The Cost of Enforcing Building Energy Codes

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ABSTRACT

Building codes, if complied with, have the ability to save a significant amount of energy. However, energy code compliance rates have been significantly lower than 100%. Although there are many reasons for lack of compliance, funding and cost may play an important role. The incremental cost of the construction measures needed to comply with building energy codes has been well documented, but the cost of enforcing the energy code has received little attention. In order to estimate the costs of enforcement at the local level, and to inform a national dialogue about the investment needed to improve compliance with building energy codes, researchers initiated a two-phase study. Phase 1 was a literature review, conducted in early 2013, covering more than 150 documents. Phase 2 comprised surveys of 17 general and 23 local experts, from May –July 2013. Phase 2 found the incremental cost of enforcing residential and commercial energy codes using a traditional plan review and inspection process ranged from typically $50 or less per home to nearly $200, and from typically less than $150 per commercial building to over $1,000, exclusive of overhead and travel. Other activities associated with enforcement and improving compliance (such as performance testing, use of voluntary programs, training, and outreach) involve additional costs that are also reviewed in this paper.

Introduction

The purpose of this paper is to present key findings regarding costs associated with enforcing building energy code compliance – primarily focusing on costs borne by local government. Building codes, if complied with, have the ability to save a substantial amount of energy. However, energy code compliance rates have been significantly lower than 100% for a variety of reasons including a cultural view that energy codes are less critical than health and safety codes and a lack of accountability for failure to comply with energy codes.

Although the incremental cost of the construction measures needed to comply with building energy codes has been well documented, particularly by the Building Codes Assistance Project (BCAP) (Pacquette, Miller, and DeWein 2011), the cost of improving compliance and enforcement has received little attention. However, the estimated cost of compliance and enforcement is thought to be significant. For example, a 2010 study by the Institute for Market Transformation (IMT), conducted using limited modeling based on inputs from a task force, estimated that the total nationwide cost for reaching 90-percent compliance would be $810 million annually, compared to current spending of $200 million annually (Majersik and Stellberg 2010). In order to further inform a national dialogue about the invesment needed to improve compliance with building energy codes, Lawrence Berkeley National Laboratory (LBNL) conducted a two-phase study to better pinpoint the costs of enforcement.

In Phase 1, LBNL conducted a literature review to identify the current breadth of information on compliance rates, barriers associated with non-compliance, strategies to overcome these barriers, U.S. Department of Energy (DOE) and key stakeholder involvement in improving compliance, and, in particular, the local government costs associated with energy code enforcement for residential and commercial buildings. LBNL reviewed more than 150

documents that discussed code compliance and enforcement and published a report on the findings in April 2013 (Williams et al. 2013). In Phase 2, LBNL conducted a survey of experts knowledgeable about building code compliance and enforcement to develop an overall range of energy code enforcement costs borne by local governments and to identify more precisely the areas of focus for improving energy code compliance, including where money might be most effectively spent (Williams, Price, and Vine 2014). General experts were surveyed as a way of gaining a big-picture, often national perspective, while local experts were surveyed to gain information on experiences in specific geographic areas and to collect cost data associated with energy code enforcement.

This paper summarizes key findings from Phase 1 and Phase 2, focusing primarily on costs borne by local government associated with the traditional enforcement process including energy code plan review and inspection. This paper also briefly summarizes cost findings for other activities that could complement or supplement traditional processes, such as third-party plan review and inspection, performance testing, Home Energy Rating System (HERS) ratings, training, and outreach.

Sample Overview and Methodology

This section presents the samples of general and local experts as well as a brief discussion of survey instruments, the methodology used for the analysis, and the study's limitations.

Expert Samples

LBNL interviewed 17 general experts, or individuals familiar with code compliance across multiple local jurisdictions, selected based on the Phase 1 literature review and industry knowledge to capture regional distribution and key organizations. LBNL conducted interviews in May 2013 with respondents from regional energy efficiency organizations - Midwest Energy Efficiency Alliance, Northeast Energy Efficiency Partnerships, Northwest Energy Efficiency Alliance, Southeast Energy Efficiency Alliance, and Southwest Energy Efficiency Project; key national organizations - BCAP, IMT, American Council for an Energy-Efficient Economy (ACEEE), and the National Association of State Energy Officials; three state building or energy offices - Connecticut, Massachusetts, and Texas; four consulting companies - Wirtshafter Associates, Inc., Ecotope, BIRAenergy, and Heschong Mahone Group; and one utility - Pacific Gas and Electric Company.

The original sample of local experts was developed based on general experts' recommendations for local government contacts that would be well suited to respond to a survey about the costs of compliance with energy codes at the local level. This list was supplemented with recommendations from local interviewees, as well as local code officials listed in the Compliance Planning Assistance Program gap analyses or jurisdictions prominent in other reports reviewed in Phase 1.[1] As in the general survey, an effort was made to obtain regional distribution. LBNL conducted 23 interviews in June-July 2013. Each local expert interviewed

[1] For more information on the Compliance Planning Assistance Program, see: http://energycodesocean.org/compliance-planning-assistance-program

represented a different jurisdiction.[2] The jurisdictions ranged from a few thousand people to some of the largest cities in the country and represent a wide array of building type, size, and complexity.

Survey Instruments

Two separate surveys were developed for Phase 2, one for general experts and one for local experts. These surveys were primarily qualitative in nature and were treated more as interview guides.

As noted previously, the general experts were each familiar with energy code enforcement across multiple jurisdictions. The goal of the general survey was to utilize the experts' knowledge of commonality or variability across jurisdictions to gain a big-picture perspective on the cost of energy code enforcement, focused less on specific cost estimates and more on contextual information. For the general expert survey, information was collected on several topics, including: time needed for residential and commercial energy code plan review and inspection, reasons for variability in those estimates, options for increasing code compliance for local jurisdictions, and the role of utilities in code compliance and enforcement.

The main purpose of the local survey was to pinpoint energy code enforcement costs for individual jurisdictions. For the local expert survey, information was collected on several topics, including: time spent on traditional enforcement (including plan review and actual building inspection), salaries of plan reviewers and inspectors (in order to calculate cost of time spent), and costs for other enforcement methods, such as performance testing and use of third-parties.

Analysis and Limitations

The costs reported in this paper are presented to inform a national dialogue about the investment needed to improve compliance with building energy codes. They are not intended to be representative of the nation as a whole, and no comparisons between the costs in Phase 1 and Phase 2 can be interpreted with any statistical significance. Development of definitive costs and other related data would require a much larger survey effort and was not the objective of this research. The main analytical choices and limitations of the data and analyses are summarized below.

Not all respondents were able to answer all questions due to the nature of their position or their jurisdiction. However, no respondents were excluded from the final analysis; as a result, the sample size varies by question.

Many of the quantitative data (such as costs, time spent, and percent incidence) were provided by respondents as ranges; when this occurred, the average of the minimum and maximum were used as their single response value. In several cases, respondents provided only a maximum value, which was used as their single response value. The overall median and average values presented in this paper were calculated using the single values for each respondent, preserving outliers with two exceptions noted in this paper. Qualitative results were coded and grouped into like responses, where possible, in order to develop ranked lists of results.

The reported values could be skewed based on the analytical choices; for example, a provided range of 1 to 5 hours may not really average to 3 hours, if 90% of plan reviews take only 1 hour and the remaining 10% take somewhere between 2 to 5 hours. In addition, the costs

[2] See Williams, Vine, and Price 2014 for full list of jurisdictions.

presented are not necessarily indicative of the costs that could be expected in a jurisdiction with many large, complex buildings; high wages; or jurisdictions with limited building enforcement experience and infrastructure. In particular, obtaining costs by specific commercial building type rather than for the commercial sector in general would help estimate more representative costs beyond the jurisdictions surveyed. The costs are exclusive of benefits, overhead, and travel, which could potentially triple or even quadruple the presented costs. In addition, the costs presented are incremental for jurisdictions that already enforce non-energy building codes; this paper does not capture the costs associated with developing enforcement infrastructure in jurisdictions without any prior enforcement experience.

The local survey in Phase 2 was not intended to be a representative sample of local jurisdictions, states, or the country as a whole due to the small sample size. Furthermore, the nature of this survey and the sample development resulted in a sample bias toward energy code enforcement. Most of the contacts recommended for this survey, and others who responded to the solicitation, were generally supportive of, or even excited about, the energy code and, therefore, willing to spend time answering a lengthy questionnaire. The sample of local experts should likely be interpreted as a best case scenario – indicative of the time and resources available in jurisdictions that value the energy code. It would not be representative of practices across the nation.

Local Government Costs for a Traditional Enforcement Process

Local level enforcement of building codes generally begins with a permit application.[3] Code officials then review building plans before issuing a permit and may perform inspections during construction to verify compliance. A certificate of occupancy will be awarded after compliance is verified. This section details the costs of these processes, obtained from both the literature review and general and local surveys.[4] The associated costs reflect the incremental time spent on energy code review and inspection beyond that devoted to other building codes, as well as the hourly wages of those performing the reviews and inspections.

Residential

Literature review. BCAP (2008) estimated that residential energy plan review typically requires 15 to 45 minutes, and residential energy inspection typically requires 30 to 60 minutes, for an overall average of 1.25 hours. BCAP recommended that jurisdictions allocate 2.5 hours for residential plan review and inspection for energy codes (OCEAN 2010a), twice the estimated average. A DOE report based on 130 jurisdictions in two states estimated average residential plan review at 1.4 hours and field inspection at 1.6 hours, for a total of 3 hours (DOE 2013a). The Maine Public Utilities Commission (MPUC 2004) also estimated up to three hours of incremental work for residential energy enforcement.

Using BCAP's estimate of 1.25 hours and assumed average wage of $25, the cost was $31 per average home. MPUC (2004) estimated between $50-$100 per home, based on a wage

[3] For a general description of the building code compliance and enforcement process at the local level, see Misuriello et al. 2010.

[4] While the Phase 1 literature review covered over 150 documents, only seven included specific time or cost information for traditional energy code enforcement activities (plan review and inspection) at the local level; these reports are all referenced in this paper.

of $30 per hour. Neither the BCAP nor MPUC estimates included training and support, infrastructure costs, or administration and overhead.[5] The cost increases if building size and complexity increase, or if a residence requires additional review and inspection because it failed to meet code (BCAP 2008).[6]

General survey. General experts received an anchor point of 1.25 hours for average residential plan review and inspection, as estimated by BCAP (2008). There was no consensus as to whether this estimate was appropriate. Eight respondents felt this value was reasonable. Seven felt the time was too low. One felt it was too high in general, and another felt it was too high only for a prescriptive approach but about right for a performance approach. Those that believed the time was appropriate assumed the following: (1) few problems occur in the review process, (2) the most appropriate measures are prioritized for review, (3) appropriate tools are available, and (4) houses are conventional and are at code minimum. If these assumptions were not true, then the estimates would likely be higher. One national expert reported that the 2009 and 2012 model building codes require more time than past codes and that the time requirement may need to double from 1.25 to 2.5 hours. The general experts noted that the time required depends primarily on the following variables:[7]

- provision of plans and drawings (*i.e.,* better plans make for shorter reviews) [7];
- education of plan reviewer and inspector (*i.e.,* the more educated, the less time it takes to conduct plan review and inspection appropriately) [5]; and
- size and complexity of building (*i.e*., smaller and simpler buildings take less time) [4].

Local survey: plan review. For residential new construction, nearly all jurisdictions conducted plan reviews. However, one jurisdiction did not conduct plan reviews, and another jurisdiction simply reviewed items as they came in at the counter but not as part of a formal review. The local expert from the jurisdiction that did not conduct plan reviews noted that they would like to add this task in addition to building inspections, but the jurisdiction would need additional funding.

Many plan reviews primarily focused on architectural and structural items and not on interior building components such as electrical and plumbing that impact energy use in buildings. Therefore, the envelope may be the only energy-related item checked in the plan, with reporting of U-values and R-values often required. However, many jurisdictions noted more extensive reviews, including the Air Conditioning Contractors of America (ACCA) Manuals J, S, and D[8]. A few jurisdictions required RES*check*™[9]. One jurisdiction also required the design drawings to include values that were produced by code compliance software tools (typically RES*check*), as well as a list of all the code-required inspections that have to take place during construction. For this jurisdiction, a professional inspector must sign off that the values in the completed buildings were the ones approved in the energy analysis.

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

[6] See Williams, Price, and Vine 2014 for a review of re-inspection rates in various jurisdictions.

[7] Numbers in brackets indicate the number of experts reporting a response.

[8] ACCA Manual J: Residential Load Calculation; ACCA Manual S: Residential Equipment Selection; ACCA Manual D: Residential Duct Systems (ACCA 2014).

[9] RES*check* is a software tool developed by DOE to "simplify and clarify" energy code compliance for residential building projects (DOE 2013b).

All local experts noted that their jurisdiction generally relied on integrated plan review, where energy code is reviewed at the same time as other codes. However, one local expert noted that complicated projects went to an energy specialist, and another local expert said that one plans examiner had primary responsibility for energy review, but that other examiners could do it for less complicated projects. A third local expert noted that Manual J calculations were reviewed separately from the rest of the plan review.

The plan review time for energy code varied, as did the time spent on overall plan review, as shown below. Two local experts noted that prescriptive compliance took a lot less time to verify than RES*check* – approximately 15 minutes as opposed to 30-45 minutes. As noted by the general experts, other reasons for variability in responses may include typical building size and complexity in the jurisdictions, as well as experience of designers, contractors, and code officials in each jurisdiction. Other jurisdictions not surveyed may have different conditions that would result in different ranges.

- Time for energy code review ranged from 2-3 minutes (for plans coming from production builders) to 2-4 hours for checking all Manual calculations.
- The median time for energy code review was 30 minutes, and the average time was 43 minutes.
- The total time spent on energy code review was approximately 20% of the total time spent on plan review.

Residential plan reviewer salaries ranged from $30,000-$113,000, with a median salary of $52,000, or approximately $25 per hour.

Local survey: inspection. All jurisdictions required on-site inspections for residential starts except in a few cases where inspections were superseded by the use of ENERGY STAR. While one jurisdiction did not perform inspections themselves, instead requiring the owner to hire a professional inspector (a licensed architect or engineer), the remaining jurisdictions performed inspections with in-house staff. Nearly all jurisdictions had energy inspections integrated with other building inspections, aside from the insulation inspection, which only applies to energy and was often conducted separately. Only two jurisdictions conducted entirely separate energy inspections. The number of site visits including energy inspection ranged from 1 to 15, with a median of 3 and an average of 4.[10] The time for inspections varied significantly as shown below:

- Energy code inspection times ranged from 10-12 minutes to 4-5 hours.
- The median time for energy code inspections was 30 minutes, and the average time was 68 minutes.
- Time for an energy code inspection was typically less than 20% of total inspection time.

The salary of a residential inspector ranged from $30,000 to $100,000. The median was around $54,000, which equates to approximately $26 per hour.

[10] Inspections including energy code requirements may include foundation, framing, trade rough-ins (e.g., mechanical, plumbing, electrical), insulation, drywall, trade final, and building final (BCAP, SEEA, and Southface 2012). Not all jurisdictions may require all these inspections, as they can be difficult to schedule and each site visit results in increased costs; some inspections may be combined into one site visit. Some jurisdictions may also be reporting site-visits for re-inspections where noncompliance was found on the first visit.

Local survey: total cost. Input gathered from Phase 2 surveys found that the median times for residential energy code plan review and inspection were 30 minutes each, resulting in a total time of 1 hour, less than all of the estimates in the Phase 1 literature review. The median salaries were approximately $25 per hour, which is consistent with the estimate by BCAP (2008). Using average values, energy code review and inspection takes 1.9 hours per home at approximately $26 per hour, or a total of $49 per home. These costs are exclusive of fringe benefits, overhead, and travel.

The maximum cost calculated for any individual jurisdiction in this survey (maximum time for plan review and inspection multiplied by average salary) was $168. Across all jurisdictions, the maximum times reported ranged up to 4 hours for plan review and 5 hours for inspection,[11] resulting in 9 hours dedicated to plan review and inspection at a cost of $26 per hour, or a maximum per home cost of about $234. The range of costs is not strictly dependent on jurisdiction size.

Commercial

Literature review. Massachusetts received commercial estimates of 10 minutes to 2 hours for plan reviews and 15 minutes to 4 hours for field inspections (DNV KEMA, ERS, and APPRISE 2012). DOE (2013a) showed commercial plan review averaging 1.9 hours and inspection averaging 2.5 hours, for a total of 4.6 hours. MPUC (2004) estimated a commercial energy enforcement cost of less than $500 for small, common buildings, but thousands of dollars for more complex buildings, partly because of the increased fees for a professional engineer to do an inspection. Using Maine estimates of labor rates, the costs in Massachusetts would range from $13 - $180 per building at $30/hour, up to $810 at $135/hour, and the costs estimated in the DOE report would equate to $138 per building at $30/hour, up to $621 at $135/hour.

General survey. General experts had trouble answering questions regarding commercial plan review and inspection time. They were provided with the Massachusetts time estimates as an anchor point. Five experts indicated that this seemed appropriate. Four did not give an answer. The remaining eight experts felt that the 10-minute figure was too low and that the range expanded beyond 4 hours on the high end. On the commercial side, the most prevalent reason for variability, cited by 13 experts, was the type, size, and complexity of building. The experience and knowledge of the code inspector was mentioned as a key variable by 5 respondents.

Local survey: plan review. On the commercial side, all of the jurisdictions interviewed conducted plan reviews, although not always for all trades. Eight jurisdictions required COM*check*™,[12] while others only required documentation and sometimes load calculations. The documentation required may have various levels of review and verification; one local expert noted that forms with envelope information were not verified. Almost all jurisdictions conducted integrated plan reviews, although one jurisdiction had a separate energy code review for large projects. One local expert noted that verifying compliance for energy code took the longest time compared to other parts of the code, and another local expert said that the mechanical reviewer

[11] The maximum referred to here is the high end of the range provided to us by a respondent. It does not always indicate the absolute maximum in the jurisdiction; it may be the maximum of their best estimate of average.

[12] COM*check* is a software tool developed by DOE to "simplify and clarify" energy code compliance for commercial building projects (DOE 2013b).

spent almost all of their time on the energy code. The reasons for variability are the same as for residential, although the range is exacerbated due to the wide variety of commercial projects (in terms of building type, size, and complexity) within and across jurisdictions.

- The time spent on energy code review ranged from a few minutes to 2 days.
- The median time for energy code review was 1 hour, and the average was 2.3 hours.
- For a given jurisdiction, energy code inspection was typically under 20% of total inspection time.

The salary for a commercial plan reviewer ranged from $30,000 to $100,000. The median salary was $55,000, or an hourly wage of approximately.

Local survey: inspections. All jurisdictions required on-site inspections for all buildings, but in one case these were done by third parties. Inspections were typically integrated, except for the insulation inspection, which was often conducted separately. The number of visits to a single site that included energy inspections ranged from 1 to 20, with a median of 4 and an average of 5. One local expert reported that inspections in his region focused on the envelope and insulation, rather than mechanical systems, because if mechanical system issues are not caught in the plan review, it is too late to make any changes in those systems upon inspection.

- The time for energy code inspection ranged from 30 minutes to days or months, depending on the type, size and complexity of the building and its mechanical systems.
- The median time was 1.3 hours, and the average time was 2.7 hours (excluding two outliers of "days" and 6 months).
- For a given jurisdiction, time spent on an energy code inspection was around 15% of total time spent on inspections.

The salary for a commercial inspector ranged from $30,000 to $100,000. The median was $55,000 per year, or an hourly wage of approximately $26.

Local survey: total cost. Input gathered from the Phase 2 surveys resulted in a median time of 1 hour for commercial energy code plan review and 1.3 hours for inspection at a median salary of $26 per hour. This equates to $61 per commercial building. Using average values, plan review takes 2.3 hours and inspection takes 2.7 hours, for a total of 5 hours, similar to the total identified in the Phase 1 literature review. At $$28 per hour on average, this equates to approximately $139 per commercial building, which is on the low end of the costs estimated in Phase 1.

It is very difficult to identify the top end of spending for commercial buildings given the wide range of building type, size, and complexity. The maximum calculated cost in any jurisdiction (maximum time for review and inspection times average salary) was approximately $1,000. However, certain projects may require months of an inspector's time, resulting in several thousands of dollars for energy code alone. It is expected that these would be very rare, except possibly in jurisdictions with many large, complex buildings.

Supplemental and Alternative Enforcement Processes

In addition to costs incurred for traditional enforcement processes of plan review and inspection, some local jurisdictions use alternative or additional methods of code compliance and enforcement. Third-party energy code enforcement has been suggested by general experts as a

way to increase compliance and reduce financial burden on local jurisdictions, whose officials may not have enough time, or needed expertise, to focus on the energy code. Where third parties are used, jurisdictions may require builders to hire third parties for plan review and inspection, give builders the option to do so, or contract directly with third parties for work when needed. In the Phase 2 survey, while a few local jurisdictions allowed or required owners to hire third-party inspectors, jurisdictions were more likely to outsource to third parties if overloaded, most frequently for all building codes, not just energy. Local jurisdictions that outsourced gave third parties either all, or a portion of, the plan review or permit fees. This indicates that third parties are often no more expensive than in-house plan review and inspection. Therefore, the Phase 1 cost estimates for third parties, of $200 for residential (MPUC 2004) and $750-$940 for commercial (Cohan 2011) may be too high, unless third parties are negotiating higher rates when contracted directly by builders or owners.

Additional methods of verifying energy code compliance include performance testing or programs such as HERS ratings. Performance testing determines compliance through testing building envelope and duct leakage, along with other building features.[13] The Phase 1 review identified typical performance testing costs of $300-$400 per home (IMT and GBPN 2011a, 2012; Meres et al. 2012), compared to a range of $90-$500 per home found in Phase 2. The range is likely due to the type of testing reported; the low end is for a single test, while the high end may include a HERS rating. A HERS rater can work with developers from start (building plans) to finish (occupancy), developing a HERS index to determine whether the building complies with code.[14] The range found in the literature for this service was $450-$1700 per home (OCEAN 2010b; WSDC 2011), while the range in the surveys was $275-575. It may be that the higher costs of Phase 1 account for inspection and testing on all homes rather than a sampling approach that may be employed for production homes. However, there may also be differences in cost by location due to quality or extensiveness of requirements.

Use of third-parties for plan review and inspection, performance testing, or HERS ratings all require expenditures by a local jurisdiction or state for administration, quality assurance, and oversight. The range found in the literature review was $23,000-$300,000 per year (IMT and GBPN 2011a, 2011b; Kunkle 1997; MPUC 2004), while the Phase 2 surveys found $25,000-$500,000 with one high outlier. Local jurisdictions could also make compliance-related investments in training of code officials and outreach to owners, contractors, and others regarding the importance of energy efficiency and energy codes. The per full-time equivalent (FTE) training budgets identified in the Phase 2 surveys are consistent with the costs for a student attending one or more energy trainings a year. However, the overall training and outreach budgets identified in the surveys are significantly less than those recommended by BCAP (2008). These budgets may be less than ideal, although in some cases the training budgets are supplemented by in-house training by an energy expert.

Cost Summary and Conclusions

This paper summarized key findings from Phase 1 and Phase 2, with a focus on costs to local government based on the traditional enforcement process of plan review and inspection,

[13] Performance testing is required by the 2012 International Energy Conservation Code (IECC) and therefore is mandatory in jurisdictions that have adopted that code, but it supplements, rather than replaces, traditional plan review and inspection.

[14] The 2015 IECC will allow a HERS Index Score to be used as a voluntary performance compliance path.

and touching briefly on the cost findings for other activities including third-party plan review and inspection, performance testing, voluntary programs, training, and outreach. Table 1 summarizes theses costs; as stated previously, the costs are not intended to be representative of the nation as a whole, and no comparisons between the costs in Phase 1 and Phase 2 can be interpreted with any statistical significance.

Table 1. Local jurisdiction costs for energy code enforcement: Phase 1 and Phase 2 comparisons

Activity	Sub-Group	Sector*	Cost Phase 2	Cost Phase 1**	Phase 1 Reference
Traditional [costs do not include overhead or travel]	Plan Review and Inspection (energy incremental)	R	$25-$45/home (typical); $192+ maximum	$31-$100/home (average/recommended)	*BCAP 2008; DOE 2013a; MPUC 2004; OCEAN 2010a*
		C	$61-$139/building (typical); $1000+ maximum	$13-$1000s/building (full range)	*DNV KEMA, ERS, and APPRISE 2012; DOE 2013a; MPUC 2004; Smith and Nadel 1995*
Alternative / Supple-mental	3rd Party Review or Inspection	R	Equal to or less than in- house	$200 (estimated)	*MPUC 2004*
		C		$750-$940 (estimated)	*Cohan 2011*
	Performance Testing	R	$90-$500/ home (full range); $325 median	$300-$400/home (typical)	*IMT and GBPN 2011a, 2012; Meres et al. 2012*
	HERS Rating	R	$275-$575/ home (full range); $400 median	$450->$1,700/home (full range)	*OCEAN 2010b; WSDC 2011*
	3rd Party Admin-istration		$25,000-$500,000 (full range excluding 1 high outlier)	$23,000-$300,000 (full range)	*IMT and GBPN 2011a, 2011b; Kunkle 1997; MPUC 2004*
Training	Training per Full-time Equivalent (FTE)	R,C	$50-$1,000/ FTE/year (full range)	$60-$250/class or certification	*BCAP 2008, BCAP and AEO 2010; BCAP, SEEA, and Southface 2012*
	Training per Jurisdiction	R,C	$0- $15,000 (full range); few thousand (typical)	$5,000/year (ex. 4 FTE, 29 hours/year each, including downtime)	*BCAP 2008*
Outreach	Outreach	R,C	$0-$6,000/ year (full range excluding 2 high outliers)	$39,000/year (ex. 4 FTE including downtime)	*BCAP 2008*

*R = Residential; C= Commercial.
**Some Phase 1 costs estimated based on the cited sources. See Williams et al. 2013 for further details.

The results of the Phase 2 survey show time spent on residential energy code enforcement to be, on average, lower than the times estimated or recommended in the literature (as identified in the Phase 1 review). The surveys indicate that shorter times may be a result of well-trained designers, contractors, and code officials. As noted by the surveyed experts, when attempting to improve compliance, focus should not necessarily be put on increasing the time spent on plan review and inspection across all jurisdictions, but rather investing in resources, such as training

tools, or outreach, that allow the time needed to be as short as possible. Experts added that in order for these investments to occur, key stakeholders must make long-term commitments to code compliance and enforcement, and there must be a cultural change that prioritizes energy efficiency, along with life and safety, in order to get the energy and carbon savings that codes are expected to save.

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