliance studies have reported the compliance rate as the percent of homes or buildings sampled that satisfied all minimum code requirements. This metric provides no information about how the efficiency of either compliant or non-compliant buildings compares to a similar minimally-compliant building. Moreover, if this approach is used to determine compliance, a building that fails only one measure is treated the same as a building that fails all measures in the calculation of the compliance rate. Nevertheless, this metric is important for assessing the degree to which new construction meets legal requirements. Indeed, the studies that report energy code compliance rates do so by using many different metrics. ACEEE found nine different metrics used in these studies to express the energy code compliance rate as shown in Table 2 (Misuriello and Makela 2011). While the results of each can be plotted on the same scale (see Figure 3), the metrics widely vary, making them difficult to compare.

Figure 3. Building Energy Code Compliance Rates by State and Year of Study



Source: ACEEE

Table 2. Building Energy Code Compliance Metrics

Energy Code Compliance Metrics	Commentary
Percent of buildings meeting *all* code requirements (pass/fail)	Most common metric in studies. Considers all code measures equal in impact. Associated with low compliance rates.
Percent of individual code requirements met in each building	More realistic metric in that code measures can be separated into high, medium and low energy impacts. Recommended for use in BECP methodology.
Net-to-gross ratio	Limited to use in some utility programs as part of program evaluation.
Percent above or below modeled energy use comparison to code	This is an energy performance metric that can estimate energy consumption impacts of code compliance. Used in very limited number of studies.
Envelope "UA" or overall heat loss	Metric using engineering calculations based on building envelope values found on building plans as compared to code requirements.
Home Energy Rating (HERS) scores	Metric uses HERS design analysis and field tests to score subject building. Score compared to energy code minimum baseline. Sometimes an alternative code compliance path tied to Energy Star homes in certain states.
Percent above or below code using DOE REScheck or similar	DOE code compliance software developed for versions of IECC and ASHRAE codes with some custom state applications. Calculates code compliance percentages from building plan data.
Percent of code officials enforcing code (survey)	Surveys of these types are useful for directional information rather than quantitative data on code compliance. Participants often self-selected. Useful for targeting code support activities such as training.
Percent of designers reporting compliance with code (survey)	

Source: ACEEE

Most building energy code compliance evaluation studies have been one-off efforts intended to meet a short-term need specific to the entity conducting the evaluation. There has been little consistency in the design of studies or in the presentation of results. This lack of uniformity has made comparing the results of compliance studies very difficult. Of course, prior to ARRA there was no need to provide code compliance results that can be used nationally to meet federal requirements. The main lesson learned from a review of these studies is that the ability to compare compliance rates among states and over time requires developing standard methods for collecting, analyzing, and reporting data. Standard methods would:

- Reduce barriers to evaluating compliance due to the time and cost involved in developing state-specific methods from scratch;
- Provide benchmarking opportunities for states to compare building energy code performance and compliance rates with other states; and
- Highlight areas associated with or responsible for non-compliance so that resources can be better directed towards improving compliance.

The advent of the ARRA SEP stimulus funding and energy code legislation has quickly created a national need for uniformity in building energy code compliance evaluations. A review of the code compliance study literature has not found any individual method that could be applied to meet this need. The U.S. Department of Energy (DOE) Building Energy Codes Program (BECP) methodology discussed in the following sections provides an opportunity to achieve this uniformity.

BECP and Pacific Northwest National Laboratory (PNNL) have taken on the task of developing and pilot testing a methodology for measuring and expressing the rate of energy code compliance so that states could uniformly use that methodology in meeting ARRA requirements related to compliance verification. In doing so, DOE and PNNL have had to address the key evaluation issues described previously and outline a methodology that can be used nationwide as well as adapted to individual state needs. BECP has published a consolidated set of checklists and manuals on these issues (BECP 2010). The *Measuring State Energy Code Compliance* guidelines provide detailed recommendations on methodologies for meeting ARRA compliance evaluation at different levels of cost, complexity, and effort according to available state resources.[19] The recommended methods range from a minimum state-level report for residential and commercial construction, to reports accounting for multiple climate zones, more detailed code variable data. and expanded building size strata. Guidelines and tools are also provided for sampling procedures. Pilot programs in several states have been fielded to test the new methodologies.

Concurrent with these developments, a number of efforts are ongoing nationwide to explore appropriate energy efficiency program support for the 2009 IECC and ANSI/ASHRAE/IES Standard 90.1-2007. Some tools and resources to guide energy efficiency program administrators seeking a role with these documents have been published by the joint DOE/EPA National Action Plan for Energy Efficiency (EPA 2009). In other states, notably California, utility efficiency programs have a high involvement in many aspects of basic energy code developments and implementation (Lee et al. 2008).

In summary, we observe that since building energy code compliance has become an important concern for policy-makers, utilities and program administrators, energy efficiency advocates, and

[19] BECP provides a useful website to access these publications and compliance evaluation tools. See http://www.energycodes.gov/compliance for further information. Additional information on the topic is accessible at http://www.energycodes.gov/compliance/evaluation.

other stakeholders, some uniformity in evaluation methodologies is in order. Agreement on the essential metrics to evaluate compliance is needed and also required are uniform data collection and analysis procedures that correspond to the ability of the market to use them in terms of available resources and needed complexity/simplicity.

ESTIMATING LOST ENERGY SAVINGS DUE TO COMPLIANCE SHORTFALLS

Estimating the energy savings lost due to non-compliance could be very useful in assessing whether increasing code enforcement efforts should be ramped up. The literature review indicates, however, that there is very little experience in this area. While several studies have used modeling to predict the impacts of code updates or building programs, most compared model predictions with building designs and prototypes; only a few have compared modeling results with actual building energy use data. While the simulation models did not accurately predict absolute savings, the relative difference between baseline and modeled energy use—the "compliance margin"—was deemed to be reasonably accurate.

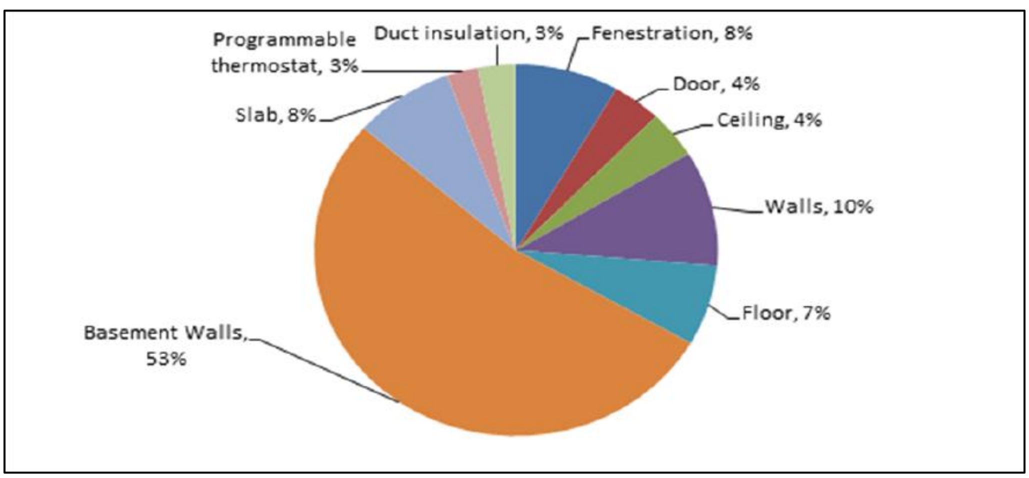
At the heart of arguments that utility energy efficiency Program Administrator involvement in building energy code compliance is a worthwhile endeavor is the notion that “lost” savings that are possible “on paper” due to compliance shortfalls can have substantial effects on building owners and consumers as well as utilities and their customers. Implicit in this notion is the assumption that the lost energy savings can have significant monetary value to utility customers (as higher, unnecessary utility costs) and that shortfalls in expected new construction and addition/renovation of existing building energy performance (usage and demand) can have unintended consequences for utility system planning outcomes. Thus, a wide spectrum of energy policy stakeholders is interested in cost-effective ways to capture the full energy savings potential of the most recent model energy codes and standards.

While most observers would agree that there can be substantial energy and monetary value in enhancing the rate of compliance with building energy codes, there are few studies that have quantified this effect in detail. In the absence of an accepted method, some observers suggest that the lost energy savings can be approximated by adjusting the estimated energy savings by the observed energy code compliance rate. For example, if the building energy code compliance rate for a statewide code was measured at 75%, expected energy code savings would be discounted to 75% of that amount. While this approach does acknowledge that some energy savings are lost due to code compliance shortfalls, its simplified application may overstate the lost savings.

Previous research suggests that investments in energy code compliance can be broadly cost-effective, producing six dollars in energy benefits for each dollar spent on code compliance initiatives (IMT 2010). Although there are methodologies available to quantify code compliance shortfalls in terms of building component values (R-value, Solar Heat Gain Coefficient (SHGC), Energy Efficiency Ratio (EER) etc.), there do not yet appear to be integrated methods to translate these values into units of energy usage (kWh, kW, therms, etc.). Indeed this is one of the strongest technical challenges to developing processes that facilitate fair and accurate attribution and allocation of utility incentives tied to improvements in energy code compliance. Many of the ongoing individual state efforts are seeking ways to quantify these lost energy savings and measure the effectiveness of ways to improve energy code compliance.

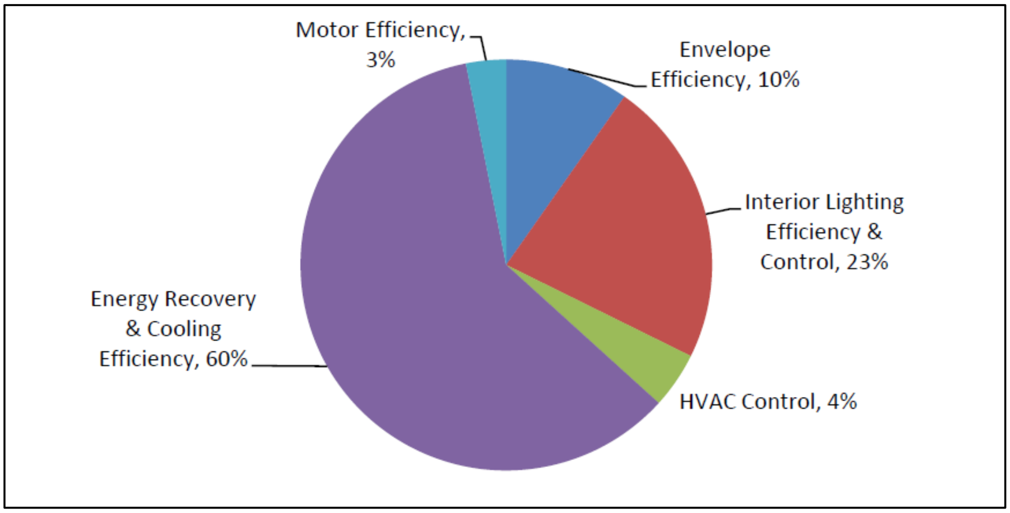
In a recent energy code compliance study of the 2007 New York State Energy Conservation Construction Code (ECCCNYS-2007) for residential properties and ASHRAE 90.1-2004 or ASHRAE 90.1-2007 for commercial properties, researchers found that lost energy savings due to code compliance shortfalls are indeed substantial. Using the DOE Building Energy Codes Program methodology from the pilot test program mentioned above, as modified by the state, residential code compliance rates were estimated at 73% while commercial code compliance was estimated at 83%.The collected field data on energy code compliance was evaluated with whole building energy models to estimate lost energy savings. In new residential construction, annual lost savings from energy code compliance shortfalls were estimated at 8% of the home's total annual energy costs and 14% of heating and cooling costs with cost impacts of $373 per non-compliant home. In the commercial sector, lost energy code savings were estimated at 5% of annual energy costs, or about $0.10 per square foot of floor area. A breakdown of the lost energy savings by code components for both residential and commercial new construction is shown in Figures 4 and 5. Given assumptions on annual construction volumes and useful life of buildings, the researchers estimated lost energy code savings at $300 million in the residential sector and $960 million in the commercial sector, for a total of $1.3 billion in cumulative lost savings over a 5-year construction cycle (Harper et al. 2012). Clearly, lost benefits of this magnitude are a legitimate public policy concern.

Figure 4. Lost Energy Savings Opportunities by Residential Building Components



Note: Cumulative lost energy code savings estimated at $300 million in the residential sector over a 5-year construction cycle.
Source: Harper et al. 2012

Figure 5. Lost Energy Savings Opportunities by Commercial Building Components

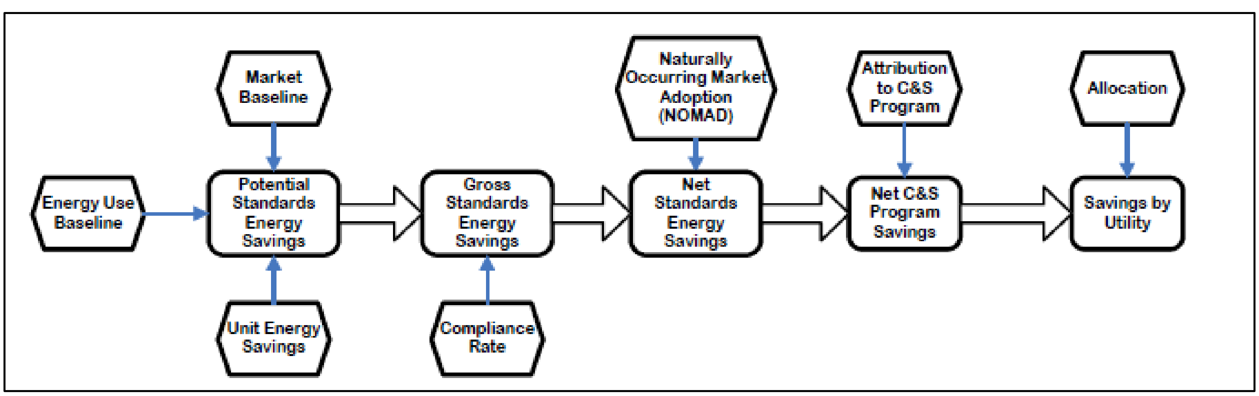


Note: Cumulative lost energy code savings estimated at $960 million in the commercial sector over a 5-year construction cycle.
Source: Harper et al. 2012

Apart from promising development efforts in Massachusetts, Arizona, and other states, the state with the most fully developed code compliance evaluation methodology involving utility program savings credits is California. The treatment and evaluation of energy savings from California's statewide utility programs for appliance standards and Title 24 building energy code has been well described in the literature (Lee et al. 2008, 2012) and in recent program evaluation reports (KEMA et al. 2010). The California method is comprehensive and provides an integrated calculation process to determine program energy savings eligible for attribution as credit towards meeting state energy savings goals. Among evaluators, the California process is often viewed as the "gold standard," not only for breadth and depth of analysis, but also for the resources required for its implementation.

The general methodology for the California energy code and appliance standards evaluation is shown in the process flow chart in Figure 6.

Figure 6. California Codes and Standards Evaluation Methodology



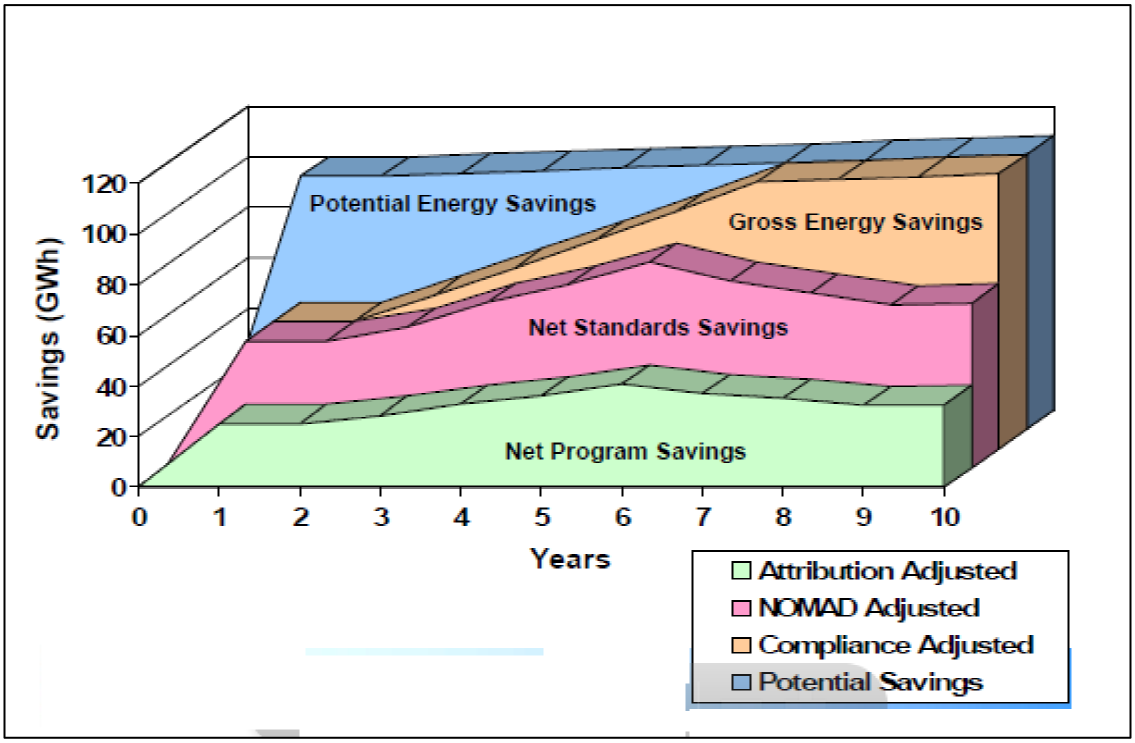
Source: KEMA et al. 2010

The methodology treats utility programs involving California's Title 20 appliance standards program as well as Title 24 building energy codes. The methodology estimates five different energy savings parameters in order to determine the final allocation of energy savings to each of the California utilities supporting the statewide program. These parameters, summarized at a high level, include:

- **Potential energy savings.** These are the energy savings estimated if all buildings were in full compliance with all Title 24 requirements. These estimates are based on previous studies, including market effects studies, energy use baselines, and unit savings estimates from special Codes and Standards Enhancement Initiative (CASE) reports. Building simulation models used for Title 24 compliance (e.g., Micropas) have a role in making these estimates. Representative buildings are modeled and results weighted by climate zone and building type construction volume.
- **Gross energy savings.** Code compliance effects are taken into account to adjust potential energy savings due to code compliance observed in the market. This often involves plan reviews and site surveys to compare Title 24 prescriptive requirements to those found in the field. Again, building simulation models are used in making these adjustments.
- **Net energy savings.** This adjustment accounts for Naturally Occurring Market Adoption of energy efficiency measures included in Title 24. This is referred to as 'NOMAD.'
- **Net program savings,** or attribution. This adjustment quantifies the effectiveness of the utility program effort in achieving the energy savings goals.
- **Savings by utility**, or allocation. The final step is to allocate the program energy savings to the individual California utilities according to their respective shares of California electricity and natural gas sales. It also includes a CPUC policy adjustment of capping utility savings claims at 50% of the verified net energy savings for the 2006-2008 program cycle.

In the California energy codes and appliance standards evaluation method, the individual analyses for each of these energy parameters are integrated through a specialized spreadsheet that generally follows the process described in Figure 6. The Integrated Standards Savings Model (ISSM) has been developed over several program evaluation cycles. A version of the spreadsheet is available to the public from the California Public Utility Commission (CPUC 2007). The results of these adjustments, following the California Codes and Standards Evaluation Methodology are illustrated in Figure 7.

Figure 7. Energy Savings from Codes in California



Source: Lee 2010

This chart clearly shows how the potential energy savings from codes and standards are adjusted for compliance considerations. However, it is assumed that compliance improves over the years until the potential savings level is reached. The "lost" energy savings due to lack of code compliance is the difference between these two. Naturally occurring market adoption of energy efficiency measures (NOMAD) ramps up over time. The final result is the net energy savings available for attribution to the statewide codes and standards program, with allocation of the net energy savings to individual California utilities to follow.

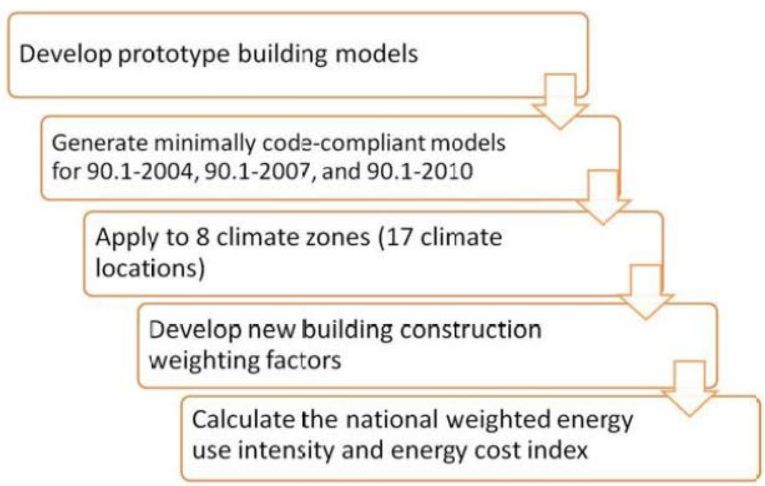
As more individual states pursue policies that incorporate building energy code support into efficiency program portfolios, utility regulators are faced with deciding what levels of effort and resources are appropriate for determining energy savings credits for utility attribution and allocation.

Technical Framework for Estimating "Lost" Energy Savings from Energy Code Compliance Shortfalls

In states where utility program support for basic energy codes is under discussion, a key concern is how lost energy savings are to be calculated along with estimates of energy savings due to improvements in the codes. In the California example, these estimates are key factors in determining Potential Energy Savings (assuming full code compliance) and Gross Energy Savings (factoring in observed compliance rates.) As noted previously, there is not a nationally applicable method to translate code compliance measurement data into units of lost energy savings. This section describes a technical framework for doing so based on engineering calculations and building simulation models employed in model energy code development.

The example for this discussion is the "Progress Indicator" methodology used by DOE and PNNL to support the ongoing maintenance and enhancement of ANSI/ASHRAE/IES Standard 90.1. This method was used for the 2010 and 2013 versions of the Standard to provide the Standing Standard Project Committee (SSPC) 90.1 responsible for maintaining the standard with feedback on making progress towards ASHRAE's energy efficiency improvement goals. For Standard 90.1-2010, the improvement goal was 30% over the 2004 Standard; for Standard 90.1-2013, the efficiency improvement goal is a 50% improvement for regulated end-uses (i.e., heating, cooling, ventilation, lighting, and service water heating) and a 40% improvement for the whole building (i.e., all end-uses including unregulated plug loads and process use). The Progress Indicator is the method for testing new provisions to Standard 90.1 to assess energy savings. A similar method was recently developed by DOE and PNNL for ASHRAE Standard 90.2 for residential buildings.

Figure 8. ASHRAE 90.1/PNNL Progress Indicator Process



Source: Thornton et al. 2011

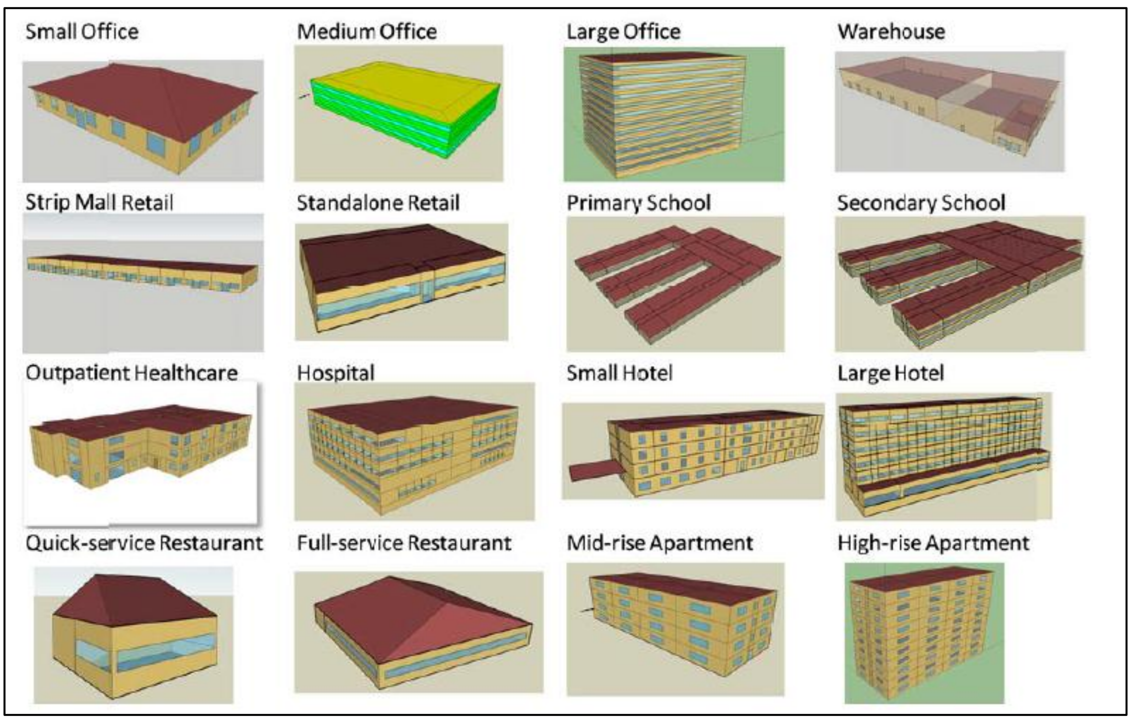
The Progress Indicator is fully documented in a detailed Technical Support Document (Thornton et al. 2011). The overall process is shown in Figure 8. The Progress Indicator method relies heavily on building simulation models of typical commercial buildings within the scope of ASHRAE Standard 90.1 and includes these major capabilities:

- Representative building models that include the most prevalent building types in the national building stock as profiled by the DOE/EIA Commercial Building Energy Consumption Survey (CBECS.) Available prototype buildings from the Progress Indicator system are shown in summary drawings in Figure 9 and represent about 80% of the nation's commercial floor space and 70% of commercial building electricity use nationwide. These building models are configured for exact minimum conformance with the 2004, 2007, and 2010 editions of Standard 90.1. Different versions of the models were created to match the Standard 90.1

requirements that vary with climate such as wall insulation. The prototypes are also configured with standardized building operating conditions, occupancy schedules, and other specifications for internal loads; HVAC system types; and other relevant parameters that are generally held constant from one simulation task to the next to isolate the effects of proposed code changes. These prototype buildings are excellent vehicles to test the performance of building design and construction criteria that vary with different editions of the standard as well as proposed change to the standard across a wide range of building types.

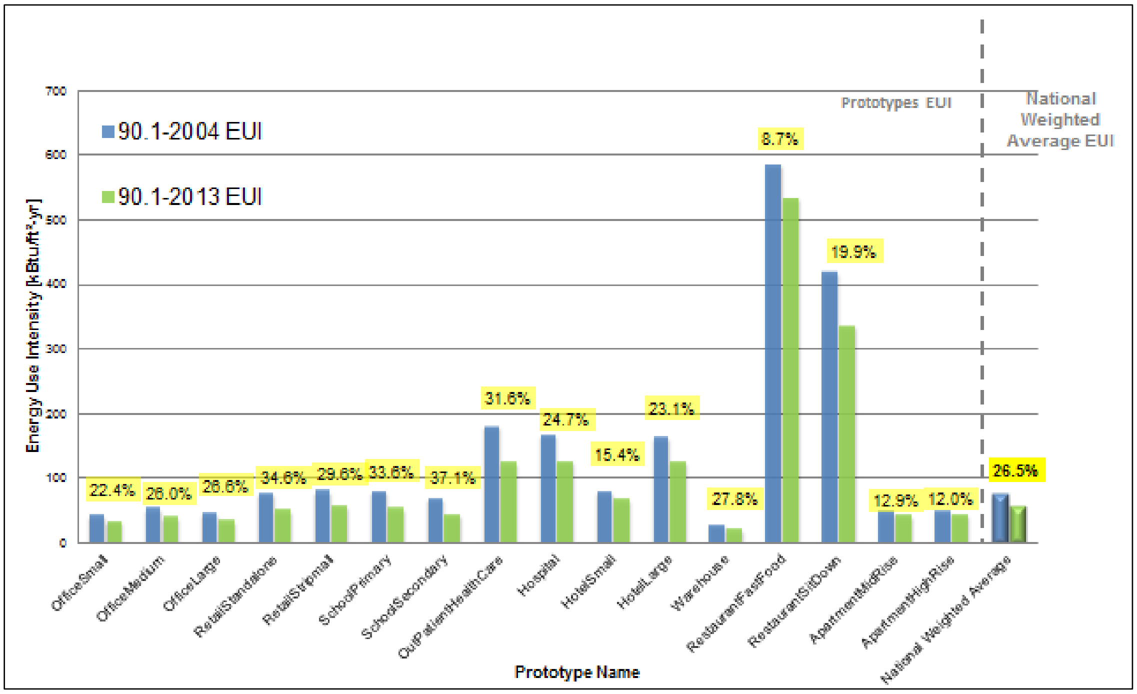
- Ability to weigh building simulation model results by climate zone or location and construction volume of the building type. In developing Standard 90.1, SSPC 90.1 strives to accomplish the energy efficiency improvement target on a nationally-weighted basis. This means that the individual simulation model results for a climate zone are weighted by the volume of building type construction in a particular climate zone. The prototypes are modeled in the eight DOE climate zones that are further divided into moist and dry regions, represented by 17 climate locations. The results of this weighting are rolled up into an aggregate national number as shown in Figure 10. Thus, the prototype simulations can capture the effects of characteristic building operation, the effects of climate, and the importance of new construction volume as well as the effects of possible changes and enhancements to the standard.

Figure 9. Prototype Buildings for Progress Indicator System



Source: Thornton et al. 2011

Figure 10. Example Progress Indicator Results for ASHRAE Standard 90.1-2013



Source: PNNL Progress Indicator Report, January 2012

Application to Energy Code Lost Savings Estimates

The Progress Indicator system just described has been designed to test and quantify the effects of making technical revisions or enhancements to Standard 90.1. However, these capabilities can be adapted to the problem of estimating the lost energy savings due to shortfalls in achieving compliance with Standard 90.1 or the IECC. Indeed, there may be some technical similarities between quantifying energy savings due to new model code or standard provisions and quantifying lost energy savings. For example, the DOE/PNNL report *Measuring State Energy Code Compliance* (PNNL 2010) provides a methodology to measure specific shortfalls in building energy code compliance and provides quantitative information on as-built code compliance conditions as compared to exact compliance with requirements in the code book (this was developed to assist states in meeting ARRA requirements for at least 90% code compliance rates by 2017.) The observed differences can be input into the building simulation prototype buildings to estimate the energy use differences. A summary of how this approach might be applied is shown in Table 3.

Table 3. Adaptation of Progress Indicator to Quantify Compliance Shortfalls

General Features and Capabilities of ASHRAE Progress Indicator	Adaptation to Quantifying Compliance Shortfalls
Prototype Reference Buildings	Prototypes are well developed for new construction analysis. Prototypes for existing buildings for code compliance (additions, alterations, etc.) are available but need further development. Residential prototypes are in a similar stage of development.
Code-Compliant Data Sources	Prototypes configured for exact compliance with ASHRAE model codes are available. Prototypes configured for exact compliance with the IECC need additional development work. These would be the baseline buildings to which the code compliance shortfalls are compared.
Code Compliance Shortfall Parameters	The DOE/PNNL code compliance methodology is intended to report quantified numerical differences between energy code requirements and actual conditions observed on construction documents and through in-the-field building inspection surveys. These data would be the inputs used in the simulation models to estimate energy lost to energy code compliance shortfalls by comparing energy results to the baseline. It is analogous to modeling proposed changes to a model energy code or standard.
Simulation in Climate Zones and Climate Locations	The building simulations would be run with standard weather data from the climate zones in question as provided in the IECC or Standard 90.1. Climate zones may be further subdivided into utility service areas if appropriate.
Apply Construction Weighting Factors	The DOE/PNNL energy code compliance methodology also includes a sample generator and a scheme for weighting the results according to new construction volume. It is likely that this weighting scheme can be adapted to this use since the weighting scheme is based on the one used in the Progress Indicator.

In summary, this approach could have a number of benefits for users trying to quantify the effects of energy code compliance shortfalls. A uniform prototype building modeling approach would allow analysis results to be consistently compared among different geographic areas and different minimum model energy codes or standards selected for use, and across time. If further developed, this approach would also save development time and effort by states and utilities that may otherwise resort to reinventing analysis methods. Our recommendation is for DOE and PNNL to link the ASHRAE Progress Indicator process to the closely related task of quantifying energy code compliance shortfalls.

The foregoing approach would be suitable for larger jurisdictions and larger program administrators with sufficient resources to handle the building energy code compliance data collection and subsequent prototype building modeling. However, not all jurisdictions and program administrators may have the necessary resources to support detailed data collection or the skilled personnel to carry out the building modeling. In these situations, the DOE/PNNL code compliance evaluation method can be used at a reduced level of detail by reducing the number of building types included in the code compliance surveys and restricting the number of code-related building characteristics that are included. For example, the methodology could be applied only to residential new single-family detached construction and consider only high impact energy code building characteristics. However, the technical issue of estimating and quantifying energy code compliance shortfalls in units of energy use still remains. This technical issue could be addressed through simplified impact estimates involving spreadsheet calculations instead of prototype building modeling. The spreadsheet models would need to account for lost energy savings through estimates tied to building energy code compliance rates (best estimated with the DOE/PNNL compliance evaluation method for consistency) and energy end-use intensities and relative local market shares of end-use energy (e.g., natural gas vs. electric heating, etc.). Simplified methods would also need to be able to scale the impact estimate results to the jurisdiction or utility service area level using construction volume data such as the number of building permits issued or construction "weights" such as those used in the DOE/PNNL methodology. We would recommend that, resources permitting, DOE and PNNL work with evaluators and other interested stakeholders on guidelines and recommendations for developing and using simplified or spreadsheet-based impact estimating tools.

Pilot Program Concepts

With increased gains in efficiency, energy codes have also increased in complexity and the level of technical expertise required for all concerned. Utilities are often the best placed to make a difference since they have a staff well qualified for the role, access to actual energy use data, credibility with builders and other stakeholders, and extensive experience in implementing efficiency programs. While there are several concerns with efficiency program involvement in minimum mandatory codes, there is ample evidence that numerous efficiency program administrators have decided that these energy codes can have a place in their portfolio. The most convincing evidence is from California where third-party measurement of the energy code enhancement activities of investor-owned utilities during the 2006-2008 program cycle indicated savings of 10-12% of their total portfolio. Based on program expenditure data from the utilities, codes-related savings cost about $0.01 per first-year kWh (Lee et al. 2008). Elnecave et al. (2012) have proposed a framework for program design for utilities interested in code advancement. They list five issues that need to be considered:

- The types of energy savings involved (electricity or natural gas)
- The types of activities in which utilities should engage
- How to measure the energy savings from utility activities
- How to attribute the energy savings to utilities
- The allocation of the energy savings among the utilities in a state

Different building types offer different electric and natural gas savings opportunities. In many cases, these are served by separate utilities and can serve the purpose of delineating the territorial efforts. Component savings from building energy codes (as shown in Figures 4 and 5 in the previous section) can provide another pointer to prioritization of efforts. In the next section, we highlight some of the activities in which utilities can engage.

ACTIVITIES IN THE CODE CYCLE DEEMED APPROPRIATE FOR UTILITIES

As discussed earlier, different states are at varying levels of advancement regarding utility involvement in energy codes, hence there is no one size fits all approach that can be replicated universally. The National Action Plan for Energy Efficiency (NAPEE) examined the topic (EPA 2009) and documented efficiency program efforts throughout the typical energy code cycle of development, adoption, implementation, compliance/enforcement, and evaluation. Examples of program activities from the NAPEE report and other sources are summarized below.

Development

Most states have adopted the national model energy codes without amendments and hence utility involvement in code development has generally been limited. At the same time, the time lag of about three years in the revision of model codes provides an opportunity for utility involvement. Laying the groundwork for future building energy code upgrades by the state provides a dual advantage—for the state it helps in determining the technical feasibility of emerging technologies that may be a part of the new code provisions, and for the utilities it is a clear case of unambiguous savings while the code is not yet the law. Florida Power and Light conducted research, development, and demonstration of duct sealing and cool roof technologies that have since been included in the state's mandatory code. Similarly, California utilities worked with the state to establish a utility retrofit program that achieves energy and demand savings from increased daylighting of existing office buildings and also to inform the next round of Title 24 building code changes (Wagner and Lin 2012).

Adoption

As our summary of state efforts suggests (see Figure 2), many states across the country have yet to adopt a statewide building energy code or have not upgraded to more efficient codes in a long time (or in the case of home rule, states may not have the legislative or constitutional foundation to do so). Such states clearly present opportunities for utilities to get involved in advocacy for code adoption especially as they are often well-positioned to collaborate with different state agencies, builders, developers, and policy-makers. There are also examples of utilities working with local governments for code adoption in home rule states. Training workshops, cost savings analysis, and advocacy for building energy codes by utilities in Arizona have prompted adoption in several local jurisdictions across the state (Wagner and Lin 2012).

Learning from the experience in states like California, Arizona, and Massachusetts, some activities that can be undertaken by utilities directly or through their trade associations to promote code development and adoption may include:

- Conducting research, development, and demonstration for new technologies and building practices that are included in future codes
- Providing inputs on ASHRAE and IECC code development proposals
- Participating in state/local code adoption proceedings and providing testimony in support of code upgrades
- Providing technical support on cost and energy impact questions

Implementation

A common and effective activity for program administrators is training and code education for code officials, builders, designers, contractors, and product distributors and suppliers. Many states have only recently adopted or upgraded to newer building energy codes and the current level of training and education efforts is grossly insufficient. Utilities have expertise in buildings and systems and are uniquely poised to develop and help provide code training for builders, code officials, and product distributors/suppliers. The Northwest Energy Efficiency Alliance (NEEA), which funds a large majority of the energy code implementation support in the four Pacific Northwest states, runs a comprehensive program on energy code education and training (Cohan 2012). In this program, overview sessions on basic elements of code (changes) are followed by focused trainings that address in-depth areas of the code that are predicted to have low compliance. These classroom-based experiences are supplemented by visits to both building departments and industry firms in which trainers sit with department or firm staff to review plans and then visit buildings with field inspection staff and builders to provide real-time feedback. There is no punitive aspect to these visits; participants understand that they are not being judged or reported on, which makes them receptive to accepting help. Finally, telephone technical assistance is always available, generally from the same people who conduct the trainings.

Compliance Support

This is an area where most states are believed to be lagging and utility support can go a long way. Energy code compliance shortfalls are often attributable to lack of knowledge about specific energy code requirements by builders, contractors, and design professionals. It would follow that training and education efforts should figure prominently in an energy code compliance support program. Fortunately there are numerous resources for energy code training targeting various audiences from the DOE code program and other sources. There are a variety of ways utilities can be engaged in code compliance support without being direct enforcers. Some examples include:

- Provide training content, guidebooks, and code field guides for building inspectors. Often, code officials are without adequate resources to learn about the latest energy codes.

- Provide training courses on building energy codes to audiences of builders, contractors, and design professionals.
- Make blower door and duct testing equipment available on loan to builders/contractors so they can pre-test homes for air sealing and duct sealing compliance.
- Provide staff time for plan reviews, site inspections, and technical design assistance.
- Develop marketing materials to raise awareness of building energy code compliance and to communicate with the building community; use media outreach and community-based initiatives to emphasize the value of energy codes to different stakeholders.

As an example, Vermont's Energy Code Assistance Center provides technical assistance, forms and certificates, free compliance software, code training materials, and assistance with form completion. The Center also operates the E-Call Energy Code Hotline, a toll-free telephone hotline that builders and tradespeople can call with codes-related questions (Stellberg et al. 2012).

An emerging way to support energy code enforcement, without being directly involved, is to develop infrastructure for third-party inspection. Utilities can take the lead in identifying and training technical personnel for this purpose especially in jurisdictions with inadequate resources. A current example is that of National Grid, which is supporting enforcement and evaluation in Massachusetts and Rhode Island with the help of third-party inspectors.[20]

Evaluation

Evaluation studies are important for two reasons: 1) to help document savings from codes, a key variable before utilities can claim credit from savings; and 2) to document changes in savings so credit can be given for increasing compliance levels, for example. Unfortunately, measured data of savings from mandatory energy codes is severely lacking, which makes it hard to evaluate the cost-effectiveness of such policies. Where data exists it is usually *ex ante* projection of future savings rather than rigorous *ex post* estimates of achieved savings (EPA 2009). Utilities have the best available data on actual energy consumption and can work together to overcome this serious gap in the evaluation of energy code programs. There are examples of several statewide programs, as well as local program administrators that are involved in measuring energy savings attributed to energy codes. Massachusetts, Rhode Island, and Minnesota are some of the leading states on this apart from California which has already been discussed in detail in the EM&V section. Some of the common activities that utilities can undertake are:

- Support energy code compliance evaluation through financial and technical support
- Consider supporting state ARRA reporting requirements to DOE

[20] See http://www.nationalgridus.com/non_html/eer/ri/2012-2014%20Energy%20Efficiency%20Three%20Year%20Plan.pdf

- Quantify the impacts of savings from mandatory code changes and share energy use data, without compromising confidentiality, in a standardized format that can help in scaling up and inform future decisions regarding code-based programs.
- Measure and report the cost of compliance to builders and assess the overall cost-effectiveness of proposed measures—and the code overall—using regulator-approved cost tests.

Potential Additional Regulatory Tools to Enhance Building Energy Code Effectiveness

In circumstances where state policy and utility regulators are strongly supportive of achieving energy savings by optimizing building energy code effectiveness, there are at least two traditional utility responsibilities that could be structured to support higher efficiency in new buildings and could be used directly or indirectly to support building energy codes.

First, utilities routinely apply certain rules and fees to new customers seeking to connect to utility service. That function could be used to apply a sliding scale hook-up fee that was tied to building efficiency (e.g., a lower fee for buildings meeting and/or exceeding the energy code). Second, utilities and commissions routinely apply different rate designs to different customer classes or sub-classes. If desired, a differential (i.e., lower) rate structure could be designed for buildings meeting some stretch code criterion of high efficiency above the basic energy code.. Such a design should be justifiable if highly efficient customers are putting less cost burden on the utility system.

While adopting such policies would require a strong and supportive utility commission, these activities (connection fees and rate design) are normal legitimate utility activities, and designing differential structures tied to building efficiency could be justified on the basis of the impact on overall utility cost of service.

Policy Recommendations

We believe that improved building energy codes will have an increasingly important effect on efficiency program administrators in the next few years. Model energy codes and standards are making significant improvements in energy efficiency and reaching levels associated with beyond-code and advanced energy design programs. At the same time we find energy code compliance rates are probably less than expected with uncertain but underperforming efficiency levels. The shortfall in expected energy savings could be recaptured through efficiency program efforts focused on energy code compliance enhancement. At every stage of the process associated with energy code and standard development, adoption, implementation, compliance verification, and evaluation, there are examples of effective and viable activities that utilities can consider replicating in their own markets. Such code-related programs could be evaluated with a proper baseline and annual surveys to measure changes in energy code compliance rates. The new DOE/PNNL energy code compliance evaluation methodology was developed to assist states in meeting their annual ARRA code compliance reporting requirements to DOE and to achieve at least a 90% energy code compliance rate by 2017. We believe that the DOE BECP method could be applied to efficiency program service areas and contribute to that goal.

We recommend that efficiency program administrators look closely at energy codes as a potential resource in their portfolios and strongly consider use of the DOE BECP energy code compliance evaluation method. State utility regulators have an equally important role to play in making it administratively easier to include energy code activities in the utility's portfolio and thus maximize the savings from energy code implementation. The regulators can work with utilities to address issues related to program baselines, cost recovery, mandatory savings targets, and other utility policies. The transformational potential of modern energy codes is such that it will be remiss not to have them as an integral part of the energy policy of any jurisdiction.

References

[ASE] Alliance to Save Energy. 2011. *Alliance to Save Energy Hails 25-30% Advance in 2012 Energy Code for New & Renovated Residential, Commercial Buildings.* Washington, DC: Alliance to Save Energy.

[CEE] Consortium for Energy Efficiency. 2011. *Summary of Residential New Homes Programs in the United States and Canada.* Boston, MA: Consortium for Energy Efficiency.

Cohan, D. 2012. "A Comprehensive Approach to Energy Code Education and Training." In *Proceedings of the 2012 ACEEE Summer Study on Energy Efficiency in Buildings.* Washington, DC: American Council for an Energy-Efficient Economy.

Cooper, A. and L. Wood. 2011. I*ntegrating Codes and Standards into Electric Utility Energy Efficiency Portfolios.* Institute for Electric Efficiency.

[CPUC] California Public Utilities Commission. 2007. "Savings Estimating Worksheet." San Francisco, CA: California Public Utilities Commission.

Elnecave, I. 2012. *How Utility Programs Can Help Realize the Potential of Building Energy Codes and How Energy Codes Can Help Utilities Achieve Energy Efficiency Goals.* Chicago, IL: Midwest Energy Efficiency Alliance.

Elnecave, I., C. Baker, Carolyn Sarno, and Puja Vohra. 2012. "Enhancing Energy Code Compliance through Partnerships with Utilities." In *Proceedings of the 2012 ACEEE Summer Study on Energy Efficiency in Buildings.* Washington, DC: American Council for an Energy-Efficient Economy.

[EPA] Environmental Protection Agency. 2009. *National Action Plan for Energy Efficiency. Energy Efficiency Program Administrators and Building Energy Codes.* Washington, DC.: Environmental Protection Agency.

Foster, B., A. Chittum, Sara Hayes, Max Neubauer, Seth Nowak, Shruti Vaidyanathan, Kate Farley, Kaye Schultz, Terry Sullivan, Colin Sheppard, Arne Jacobson, Charles Chamberlin, and Yerina Mugica. 2012. *The 2012 State Energy Efficiency Scorecard*. Washington, DC: American Council for an Energy-Efficient Economy.

Harper, B., L. Badger, Jennifer Chido, Glenn Reed, and Robert Wirtshafter. 2012. "Improved Code Enforcement: A Powerful Policy Tool—Lessons Learned from New York State." In *Proceedings of the 2012 ACEEE Summer Study on Energy Efficiency in Buildings.* Washington, DC: American Council for an Energy-Efficient Economy.

Heinemeier, K. 2012. "Contractors Walk on the Wild Side: Why?" In *Proceedings of the 2012 ACEEE Summer Study on Energy Efficiency in Buildings.* Washington, DC: American Council for an Energy-Efficient Economy.

[IMT] Institute for Market Transformation. 2010. "$810 Million Funding Needed to Achieve 90% Compliance with Building Energy Codes." *Factsheet*. Washington, DC: Institute for Market Transformation.

KEMA, Cadmus, et al. 2010. "California Investor Owned Utilities' Codes and Standards Program Evaluation for Program Years 2006-2008." *Codes & Standards (C&S) Programs Impact Evaluation*. Volume III. California Public Utilities Commission. San Francisco.

Lee, A. 2010. "NEEP Workshop Presentation." September. Cadmus Group.

Lee, A., D. Groshans, C. Gurin, R. Cook, and T. Walker. 2012. "Raising the Bar: Getting Large Energy Savings through Programs that Support Energy-Efficiency Codes and Standards." In *Proceedings of the 2012 ACEEE Summer Study on Energy Efficiency in Buildings.* Washington, DC: American Council for an Energy-Efficient Economy.

Lee, A., H. Haeri, Ayat Osman, Kenneth Keating, and John Stoops. 2008. "Utility Codes and Standards Programs: How Much Energy Do They Save?" In *Proceedings of the 2008 ACEEE Summer Study on Energy Efficiency in Buildings.* Washington, DC: American Council for an Energy-Efficient Economy.

Misuriello, H. 2010. "Lessons Learned from Building Energy Code Compliance and Enforcement Evaluation Studies." In *Proceedings of the 2010 ACEEE Summer Study on Energy Efficiency in Buildings.* Washington, DC: American Council for an Energy-Efficient Economy.

Misuriello, H. and E. Makela 2011. "Building Energy Code Compliance Evaluation: Lessons Learned and New Directions." Association of Energy Services Professionals National Conference and Expo.

Nadel, S. 2004. *Supplementary Information on Energy Efficiency for the National Commission on Energy Policy.* Resources for the Future. Washington, DC: American Council for an Energy-Efficient Economy.

[PNNL] Pacific Northwest National Laboratory. 2012. *Progress Indicator Report, January.* Richland, WA: Pacific Northwest National Laboratory.

———. 2010. *Measuring State Energy Code Compliance.* Richland, WA: Pacific Northwest National Laboratory.

Stellberg, S., A. Cooper, Carolyn Sarno, and David Lis. 2012. "Role for Utilities in Enhancing Building Energy Code Compliance." In *Proceedings of the 2012 ACEEE Summer Study on Energy Efficiency in Buildings.* Washington, DC: American Council for an Energy-Efficient Economy.

Thornton, B. A., M. I. Rosenberg, E.E. Richman, W. Wang, Y. Xie, J. Zhang, H. Cho, V. V. Mendon, R. A. Athalye, B. Liu 2011. *Achieving the 30% Goal: Energy and Cost Savings Analysis of ASHRAE Standard 90.1-2010.* Richland, WA: Pacific Northwest National Laboratory.

Wagner, C. and D. Lin 2012. *Leveraging State Energy Office-Utility Partnerships to Advance Building Energy Codes.* National Association of State Energy Officials.