Third-Party Performance Testing for Energy Code Compliance

Value added through verification and accountability

A case study of energy code enforcement in Austin, Texas

IMT Institute for Market Transformation

Fall 2011

In the City of Austin, Texas, which had grown to nearly 800,000 residents by 2010, the adoption and implementation of a requirement for third-party testing to verify compliance with energy codes in new residential buildings has bolstered energy efficient residential construction. The process of designing and adopting a third-party testing requirement has generated awareness among developers, homebuilders, and contractors of the need to achieve minimum energy efficiency standards. Implementation of a code-required testing program has held these stakeholders more accountable for seeing that these standards are met. The end result: higher energy code compliance rates in newly constructed homes.

Fast Facts

45 *– Number of performance testers registered with Austin Energy – 4 of these contractors do 60% of testing.*

1,909 *– Number of new homes and renovations tested in Austin during FY 2010*

$400 *– Average cost for performance testing*

$165 *– Energy savings per household each year with the adoption of IECC 2009 (BCAP).*

$131,200 *– operating budget of performance testing administrators.*

800,000 *– Population of Austin*

2015 *– Year when code will require all newly constructed or renovated homes to be zero energy capable*

Austin's experience highlights a number of design and implementation elements that can contribute to the success of a third-party energy code enforcement program, including

- gaining broad-based stakeholder support around a third-party enforcement role;
- securing sustainable, long-term financing for program administration;
- designing an administrative structure that allows for adequate program oversight without being so burdensome as to offset any resource or capacity gains accrued from delegating responsibility to third-party agents; and
- scrutinizing program performance in order to identify areas where incremental improvements can be made.

Austin's experience also provides an instructive model that other jurisdictions can refer to when considering how to verify compliance with the residential performance testing requirements in the International Energy Conservation Code (IECC).[1(Details)]

Background

In 2006, then-Mayor Will Wynn and Austin's City Council committed the City of Austin to improving the sustainability of its residential building stock by requiring all newly constructed residential buildings to be zero-energy capable by 2015.[2(Definition), 3(Details)]

[1 (Details)] The IECC 2012 includes mandatory envelope infiltration and duct system leakage testing, whereas Austin's local amendments to the IECC 2006 require these same tests as well as air flow and system static pressure testing. The IECC 2009 requires mandatory duct system leakage testing, but allows for either envelope infiltration testing or a visual inspection.

A Zero Energy Capable Homes Task Force (ZECHT) was convened and met from October 2006 to April 2007. The task force developed a package of local amendments to the IECC 2006—along with incremental goals to be incorporated during each code review year through 2015—that could help bring about the energy efficiency gains needed for new homes to become zero-energy capable (Figure 1). In recognition of the role that energy code compliance plays in achieving increased energy efficiency in newly constructed buildings, one of the Task Force's key recommendations was the adoption of a performance testing requirement for all new residential single- and multi-family homes.[4(Details)] According to this testing requirement, all new homes built in the City of Austin would need to pass a variety of performance tests administered by third-party companies prior to final mechanical inspection by the City's Planning and Development Review Department. The results of these tests would verify a new building's compliance with energy code provisions regarding mechanical systems and a building's thermal envelope (see "Holding Builders Accountable"). The IECC 2006 and the local amendments recommended by the ZECHT were adopted in October 2007 and became effective on January 1, 2008. An eventual goal for Austin Energy is to require residential energy

Holding Builders Accountable

The performance tests implemented by Austin in 2006 go beyond those that will be required under the IECC 2012. Like Austin's, the IECC 2012's performance testing aims to increase the efficiency of a new home by limiting envelope infiltration and duct leakage. Austin's required performance testing, however, also seeks to encourage designers, builders, and contractors to install the most appropriate and effective heating and cooling systems given a home's size and architecture. Both Austin's and the IECC's testing requirements serve to eliminate waste in system operation, but by holding builders accountable for meeting system airflow and room pressurization requirements, Austin also seeks to induce builders to properly size and configure the mechanical systems they install.

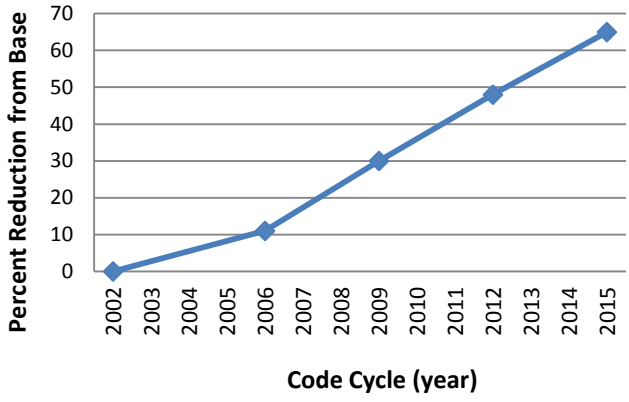
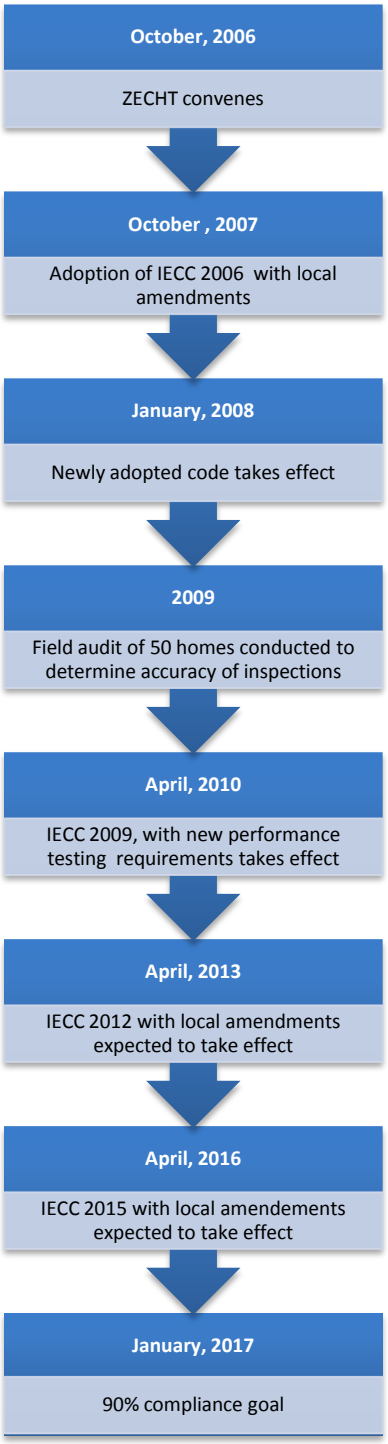


Figure 1: Zero energy capable homes (ZECH) energy reduction goals

[2 (Definition)] Zero-energy capable homes are those that are energy efficient enough to achieve net-zero energy consumption over the course of the year with the addition of on-site renewable energy generation. The City of Austin defined a zero-energy capable home as a single family home that was 65 percent more energy efficient than a typical home built to the Austin Energy Code in 2006 (82,499 MBTU). Energy consumption values were attained using computer modeling.

[3 (Details)] See Zero Energy Capable Homes for more information about Austin's Zero-Energy Capable Homes program.

[4 (Details)] The performance testing requirement also applies to residential building shell construction, complete build-outs, finish-outs, additions and major building remodeling projects. The code-required testing program administrator (see ***Administering Third-Party Testing Contractors*** section) provides testing companies with general guidance about which performance tests apply in different situations, depending on the type of renovation being undertaken in a residential space. Testing companies and individual technicians can also contact the program administrator directly for specific guidance around a particular renovation project.



code plan reviews during the building permit application process. Finally, the commercial code is expected to have performance requirements with the adoption of the IECC 2015[5].

The testing requirement was designed to maximize the energy efficiency gains associated with the City's building energy code while minimizing the administrative burden placed on the City's Planning and Development Review Department. Like many municipal building departments around the country, Austin's Planning and Development Review Department was already underfunded and overworked. Therefore, responsibility for overseeing performance testing was not assigned to Department staff. A number of factors contributed to this decision: the training hours and capital expense associated with in-house performance testing; the difficulty of retaining skilled testing technicians during lulls in the building cycle; and the time demands imposed by the energy code inspection duties already assigned to Planning and Development Review staff.

Placing the performance testing requirement in the hands of private third-party contractors was identified as the best alternative to developing an in-house capacity.

Stakeholder Consultation

The ZECHT was formed as an inclusive body of various stakeholders representing interests that would be affected by the adoption of more stringent building energy efficiency requirements, including relevant industry trade associations (i.e. homebuilders, HVAC contractors, and architects), energy efficiency advocates, affordable housing providers, Austin Energy and the local gas utility, and relevant City bodies. Austin's Resource Management Commission, Electric Utility Commission, and Watershed Protection Department were all represented on the ZECHT. Membership on the taskforce provided each of these groups the opportunity to voice their concerns with a performance testing requirement and to influence

Figure 2: This sequence of events depicts the code adoption process in Austin, beginning with the creation of a Zero Energy Capable Homes Taskforce (ZECHT) in 2006. The plan developed by ZECHT called for periodic code updates between 2007 and 2015, which would result in homes energy efficient enough to achieve net-zero energy consumption over the course of a year, and with the addition of on-site renewable energy generation. Performance testing requirements—including blower door, duct leakage, air flow, and system static testing—came into effect in 2010 to ensure that homes were in compliance with codes.

[5] This requires the development of enhanced modeling capabilities, and a knowledgeable workforce of engineering firms to conduct performance tests.

the ultimate design of the testing program.

The greatest opposition to a third-party performance testing requirement came from the homebuilding industry. Homebuilders would be responsible for seeking out and hiring testing companies to perform the code-required testing, and industry representatives opposed the requirement on grounds that it would increase the industry's total costs (performance testing by third-party contractors typically costs around $400 for single-family homes of 2,000 square feet or less). However, representatives from the City were adamant that the additional expense would be far outweighed by the lifetime energy savings resulting from greater energy efficiency—according to the Building Codes Assistance Project, an estimated $165 each year with the adoption of amendments to the 2009 IECC. *The interests of the building industry had to be weighed against the interests of the consumer, who would ultimately bear the costs of operating an inefficient home*.[6(Definition)] The interests of the building industry also had to be weighed against the City's interest in seeing its broader energy efficiency policy goals met.

The City of Austin's primary strategy for addressing the building industry's concerns was to raise awareness about the scope of the City's energy code compliance problem so that all parties had an incentive to find a solution (see "Evidence of Energy Inefficiency"). When confronted with evidence of inefficient construction, home-builders came to view the third-party testing requirement in a more positive light. Duct leakage testing, for example, was a way to verify that installed HVAC systems were meeting code requirements and that builders were receiving quality, code-compliant work from their mechanical contractors.[8(Details)] With better information, homebuilders could weigh the costs of testing against the benefits of the program.

Evidence of Energy Inefficiency

By virtue of Austin Energy's long-running energy efficiency rebate and green building programs, the City of Austin possessed a substantial amount of benchmark data illustrating the inefficiency of many of the City's homes.[7 (Details)] For example, this benchmark data showed that most newly installed duct systems in the City were leaking on an order of 20-25% of capacity. According to anecdotal estimates, prior to the institution of the performance testing requirement, 85 – 90% of new homes were not meeting the 10% duct leakage standard required by the energy code. Yet most homebuilders and HVAC contractors alike were unaware of the degree to which HVAC duct system leakage and other problems were decreasing the efficiency of residential buildings. With this benchmark data, the City could credibly communicate the scope of the City's energy efficiency problem.

Administering Third-Party Testing Contractors

In line with the decision to buffer the Planning and Development Review Department from any added responsibility stemming from the performance testing requirement, Austin's code-required testing

[6 (Definition)] Austin Energy is the community-owned municipal electric utility that serves the City of Austin and supports the administration of the City's performance testing requirement.

[7 (Details)] See Rebate Programs and AEGB for more information on Austin Energy's energy efficiency programs.

[8 (Details)] Mechanical contractors also saw a benefit to the code-required testing. The required pressure differential test encouraged builders to meet room pressurization standards for which mechanical contractors had been lobbying for years. Most customer comfort complaints received by mechanical contractors are a result of pressurization differentials between rooms and are unrelated to the base mechanical systems installed by these contractors; room pressure differential testing would help rectify this issue and increase customer satisfaction with the work performed by mechanical contractors.

program is administered by a staff member from Austin Energy's Green Building program. This staff member, the program administrator, is the party responsible for certifying, registering, and overseeing all third-party testing companies wishing to conduct code-required performance testing in the City of Austin. These tasks make up only 15% of the administrator's responsibilities at Austin Energy. The nature of the policy set in place instills a new mindset in builders and mechanical contractors, motivating them to meet performance requirements from the start, and resulting in minimal oversight requirements on the administrative end.

Energy Source	Cost in 2008 ($/MWh)[11]
Energy Efficiency	24
Renewable Energy	33
Nuclear Power	35
Coal Power	41

Since Austin Energy's Green Building program had experience with home performance testing through its *Home Performance with Energy Star* service, the Planning and Development Review Department felt that Austin Energy was better suited to oversee the code-required testing program. Austin Energy provides budget support for the Green Building program's operations because the program is able to document reductions in peak load demand resulting from its energy efficiency initiatives. Energy efficiency, especially of new load growth is one way Austin Energy plans to meet its peak load demand through 2020. In fact, incentivizing energy efficiency cost Austin Energy just $23.50 per MWh in 2008[9] while renewable energy, nuclear and coal generation cost $33, $35 and $41 per MWh respectively.[10] (Financing for the administration of the code-required testing program—an operating budget of $131,200—can be justified given the role that effective enforcement plays in achieving higher rates of energy code compliance. Placing the administration of the testing program with Austin Energy takes advantage of the utility's technical expertise, and its role in developing the City's energy code.

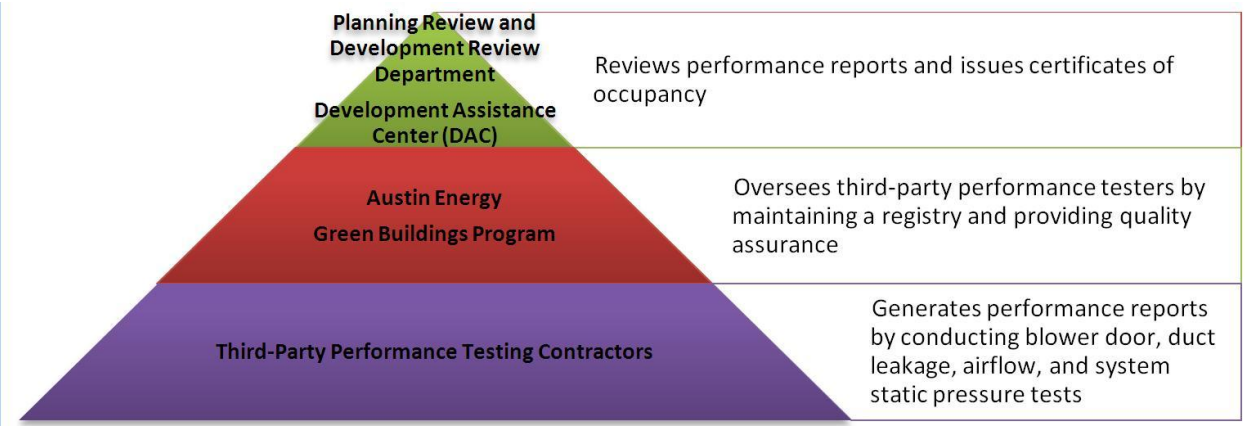


Figure 3: Hierarchy of energy code compliance oversight

[9] Weighted utility life cycle cost of all programs (residential, commercial, and Green Buildings) reported in DSM Performance Measures Report. In 2010, incentivized energy efficiency cost decreased to $21/MWh.

[10] Cleanest was Cheapest Energy in 2008, Power Smack

Certification and Registration

Home performance testing in Austin is carried out by a pool of approximately 45 testing companies, some of which are sole proprietorships and some of which are larger businesses employing multiple technicians.[11(Details)] A small proportion of the testing companies are very active in the market—four of these companies carry out approximately 60% of performance tests—while the remaining inspectors do only occasional testing work.[12(Details)]

To become registered with the City as a code-required tester, an individual technician must demonstrate knowledge and expertise around energy efficiency matters by holding certification as a Home Energy Rating System (HERS) Rater, National Comfort Institute (NCI) Analyst, or Building Performance Institute (BPI) Building Analyst. Performance testing companies must register each technician on staff and provide proof of qualification, submitting all necessary paperwork to the program administrator on a one time basis; testing companies need to submit additional paperwork only when bringing on new technicians.

Relying on external credentialing systems for individual technicians injects a degree of quality variability into the performance testing program, but it is an essential element that relieves the administrator of the enormous burden of having to design an in-house certification system and then evaluating all prospective technicians against this metric.[13(Details)] Relying on a variety of widely-held professional certifications also created an immediate pool of technicians to draw on when the code-required testing program was first implemented, thereby addressing the homebuilders' concern that there would be an insufficient supply of technicians to meet demand.

Reporting Test Results

After completing all code-required performance tests for a new residential building, technicians will either leave a completed test report form on-site or provide it to the homebuilder, who will be responsible for providing the completed form to City inspectors. *The test report form is a relatively simple excel document, whose design serves the express purpose of being quickly and easily reviewed by*

[11 (Details)] There were 43 registered testing contractors as of the time of this writing. See 3rd Party Testers

[12 (Details)] This variability in market share reflects that the business model for most of the City's testing contractors is not totally dependent on energy efficiency testing. Many testing contractors are also field technicians that serve as third-party code inspectors for other elements of the City's building code, engage in land surveying and Energy Star rating work, or are otherwise involved in some aspect of the building industry. Contractors therefore have some flexibility to shift personnel between their different service areas in order to accommodate changes in demand for energy efficiency performance testing. Some testing contractors may only provide testing services at times of peak demand, when the most active testing contractors lack the capacity to meet this demand. As a result, performance testing is typically completed within three days of contacting testing contractors.

[13 (Details)] To address the variation in skill and knowledge that is evident between the different technician certifications, the administrator is considering instituting a policy whereby technicians can be granted a provisional registration if they possess a BPI certification, but they will be required to obtain HERS certification within eight months in order for the registration to remain valid. This policy would be based on the administrator's own observation that technicians possessing a valid HERS certification are the most qualified and conduct the most rigorous performance tests. Seventy to eighty percent of performance testing is presently completed by HERS-certified technicians, so this policy would not be a significant departure from current practice.

City inspectors without requiring any additional explanation or calculation on the inspector's part. Information on the test report form allows inspectors to rapidly determine whether a new home meets code requirements or identify those areas where the building needs to improve before it can pass inspection. However, a best practice for reporting the test results would be electronic submission to a central registry.

If a new home fails to meet the City's energy efficiency standards, the technician who performed the testing will inform the homebuilder and the mechanical contractor of the failure. Homes rarely pass all performance tests in the first round, usually as a result of duct leakage test failure, with some homes reaching the 20% range. However, performance testers may request HVAC contractors to be on hand, and allow some time (up to an hour) to troubleshoot for problems during testing.

Test results become part of the background documents for a home's Certificate of Occupancy. In theory, this testing data could be aggregated and analyzed as part of a more rigorous quality assurance process for testing contractor performance, but there are insufficient resources available to the program administrator to conduct such an intensive degree of oversight.

Education and Outreach

The administrator engages in a variety of educational and outreach efforts aimed at testing companies and technicians in hopes of improving the quality and consistency of performance testing and to refine the administration of the testing requirement, including:

- providing assistance to testing companies to answer questions on energy code and performance testing matters;
- providing assistance to individual technicians on particular testing or code issues related to specific homes;
- developing an FAQ that technicians can refer to when making determinations regarding a specific building project;
- developing a comprehensive guide to Austin's energy code; and
- meeting bi-monthly with City residential code inspectors to address concerns this group may have with the testing process.

Continuing education requirements through the various training institutions—independent of the City—are necessary for maintaining certification as a performance contractor (HERS, NCI, and BPI).

Contractor Oversight

A great deal of flexibility is afforded to the administrator to manage the performance testing program; this has allowed the administrator to operate a robust and vigilant oversight process that remains relatively informal. Since the performance testing requirement was first put in place in 2008, the administrator has been able to establish a solid rapport with the testing contractors and with many of the contractors' individual technicians through annual or biannual face-to-face meetings and regular, unscheduled telephone contacts. *These relationships allow the administrator to effectively monitor the*

quality of work being carried out by each technician, and to do so without necessitating an onerous evaluation and review process (see "Preventing Conflicts-of-Interest"). Occasional efforts to measure code compliance levels in new homes, and to compare a home's code compliance status against its performance testing outcome, have validated the reliability of Austin's third-party performance testing companies and their technicians, finding no evidence of erroneous test reports.

Preventing Conflicts-of-Interest

Performance testing companies are required to be financially and organizationally independent of any homebuilder/mechanical contractor whose work the testing companies are evaluating. There has been no need, however, to implement regimented conflict-of-interest procedures to enforce this provision. Rather, the administrator has been able to rely on the testing companies to informally identify and report any of their competitors who are violating this protocol.

When code-required testing was introduced, some stakeholders expressed a concern that HVAC contractors that also provided performance testing services would engage in quid-pro-quo exchanges, passing each others' work sight unseen. Thus far, this concern has proved unfounded. Performance testing companies have been caught violating the independence requirement only twice.

This informal oversight process has its limits. For example, if the pool of testing companies were to expand significantly, there would be a point at which the program administrator would no longer be able to maintain the relationships that enable the current informal review and evaluation process to operate successfully. In that case, the credentials that technicians must possess in order to be registered with the City would provide some safety net against widespread malpractice or incompetence. However, the institution of an administrative process that is more burdensome for both the administrator and for the testing companies would likely be necessary.[14(Details)]

The administrator notes that there are likely gaps in his oversight of performance testing companies, and is quick to point out that Austin's is not a *perfect* system. However, he feels that it is a *pretty good* system, and expects that there are few jurisdictions whose oversight of third-party code enforcement agents is as extensive as Austin's.

Program Evaluation

For all intents and purposes, it is unlikely that a perfect third-party performance testing system will ever exist, at least not without being so resource intensive as to offset any of the burden-relief benefits that frequently are a driving force behind the use of third-party code enforcement agents. However, the system in Austin has, by and large, delivered the services and outcomes that it was designed to produce, and it has done so at minimal cost (see ***Energy Efficiency Outcomes*** section).

From its certification and registration process to its reporting procedures, many different elements of the City's third-party testing program have contributed to its success, but *an especially key component has been the administrator's efforts to regularly evaluate the program in order to identify areas of*

[14 (Details)] The demand for technicians in a particular jurisdiction will determine the number of technicians that can be supported in that market; to some extent the problem of having "too many" technicians will be self-corrected by market forces.

weakness. These efforts, including occasional efforts by the administrator to measure code compliance levels in new homes following the initiation of the code-required testing program, have not only illustrated the success of the program, but have also identified problems with the implementation and administration of code-required testing services. As Austin's experience with batch testing shows (see "Batch Testing"), taking steps to strengthen areas of weakness can mean the difference between an effective third-party enforcement program and one that fails to hold builders and contractors accountable.

Batch Testing

Batch testing of new single- and multi-family homes was allowed under the third-party performance testing requirement, adopted as a local amendment to the IECC 2006.[15(Definition)] The protocol for batch testing in Austin was to follow the EPA's Energy Star batch testing guidelines. With Energy Star rating, however, performance testing does not occur until after construction is completed; testing in Austin had to be done before final inspection. To accommodate this difference, the stipulation was made that all new buildings included in a batch in Austin had to be "substantially completed and ready for testing."[16]

Following this modified Energy Star protocol, batch testing in Austin was found to have a number of flaws. Most notably, many houses being included in batches were not sufficiently complete to be ready for testing, and builders were on occasion "gaming the system" by stacking the batch sample with houses that were built to code while leaving out those houses that were not; the sampling protocol for identifying those houses in a batch that were to be tested was not working as intended. Batch testing was enabling homebuilders to reduce their costs by limiting the number of performance tests that had to be completed, but this cost-savings was coming at the expense of energy code compliance in a large portion of batched homes.[17(Details)]

Once alerted to these practices, City and Austin Energy officials had little confidence that buildings in a batch were meeting code if they were not directly tested. As a result, Austin dropped batch testing when it moved to adopt the IECC 2009 standard. Moving forward, every new single- and two-family residence was and is required to undergo performance testing.[18(Details)]

Energy Efficiency Outcomes

As discussed above, the City was aware that relying on third-party agents to carry out performance testing would inject variation into the quality of the testing work being completed. However, the City was confident that the prospect of review would motivate contractors and builders to ensure that their

[15 (Definition)] Batch testing entails randomly selecting a sample of new homes from among a group of "substantially similar" buildings and then conducting performance testing on only those sampled houses in order to pass the entire group. Batch testing assumes that each house in the group is under construction by the same builder using the same contractors, and that a representative sample of houses should reflect the quality of work present in all the homes. This allowance followed the EPA's Energy Star batch testing protocol

[16 (Details)] Generally, before code-required testing in any new residential building can be performed, all cooling equipment must be operational and exterior doors much have seals and thresholds installed.

[17 (Details)] Austin Energy carried out a field audit of newly constructed homes in 2009, finding that approximately two-thirds of those homes that were included in a batch and had not been directly tested failed to meet code requirements; these batched homes failed to meet code by varying degrees, with some houses being "very close" to meeting the standard.

[18 (Details)] Batch testing of new multi-family homes continues to be allowed. Each new building containing multiple dwelling units constitutes a single batch, and at least 15% of the dwelling units in each batch have to be tested. The large mechanical contractors' experience with Austin Energy's Green Building Program gives a greater level of confidence with batch testing of multi-family homes.

work met minimum standards. *It was not necessarily the performance testing itself that would improve code compliance rates, but rather the fact that builders and contractors knew that their work would be tested.*

Behavioral responses to the testing requirement by some homebuilders and contractors in the Austin region validate these assumptions. Some builders have started to hire testing contractors to conduct an initial performance test at the rough-in stage of new home construction, to ensure that the builder was on point to meet code requirements. Similarly, some of the larger mechanical contractors have developed their own quality assurance crews to perform preliminary performance tests on newly installed mechanical systems.

According to Austin Energy, performance testing has, in addition to encouraging builders and contractors to take added measures to improve product quality, "absolutely" brought about a significant improvement in energy code compliance rates among new residential buildings. Austin Energy carried out a field audit of around 50 newly constructed, unoccupied homes in 2009, finding that nearly all sampled homes that had undergone mandatory third-party performance testing met code requirements. In comparison, of the houses that avoided testing through the batch process, two-thirds did not meet the code (by varying degrees). With the elimination of batch testing, all homes are verified for compliance with Austin's prescriptive and performance requirements, with most exceeding the requirements by 4-5%.

Concluding Remarks

Austin's third-party performance testing requirement for new residential construction has successfully marshaled the technical expertise and human capital of the private sector in support of the City's goal of achieving greater energy efficiency in its expanding housing stock. Establishing a third-party performance testing requirement has resulted in better designed, better built, more energy efficient homes.

Given the success of its program, Austin can serve as an instructive guide to those jurisdictions who may soon be grappling with how to implement the residential performance testing requirement featured in the IECC 2012. Many jurisdictions may not share Austin's agreeable political environment or the active support that Austin receives from of its local electric utility. Many jurisdictions may also lack the baseline data on energy code compliance levels that Austin has access to by virtue of Austin Energy's robust green building and energy efficiency rebate programs.[19(Details)] Nevertheless, Austin's model for third-party performance testing can serve as a prototype for jurisdictions looking to adopt performance testing requirements at minimal cost, providing a foundation upon which a program can be built that is adapted to the specific needs, resource constraints, and policy goals of the jurisdiction.

[19 (Details)] Many states are working with the U.S. Department of Energy to establish baseline data on energy code compliance rates. This baseline data will feed into states' strategies for achieving 90% code compliance rates by 2017, as called for under the ARRA State Energy Program. See State Compliance Activities for more information.

Acknowledgements

IMT acknowledges John Umphress and Michael Husted of Austin Energy, along with David Malone, of 1st Choice Energy for their assistance in compiling this case study.