

## **Final Technical Report (FTR)**

**Project Title:** West Virginia Residential Codes Study

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## Summary

The U.S. Department of Energy (DOE) Building Energy Codes Program launched a series of research studies in 2014 across several U.S. states to investigate typical energy efficiency practices in residential buildings and identify opportunities to reduce household utility bills. A primary goal of the study was to help document baseline practices in new single-family construction, target areas for improvement relative to the state energy code, and quantify related savings potential. This information was intended to assist states in measuring energy compliance with their codes and to identify areas of focus for future education and training initiatives.

Following the original baseline studies, project teams in each state conducted a series of education, training and outreach activities aimed at improving compliance with the state residential energy code. A second baseline study was then implemented in several states with the objective of determining whether the investment in education, training and outreach programs had produced a significant and measurable change in statewide residential energy use. Through the program, DOE planned to establish a sufficient data set to represent baseline construction trends across states and detect significant changes in energy use resulting from education and training activities.

The three basic phases employed were as follows:

- I. **Pre-Study:** A baseline study to identify the energy use in typical single-family residential buildings in a given state and opportunities for improving energy efficiency
- II. **Education & Training:** Education, training and outreach activities targeting issues identified through the baseline study
- III. **Post-Study<sup>1</sup>:** A second study to identify the change in energy use following the education and training activities

This report outlines the application of the study in the state of West Virginia with a focus on the experiences of the project team across the multi-phased approach. Data gathered through phase I has been submitted to Pacific Northwest National Laboratory (PNNL) for analysis. Findings available to date are published as PNNL technical reports on the DOE Building Energy Codes Program website<sup>2</sup> with final analysis pending publication later in 2018.

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<sup>1</sup> Phase III, the post-study component, was not implemented in West Virginia.

<sup>2</sup> See <https://www.energycodes.gov/compliance/energy-code-field-studies>

## Introduction

The current project was funded through the U.S. Department of Energy (DOE) Funding Opportunity Announcement (FOA), “Strategies to Increase Residential Energy Code Compliance Rates and Measure Results” (DE-FOA-0000953). A primary goal of the FOA was to determine whether an investment in education, training, and outreach programs could produce a significant, measurable change in single-family residential energy use, and therefore energy savings, within 2-3 years. DOE ultimately intended for public and private entities to use this information to justify and catalyze additional future investments in energy code training, education and related energy-efficiency improvement programs.

Project teams were selected through a competitive process to implement a prescribed methodology in eight states<sup>3</sup>. Each team was required to:

- Measure the pre-program compliance rate using a DOE-developed methodology;
- Implement education, training, and outreach activities designed to increase code compliance, and;
- Measure the post-program compliance rate using the same methodology as the pre-program study.

Pacific Northwest National Laboratory (PNNL) developed the procedures and methodology implemented as part of each project, constructed the public data set, and conducted all resulting analysis. A guidance document (PNNL 2014) containing the pilot methodology implemented in each state is available on the DOE Building Energy Codes Program website<sup>4</sup>.

## Project Team

The following members comprised the West Virginia project team:

- Chris A. Ilardi, Project Director *HBAWVF*
- Sheila Coleman-Castells, Project Manager, *HBAWVF*
- Regina Skeen Financial Official, *HBAWV*
- Christine M. Risch, Director of Resource & Energy Economics *Marshall University, Center for Business & Economic Research (CBER)*
- Emmett Pepper, Executive Officer, *Energy Efficient West Virginia (EEWV)*
- Kelly A. Bragg, Director, *West Virginia Office of Energy*
- John Keener, Certified Trainer & Rater
- Xavier Walters, Certified Trainer & Rater
- Greg Paxton, Certified Trainer & Rater
- Travis Paxton, Certified Trainer & Rater

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<sup>3</sup> See DOE website for a complete list of pilot states selected through the FOA process at <https://www.energycodes.gov/compliance/energy-code-field-studies>

<sup>4</sup> See <https://www.energycodes.gov/compliance/energy-code-field-studies>

## Methodology

The approach implemented by the West Virginia project team employed a combination of activities prescribed by DOE and proposed by the project team over ~~+~~basic study phases:

- I. **Pre-Study:** A baseline study to identify the energy use in typical single-family residential buildings in a given state and opportunities for improving energy efficiency
- II. **Education & Training:** Education, training and outreach activities targeting issues identified through the baseline study

The project initiated with a baseline field study to inventory current practices, establish baseline trends, and identify potential areas for improvement. Following the original baseline study (Phase I), the project team conducted a series of education, training and outreach activities aimed at improving compliance with the state residential energy code (Phase II). The West Virginia project was initiated following the original DOE FOA, and did not include a Phase III component (post-study).

The initial steps of the project comprise the baseline field study (Phase I). The overall study methodology and state-specific sampling plan were confirmed through a meeting with key stakeholders in the state. This helped to ensure the study and analysis assumptions were valid and adequately represented the conditions and construction trends specific to the state. Following, the project team began making contact with local jurisdictions to identify homes currently under construction, and that could be visited to make observations and collect the prescribed data. The project team then began actual data collection, which continued until the sampling plan was complete, and culminated in the submission of the resulting data to PNNL for technical analysis. Through this analysis, PNNL identified key measures for potential improvement (to be targeted in Phase II), as well as the associated energy and cost savings.

Phase II represents the education, training and outreach activities implemented within the state as part of Phase II. The team selected and recommended specific activities that were expected to have the greatest impact within the state. In doing so, the team balanced various factors such as the existing compliance and enforcement infrastructure, available resources, and previous compliance-improvement programs implemented within the state. These activities were deployed over a 1-2 year period following the completion of the baseline field study (Phase I).

Throughout the course of the project, the team remained in regular contact with DOE and corresponding project teams in other states. Collectively, the group held monthly calls to discuss progress, challenges, and to identify practices that could provide insight on residential energy-efficiency practices. This was useful in helping to establish current baseline practices, as well as for teams considering similar future work in other states.

A full description of the prescribed field study methodology is available on the DOE Building Energy Codes Program website<sup>5</sup> and provides further guidance on steps taken by project teams, sampling, recruiting, target data, and resulting analysis. More information on strategies and

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<sup>5</sup> See <http://www.energycodes.gov>

activities selected by the project team for Phase II implementation within the state are further described in the following sections.

## Accomplishments

Key accomplishments from the project are outlined below relative to the prescribed work plan:

### Task 1: Baseline field study:

- Conducted baselined study guided by established DOE Methodology<sup>6</sup>

### Task 2: Development of training materials:

- Developed an energy code training curriculum in conjunction with Southface Energy Institute—an educational curriculum targeting builders and other tradesman on the requirements of the IECC.
- Curriculum is flexible in that it can be deployed in a 1-2 day comprehensive training program, or easily adapted to train on individual sections, such as building envelope or lighting requirements, as well as for educating the general public.

### Task 3: Deploy and expand education, training and outreach program:

- Held multiple full-day (or 1.5 days) training seminars for building professionals
- Presentations targeted builders, real estate professionals, and building officials
- Outreach efforts included home exhibits and trade shows, including several local home builders associations, reaching hundreds of professionals and potential home owners.
- Residential energy efficiency trainings at trade schools around the state.
- Onsite blower door and duct testing demonstrations to educate builders and trades on proper material and equipment installation practices.
- Marketing and awareness on the West Virginia energy code and benefits of the IECC.

With the assistance of the West Virginia Office of Energy we also expect to be able to continue our education and outreach efforts after completion of the DOE program.

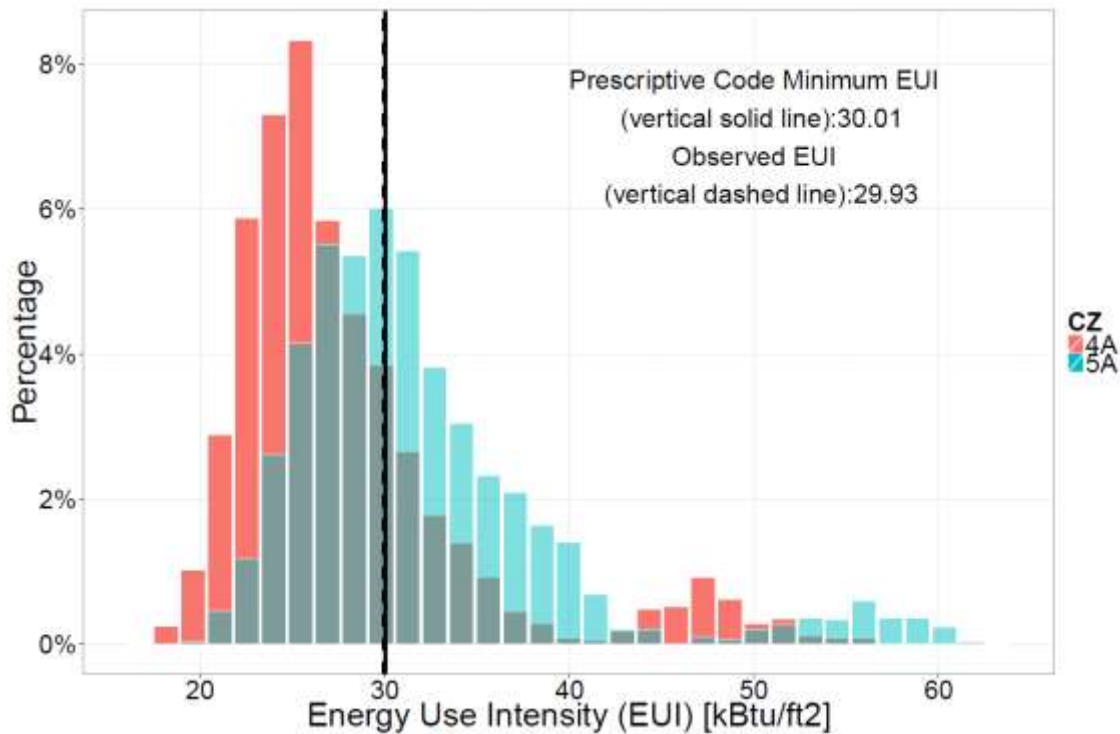
## Findings

The findings resulting from the baseline field study are summarized as follows:

Key Item	Total Savings (kBtu/home)	Total Energy Savings (MMBtu)	Total Energy Cost Savings (\$)
Air Tightness	5307.55	9,824	207,262
Duct Leakage	1002.16	1,855	44,858
Lighting	552.02	1,022	39,353
Wall Insulation	656.98	1,216	26,683
<b>TOTAL</b>	<b>7518.71 kBtu/home</b>	<b>13,917 MMBtu</b>	<b>\$ 318,156</b>

<sup>6</sup> <https://www.energycodes.gov/compliance/energy-code-field-studies>

**Table:** Key Items and Estimated Annual Savings Potential in West Virginia



**Figure:** Average Statewide Energy Use Intensity

The official results of the study are published by PNNL on the DOE Building Energy Codes Program website<sup>7</sup>.

The West Virginia project team also implemented a survey following its classroom training seminars. Based on 85 responses (which includes all locations), 97% of respondents claimed that they learned something new about the IECC. Additionally, 86% of responders claimed they learned something applicable to their business. Common responses included how to educate customers about the advantages of energy efficiency, as well as the importance of insulation, weatherization, and air sealing.

### Suggestions for Future Research

The team observed a general lack of knowledge surrounding the IECC which is assumed to be based on the overall lack of code enforcement in most of the areas of the state. This includes many basic construction methods necessary to achieve compliance with the 2009 IECC. In many cases, builders initially believed they were meeting code, but were not due to lack of knowledge. The lack of enforcement and widespread knowledge appears to result in reluctance and general lack of motivation for builders to change their building practices to properly comply.

<sup>7</sup> See <https://www.energycodes.gov/compliance/energy-code-field-studies>



Additional field studies in the future would be useful to see if education has had an impact on building practices within the state. Education outreach on current code requirements and related construction methods should also be maintained.

## **References**

U.S. Department of Energy. Building Energy Codes Program. Residential Energy Code Field Studies. <https://www.energycodes.gov/compliance/energy-code-field-studies>.