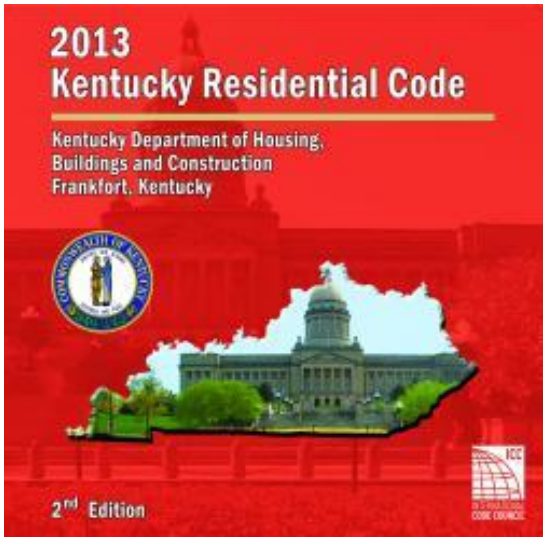
Kentucky Energy Code Compliance Study



Program Update

May 25, 2016

MEEA
Midwest Energy Efficiency Alliance

COMMONWEALTH OF KENTUCKY
HOUSING★BUILDINGS CONSTRUCTION

DEDI

Kentucky Energy Code Compliance Study

Program and Training Update

George Mann, Project Manager

May 25, 2016

Project Team

- George Mann (Project Manager)
- Larry Mahaffey (Circuit Rider)
- Isaac Elnecave/Chris Burgess/Kelsey Horton (MEEA)
- Roger Banks/Ric McNees (DHBC)
- Lee Colten /Michael Kennedy (DEDI)

Overview of Project

Purpose: Determine if energy code compliance can be improved and how.

Phase1: Establish baseline statewide level of code compliance.

Phase 2: Implement program – Circuit Rider program/Training & Education program.

Phase 3: Rerun baseline study to determine level of improvement.

Phase 2

- **Southface**, an Atlanta based training provider, has been contracted to provide our onsite training
- 14 full day training sessions will be offered in 2016
- Additional training sessions will be offered in 2017

Phase 2

- Online registration and paper registration
- Registration fee $25
- Attendees receive a binder including class slides and filled with valuable how-to Technical Guidelines relative to material presented in class
- Classes were approved for CEU credits by:
  - Division of HVAC
  - Division of Building Codes Enforcement
  - International Code Council (ICC)
  - Building Performance Institute (BPI)

Phase 2

Training Topics

1. HVAC
2. Air Sealing
3. Common Compliance Challenges

HVAC Training Content

Learning Objectives:

- Identify code requirements regarding **sizing, design, and selection** of HVAC equipment and ducts
- Explain how the ACCA **Manual J, S and D** load calculation standards are used to determine appropriate sizing and design of ducts and HVAC equipment
- Describe the role the **HVAC system plays in moisture control** and the effect excessive moisture has on building durability and occupant comfort and health
- Define **sensible and latent heat**
- **Review a completed load calculation printout** for common errors and intentional inputs of incorrect data and identify examples of such errors
- **Compare installed HVAC and duct systems** to outputs of Manual J, S, and D to verify proper sizing and design
- Describe the consequences of **improperly sized HVAC systems**

Phase 2

Madisonville -- March 28

14 Brothers Bar-B-Q
1055 North Main Street

Lexington -- March 30

38 Brock McVey
1100 Brock McVey Drive

Corbin -- March 31

29 Brock McVey
71 Peachtree St.

Morehead -- May 17

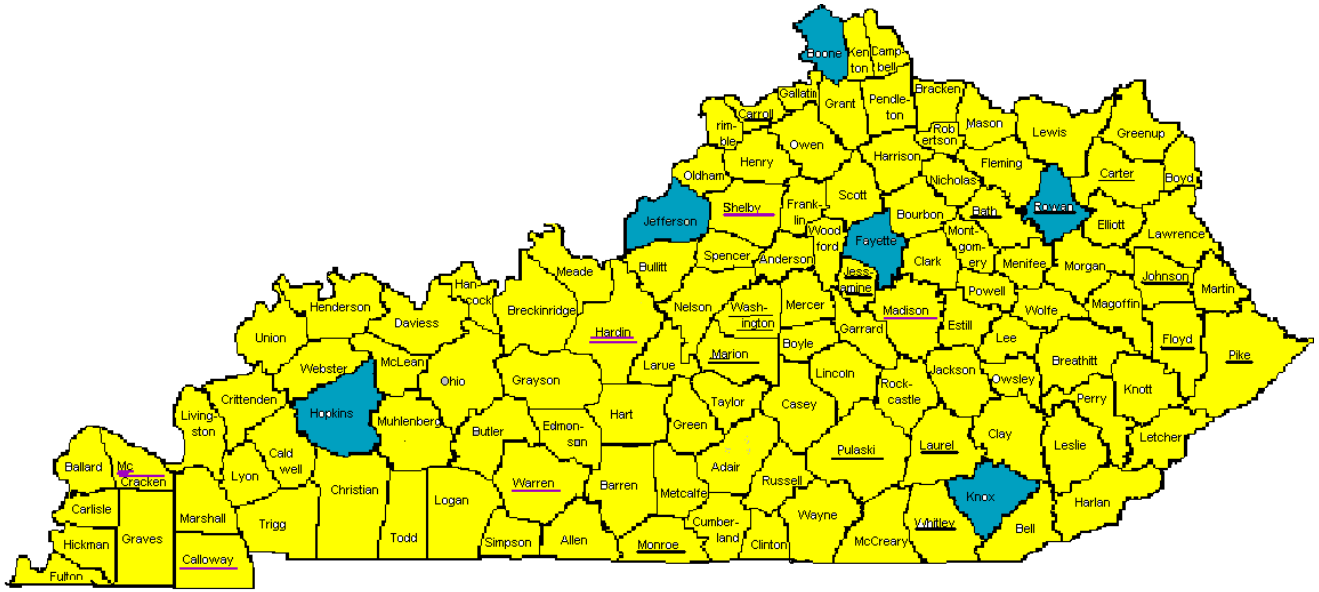
8 KCTCS
609 Viking Dr.

Louisville -- May 19

4 Corken Steel
1226 W. Market St.

Florence – May 20

13 Corken Steel
7920 Kentucky Dr



Thermal Envelope Content

- **Define the building envelope** and identify the qualities of effective and ineffective envelopes
- Summarize fundamental **properties of air movement** and describe **importance of air sealing**
- **Compare infiltration and controlled ventilation** and identify benefits of controlled ventilation
- Identify **code requirements for air sealing** and **identify accepted methods to verify compliance**
- Discuss **methods commonly used** to perform air sealing in homes
- Explain **relationship between air sealing and insulation**
- **Define methods of heat transfer**
- Identify **code requirements for insulation** and describe importance of insulation for home performance
- Summarize **common methods used to insulate homes**
- Employ industry-established **inspection methods for determining effectiveness of insulation installation**

Thermal Envelope

Ashland -- April 19

13 — Transportation Center
99 15th Street

Prestonsburg -- April 20

6 — Fire Training Center
132 Cliff Rd

London -- April 21

18 — Community Center
529 S. Main Street

Burlington -- May 4

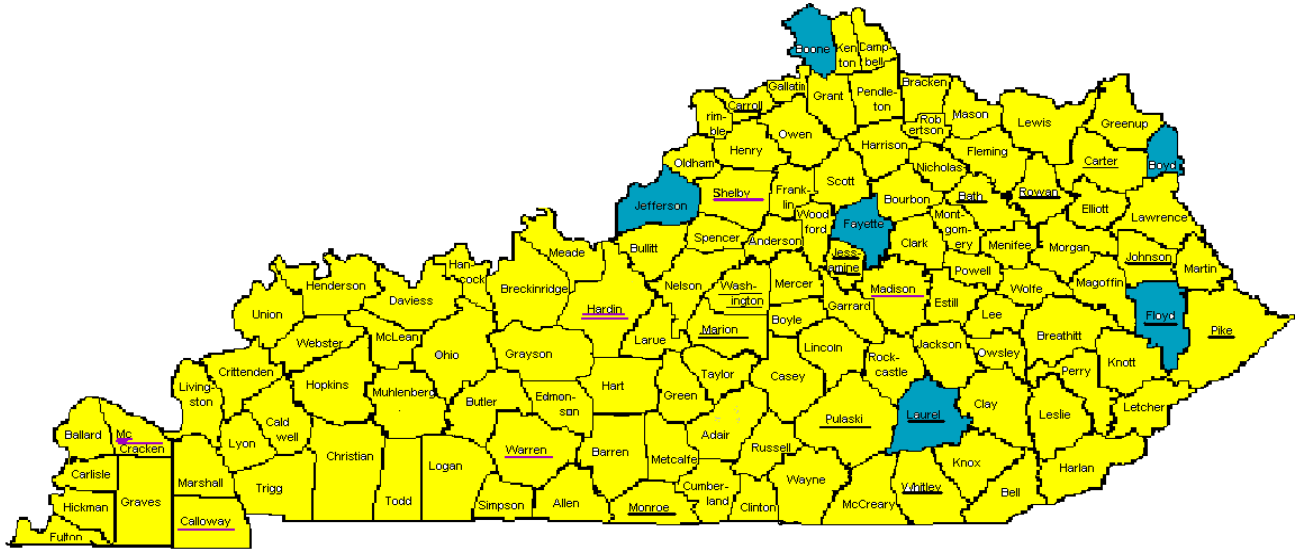
7 — Boone Co Extension Office
6028 Camp Ernst Road

Lexington -- May 5

11 — HBAL
3146 Custer Drive

Louisville -- August 30

? — Memorial Auditorium
970 South 4th Street



Common Compliance Challenges

- Discuss accepted **methods of air sealing and insulating conditioned crawl spaces**
- **Calculate appropriate sizing for attic ventilation**
- **Define building envelope** and **identify qualities of effective and ineffective building envelopes** in homes
- Define **high-efficiency lighting and explore lighting options**
- Identify **common missed air sealing opportunities** and describe how to air seal in these locations
- Explain **importance of sealing ducts** within conditioned space and summarize common methods used to seal ducts
- Summarize **common methods, materials and practices used to install insulation effectively**
- Identify **methods to air seal and insulate attic doors and hatches**

Common Compliance Challenges

Lexington -- May 3

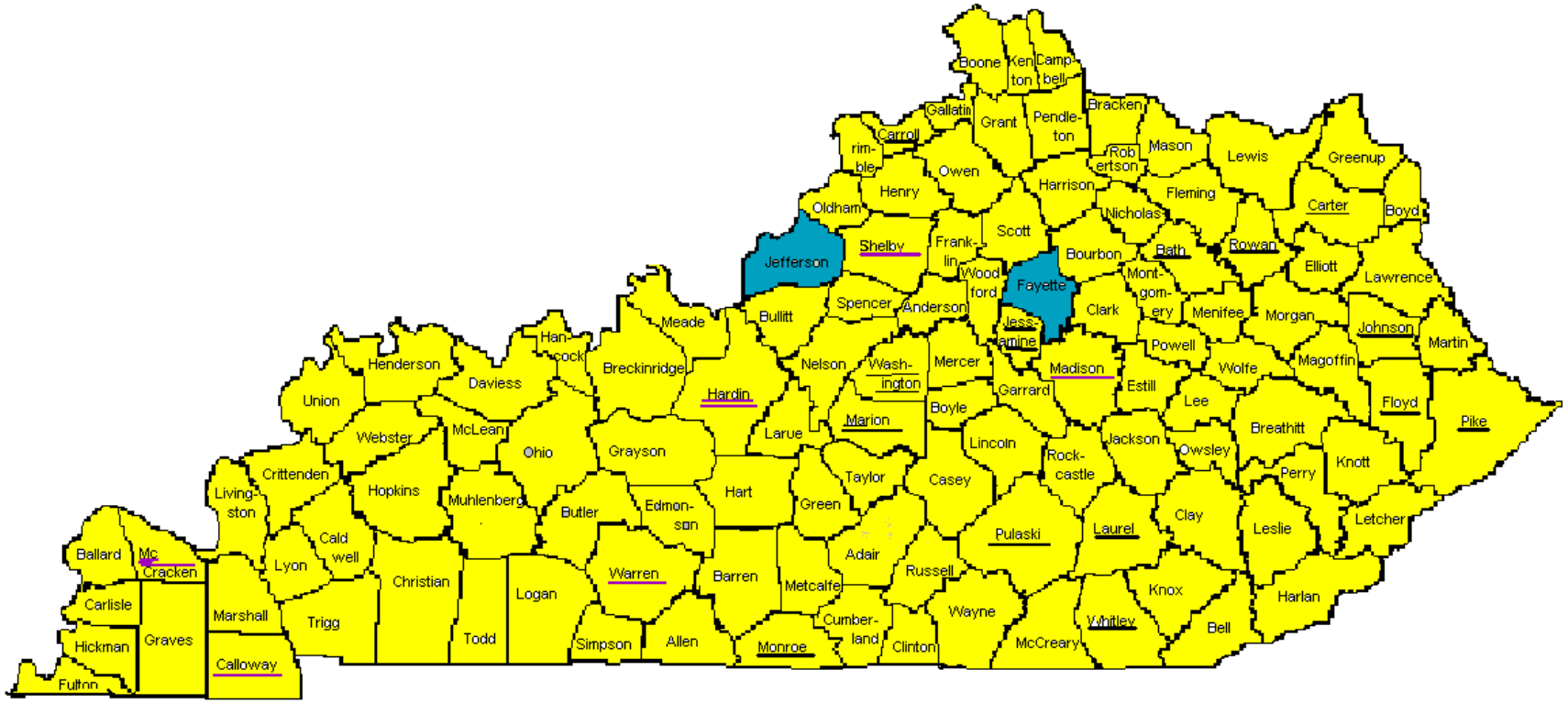
8

HBAL
3146 Custer Drive

Louisville -- August 30

?

Memorial Auditorium
970 South 4th Street



Class Attendance

- Total attendance to date
  - HVAC 113
  - Thermal Envelope 55
  - Common Compliance Challenges 8
- Attendee breakdown
  - HVAC industry 63
  - Builder / Contractor 31
  - Building Inspector 74
  - Designer 3
  - Utilities 4
  - Energy Auditor 1
  - Fire Officials 2

Future Classes after October 1

Common Compliance Challenges

Paducah – October 6
Emergency Management Complex
3700 Coleman Road

Bowling Green – October 18
Neighborhood Community Ctr
707 East Main St

Burlington – October 20
Boone Co Extension Office
6028 Camp Ernst Road

Ashland -- November 7
Transportation Center
99 15th Street

Pikeville -- November 8
Fire Station #1
104 Chloe Rd

London -- November 10
Community Center
529 S. Main Street

Thermal Envelope

Paducah – October 5
Emergency Management Complex
3700 Coleman Road

Bowling Green – October 17
Neighborhood Community Ctr
707 East Main St

Class Advertising and Outreach

- **Kentucky Association of Master Contractors**
- **Home Builders Association of Kentucky**
- **Code Administrators Association of Kentucky**
- **Home Builders Association of Lexington**
- **Regional offices of the Home Builders Assoc.**
- **Lowes**
- **Home Depot**
- **Local building departments**
- **And others**

Contact Information

- George Mann, Project Manager - gmann@kyenergystudy.org
- Larry Mahaffey, Circuit Rider – lmahaffey@kyenergystudy.org
- Isaac Elnecave, MEEA – ielnecave@mwalliance.org
- Chris Burgess, MEEA – cburgess@mwalliance.org
- Kelsey Horton, MEEA – khorton@mwalliance.org
- Roger Banks, DHBC – roger.banks@ky.gov
- Ric McNees, DHBC – ric.mcnees@ky.gov
- Lee Colten, DEDI – lee.colten@ky.gov
- Michael Kennedy – michael.kennedy@ky.gov

Questions?

Kentucky Energy Code Compliance Study

Circuit Rider Program

Larry Mahaffey, Circuit Rider

May 25, 2016

MEEA Midwest Energy Efficiency Alliance

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Introduction

Circuit Rider Position

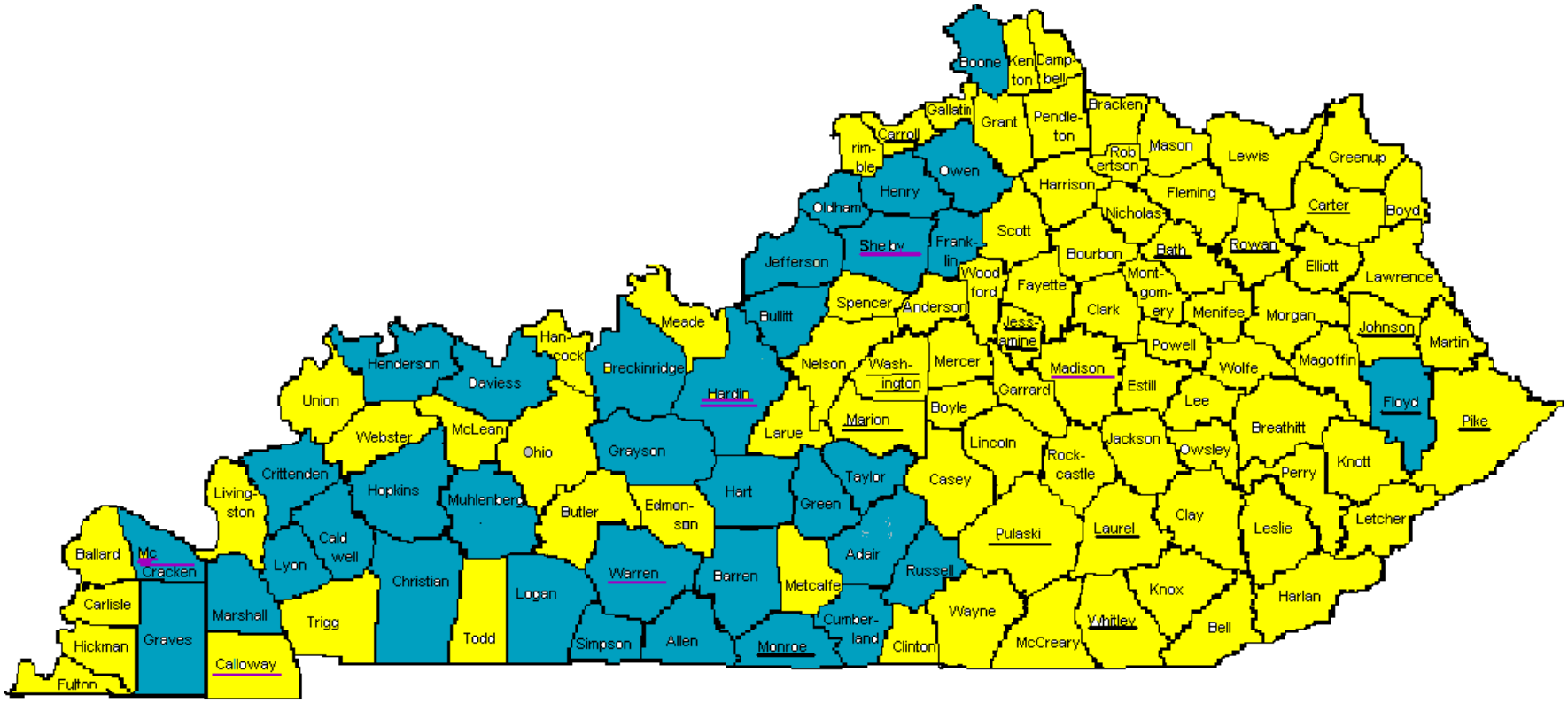
- Started work on August 1, 2015
- 10th month of 26 month program
- Provide individual assistance to code officials, builders and other energy code stakeholders
- Pro-actively reach out to stakeholders on a regular basis
- Establish and maintain a trusted energy code advisor relationship

Circuit Rider Outreach
Meetings/Contacts Conducted

- 65 Meetings to Date: 20 with homebuilders, 35 with inspection departments, 3 with HVAC contractors, 2 with Insulation contractors, 2 with a local officials and 3 with building supply business managers/owners
- Meeting typically last from 30 – 120 minutes with 1 to 4 attendees
- Builders, contractors and code officials have generally been open to meetings and often willingly provide referrals
- Continuing follow-up visits with previous contacts

Kentucky Circuit Rider Visits

Through 5/25/2016



Circuit Rider Outreach

Topics Discussed with Homebuilders

- Provide information on the Kentucky Energy Code Improvement Study, contact / hotline information, classroom training opportunities and online videos.
- Discuss Prescriptive requirements of the 2009 IECC
- Maintaining continuous alignment of the insulation with the building envelope air barrier
- Equipment sizing and duct sealing
- Insulation installation and air sealing around tub/shower units, garage separation, wall corners, headers and around windows / doors
- Foundation types; Slabs, crawlspaces and basements
- The posting of the required permanent certificate

Circuit Rider Outreach

Topics Discussed With Building Officials

- Application and compliance issues with the 2009 IECC during plan review and inspection
- Field inspections of energy code requirements
- Insulation installation and air sealing the envelope requirements in table 402.4.2
- Foundation types and insulation requirements
- Checking energy certificate for correct information
- Kentucky Energy Code Compliance Study; support, training opportunities, hotline use and online videos

Circuit Rider Outreach

Building Departments Visited to Date

City Departments

Murray
Paducah
Mayfield
Madisonville
Henderson
Hopkinsville
Kuttawa
Owensboro
Central City
Russellville
Leitchfield
Elizabethtown
Bowling Green
Scottsville
Shelbyville
Glasgow
Louisville
Mt. Washington
Tomkinsville
Greensburg
Campbellsville
Columbia
Burkesville
Jamestown

County Departments

McCracken
Marshall
Hopkins
Henderson
Daviess
Simpson
Hart
Hardin
Warren
Barren
Franklin
Shelby
Oldham
Owen
Jefferson
Bullitt

Circuit Rider Outreach

Deficiencies noted during Field Observations

- Lack of air sealing around windows and doors
- No insulation or air barrier behind tub/shower units
- No insulation in voids of exterior wall framing
- Poor insulation installation
- Floor slab edge insulation omitted
- No blocking between ceiling joists and attached garages

Positive Observations from the Field

- Window and Door U-Factors
- Framing Techniques
- Duct Sealing

Upcoming Circuit Rider Visits

- Areas to visit next
  - Bluegrass Region
  - Lincoln Trail
  - KIPDA
  - Northern KY
  - Follow-up visits

Contact Information

Larry Mahaffey
(502) 645-6542
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Energy Code Hotline:
energycodehotline@kyenergystudy.org

Website: www.kyenergystudy.org

Questions?

Kentucky Energy Code Compliance Study

Review of Training Modules

Kelsey Horton, MEEA

May 25, 2016

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Online Training Modules

MWAlliance Videos Playlists Channels Discussion About

Kentucky Residential Energy Code Trainings

MWAlliance • 14 videos • 16 views • Updated 5 days ago

This video series was created as part of the Residential Energy Code Field Study, a project of the United States Department of Energy. Kentucky Department of Housing, Buildings, and Construction, Kentucky Department for Energy Development and Inde... more

Play all | Share | Save

1		Energy Codes: An Introduction & Background by MWAlliance	5:01
2		Structure of IECC by MWAlliance	3:16
3		The Energy Code: 2009 IECC by MWAlliance	14:23
4		Overview of Mandatory Compliance Requirements by MWAlliance	11:39

Online Training Modules

- Introduction & Background
- Structure of IECC
- The Energy Code: 2009 IECC/2013 KRC
- Mandatory Compliance Requirements
- Building Thermal Envelope
- Air Leakage
- Duct Installation & Duct Sealing
- HVAC and Building Pressure
- Insulation Installation & Walls
- Roof/Attics/Above-Grade Walls/Floors
- Basements/Crawlspaces & Slabs
- Water & Moisture Issues
- Fenestration, Ducts, & Electrical
- Compliance Software

Online Training Modules

- **All videos are now available for use at bit.ly/KYcodes** (case-sensitive link)

- Example Video Clip: *Prescriptive Compliance: Fenestration, Ducts & Electrical*

Marketing Strategy

- MEEA e-mail blast, blog post, social media
  - Sample tweets and social media posts will be made available to all partners
- Adding link to videos in all places where we currently market our in-person courses
  - Websites, registration pages, flyers
- Circuit Rider & In-Person Trainers sharing link to videos

Kentucky Energy Code Compliance Study

Review of Demand Reduction Potential Analysis

Chris Burgess, MEEA

May 25, 2016

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Demand Reduction Potential Analysis

- Since compliance with ACCA Manual J is a code requirement, information about installed HVAC systems was collected in addition the “key item” data
- Sufficient building envelope and mechanical system data was collected to conduct an oversizing analysis (Manual J block load) on 54 homes
- This analysis was mostly concerned with the demand reduction aspect of HVAC oversizing, but energy savings were also considered

Demand Reduction Potential Analysis

Additional HVAC data collected included

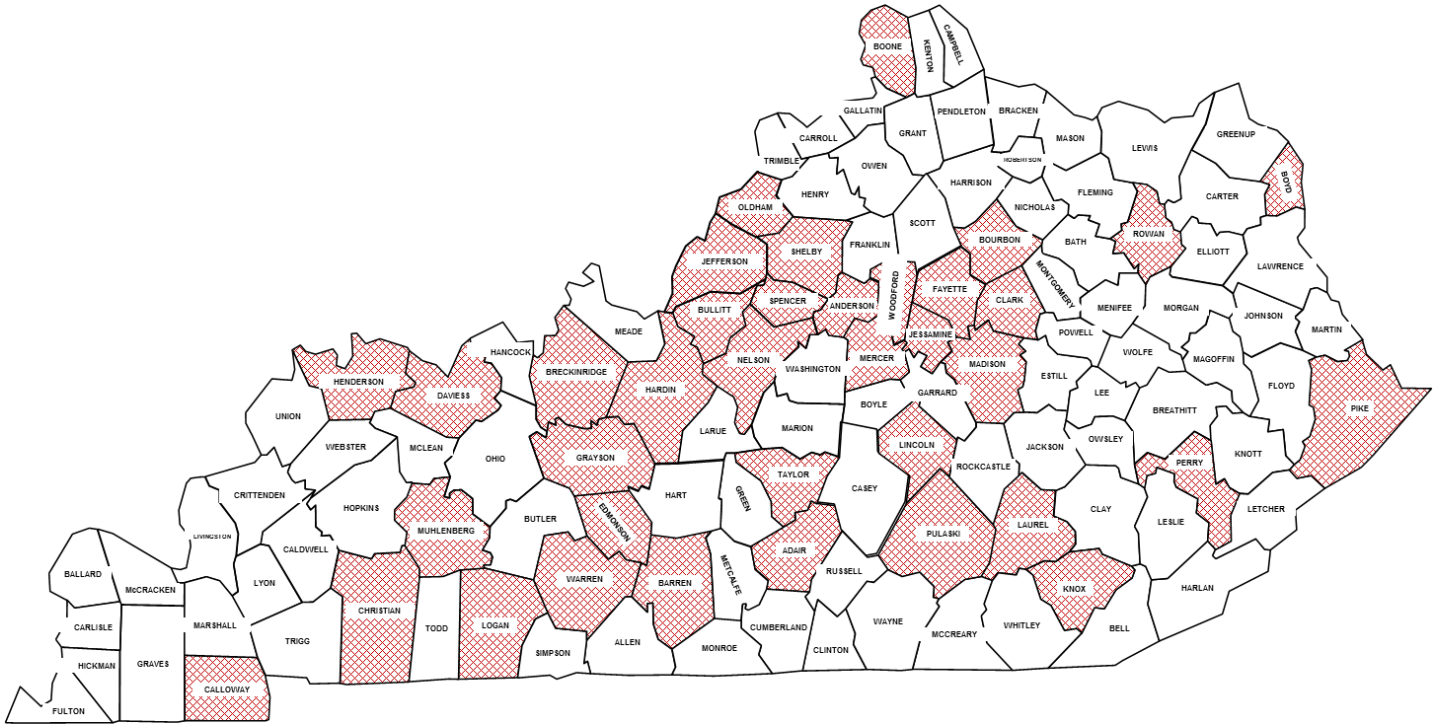
- Capacity of installed equipment (Btu/hr or tons)
- Type of installed equipment (central ac, heat pump)
- Equipment model number
- Building orientation
- Conditioned volume
- Conditioned wall, floor, and ceiling areas
- Window area for each facade

Demand Reduction Potential Analysis

- HVAC data was collected at the same time as the key item data for a given house

- Consequently, the Manual J block load data was typically collected at the “final” stage of construction, when the HVAC system had been fully installed

Demand Reduction Potential Analysis



Key Item Sampling Plan

Demand Reduction Potential Analysis

Oversizing Sampling Plan

Demand Reduction Potential Analysis

- Two independent aspects of demand reduction were analyzed
  - Improved measure level compliance
  - HVAC equipment sizing

- Interactive effects between individual measures, or between measures and oversizing, was beyond the scope of this analysis
  - Time of peak is likely different for different measures

Demand Reduction Potential Analysis

- The demand impact analysis was conducted through energy modeling using *EnergyPlus*
  - 4 compliance measures were analyzed: high efficacy lighting, above-grade wall insulation (including quality), envelope air tightness, and duct tightness
- Each worse-than-code observation was used to create a building energy model
  - All other components, except the measure being evaluated, were maintained at the prescriptive code level, regardless of the observed value

Demand Reduction Potential Analysis

- The data collected indicated common use of 4 foundation types
  - Vented crawlspace, Conditioned crawlspace, Slab-on-grade, Heated basement

- And three HVAC system types
  - Electric heat pump, Electric AC with natural gas furnace, Electric AC with electric furnace

Demand Reduction Potential Analysis

Foundation Types and Weighting Factors

Foundation Type	*Weight*
Heated Basement	53.49%
Slab-on-grade	18.60%
Vented Crawlspace	23.25%
Conditioned Crawlspace	4.65%

Demand Reduction Potential Analysis

HVAC Systems and Weighting Factors

HVAC System Type	*Weight*
Electric AC with Electric Furnace	8.78%
Electric AC with Natural Gas Furnace	47.37%
Electric Heat Pump	43.86%

Demand Reduction Potential Analysis

- Lexington was used as representative weather data
  - Typical Meteorological Year (TMY3)

- Use of TMY3 data likely underestimates peak loads since they are designed to represent typical rather than extreme conditions*

*Wilcox and Marion, 2008, NREL

Demand Reduction Potential Analysis

- Annual gas and electric EUIs are extracted for each model and weighted across HVAC systems and foundation types
- This information is then used to generate weighted average EUIs
- These EUIs are then compared to energy models that use minimally code compliant measure levels
- The EUI difference is the potential energy savings

Demand Reduction Potential Analysis

Potential Measure Level Demand Reduction - Preliminary

Measure	*Electric Demand Reduction (kW/year)*
High-efficacy Lighting	558
Above-grade Wall Insulation	971
Envelope Air Tightness	2,987
Duct Air Tightness	40

Demand Reduction Potential Analysis

- The oversizing analysis was conducted using *Wrightsoft* Right Suite, Version 8
  - Homes were analyzed to determine if the installed HVAC system was appropriately sized for the building as built
  - Where actual installed measure information was not available, the more energy intensive of the average or median observed measure value was used

Demand Reduction Potential Analysis

Default Values Used in Sizing Calculations

Component	*Number of Occasions Used*	*Default Value Used*	*Minimum Value*	*Maximum Value*	*Average Value*	*Median Value*
Wall Insulation	39	R-13	R-11	R-21	R-14	R-13
Ceiling Insulation	4	R-38	R-14	R-56	R-38	R-38
Window U-factor	32	0.31	0.27	0.47	0.31	0.31
Duct Tightness (CFM25/100 ft^2 CFA)	8	12.75	3.1	40.4	13.2	10.2
Air Sealing (ACH50)	8	5.6	0.51	20	5.6	4.85

Demand Reduction Potential Analysis

- Building orientation data was handled in a similar fashion
  - Where building orientation data was not provided, the most energy intensive orientation was used in the calculation
  - *Wrightsoft* automatically calculates the orientation with maximum load

Demand Reduction Potential Analysis

- The design load for each home was calculated separately, using the installed measure level, whether above or below code requirement
  - The intent of the analysis was to determine if the equipment was appropriately sized for the building as build, not as fully compliant with each measure

Demand Reduction Potential Analysis

- In establishing the baseline appropriate size of installed units, the calculated design load was upsized to the next standard unit size
  - This is a conservative methodology since Manual S allows a plus/minus 2,000 Btu/hr consideration when sizing units
  - In other words, a 25,000 Btu/hr baseline design load was upsized to 30,000 Btu/hr even though a 24,000 Btu/hr unit would be allowed by Manual S

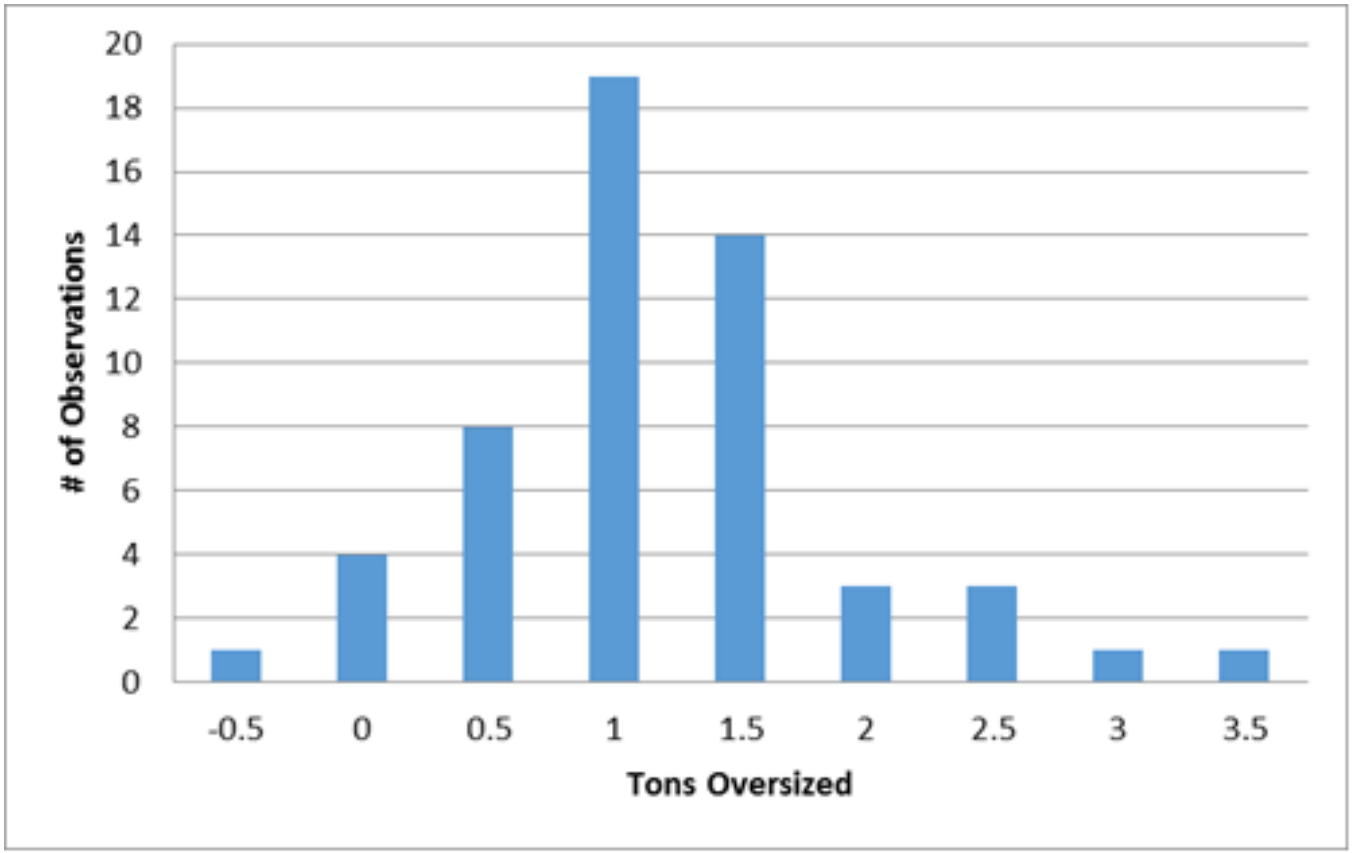
Demand Reduction Potential Analysis

- Range of sizing was from -0.5 tons (undersized) to 3.7 tons (oversized)

- Average system was oversized by 1.2 tons, with a median oversizing of 1 ton
  - This corresponds to an oversizing factor of 159%

Demand Reduction Potential Analysis

Distribution of Oversizing



Demand Reduction Potential Analysis

- The sizing factors calculated using *Wrightsoft* were used to create a model with an “average” oversized HVAC system
- The peak electric draw from this model was compared with the draw from a minimally code compliant model to calculate the potential demand reduction
- This difference was aggregated over the foundation types and HVAC systems to determine the average statewide demand reduction

Demand Reduction Potential Analysis

- The potential demand reduction (preliminary) from right sizing is 2,373 kW per year

- Oversizing equipment also impacts energy consumption
  - A preliminary analysis using this simplified approach shows a potential energy savings of 85 kWh / home / year, or 624,325 kWh annually statewide.

Fifteen Minute Break

Kentucky Energy Code Compliance Study

Review of Potential HVAC Unit Cost Savings

Lee Colten, DEDI

May 25, 2016

MEEA Midwest Energy Efficiency Alliance

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Cost of HVAC Over-Sizing

1. Installation – for single-family homes only
2. Short-cycling/wear-out
3. Performance/efficiency

Cost of HVAC Over-Sizing
Installation only

	Base case	Conservative est.
New homes (90% oversized)	5,400	4,016
Existing homes (90% oversized - 66% single-family detached)	52,713	33,947
Unit life span	5% (20 yr life)	4% (25 yr life)
Total units	58,113	37,963
AC / HP incremental cost	$418 / $546	$418 / $547
Potential Savings - AC (30%)	$7,278,650	$4,754,823
Potential Savings - Heat Pump (70%)	$22,190,439	$14,496,040
Total Potential Savings	**$29,469,089**	**$19,250,863**

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Cost of HVAC Over-Sizing
Total Impact?

1. Installation – priors slides for single-family homes puts cost between $19.3 - $29.5 million
2. Short-cycling/wear-out - ?% penalty
3. Performance/efficiency – $8 - $72 / home / yr
4. Another ~17,500 units (MH, duplexes, etc.) not represented in these calculations

What is total costs of over-sizing to consumers?...

New Business

- HVAC Installation Analysis
- Other topics
- Upcoming conferences

Next Steps

- Continue Circuit Rider Program across the State
- Promote online training videos
- Continue promoting in-person trainings

Contact Information

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