Lessons Learned from Building Energy Code Compliance and Enforcement Evaluation Studies

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ABSTRACT

The goal of our research is to support debate and advocacy for additional code compliance and enforcement resources, because compliance with energy efficiency requirements in building codes is critical for achieving energy savings. We reviewed fifty studies of state energy code compliance and enforcement efforts to develop recommendations for focused code enforcement that will be necessary to meet expected Federal code compliance performance goals. The studies and papers reviewed were based on on-site surveys, building department plan reviews, builder and code official interviews, analysis of compliance software results, use of random building samples, and end-use metering. The analysis techniques used to estimate compliance metrics included simple and detailed code measure checklists, and simulation modeling to estimate "lost" energy savings.

Preliminary results of our ongoing analysis indicate a number of common issues: as-built conditions often differ from plans (often there is little on-site review of construction to compare with blueprints). Further, during construction, substitution of non-compliant products is common. Nearly all studies found that training and education efforts for code compliance need to be strengthened. Also, many of the studies were one-time efforts done with unique methods, and this lack of uniformity has made comparing compliance studies virtually impossible. The main lesson learned from a review of these studies is that the ability to compare compliance rates between states and over time requires developing standard methods for collecting, analyzing, and reporting data. Recent Federal stimulus funding and energy code legislation have quickly created a national need for uniformity in energy code compliance evaluations. The proposed DOE methodology for this purpose, when further developed and tested, can provide this uniformity.

Introduction

Implementation of the American Recovery and Reinvestment Act of 2009 (ARRA) has generated new interest in building energy code compliance assessment. In order to receive supplemental State Energy Program stimulus funding, all 50 states and the District of Columbia have pledged in Governors' letters of assurance to the Department of Energy[1] not only to meet code stringency requirements but also to create plans to achieve and measure 90 percent code compliance within eight years.[2] States have never before faced code or compliance requirements from the federal government. The energy efficiency literature addressing building energy code compliance that was reviewed for this paper provides useful information about who has experience evaluating compliance and where significant gaps exist.

1 See individual state websites: e.g., http://recovery.arkansas.gov/ , http://www.recovery.wa.gov , etc.

2 States have pledged to adopt a building energy code that meets or exceeds the requirements of the 2009 International Energy Conservation Code (IECC) for residential buildings and ASHRAE Standard 90.1-2007 for commercial buildings.

This paper updates and expands previous work by the Building Codes Assistance Project (BCAP) and The American Council for an Energy-Efficient Economy (ACEEE). In 1995, ACEEE conducted a literature review of studies related to building energy code compliance and enforcement (Smith & Nadel 1995). At the time, however, only a small number of states had completed energy code compliance studies. In 2005, BCAP compiled and analyzed 16 state-level residential code compliance studies (Yang 2005). BCAP added several additional state and regional studies from both the residential and commercial sectors to its review in 2008 (Willock 2008; BCAP 2008). In this paper, ACEEE has broadened the scope of the literature review by including new construction baseline studies and program evaluation papers. The studies cover residential and commercial code issues at the local, state, regional, and national levels and will be published in a separate annotated bibliography.

In order to perform a comprehensive assessment of compliance and enforcement activities, ACEEE sent a survey to state officials responsible for building energy codes. This inquiry sought to determine whether states had completed studies on the status of code compliance. The survey garnered responses from 34 state energy officials and others involved in energy codes in 31 states; no responses were received from 19 states or Washington, D.C. ACEEE obtained a few additional reports from survey respondents and learned about compliance studies currently underway in several states. The survey also provided valuable information about deficiencies in code compliance evaluation as most officials confirmed that no compliance work has been completed in their states.

Current Trends in Code Enforcement

Before addressing the details of issues related to evaluation of code compliance and enforcement, it will be useful to review the context in which plan reviews and site inspections for new residential and commercial building design and construction take place.

States delegate the authority to enforce energy codes to local jurisdictions even when the code is set at the state level. The degree to which local building departments are legally responsible for enforcing codes varies widely. In some states, local jurisdictions are not required to enforce the energy code. In Georgia, for example, a 2004 survey indicated that the energy code was enforced in slightly more than half of all jurisdictions (Meres 2009). Although complying with the code is still considered mandatory for all construction projects, in some places there is simply no enforcement.

Building departments have different requirements for demonstrating compliance. One common enforcement model involves the permitting process. In states with lax enforcement, an architect or engineer simply has to certify that the building plan is code-compliant in order to obtain a permit, and code officials are not involved in determining compliance. In California, on the other hand, builders must submit building plans to the local building department for review in order to obtain a permit. A code official also conducts a field inspection prior to issuing a certificate of occupancy. In other states, the inspection may not be required and officials rely solely on plan reviews to determine compliance. Epstein et al. (2005) suggest that this approach may be problematic. Compliance documents were not useful for determining compliance in Massachusetts because finished buildings often differed significantly from their plans. An important implication of this finding is that code enforcement should not be based solely on building plan reviews.

BCAP's 2008 studies on residential and commercial energy code enforcement and compliance provide insight into current enforcement issues (BCAP 2008). The primary goal of the residential study was to provide information on cost-effective code enforcement. To fulfill this goal, BCAP surveyed code officials and created a framework for calculating enforcement costs. The commercial study aimed to obtain information about compliance

issues from the perspectives of both code officials and code users (including architects, engineers, and contractors). A literature review of existing compliance studies informed the development of survey and interview questions as well as the subsequent data analysis for these studies.

After surveying hundreds of code officials from across the United States, BCAP found that the majority are directly employed by local governments, rather than by third parties. The respondents identified budget and personnel limitations as key challenges to code enforcement. BCAP found that energy code officials are typically responsible for both residential and commercial buildings and enforce several codes in addition to the energy code. The survey respondents generally perceive the energy code to be less important than other codes, and therefore officials may neglect to enforce the energy code when faced with time and resource constraints. A 2009 study conducted for Southern California Edison confirmed that the lack of prioritization of the energy code is a major challenge even in California, a national leader in energy efficiency (Heschong Mahone Group 2009).

BCAP also obtained information about education, training, tools, and outreach methods from its 2008 survey. The licensing and certification requirements for code officials vary greatly across states and jurisdictions. Code officials, as a result, have many different combinations of experience, education, and technical expertise. BCAP found that although more than 80 percent of code officials receive training at least once per year, nearly all officials desire additional code information. Familiarity with compliance software is one major area of weakness that future education efforts should target.

The survey results also highlighted the importance of providing information to code users; most respondents believe that enhancing building industry members' access to educational materials and guidance documents will lead to increased code compliance rates. A 2008 evaluation report for the Northwest Energy Efficiency Alliance (NEEA) confirms the need to provide additional materials based on a survey of builders and designers in the Northwest (Seiden et al. 2008). Educational pamphlets and websites are currently the two most popular tools for public outreach, and code officials perceive them to be the most effective methods.

According to BCAP, both the quantity and the quality of training materials for code users and code officials need improvement. Instead of simply covering the content of the code, training should include guidance on how to meet requirements, how to demonstrate compliance, and how to inspect for compliance. Increasing the amount of state-specific training will also be useful for both code officials and code users. The NEEA study also found that existing outreach services, including training, were underutilized primarily due to lack of awareness about their availability; approximately half of builders and designers surveyed were unaware of training opportunities (Seiden et al. 2008).

In addition to conducting surveys, BCAP explored the costs associated with effective code enforcement (Willock 2008). The study addressed staffing, education, training and outreach costs. Quantifying these various costs is essential for estimating the incremental cost of enforcing an energy code and determining the size of staff required. BCAP created a framework for calculating the budget in order to assist in planning and to inform energy code appropriations.

Status of Compliance Assessment Activities

State governments are a common sponsor of code-related studies. While states typically hire independent contractors to collect and analyze data, in one example a government office conducted the study. One of the new reports obtained in our survey was an updated compliance study from the Arkansas Energy Office which had inspected 100 new

homes between 1997 and 1999 to evaluate baseline practices and code compliance (Brown 1999). The Energy Office repeated this procedure in 2006 and compared the results of the two code compliance surveys (Brown 2006). In home rule states where there is no statewide code, local building departments would be responsible for compliance assessment, although ACEEE found only one example of such a study (City of Fort Collins 2002).

Code compliance studies not only assist states in determining the status of code compliance, but can also help identify common causes of non-compliance in individual buildings. The 2006 Arkansas study found much lower compliance rates in the northwest region of the state than in other regions. An analysis of various building measures indicated that builders in the northwest were not making the adjustments demanded by the colder climate in that region compared to the rest of the state. Informed by this finding, the state could design future training programs for builders to address the problem. Such a study, therefore, can potentially contribute to improvements in code compliance.

States may also seek to assess the potential impacts of updating codes through compliance-related studies. Establishing an energy efficiency baseline enables estimations of the energy and economic impacts of increasing building code stringency. In several cases, the U.S. Department of Energy (DOE) has sponsored or conducted such studies on behalf of individual states.

In 2005, for example, the Indiana Department of Commerce supported a commercial building energy code baseline study that showed, based on the results of 55 inspections, that new buildings generally met the 2003 IECC requirements for building envelope and HVAC systems, despite Indiana's current state code being based on the 1992 Model Energy Code (MEC). The buildings in the sample did not, however, generally meet the lighting and switching provisions. The results of the study indicate that the marketplace was already providing stringency levels comparable to the 2003 IECC in some baseline practices, therefore reducing the number of changes needed to update to a newer, more stringent code (ICC & Britt/Makela Group 2005).

Even if determining code compliance is not their primary objective, studies related to energy efficiency programs often provide useful information about code compliance. A variety of entities are involved with these types of programs, including state and local governments, utilities, and regional energy efficiency organizations. Relevant projects may have the goal of evaluating the efficacy of existing programs or potential opportunities for new programs.

A report on the Efficiency Vermont Residential New Construction Program, performed for the Vermont Department of Public Service, is an example of a useful program evaluation. Because the program aims to increase the energy efficiency of new homes, the evaluation included an analysis of data from home inspections and program records and presented code compliance results (Xenergy 2003). In reports analyzing potential targets for energy efficiency improvements, efficiency baselines may be used to estimate compliance rates even when compliance is not directly measured.

Utilities support baseline studies because they are increasingly involved with demand-side management programs. Additionally, determining the energy efficiency of new construction is essential for predicting changes in electricity demand. Individual utilities in California and Texas have commissioned baseline assessments in recent years. NEEA, which receives its funding from major utilities in Washington, Oregon, Idaho, and Montana, has undertaken similar projects in the Pacific Northwest region.

Since NEEA represents a partnership between states, public interest groups, efficiency representatives and utilities, the organization has commissioned studies that specifically involve code compliance assessment in addition to baseline efficiency evaluations. Most recently, a 2008 report presented a baseline assessment of the non-residential sectors in each

state in the region based on data obtained between 2002 and 2004 (Ecotope 2008). The data indicated that code compliance has significantly improved since a similar study was completed in 2001. Also in 2008, a market progress evaluation report contained a code compliance analysis for the residential sector based on data collected in a 2007 study (Seiden et al. 2008). One of the key goals of NEEA's Codes and Standards Support Project is to raise compliance rates, so these types of studies help NEEA track progress and identify opportunities for future activities.

Although several different types of studies provide information relative to compliance assessment, as described above, our review indicates that the level of compliance assessment is weak. Just as a patchwork codes exists across the United States, the number and type of studies that have been completed vary widely. In fact, only a handful of states have experience directly assessing energy code compliance in both the residential and commercial sectors. Most states will greatly benefit from guidance on implementing compliance evaluations in the future. Another implication from the diverse studies is that there is no consistency in study design or in the presentation of findings. This has made comparing compliance studies virtually impossible in the past, as noted by BCAP. In the future, the ability to compare compliance rates between states and over time will require the development of standard methods for collecting, analyzing, and reporting data. The next section of this paper explores these methodological issues.

Trends and Issues in Compliance Evaluation Methodologies

The code compliance studies examined, while diverse in many respects, shared a number of recurring issues and challenges in their methodologies. These include: sample size and selection, data collection methods, metrics for reporting compliance results, and estimating energy impacts due to compliance levels. However, the building energy code compliance evaluation methodology may be made more consistent and provide comparable results across jurisdictions with the advent of the ARRA legislation. Because ARRA requires that states annually report compliance rates and achieve a 90 percent compliance rate within eight years, DOE's Building Energy Codes Program (BECP) has developed a uniform methodology in several US climate regions. These issues and recent ARRA developments are discussed below.

Sample Design

Past compliance and baseline studies have designed the sample set in several ways. While selecting a simple random sample from all buildings in a state may be the ideal way to avoid sample bias, this approach is unfeasible in many circumstances involving on-site inspections. In jurisdictions with high volumes of new construction, visiting the number of sites required to create a valid sample could be prohibitively expensive. Furthermore, in large study areas, the geographic dispersion of buildings in the sample adds to the cost of conducting inspections. As a result, most studies employ some type of stratified sample method and some choose to focus on areas of highest building activity.

Selecting a statistically valid stratified sample requires close attention to a variety of variables affecting the building population. One important factor is climate. Code requirements may differ between regions within a single state due to variations in climate. Detecting variation in compliance rates between climate zones may reveal where changes in practices are most needed (as was demonstrated by the 2006 Arkansas study referenced above). By designing a sample such that each regional subsample is representative, a study

can perform this type of analysis. Housing starts, however, are not likely to be distributed uniformly across the state under consideration. Consequently, geographical divisions should not receive equal weight in the calculation of overall state statistics.

The commercial sector presents a few additional challenges to sample design. The buildings that comprise the commercial building population have many different uses and have more significant structural variations than residential buildings do. Furthermore, commercial building sizes span a much greater range. Treating buildings of all sizes equally in compliance evaluations may generate misleading results, particularly if energy savings estimates are involved. When buildings are divided into categories by size, the frequency of each building size is not correlated with the amount of square footage of new construction represented by those buildings. For example, the recent nonresidential baseline study by NEEA found that the largest 20 percent of buildings represents over 70 percent of the overall new construction square footage, while the smallest 50 percent of buildings represents only 11 percent of the square footage of new construction (Ecotope 2008). The energy impacts of noncompliance in larger buildings may be much greater than for smaller buildings.

In order to assess compliance in a cost-effective manner, future studies should select the smallest sample size possible that accurately represents the building population at a specified level of precision. The high degree of inconsistency observed in the existing literature indicates that states need assistance with selecting a sampling method and determining the appropriate sample size. This guidance should include a recommendation for a standard statistical confidence level for compliance studies.

Data Collection

Studies have based compliance estimates on several different types of data. The simplest studies rely solely on reviews of building plans. A paper presented at the 2005 International Energy Program Evaluation Conference (IEPEC) by Epstein et al. (2005) calls into question the accuracy of building data that is not confirmed by on-site inspections. After reviewing plans and conducting site visits, the authors found that buildings often differed significantly from their design plans. The authors concluded, therefore, that the compliance documents maintained in building departments' files were not useful for evaluating compliance. They also found that compliance documents for commercial buildings were often missing from records in Massachusetts. Similarly, during an effort to quantify non-compliance rates for buildings measures in California, Khawaja et al. (2007) discovered that building permit data was frequently incomplete. These studies indicate that while reviewing documents may be less expensive than conducting site visits, the former may present significant obstacles to obtaining accurate and complete data.

Many studies have in fact involved building inspections. Activities included in site visits range from simply verifying data obtained from plan reviews to conducting energy performance testing. In a few cases, Home Energy Rating System (HERS) evaluations were performed. Surveys of builders, modeling, and utility bill analysis have all been used to supplement information obtained from plans and inspections. Individual studies employ different combinations of these data collection methods, which complicates efforts to compare results. Even studies following the same approach may not collect data on all of the same building components, creating another challenge for data analysis.

Reporting Compliance Results

The majority of past compliance studies have reported the compliance rate as the percent of homes sampled that satisfied 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. If the checklist 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. While this type of compliance rate can also be useful for determining the efficacy of enforcement practices, it cannot be used alone to evaluate energy savings lost due to non-compliance with a code.

A few studies have assigned ratings to individual buildings equal to the percent by which they fail or surpass code requirements. In these cases, the average rating value is reported as the compliance metric. Calling this metric a “compliance rate” can be misleading if buildings that exceed code requirements are included in the calculation of the average. Since the values for above-code and non-compliant buildings cancel each other out, the average percentage does not indicate a particular distribution. Theoretically, the average could be above code even when more than half of the buildings in the sample are non-compliant. If no buildings receive a rating of better than code, the average would be a better indicator of the magnitude of energy savings lost due to noncompliance, but the average would still not reveal the percent of non-compliant buildings. The average percent above or below code can be a useful supplement to, but not a replacement for, compliance rates as defined above. Reporting the average percentage "below code" for non-compliant homes only can provide an indication of the degree of failure, although such averages may still be skewed due to outliers.

Estimating Energy Savings Impacts

Estimating the savings lost due to non-compliance could be very useful in assessing whether increasing code enforcement efforts is worthwhile. 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. One of the latter, a study by Bernier and Metoyer (2007), sought to determine whether compliance models give accurate estimates of energy savings in residential construction. When the authors compared the model results to energy data from end-use metering, they found that the models typically overestimated average annual energy usage, and thus would tend to overstate savings from compliance. The authors identified faulty assumptions about climate and occupancy as the major source of error.

However, *because* the models seemed to err on climate and occupancy assumptions, they would likely also overestimate the baseline against which compliance is measured. Therefore, even though the models did not accurately predict absolute savings, the relative difference between baseline and modeled energy use – the "compliance margin" – should be reasonably accurate. Bernier and Metoyer concluded that even while the models did not produce accurate estimates of absolute savings, they still serve a valuable compliance purpose.

DOE Compliance Evaluation Methodology for ARRA

The DOE BECP and Pacific Northwest National Laboratory (PNNL) have taken on the task of developing and testing a uniform methodology for evaluation of state energy code

compliance to meet ARRA requirements.[3] 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. While still under development, the BECP has already produced a consolidated set of guidelines based on nine earlier Topic Briefs on these issues (BECP 2010). The guidelines provide detailed recommendations on methodologies for meeting ARRA compliance evaluation at different levels of cost, complexity and effort according to available state resources. 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.

The BECP compliance evaluation methodology is expected to make advances in the following areas:

- Uniform methods. A consistent methodology used nationwide has the promise of making evaluation results comparable across states. The lack of uniformity in previous studies has hampered feedback to improve the code inspection process and the model codes themselves.
- Compliance evaluation metrics. The BECP method provides uniform definitions for the compliance metrics. The recommended metric is one where evaluated buildings are each assigned a compliance rating of 0-100% based on the proportion of code requirements that each has met, and the evaluated buildings' scores within a state are averaged to derive an overall compliance metric with an associated confidence. A simple whole building "pass/fail" method was examined but was not felt to meet the ARRA's evaluation goals. Establishing a uniform metric settles many technical and methodological issues for these evaluations.[4]
- Data collection. A key contribution of the BECP method is to recommend standard processes for collection of uniform data across building types. For example, the complex list of variables comprising energy code requirements has been organized into three tiers (high, medium, low) of energy savings impacts, and addresses code requirements such as R-values of insulation installed in the building envelope assemblies; fenestration U-factors and SHGC values; commercial building equipment efficiencies; heating and cooling equipment capacities; infiltration and duct leakage test results; commercial building lighting system controls and connected lighting loads; and generic information about the building being evaluated, such as the compliance approach and the conditioned floor area of the building. Other BECP guidelines recommend on-site evaluation and data collection methods, including recommended qualifications for personnel. The standardized evaluation checklist for residential buildings and instructions for its use should contribute significantly to providing comparable results.
- Sampling issues. For basic state-level compliance metric estimates the BECP method recommends a minimal sample size for each population of residential and commercial

3 See BECP 2010. DOE plans to fund five to six energy code compliance evaluation pilot studies based on this methodology over a 10-month period in 2010. A more detailed timeline is available here: http://www.energycodes.gov/ arra/pilot_studies.stm.

4 The methodology does not provide "extra credit" for above-code buildings. They are encouraged, but voluntary, and therefore do not fall within the scope of the BECP guidelines, which are intended to evaluate and improve legally mandated code compliance. Including above-code buildings when calculating the compliance metric could positively skew the data, obscuring the percentage of buildings that are out of compliance with mandated codes.

buildings. Guidelines have been published on determining sample sizes for a state and sample distribution and make-up. Here again, uniform methods should contribute to approaching sample designs efficiently.

Conclusions and Recommendations

Most code compliance evaluation studies have been "one off" efforts intended to meet a short-term, state-specific need. There has been little consistency in the design of studies or in the presentation of results. This lack of uniformity has made comparing compliance studies virtually impossible. The main lesson learned from a review of these studies is that the ability to compare compliance rates between 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;
- Highlight areas 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 energy code compliance evaluations. The proposed DOE BECP methodology, when further developed and tested, can provide this uniformity. The potential to gain knowledge from ongoing code compliance evaluations for an eight-year period calls for wide use of such a methodology.

References

[BCAP] Building Codes Assistance Project. 2008. **Commercial Building Energy Codes – Usability and Compliance Methods**. Washington, D.C.: Building Codes Assistance Project.

[BECP] Building Energy Codes Program. 2010. **Measuring State Energy Code Compliance**. PNNL-19281. Prepared by the Pacific Northwest National Laboratory for the U.S. Department of Energy Building Technology Program. http://www.energycodes.gov/arra/documents/MeasuringStateCompliance.pdf. Richland, Wash.: Pacific Northwest National Laboratory.

Bernier, C. and J. Metoyer. 2007. "**Cracking the Code for Residential New Construction: Using End-Use Metered Data to Revise Energy Estimates of Compliance Models**." Paper presented at the International Energy Program Evaluation Conference, Chicago, Ill., August 14-16.

Brown, E. 1999. **Energy Performance Evaluation of New Homes in Arkansas**. Prepared for the Arkansas Energy Office. http://www.energycodes.gov/implement/pdfs/Arkansas_rpt.pdf. Little Rock, Ark.: Arkansas Energy Office.

Brown, E. 2006. **Code Compliance Then and Now**. Prepared for the Arkansas Energy Office. Little Rock, Ark.: Arkansas Energy Office.

City of Fort Collins. 2002. **Evaluation of New Home Energy Efficiency: An assessment of the 1996 Fort Collins residential energy code and benchmark study of design, construction and performance for homes built between 1994 and 1999**. Summary Report. http://www.energycodes.gov/implement/pdfs/ft.collins_compliance_2002.pdf. Fort Collins, Colo.: City of Fort Collins.

Ecotope. 2008. **Baseline Characteristics of the 2002-2004 Nonresidential Sector: Idaho, Montana, Oregon, and Washington**. Report #08-196. Prepared for the Northwest Energy Efficiency Alliance. http://www.nwalliance.org/research/reports/08-196.pdf. Portland, Ore.: Northwest Energy Efficiency Alliance.

Epstein, G., Y. Patel, B. McCowan, M. D'Antonio, and S. Haselhorst. 2005. "**Application of Commercial Sector Energy Code Compliance Documents for Assessing Baseline Practice: Assessing Whether Compliance Documents Can Be Used for Developing Lighting Baseline Data**." Paper presented at the International Energy Program Evaluation Conference, New York, N.Y., August 17-19.

Heschong Mahone Group. 2009. **SCE Codes & Standards Process and Market Assessment Study**. Prepared for Southern California Edison. http://www.calmac.org/publications/C&S_Combined_Study_Report_041509.pdf. Fair Oaks, Calif.: Heschong Mahone Group, Inc.

International Code Council and Britt/Makela Group, Inc. 2005. **Indiana Commercial Energy Code Baseline Study**. Prepared for the Indiana Department of Commerce, Energy and Recycling Division. Indianapolis, Ind.: Indiana Department of Commerce.

Khawaja, M., A. Lee and M. Levy. 2007. **Statewide Codes and Standards Market Adoption and Noncompliance Rates**. Prepared for Southern California Edison. http://www.calmac.org/publications/Codes_and_Standards_Final_Report.pdf. Portland, Ore.: Quantec, LLC.

Meres, Ryan (Georgia Department of Community Affairs). 2009. Personal communication.

Seiden, K., A. West, M. Perussi, S. Reeves, and N. Vellinga. 2008. **NEEA Codes and Standards Support Project: MPER#2**. Market Progress Evaluation Report. Report #E08-184. Prepared by Quantec for the Northwest Energy Efficiency Alliance. http://www.nwalliance.org/research/reports/E08-184.pdf. Portland, Ore.: Quantec, LLC.

Smith, L. and S. Nadel. 1995. **Energy Code Compliance**. Washington, D.C.: American Council for an Energy-Efficient Economy.

Willock, K. 2008. **Residential Building Energy Codes: Enforcement & Compliance Study**. http://bcap-ocean.org/resource/residential-building-energy-codes-enforcement-and-compliance-study. Washington, D.C.: Building Codes Assistance Project.

Xenergy. 2003. **Final Report: Phase 1 Evaluation of the Efficiency Vermont Residential New Construction Program**. Prepared for the Vermont Department of Public Service. http://www.cee1.org/eval/db_pdf/420.pdf. Burlington, Mass.: XENERGY Inc.

Yang, B. 2005. **Residential Energy Code Evaluations: Review and Future Directions**. http://bcap-energy.org/files/BCAP_RESIDENTIAL_ENERGY_CODE_EVALUATION__STUDY_June2005.pdf. Providence, R.I.: Building Codes Assistance Project.