Methodology for Establishing the Potential Energy Savings from Improved Energy Code Compliance

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Abstract

Currently, 37 states, covering almost 90% of the US population, have adopted at least the 2009 International Energy Conservation Code[1] (IECC). Adoption is only the first step to more efficient buildings. To generate the promised energy savings, builders need to comply with the code. There have been many studies done to evaluate code compliance over the years, however, different studies use different methodologies; making it difficult to compare within or across states as well as across time. Moreover, compliance studies did not typically collect information in such a way as to calculate the potential energy savings. In 2014, 8 states began work on a United States Department of Energy (DOE) funded project that included a code compliance assessment methodology designed to calculate potential energy savings. (DOE, 2014) The Midwest Energy Efficiency Alliance (MEEA) along with the Kentucky Department of Housing, Buildings and Construction (DHBC) and the Kentucky Department of Energy Development and Independence (DEDI) received funding to do this work in Kentucky. This paper will describe the methodology in detail; discuss how the study methodology was implemented in the field, and provide results on the amount and type of energy code non-compliance in Kentucky.

Introduction

Energy codes provide significant potential energy savings. (Livingston, 2014) However, much of that potential remains unrealized if the as-built dwellings built do not comply with the code. Enforcement is key. However, because US enforcement typically occurs at the municipal or county level, there are often inadequate resources to properly enforce the energy code (either due to lack of personnel time, or inability to properly train personnel to do an adequate job). Since jurisdictions have limited resources, it is vital to target policies and actions designed to increase compliance. To help with this, two important questions need to be answered: What is the actual level of code compliance? What are the main sources of non-compliance? Answering these questions will facilitate the development of effective policies aimed at improving compliance.[2] To answer these questions, a methodology is needed that will measure energy code compliance on a sufficiently granular basis to divulge the needed information.

There have been many attempts to measure energy code compliance over the last 25 years (Misuriello et al 2014). These studies have been plagued with several problems including: being overly expensive, susceptibility to bias, not designed to generate energy savings estimates from non-compliance, and variability in study methodology across different studies.

To address these issues, in 2014, the DOE funded seven teams to measure the efficacy of code compliance improvement efforts in eight different states (one team covered two states) (DOE 2014). One of the states to receive funding was the Commonwealth of Kentucky under a proposal

[1] The IECC is the model residential energy code. It is not developed by the federal government but by a private organization, the International Code Council. States and municipalities have ability to adopt the IECC and what amendments will be made to it. Only adoption by a state or municipality makes this a legally enforceable code.

[2] These questions can also help states with developing plans to meet the 90% compliance requirement specified in the American Recovery and Reinvestment Act. In addition, utilities are interested in funding code compliance improvement efforts. However, they won't do it unless there is a way to measure the effect of their efforts.

submitted jointly by the DHCD, DEDI and MEEA[3]. The project is divided into three phases (DOE 2014). The first phase of the project, a baseline compliance assessment has been completed. Phase 2 of the project consists of a code compliance improvement program. Phase 3 will be a second code compliance assessment done with the same methodology as Phase 1 designed to determine if there has been any improvement due to the program. The protocol is designed to measure residential energy code compliance in such a way as to determine potential energy savings from improved compliance.

This paper will describe the methodology of the protocol (including the ways the effort in Kentucky diverged from it) and to report the baseline energy code compliance across the state for each of the compliance measures along with associated potential energy savings of moving from non-compliance to compliance.

Description of the Energy Code in the Commonwealth of Kentucky

In 2011 Kentucky DHBC adopted an amended version of the 2009 IECC for residential dwellings as the statewide mandatory energy code.[4] (ICC, 2009) The IECC provides three compliance paths: prescriptive, UA trade-off, and performance. The prescriptive path simply requires a builder to install envelope components meeting minimum requirements (R-value, U-factor, etc.) without allowing for trade-offs. The UA trade-off uses a DOE developed software program called ResCheck.[5] ResCheck allows, for a given climate zone, the ability to trade-off among envelope requirements (e.g. more insulation for less efficient windows). The performance path allows the use of software to design a home that meets the energy code as long as the home's energy budget (in dollars) that is less than the energy budget for a standard reference design for the same home geometry.

While the energy code is set by a state agency and is mandatory statewide, enforcement, like much of the United States, is done at either the city or county level. In Kentucky, enforcement occurs primarily in the most populous municipalities and counties (although the rigor of the enforcement varies depending on resources). In rural areas and locales with little construction there is often no enforcement. So, while there is a mandatory requirement to meet the energy code, this requirement is often not enforced due to lack resources. This lack of resources expresses itself in that building officials expending little time looking over energy requirements. In addition, officials don't have the time to familiarize themselves with the ever more complex requirements that come with each new edition of the IECC. From a builder perspective, there is significant resistance to building to the energy code. Many builders are conservative in their practice and resist change. Builders view the energy code as an added expense that isn't justified by either health/safety concerns or consumer demands. Builders also complain about the increasing complexity of the code. These issues extend across the United States not just in Kentucky.

Description of DOE Methodology

In 2011, the Northwest Energy Efficiency Alliance (NEEA) conducted a code compliance survey (Cadmus, 2014) based on evaluating targeted individual code requirements. This was a change from previous studies that focused on assessing all the code requirements for a given

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[3] For reference, the name of this project is the Kentucky Residential Code Compliance Improvement Study (KRCCIS)

[4] Basement insulation is only required to go down 4 feet and duct sealing tests did not become a requirement for an additional 2 years. The other requirements are consistent with the unamended 2009 IECC. The Kentucky Energy Code and the 2009 IECC are used interchangeably in this paper.

[5] ResCheck provides a middle way between the prescriptive approach and the more complex performance path. The program, which is free can be downloaded from https://www.energycodes.gov/rescheck

dwelling. This earlier approach was used in the assessments conducted by the DOE in response to the requirements of ARRA back in 2009 (PNNL, [6]2009). While a good start, this original methodology had problems (DOE, 2013).

With those issues in mind, the DOE amended its methodology to line up with the work done by NEEA. (PNNL, 2014) The methodology is based on a randomized sample of a minimum number of observations for each identified (key) code requirements. The observations center around eight[7] key requirements chosen because they represent over 90% of the potential energy savings embodied in the energy code. Data collection teams were required to gather 63 sets[8] [9] of observations of these key requirements: exterior wall insulation, foundation insulation, ceiling/attic insulation, window U-factor, window solar heat gain coefficient, percentage of high efficacy lighting, duct leakage, and air leakage.

Beyond these requirements, the data collection team in Kentucky was asked to make the following additional observations.[10]

1. Collect data to allow for 54 Air Conditioning Contractors of America (ACCA) Manual J calculations designed to determine whether installed heating and air conditioning units were appropriately sized.
2. Collect data on the installation of ducts in order to determine whether they were sized correctly as per ACCA Manual D.
3. Collect air flow measurements from registers using a flow hood. The purpose being to determine whether the correct amount of air is reaching its intended target.

Unlike previous assessment methodologies, DOE allowed only one visit to a given dwelling.[11] As a result, the data collection team needed to make as many relevant observations as possible for each home visited (DOE also strongly encouraged teams to make as many observations of non-key requirements as possible).[12] Site visits were done during two times: either during the insulation installation stage[13] or at final inspection (to allow for accurate diagnostic tests). Ultimately, 140 homes were visited to gather the 63 sets of observations.[14] The additional cost to visit the large number of sites was mitigated by the fact that the data collection teams did not have to wait for a given home to complete the entire construction process, a major time saver.[15]

A key point of the assessment was the distribution of data samples across the state. For sampling purposes, Kentucky was divided into component counties and major cities. The amount of construction from each county or city was determined using the most recent three years of US Census data. PNNL then used a random number generator program to determine the number of data sets needed to be collected from each county and city so that the total number of data sets reached

[6] PNNL stands for the Pacific Northwest National Laboratory; the research arm of the energy codes program at DOE.
[7] The project team added an additional observation to the methodology. That is why the abstract referred to nine observations.
[8] A set consists of one observation of each key requirement. Because of construction volume, many jurisdictions required the observation of several sets.
[9] PNNL determined that 63 observations were sufficient to determine whether the program activities in Phase 2 actually produced changes in the compliance rate of an individual measure.
[10] The idea behind collecting HVAC data was to approach HVAC compliance (and potential energy savings) in a holistic way. Assuming units are sized correctly, the duct system (by both sizing and leakage) needs to deliver the conditioned air. To know whether the system will do so, the size of the unit, the design of the ducts (both in terms of cross sectional area and run lengths and material) and the amount of duct leakage need to be known.
[11] In previous assessments, observations at a given home were made throughout the construction process and consequently up to four visits were made to a given site. The single visit protocol addressed concerns that builders will alter their practices if they know an assessment team is coming.
[12] DOE provided each team with a sheet that listed all of the code requirements for a given state.
[13] During this stage, both insulation amount and quality was inspected as well as looking for how well air sealing had been done.
[14] This applied to a given jurisdiction. For example, in Fayette County, 10 site visits were needed to collect the five sets of observations.
[15] The field data collection time amounted to about 1 hour per house. The major cost was in travel.

63[16]. For example, if Fayette County (the county that includes the city of Lexington) was slated to collect 5 sets of data, this would mean that the data collection team would need to inspect a sufficient number of homes in the county to observe 5 examples of each of the nine items listed above. On average, the team would need to inspect at least two homes to collect one data set.

Description of Strategy for Gaining Access to Sites

Once the randomized sample was developed, attention turned to the difficult problem of getting access to the sites. Previous studies faced the issue of not being able to gain access to the identified construction sites. This failure tended to bias inspections towards builders who were more "confident" of their homes (builders who are not as confident won't allow access on the concern that their construction practices will be found deficient), skewing the results.

As a result, a protocol was designed to maximize the project's ability to gain access to the sites that were randomly chosen. First, an outreach manager was hired. This individual was a retired state code official who was well-known and respected by the construction community across the state. This official provided the team with a neutral, trusted voice to explain the project to builders and help mitigate their concerns about the aims of the project (the possibility that the project aimed to expose non-compliant work to authorities). Second, the project developed a means to randomly choose which addresses to inspect. The Commonwealth of Kentucky has instituted a statewide HVAC permitting system for all residential dwellings. Unlike other states where construction permit data must come from the individual Authority Having Jurisdiction (AHJ), all the addresses for permitted homes are located in one place, the HVAC division of the DHBC. Once a list of permits for a given county was identified, the list would be randomized, and then the outreach manager would contact the builders in the randomized order to request site access. The outreach manager would explain the rationale of the project as well as the mechanics of the data collection process in order to allay concerns and receive permission to go on site. Once that permission was granted, the data collectors would contact the builders to schedule the site visit. Additionally, the outreach manager figured out the stage of construction. Even if a yes is received, a home has to be at a stage that gives information during an inspection (typically at rough-in/insulation and final). By gathering this information, the outreach manager ensured that the site inspectors only visited homes ready for inspection, cutting down unnecessary trips for inspectors. For those construction sites that were still active[17] and for which contact was made, there was only a 5% rejection rate.

Assuring the Quality of the Gathered Data

The project included multiple levels of quality control for the collected data. Data was collected in collection sheets developed by PNNL. As the data was collected, it was inputted into a PNNL developed tool called the RCD[18]; which is basically an Excel spreadsheet designed to ease the formatting and analysis of the data. Both the data collection team and MEEA reviewed all the collected data to look for anomalous data (an example would be an obviously questionable R-Value input such as R-30 for foundation insulation walls). Second, both MEEA and PNNL went through each of the entries in the Excel spreadsheet. All anomalous results were marked and then reviewed with the data collection teams until all issues were resolved.

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[16]. The protocol required observations until every identified requirement reached 63 observations. Since the data collection teams were required to mark down every possible observation at each site, inspectors made more than 63 observations for several of the requirements. The value of 63 observations was determined by PNNL statisticians to give the program the ability to detect changes arising from the code compliance improvement work with a 90% confidence level.

[17] In many cases, by the time contact was made, construction had been completed.

[18] RCD stands for Residential Compliance Data

Analysis of Data

Once the data was scrubbed of individual identifying information, it was sent to PNNL for analysis. This analysis focused on identifying those code requirements that were found to be in non-compliance in at least 15% of the samples. To calculate the potential energy savings for each requirement, the analysts would calculate the energy savings that would be generated if all of the non-compliant observations became compliant. In the case of Kentucky, the five major requirements that generated non-compliance were:

1. Exterior wall insulation (typically as a result of poor installation)[19] (Cottrell 2012)
2. Envelope Air sealing
3. Duct sealing
4. Lighting efficacy
5. Sizing of HVAC equipment[20].

It is important to note that in the case of lighting efficacy, energy losses were completely electric, while losses for the other four included both natural gas and electricity[21].

Summary of Results

The following summary of results will include both the identified requirements along with the efficiency requirements for HVAC equipment and the internal analysis done to determine whether contractors were appropriately sizing the equipment.[22] The results are presented as a series of histograms that show the distribution of observations for a given requirement. On the y-axis will be the frequency for a given observation. For each requirement, there will be a brief discussion of the reasons for non-compliance.

Exterior Wall Insulation

For exterior wall insulation, the results indicate that the majority of builders across the state install insulation meeting the minimum R-value requirement. However, the observations also indicate that the installation is often done poorly (2/3 of the observations did not meet installation requirements) which significantly reduces the rated R-value.[23]

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[19] Based on the RESNET insulation installation grading standard.
[20] For HVAC oversizing, the source of energy loss was related to peak demand (kw) not energy savings (kwh).
[21] An additional complication involved the type of HVAC equipment. A significant percentage of homes in Kentucky use heat pumps which would result in exclusively electricity savings from improving code compliance as opposed to the mixed fuel results of having air conditioners and forced air furnaces.
[22] Additional data was gathered that will eventually allow the project team to determine whether ducts were designed properly and ultimately whether rooms within a given home were receiving the appropriate conditioned air flow.
[23] To determine the quality of the installations, the on-site inspectors took pictures of several of the installations and these pictures were presented to a group of stakeholder experts. These opinions were then combined with the opinions of the on-site inspectors to arrive at a consensus grading. Obviously, judging the quality of installations is not a strictly quantitative exercise.

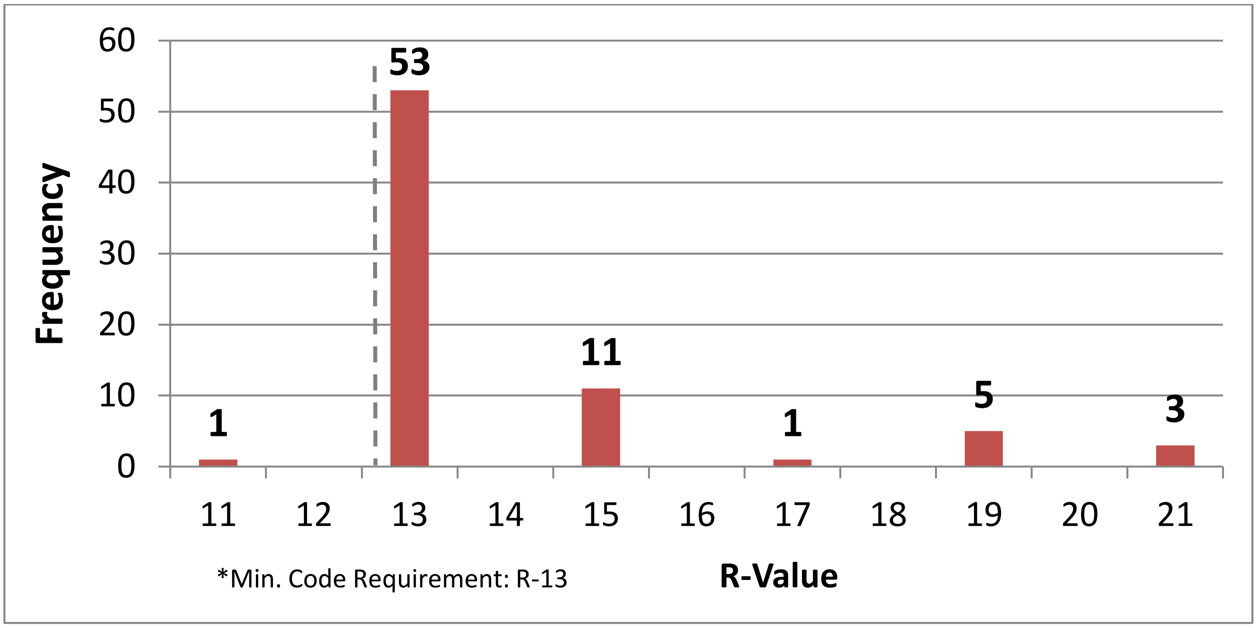

Figure 1. Wall Insulation R-Value

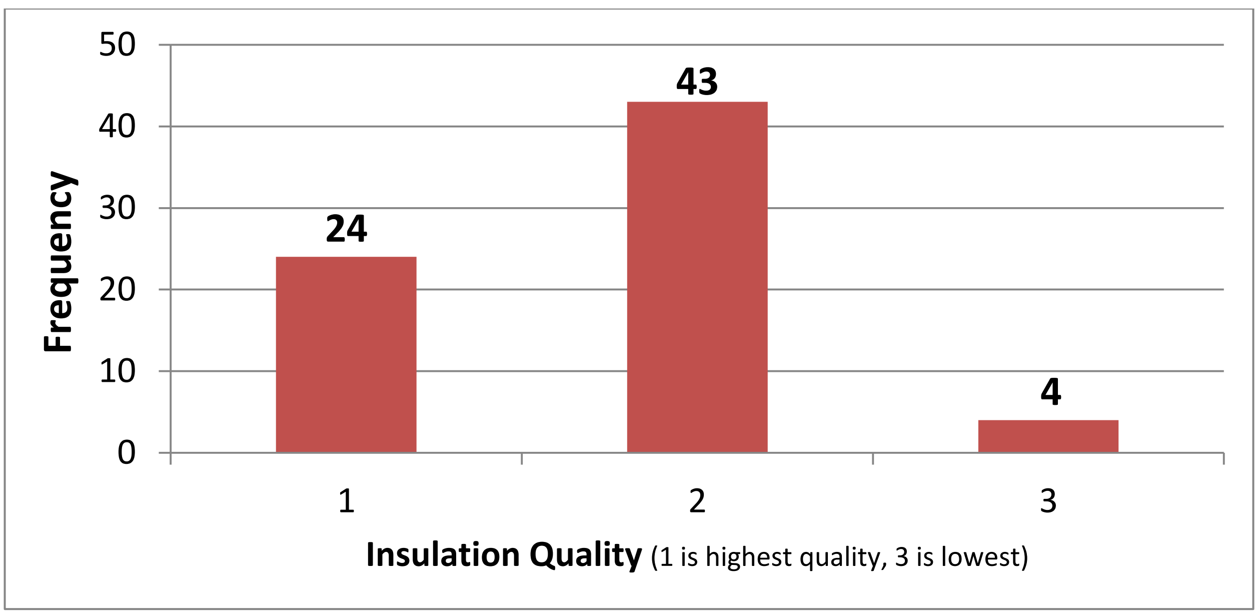

Figure 2. Wall Insulation Quality

Air Sealing

The results of the blower door tests are among the most interesting. The results show a wide range of results -- from under 1 ACH50 to 20 ACH50[24] (with 7 ACH50 being the code value). 1 ACH50 indicates an extremely air tight homes (roughly the levels required by a home built to

[24] ACH50 refers to air changes per hour at a pressure differential of 50 Pascals between the inside and outside of the building envelope.

Passive House standards). 20 ACH50 is the type of result found in poorly built existing homes. These results indicate that many builders have learned how to air seal homes well, but that testing is still necessary as many builders either do not try or do not know how to properly air seal homes. Moreover, air sealing is clearly an area where training has significant potential given the energy savings inherent in air sealing.[25]

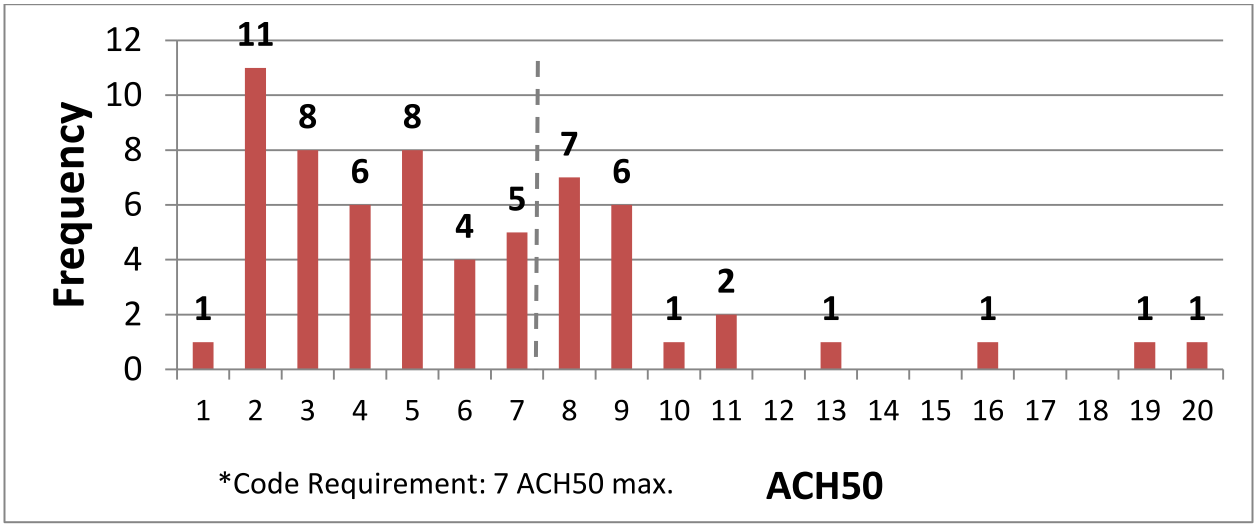

Figure 3. Blower Door Results (ACH50)

Duct Leakage

Duct sealing results showed an odd dichotomy. The data collection protocol mandated that ducts needed to be tested regardless of whether the ducts are fully in conditioned space or not.[26] For ducts not fully in conditioned space (those that would need to be tested under IECC requirements), the duct leakage levels were typically within the energy code mandated levels. However, for ducts fully in conditioned space, duct leakage rates were extremely high; as if builders assumed that there would be no adverse consequences to having extremely leaky ducts. This type of result was found in the other states that did surveys. This leads to two points.

First, the duct testing requirement is not the same as the duct sealing requirement (403.2.2, 2009 IECC). Ducts are required by code to be sealed regardless of their location. Second, there is significant debate as to the energy impact effect of having leaky ducts located fully within conditioned space. It will be relatively simple to communicate the requirement that ducts must be sealed regardless of location; the effect on energy use for sealing leaky ducts fully in conditioned space remains undecided.[27]

[25] The data is currently being analyzed to better understand what other? Deficiencies exist in homes with poor air sealing.
[26] The DHBC did not, until June 2015, require duct testing in any situation. In the model code, duct testing is not required if the ducts are located completely within conditioned space.
[27] Well sealed ducts (whether in conditioned or unconditioned space) remain important in terms of occupant comfort.

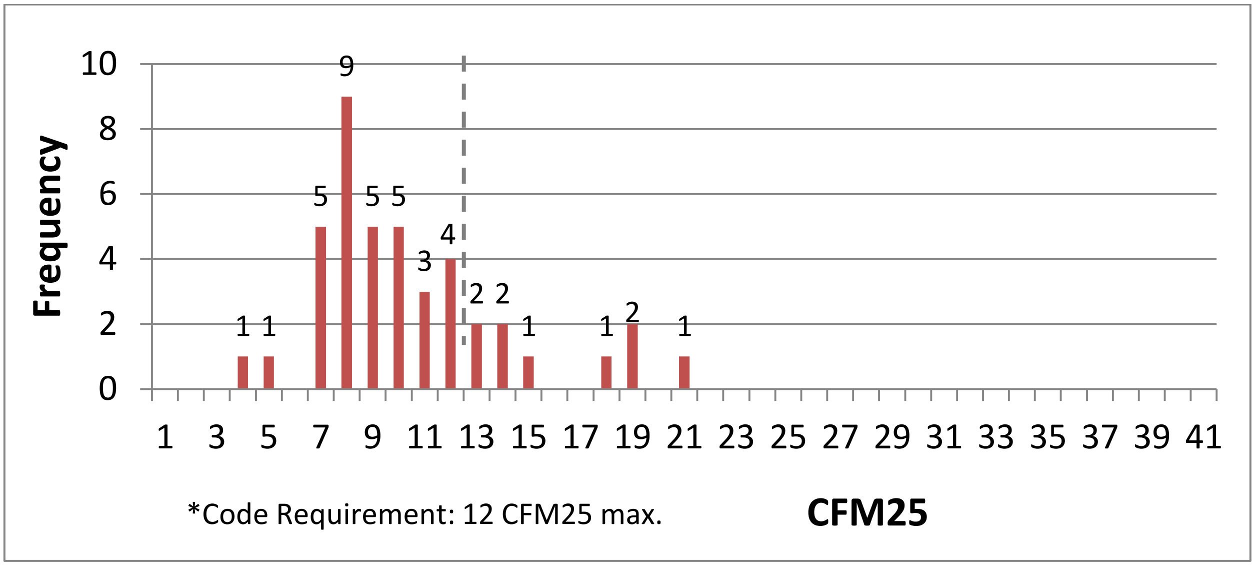

Figure 4. Duct Leakage in Unconditioned Space (CFM25)

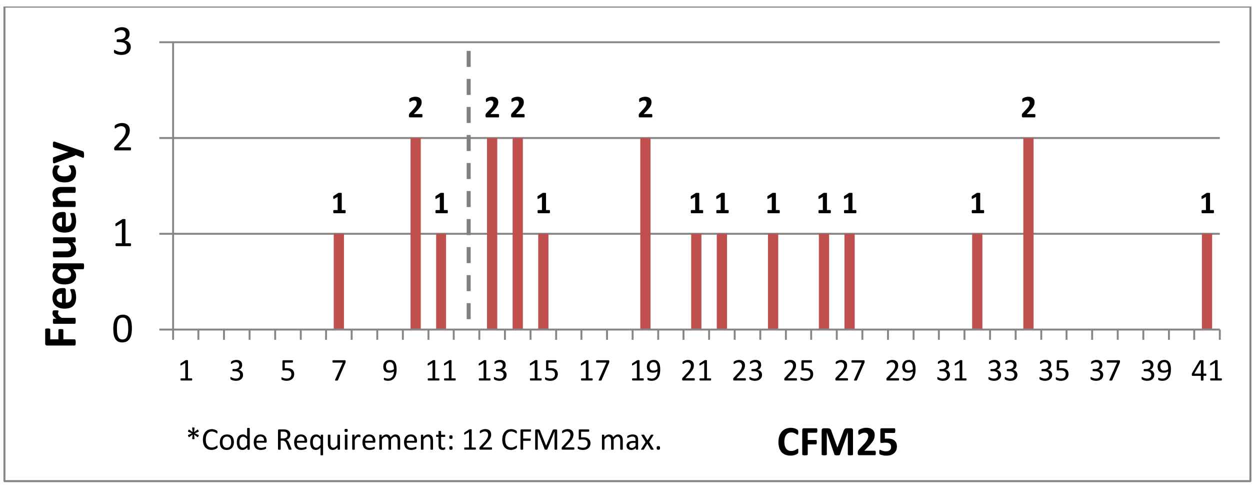

Figure 5. Duct Leakage in Conditioned Space (CFM25[28])

Lighting Efficacy

The requirement in the 2009 IECC is to have at least 50% of lamps within a home meet the efficacy requirements outlined in. The data collection results revealed a two-headed distribution. Typically, a home either had no (or almost no) high efficacy lamps or it had well over the 50% threshold. Improving compliance with this requirement would have a significant effect on electricity use. Research is being done as to why there is resistance to this cost-effective, easy to implement requirement. Preliminary discussions with builders indicate that worries with the light quality of compact fluorescent lamps, as well as the belief that high efficacy lamps tend to fail when used in certain common fixtures such as recessed can lights make builders hesitant to install them. They are concerned about customer complaints.

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[28] CFM25 stands for cubic feet per minute at a pressure differential of 25 Pascals

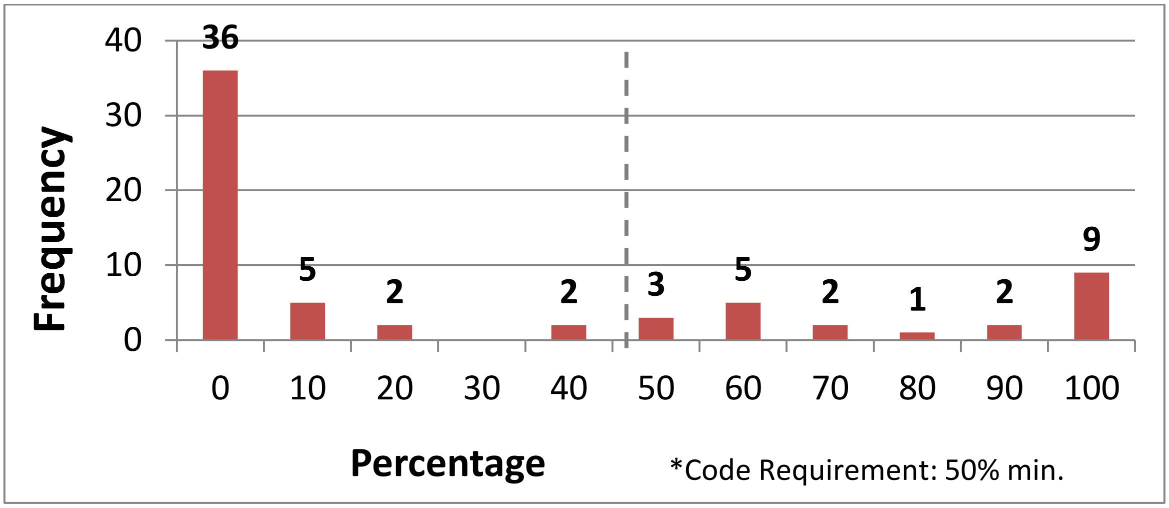

Figure 6. High Efficiency Lighting (%)

Sizing of HVAC

The project team, as was noted above, went beyond the DOE specified requirements in the protocol to require the data collection teams to gather the data necessary to determine whether installed HVAC equipment was appropriately sized as per ACCA Manuals J and S. First, the analysis answered the question of whether HVAC units are being correctly sized.[29] This was be done by comparing the size of the installed unit with the size that the Manual J software[30] calculated based on the specific data gathered on the house. The second question involves the potential energy savings that would come from turning all the oversized units into right-sized units. This analysis was done internally by MEEA with assistance by PNNL.

The results indicate that oversizing is widespread (about 90% of the units were found to be oversized). The median unit is oversized by about 60% (about 1 ton). Reasons for this include:

- Builder concerns about occupant comfort and the resultant call back;
- Desires of homeowners to plan for future additions.
- Including the basement as part of the conditioned space even if it is not currently insulated (on the possibility that it will be insulated in the future)

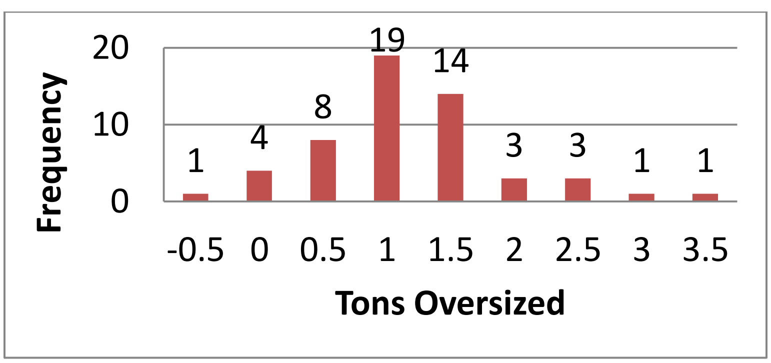

Figure 7. HVAC Oversizing

[29] The Manual J program calculates the specific heat load based on heat transfer calculations. However, as HVAC units come in specific sizes, the oversizing calculation was made comparing the closest unit in size.
[30] MEEA is using the software program Writesoft ®.

Ceiling/Roof Insulation

As with exterior wall insulation, observed ceiling insulation R-values generally met code requirements. Installation quality for ceiling insulation was somewhat better than exterior wall insulation quality, but still often substandard. Much like exterior wall insulation, non-compliance centered on insulation installation quality

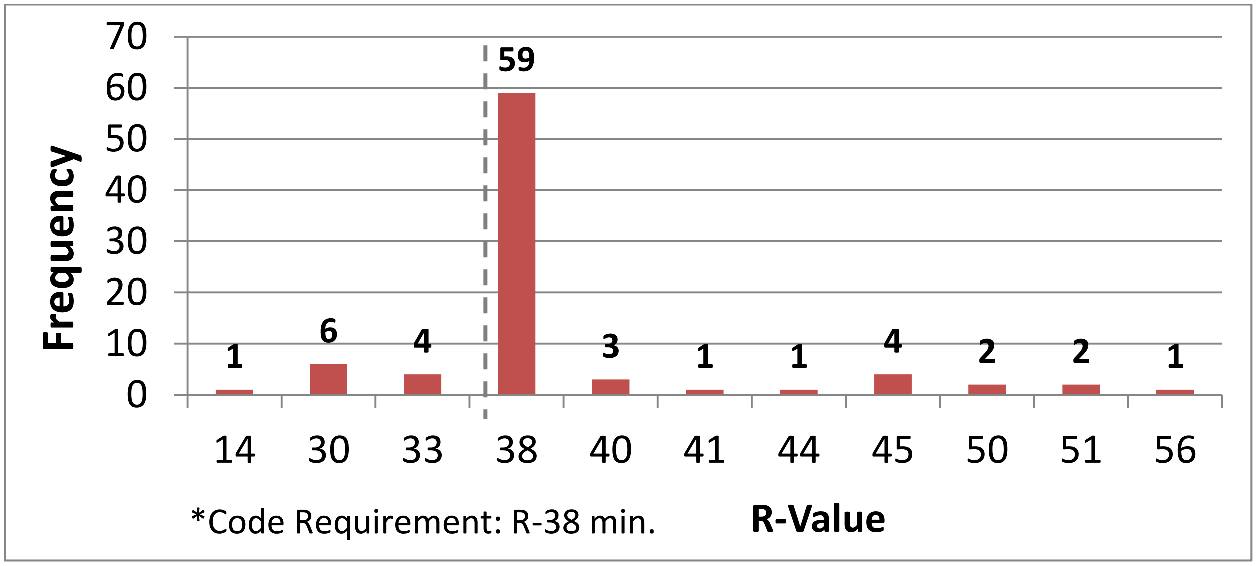

Figure 8. Ceiling Insulation R-Value

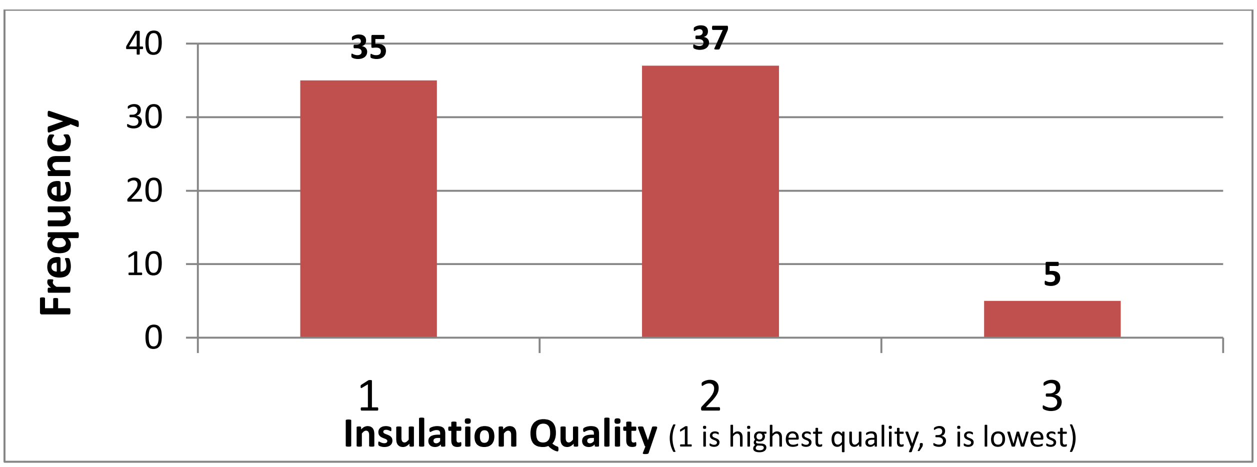

Figure 9. Ceiling Insulation Quality

Basement Insulation

Basement insulation[31] followed the same pattern as both ceiling and exterior wall insulation. R-values typically met code but data collection teams found numerous instances of poor quality installation.

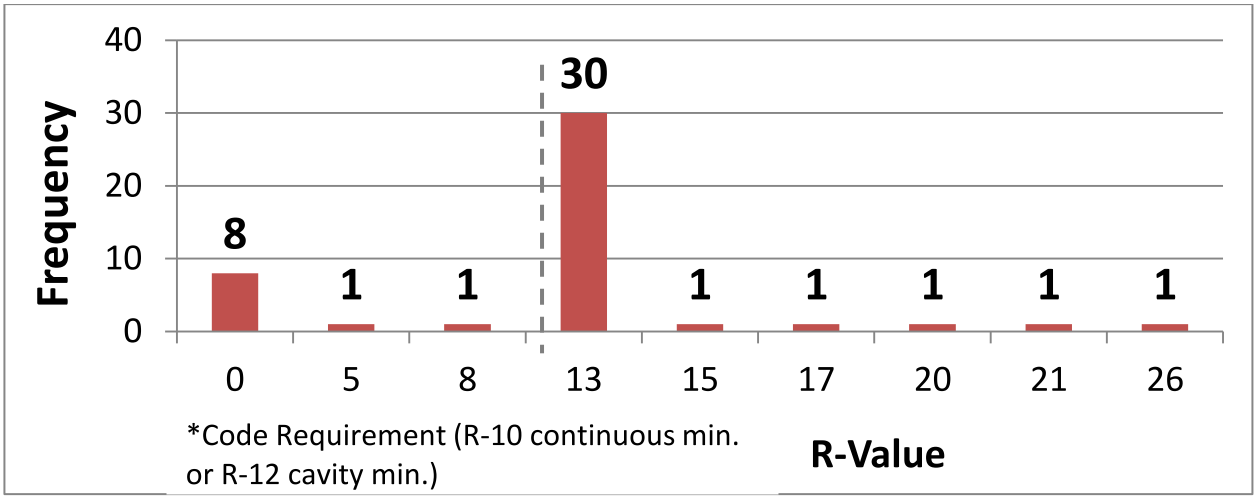

Figure 10. Basement Wall Insulation R-Value

Window U-Value[32]

Every window observed met code within a narrow range of U-values. While window manufacturers have stopped supplying non-code compliant windows, issues such as cost, weight, availability and general unfamiliarity hamper the entrance of windows lower than a U-factor of 0.30 into the market.

Heating/Cooling and Heat Pump Unit Efficiency

The majority of forced air furnaces were found to be of the condensing type (>90% AFUE), even though federal requirements (which supersede state code requirements) only mandate an efficiency greater than 80 UE. In this case the market has been thoroughly transformed. The overwhelming majority of cooling units were 13 SEER[33] which indicates that federal requirements are being followed but that there is no significant movement towards more efficient units. Heat pumps are found throughout the state. Much like furnaces and air conditioners, all observed units were found to be code compliant.[34]

Potential Energy Savings from Improved Residential Energy Code Compliance[35]

Following is a chart outlining the potential measure level savings from moving non-compliant measures to compliance.[36] Preliminary cost estimates have been calculated for implementing the code improvement program outlined in the next section at about $300,000 over the two year length of the compliance improvement program. This chart shows that successful efforts to implement programs to improve code compliance are potentially extremely cost-effective.

[31] The project team is still reviewing the data on foundation insulation quality so it was not ready to be presented.
[32] Charts will not be included for the rest of the requirements as there is little variation in the results.
[33] SEER stands for Seasonal Energy Efficiency Ratio.
[34] Much of this success is probably attributable to the imposition of federal appliance standards.
[35] A paper describing the methodology for calculating potential energy savings is currently being written up by PNNL.
[36] PNNL is currently finalizing the document describing the methodology for calculating these savings.

Table 1. Summary of Potential Energy Savings and Implementation Costs

Measure	Total Electricity Savings (kwh)	Total Natural Gas Savings (therms)	Total Energy Savings (MMBtu)	Total Electricity Savings ($)	Total Natural Gas Savings ($)	Total Energy Cost Savings ($)
Insulation Installation Quality	1,199,555	51,841	9,277	117,436	53,608	171,044
Air Sealing	3,245,622	161,079	27,182	317,746	166,568	484,314
Lighting Efficacy	2,206,514	-17,865	5,742	216.018	-18,473	197,544
Duct Leakage	444,934	13.060	2,824	43,559	13.505	57,064
Total	**7,096,625**	**208,115**	**45,025**	**$694,759**	**$215,208**	**$909,967**
Program Cost						$300,000

Right-sizing HVAC equipment reduces peak demand loads. Analysis by PNNL and MEEA find that simply right-sizing HVAC equipment reduces peak loads by 2.4 MW. Moreover, moving all other measures from non-compliance to compliance saves 4 MW (these are obviously not additive). This provides additional cost savings.

Use of the Data to Design Compliance Improvement Program

Phase 2 of the project will take the data and design a training program around the areas of non-compliance. The training for this project will focus on four items: HVAC sizing, air sealing, lighting efficacy and insulation installation quality.[37] There will also be an additional training module focused on educating inspectors and plan checkers as to what to look for during inspections to ensure the most thorough inspection possible in the least time.

On top of this training, the project has established a circuit rider program. Over two years, the circuit rider will be meeting with building departments, homebuilders, contractors (HVAC and insulation) and supply houses to discuss obstacles to enforcing and complying with the energy code – with particular attention paid to the five items that make up the bulk of non-compliance. Moreover, the circuit rider will also provide information and materials designed to help with addressing the obstacles. Importantly, the circuit rider will listen to and address participant concerns at the meeting and make follow up visits to see if the assistance provided is making a difference.

Conclusion

Although the Kentucky Code Compliance Improvement Project is still in the middle of Phase 2 (of 3 phases), certain facts have been learned about improving code compliance. It has been found that a comprehensive code compliance assessment can be done at a statewide level for a reasonable cost. The compliance assessment can identify areas of improvement from which a code compliance improvement program can be designed. The key fact left to determine is whether the program actually generates improvement. That fact will be known by the middle of 2017. Stay tuned.

[37] The use of conditioned crawl spaces has grown and builders and code officials are anxious to learn how to do this correctly. This is being included even though it did not appear in the data because code officials have raised the concern during circuit rider visits.

References

Cottrell, Charles, 2012 " RESNET Insulation Grading Criteria" Prepared *for North American Insulation Manufacturers Association;* Washington DC http://www.resnet.us/uploads/documents/conference/2012/pdfs/Cottrell-RESNET_Insulation_Grading_Criteria.pdf

Cadmus 2014. "Oregon Residential Energy Code Compliance." Report #E14-276. *Prepared for the Northwest Energy Efficiency Alliance,* Portland, OR

[DOE] Department of Energy 2014 "Strategies to Increase Residential Energy Code Compliance Rates and Measure Results." *DE-FOA-0000953.* Washington, D.C.

Halverson, M, V Mendon, R Bartlett, J Hathaway, and Y Xie 2014. Pacific Northwest National Laboratory 2014. "Residential Energy Code Sampling and Data Collection Guidance for Project Teams." *Prepared for the U.S. Department of Energy Building Technology Program.* Richland, WA.

Livingston, O, P. Cole, D. Elliot, R. Bartlett 2014, "Building Energy Codes Program, National Benefits Assessment, 1992-2014." PNNL-22610 Rev1 *Prepared for the U.S. Department of Energy.* Richland, WA

Misuriello, Harry, Sarah Penney, Maggie Eldridge and Ben Foster 2010, "Lessons Learned from Building Energy Code Compliance and Enforcement Evaluation Studies." *Prepared for the American Council for Energy Efficient Economy Summer Study.*

[PNNL] Pacific Northwest National Laboratory 2010. "Measuring State Energy Code Compliance." *Prepared for the U.S. Department of Energy Building Technology Program.* Richland, WA.

PNNL 2013. "90% Compliance Pilot, Final Report." *Prepared for the U.S. Department of Energy Building Technology Program.* Richland, WA.