Kentucky Energy Code Compliance Study

Stakeholder Meeting

June 22, 2017

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Project Team / Contact Information

- George Mann, Project Manager - gmann@kyenergystudy.org
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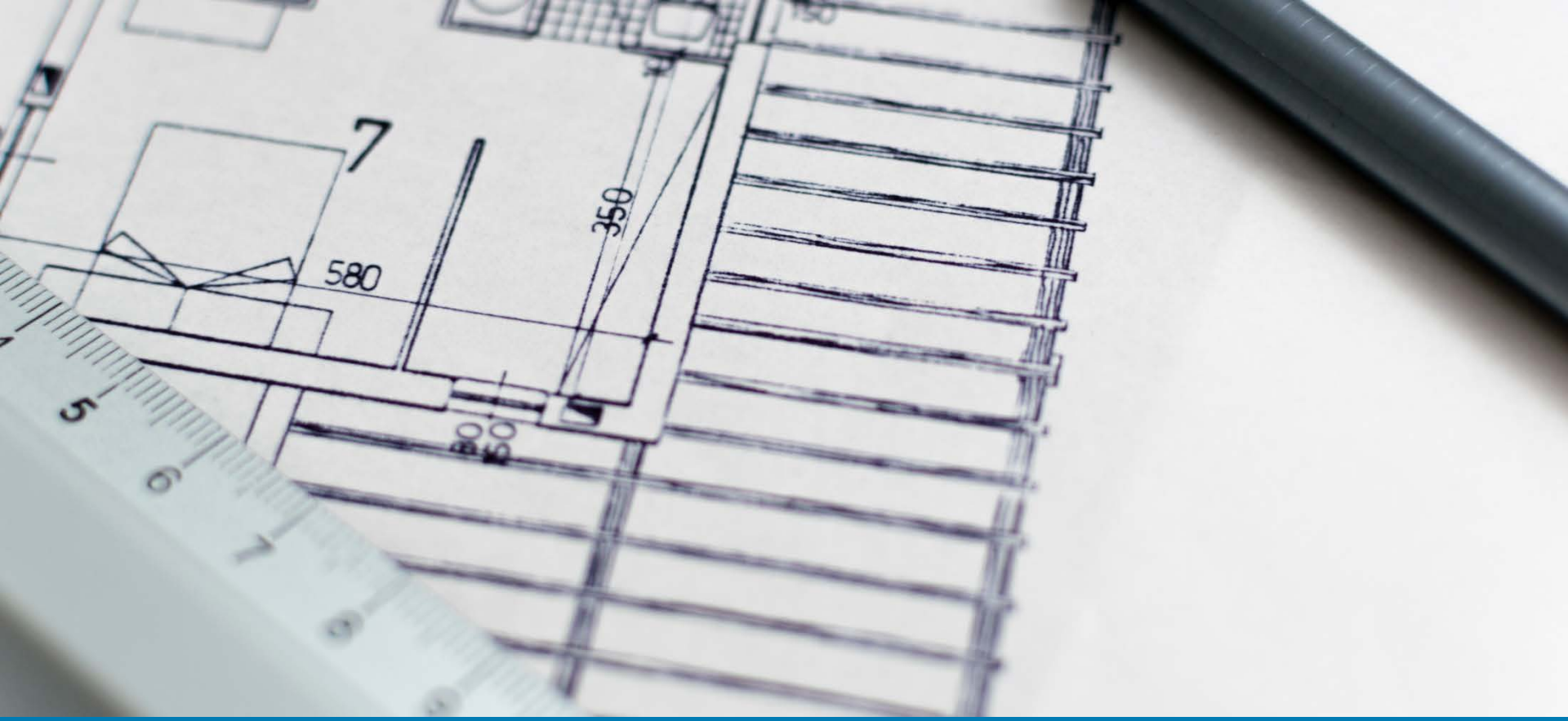

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Program Update

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Overview of Project

Purpose: Establish residential energy code compliance baseline, and determine if focused training & support can improve compliance.

- 3-year, three phase, statewide program focused on new, single-family homes
- Joint effort of DHBC, DEDI and MEEA

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Overview of Project

Phase1: Establish baseline and determine what measures typically need additional support (Oct 2014 - Sept 2015)

Phase 2: Focused training & support (Oct 2015 – May 2017)

- Circuit Rider program
- In-Person Training & Education program
- Online training videos (622 views to date)
- Numerous presentations about the project

Phase 3: May-Sept. 2017 Rerun data collection process/analysis to determine level of improvement

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Phase 2

Southface Building know-how for a sustainable future

- **Southface**, a nationally-recognized Atlanta based training provider, provided our onsite training
- **25 full day** training sessions offered in 14 different counties across the state (2016/17)
- **1 half day** class for stakeholders
- Nominal registration fee: $25 ($200+ value)
- Classes approved for CEU credits by:
  - Division of HVAC
  - Division of Building Codes Enforcement
  - International Code Council (ICC)
  - Building Performance Institute (BPI)

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Phase 2

Training Topics

- HVAC
  - HVAC Sizing / Explain ACCA **Manual J, S and D**
  - Role the **HVAC system plays in moisture control**
  - Consequences of **improperly sized HVAC systems**
- Thermal Envelope
  - Define the **building envelope**
  - Importance of **air sealing / blower door testing**
  - Inspection methods for determining **effectiveness** of insulation installation
- Common Compliance Challenges
  - Insulation installation **quality**
  - **High-efficacy** lighting
  - Common missed **air sealing opportunities**
  - Importance of **sealing ducts**

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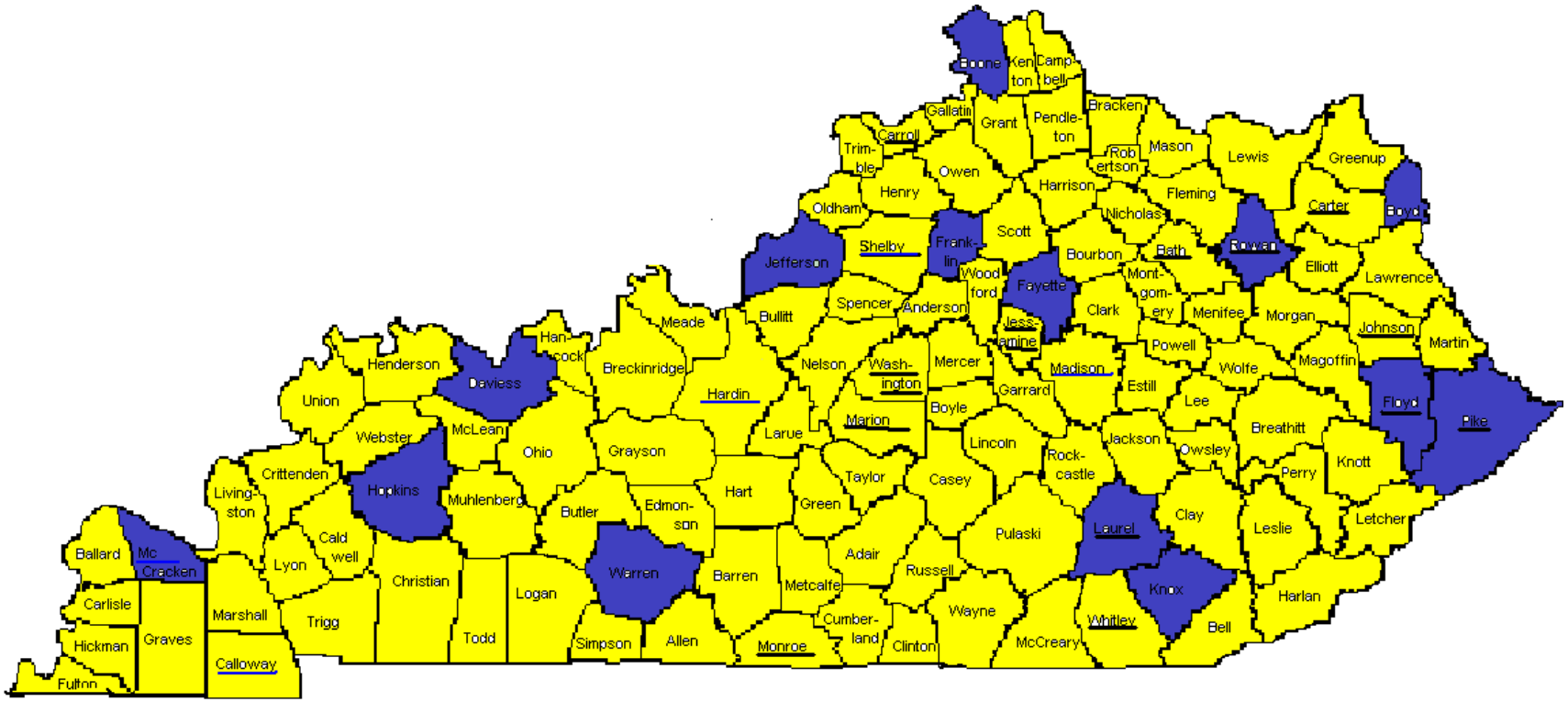
Seminar Sites Across the Commonwealth



Class Attendance

Total Attendance

- HVAC 144
- Thermal Envelope 131
- Common Compliance Challenges...106

TOTAL = 381 AVG. = 15.24 / class

Over 3,000 trainee contact hours

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
- Internet

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Circuit Rider Program

Larry Mahaffey, Circuit Rider

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Circuit Rider Position

- 23rd month of 26 month program
- Provide **individual assistance** to code officials, homebuilders and other energy code stakeholders
- **Pro-actively** reach out to stakeholders on a regular basis
- Establish and maintain a **trusted** energy code advisor relationship
- Currently assisting with building recruitment for Phase 3, and will then transition back to circuit riding through September

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Meetings / Contacts Conducted

- **190 One-on-One Meetings to date**
  - 81 with homebuilders
  - 73 with inspection departments
  - 14 with HVAC contractors
  - 6 with insulation contractors
  - 9 with local officials
  - 5 with building supply businesses
  - 2 with local co-ops

Meetings / Contacts Conducted

- Meetings typically last from 30 – 120 minutes and consist of 1 to 9 attendees. **302 total attendees** as of May 21, 2017
- Additionally, **246 "in-field"** contacts were made where information or assistance was provided on site
- All regions of the state have been visited, many more than once
- Several building departments have provided opportunities to ride with the local inspectors during site visits
- Follow-up visits with previous contacts
- Promoting the online training videos, with 622 views to date

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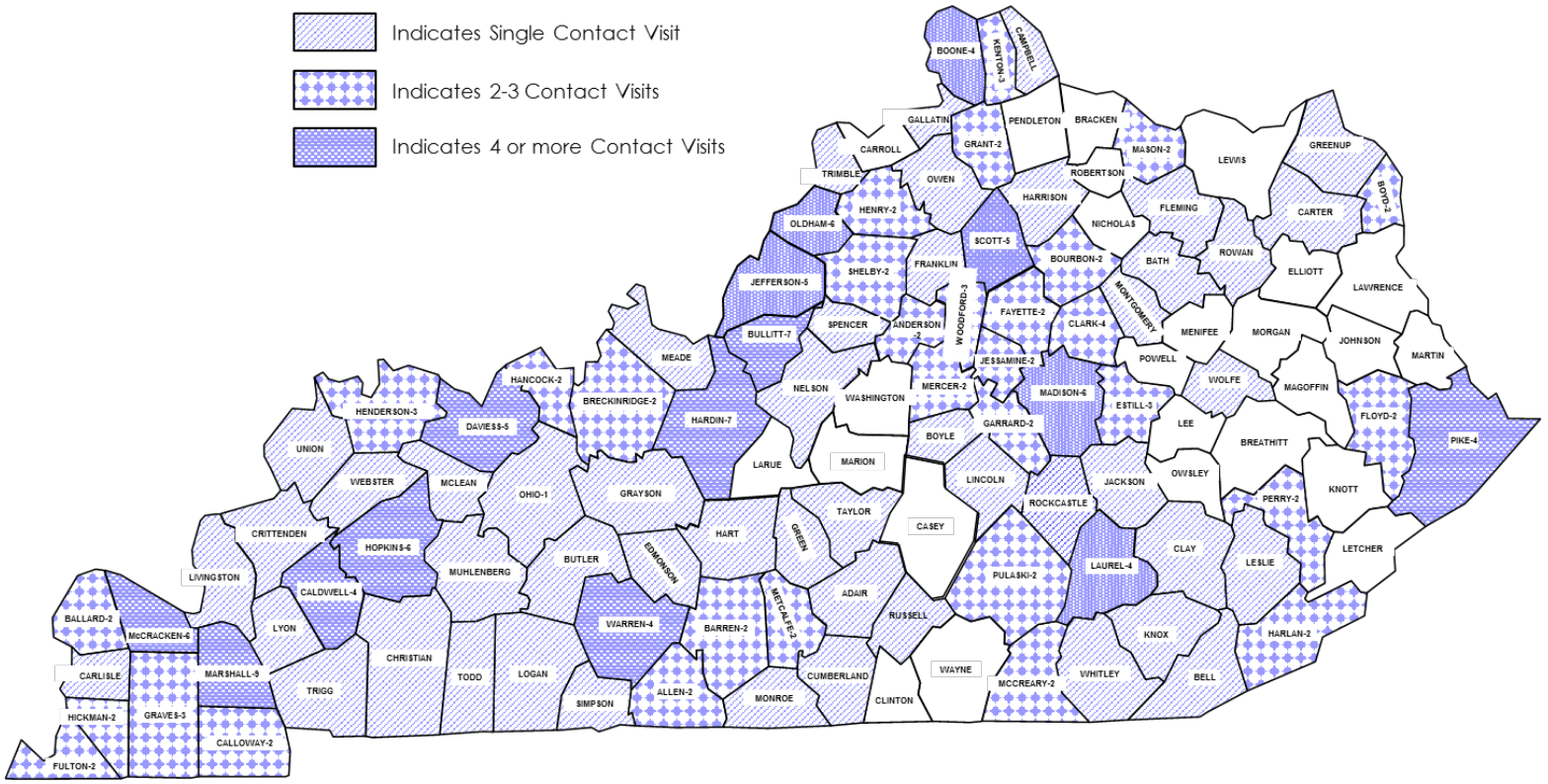
Circuit Rider Program



Topics Discussed During Meetings

- **Reviewed** items from baseline study shown to need more support
- Discussed **construction methods** that will allow better code compliance (proper insulation installation, improved air sealing)
- Most builders and code officials agree that there has been a steady compliance **improvement** over the course of the study
- **Working together;** the energy code requires significant crossover between construction trades – the work of one trade substantially impacts another trade's work

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Statewide Observations

- Several building departments have added **additional inspections** to assure better compliance with the energy code.
- During the last year, site visits have shown an **improvement** in energy framing techniques and insulation installation quality.
- Methods for installing slab edge insulation continues to pose **challenges**
- Envelope tightness of **less than 5 ACH** cannot be consistently identified by the visual inspection option
- There appears to be a **better awareness** of the energy code requirements statewide

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Questions?

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Insulation Installation Guide

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Insulation Installation Guide

Is the insulation up to code?

When insulation installation is evaluated, assemblies are often designated as Grade I, Grade II, or Grade III. Two criteria are considered when determining the installation grade: missing insulation and compression. **Grade I is used to describe insulation that is generally installed according to manufacturers' instructions (Section 303.2 2009 IECC) and therefore is the only grade considered to be code compliant for the prescriptive path.**

Missing Insulation

- **Grade I*:** 0% to 0.5% of the area, or up to 7 sq. in. of missing insulation per stud bay
- **Grade II*:** 0.5% to 2% of the area, or 7 square inches to 27 sq. in. of missing insulation per stud bay
- **Grade III*:** More than 2% of the area, or more than 27 sq. in. of missing insulation per stud bay

Almost no gaps | 2% | 10%

Diagrams based on HERS Standards

Compression**

- **Grade I*:** Up to 2% compressed area (27 sq. in. per stud bay), must be >70% of the intended depth
- **Grade II*:** Up to 10% compressed area (133 sq. in. per stud bay), must be >70% of the intended depth
- **Grade III*:** A total compression area of more than 10%, (or more than 133 sq. in. per stud bay)

* Suggested ranges based on RESNET guidelines. Area calculations are based on an 8 ft. ceiling with 16 in. stud bays.

** The Insulation Institute allows inset stapling but it is not recommended here since it reduces the R-value of the wall.

Why is having properly installed insulation important?

Gaps, voids, and compressions can cause cold spots in walls, ceilings, and floors. In addition to the loss of insulating value (and increased heating / cooling expense), these cold spots can cause drafts and encourage the formation of condensation in the wall cavity, floor, or ceiling.

Challenges and Code Compliance

It's often immediately clear whether insulation installation is Grade I or Grade III. The difficulty often comes when distinguishing between I and II (**Grades II and III are not code compliant**). That's when a closer look is necessary. Is the batt split around wiring / piping and cut tightly around switches / receptacles, do compressions reduce thickness to <70%, is the total area of missing insulation >0.5%? In other words you need to carefully assess if the sum total of imperfections leads to a Grade I or Grade II determination.

Helpful Resources

http://bit.ly/departmentofenergy

http://bit.ly/InsulationInstituteTips

http://bit.ly/owenscorninggrade1

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Insulation Installation Guide

Examples from the field

Grade I: Compliant

Grade II: Not Compliant

Grade II: Not Compliant

Grade I: Compliant

Grade III: Not Compliant

Grade III: Not Compliant

Grade I: Compliant

Grade I: Compliant

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DOE / PNNL Phase 1

Kentucky State Report

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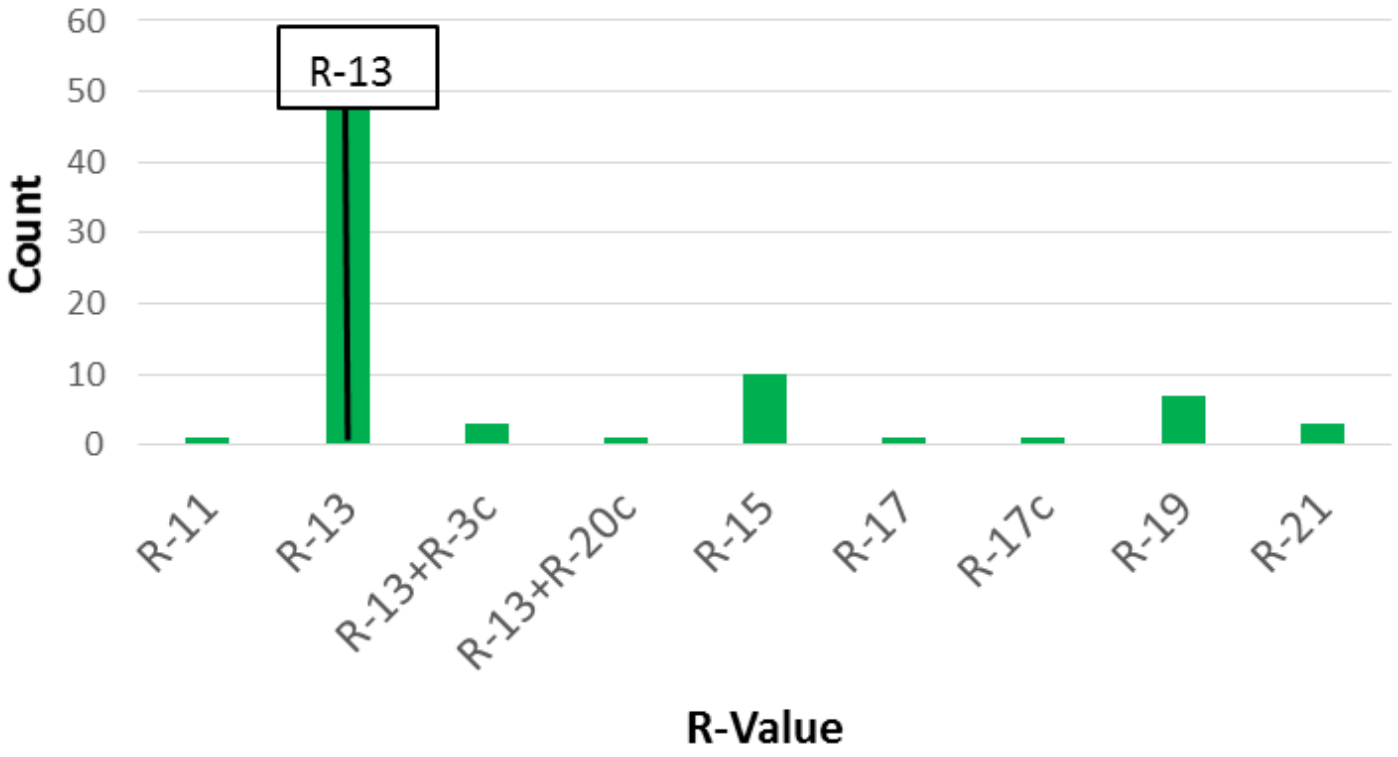
Kentucky Wall R-Values



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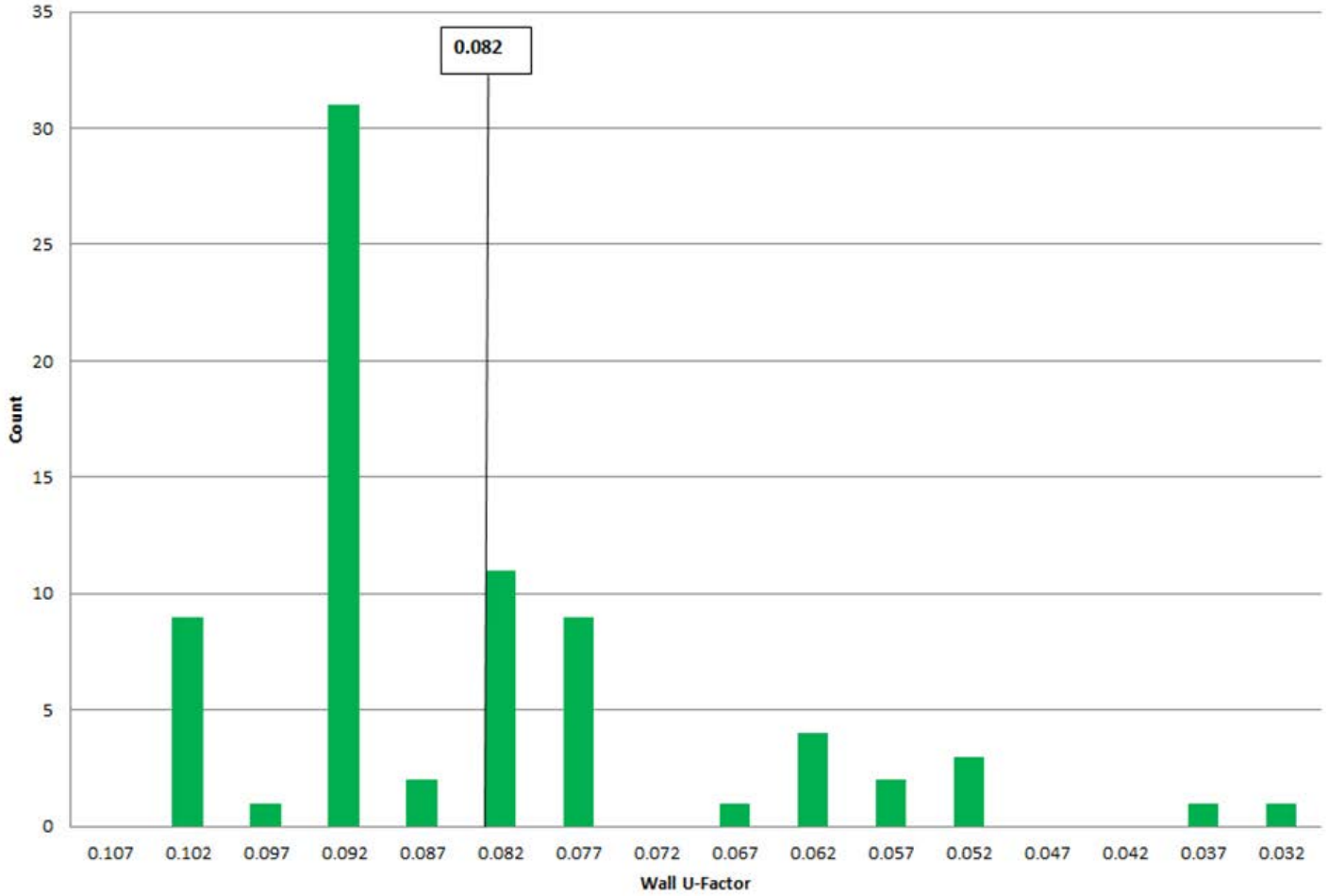
Kentucky Wall U-Factors



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Additional Data Items

- Home Size
  - (71%) 1 story
  - 2400 ft2

Conditioned Floor Area (ft^2)	< 1000	1000 to 1999	2000 to 2999	3000 to 3999	4000+
Percentage	0%	42%	32%	19%	7%

- Above Code
  - (27%) participated in an above-code program
- Builder Profile

No. of Homes per Year	< 10	10 to 50	50 to 99	100+
Percentage	20%	53%	0%	27%

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Additional Data Items

- Envelope
  - Walls:
    - (88%) 2x4 wood-framed walls
    - (12%) 2x6 wood-framed walls
  - Foundations:
    - (41%) basements; (100%) conditioned
    - (35%) slab-on-grade
    - (24%) crawlspaces

- Duct & Piping Systems
  - Avg. Duct Insulation: R-7
  - Avg. Pipe Insulation: R-2.4, mix of R-2 and R-3

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Additional Data Items

- Equipment
  - Heating:
    - (51%) Furnace; Avg. Capacity = 59,600 Btu/hr
    - (48%) Heat Pump; Avg. Capacity = 39,000 Btu/hr
  - Cooling:
    - (31%) Central AC: Avg. Capacity = 40,000 Btu/hr
    - (69%) Heat Pump: Avg. Capacity = 38,000 Btu/hr
  - Water Heating:
    - Mostly electric storage with an average capacity of 84 gallons and average efficiency rating of EF 0.91
  - Ventilation:
    - Majority exhaust-only (91%) or AHU-integrated (7%). Approximately 98% of homes relied solely upon the bathroom fan—only 2% had a dedicated exhaust fan.

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Additional Data Items - Successes

- Envelope
  - (85%) Labeled Insulation
  - (100%) Sealed Light fixtures
  - (81%) Sealed Utility penetrations
- Duct & Piping Systems
  - (96%) Building cavities not used as supply ducts
- HVAC Equipment
  - (84%) Provided user manuals for mechanical systems

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Additional Data Items - Opportunities

- Envelope
  - (60%) Attic hatches & doors complied
  - (41%) Attic access openings sealed
- Duct & Piping Systems
  - (13%) Air handlers and (5%) filter boxes sealed

Annual Potential Compliance Savings

Annual Statewide Savings Potential in Kentucky

Key Measure		Annual Savings	
		Energy (MMBtu)	Cost ($)
1	Envelope Air Leakage	27,182	484,314
2	Exterior Wall Insulation	9,277	171,044
3	Foundation Insulation	6,800	108,156
4	Lighting	5,742	197,544
5	Duct Leakage	2,135	43,142
Total		**51,136 MMBtu**	**$1,004,200**

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Cumulative Potential Compliance Savings

Five-years, Ten-years, and Thirty-years Cumulative Annual Statewide Savings for Kentucky

Measure	Total Energy Savings (MMBtu)			Total Energy Cost Savings ($)		
	5yr	10yr	30yr	5yr	10yr	30yr
Envelope Air Leakage	407,730	1,495,010	12,639,630	7,264,710	26,637,270	225,206,010
Exterior Wall Insulation	139,155	510,235	4,313,805	2,565,660	9,407,420	79,535,460
Foundation Insulation	101,997	373,989	3,161,903	1,622,345	5,948,598	50,292,689
Lighting	86,130	315,810	2,670,030	2,963,160	10,864,920	91,857,960
Duct Leakage	32,025	117,425	992,775	647,130	2,372,810	20,061,030
TOTAL	**767,037**	**2,812,469**	**23,778,143**	**15,063,005**	**55,231,018**	**466,953,149**

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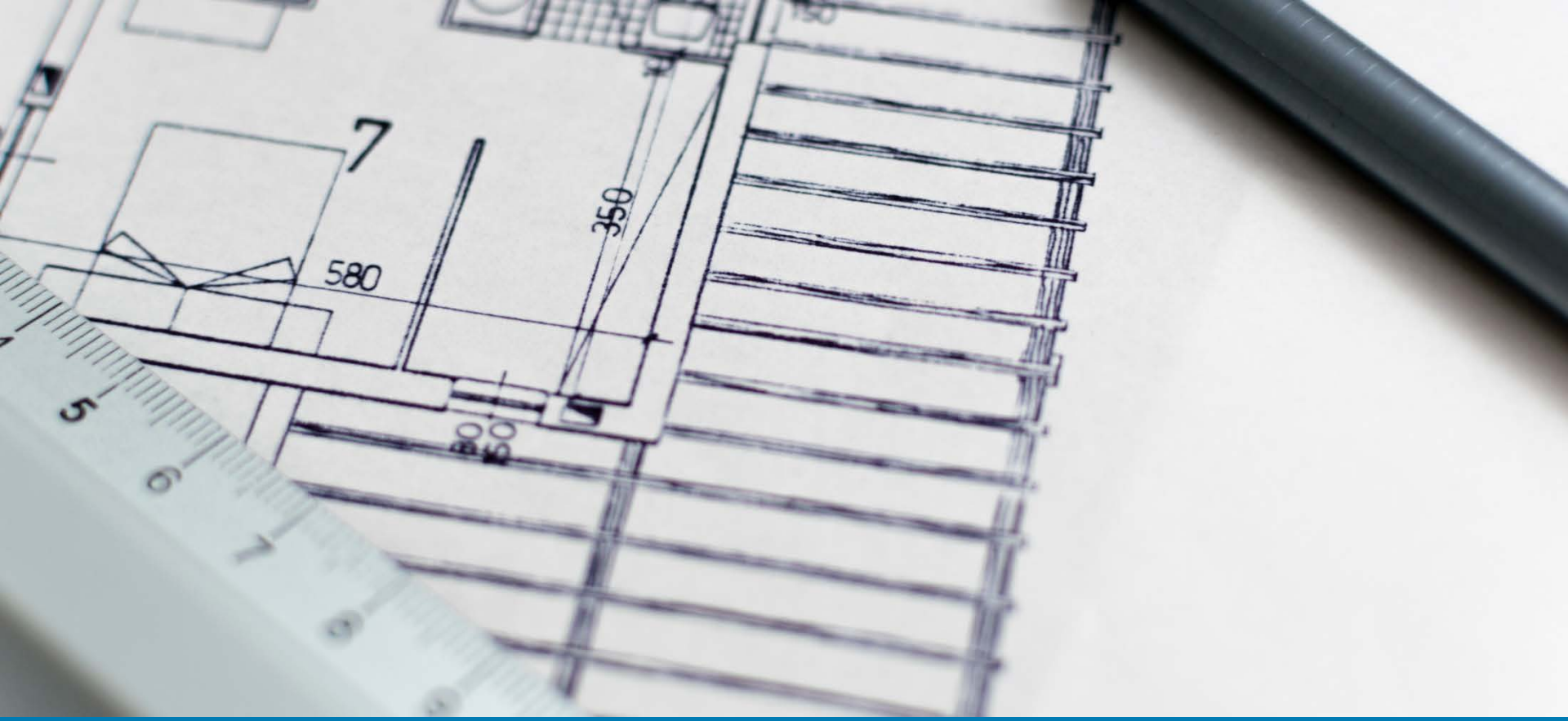

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Cadmus Update

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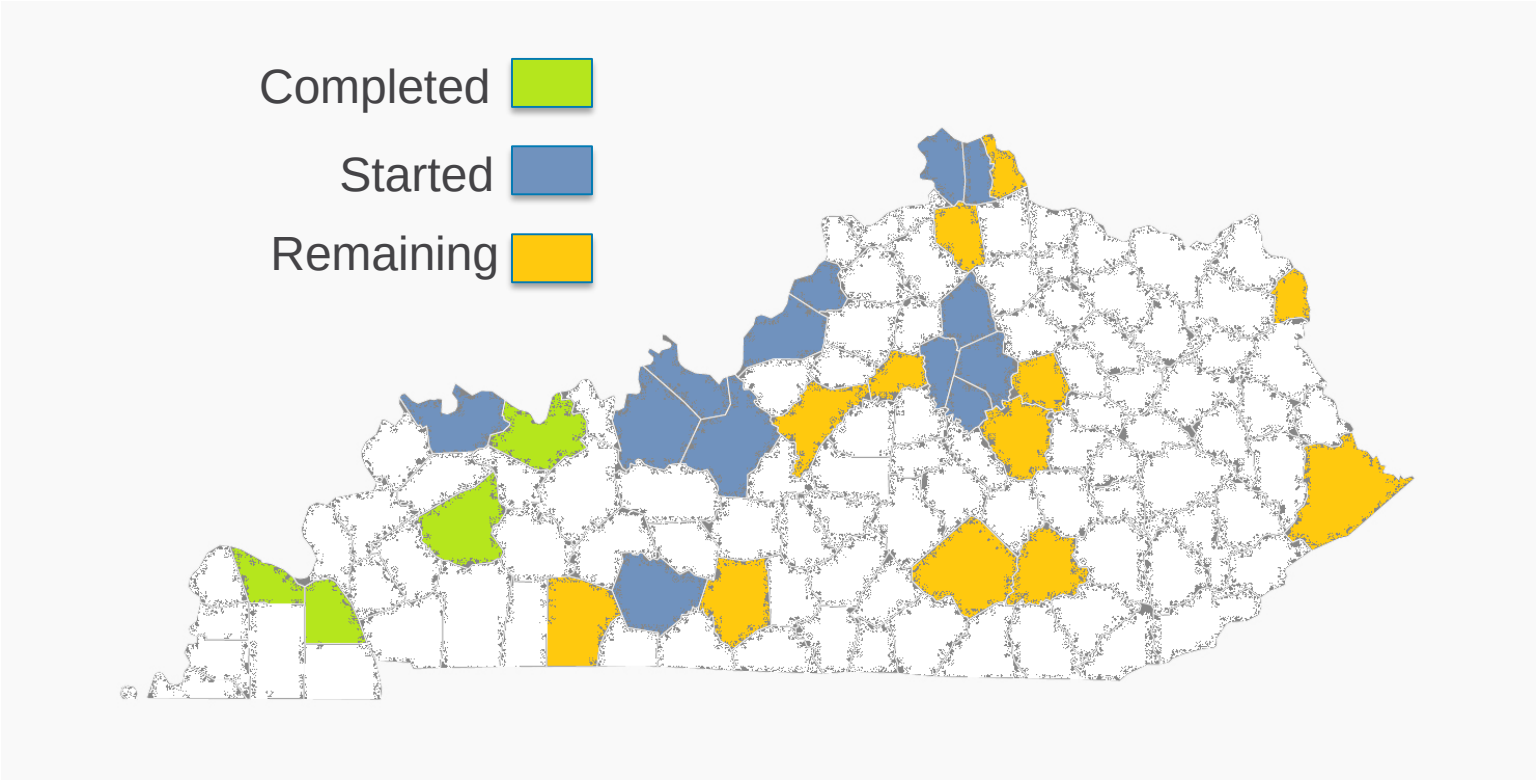
Cadmus Update

- Progress Update
- Review of Data Collection Process
- Initial Findings
  - Envelope
  - Ducts
  - Lighting

Sampling plan



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Progress Update

- 31 Insulations Completed
- 18 Finals Completed
- 5 Manual D
- 39% Complete

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Review of Data Collection Process

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Recruitment/Scheduling

- Initial Outreach by county
- Week-to-week contact with builder and Program Manager
- Weekly calls with Project Team
- 2 Person field teams
- Typically in home for <60 minutes
- All data is anonymized. No identifying information is given to DOE or code officials

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Insulation Inspection

Looking for-

- Wall and Floor Insulation R-Value
- Installation Quality
- Air Sealing
- Window Energy Features
- Basement / Slab Insulation

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Final Inspection

Looking for-

- Ceiling Insulation R-Value and Quality
- High Efficacy Lights
- Blower Door Test
- Duct Leakage Test

Final Inspection

Part 1 @ Insulation

- Ducts MUST be exposed
- Duct Design / Air Distribution System
- Room-By-Room Volume
- Mechanical Specifications

Part 2 @ Final

- Equipment Must be operational
- Duct Leakage Testing
- True Flow Testing

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Initial Findings

Only initial findings NOT FINAL

Envelope

- Air Sealing
  - Missing Electrical Boxes
  - No air barrier behind tubs
- Insulation
  - Consistently better
- House Leakage
  - Ranging from 2-6 ACH50

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Ducts

- Duct Sealing
  - Poor Sealing around framed plenums
- Duct Leakage
  - No trends. Still hit and miss.

High Efficacy Lighting

- Not consistent
  - Roughly 30% of observed homes met High Efficacy Lights requirements

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CADMUS

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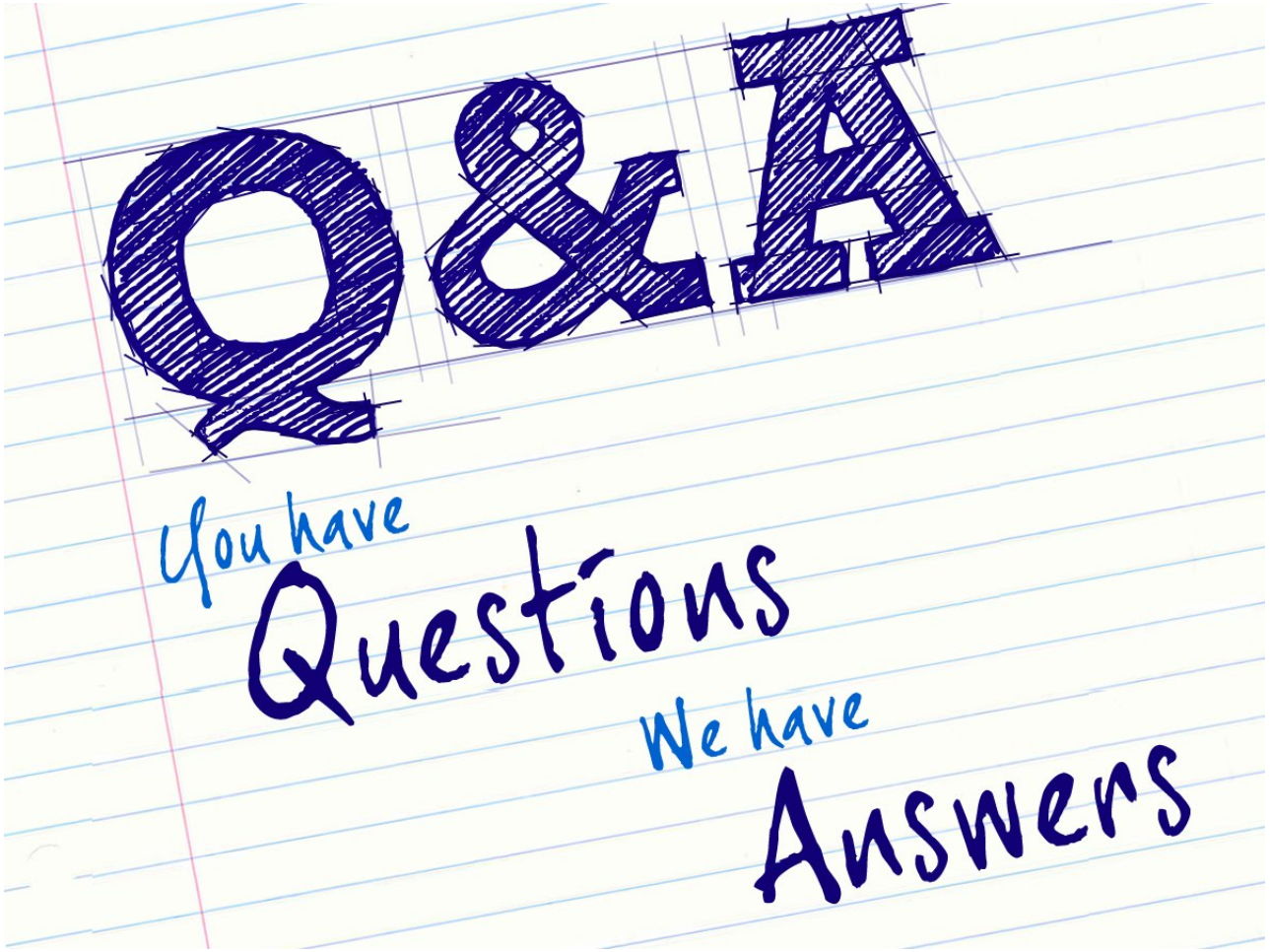
Questions?



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Kentucky HERS Data Analysis

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HERS Data set

- New Construction (2014 – 2016)
- Home types: Single Family, Duplex
- # of homes: 3,410 (16% of all building permits)
- Average size: 3700 Sq. Ft. (Conditioned)
- Code Compliance
  - 2009 IECC
- HERS Rated vs. 1 & 2-family permits statewide
  - 2014: 6%
  - 2015: 25%
  - 2016: 27%

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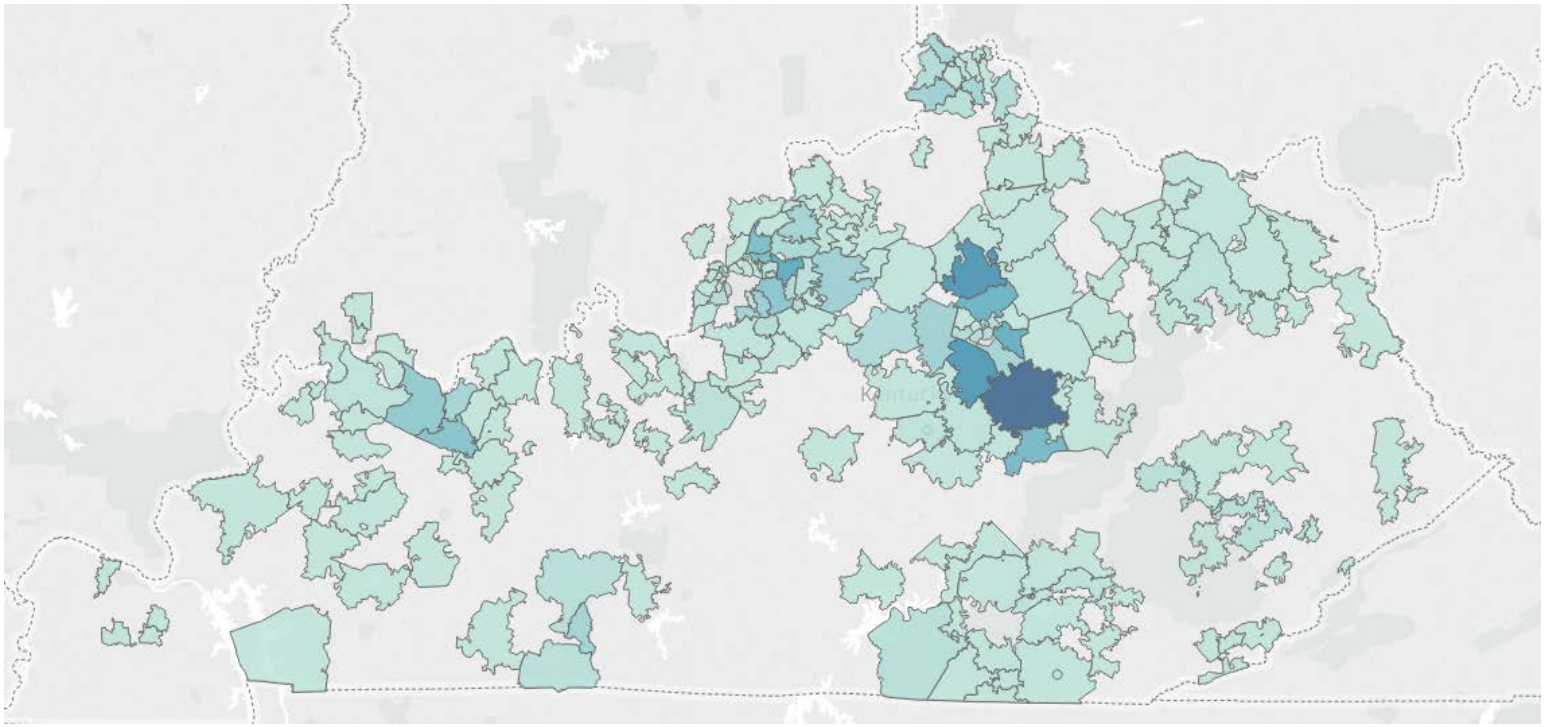
of Ratings Per Zip Code



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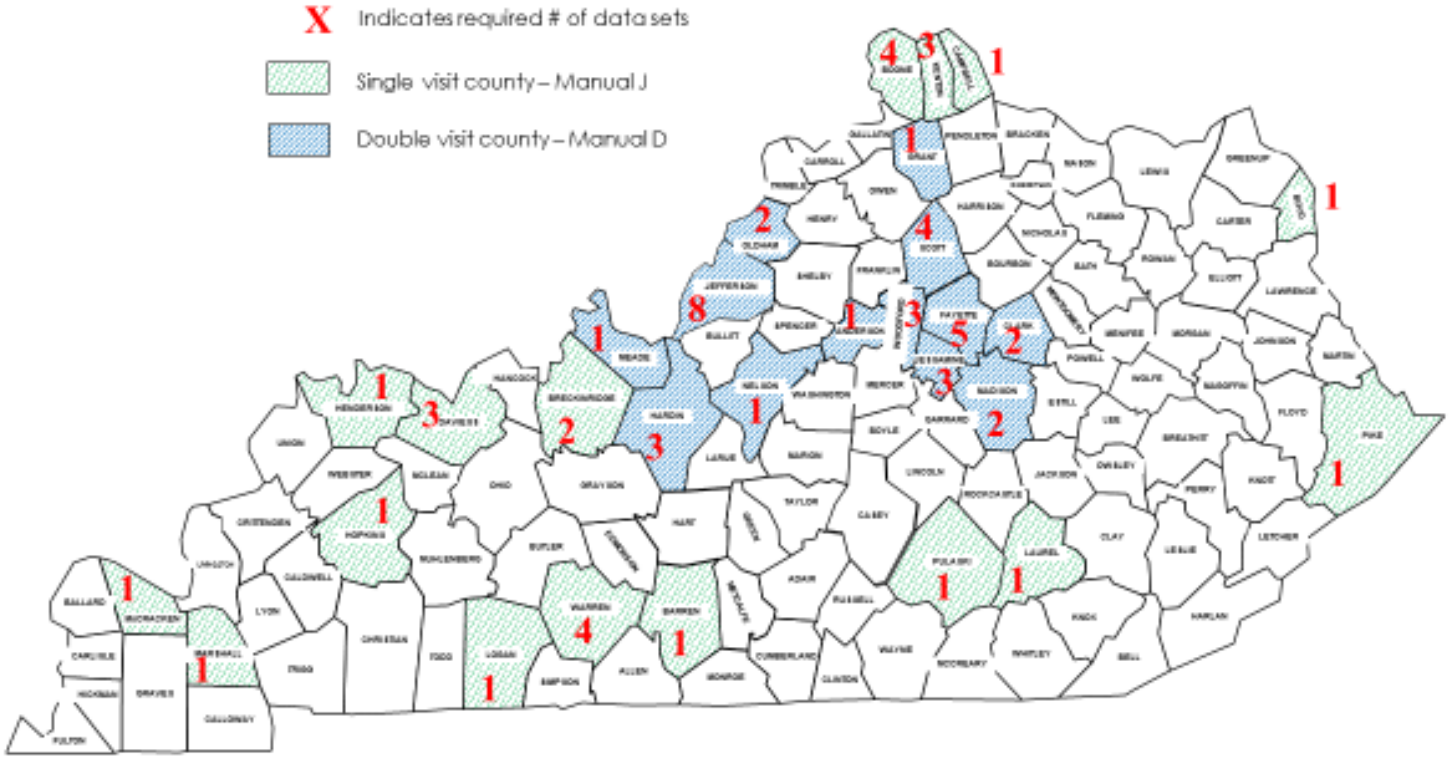
Phase 3

Option 1A

Phase 3 - Key Item Sampling Plan



Kentucky Code Requirements

2009 IECC w/ Kentucky Amendments

- **2009 IECC Amended**
  - Foundation Insulation: R-10/13 (down 4ft)
  - Wall Insulation: R-13
  - Ceiling Insulation: R-38
  - Windows: U - 0.35
  - Air Leakage: 7 ACH50
  - Duct Leakage: 8 CFM/100 sq. ft. (outside)
  - High Efficacy Lighting: 50%
  - AC Efficiency – 13 SEER
  - Furnace Efficiency – 80 AFUE

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Using the Data

ERI Compliance

- The following slides can help us determine how homes are currently being built and how they can meet the ERI compliance pathway in the IECC.
  - **Important to note**: the following ratings would likely see a 2-3 point increase in HERS index when rated in 2015 IECC compliance software.

- We will gain an understanding of which primary energy code components have a big impact on HERS scores in Kentucky.

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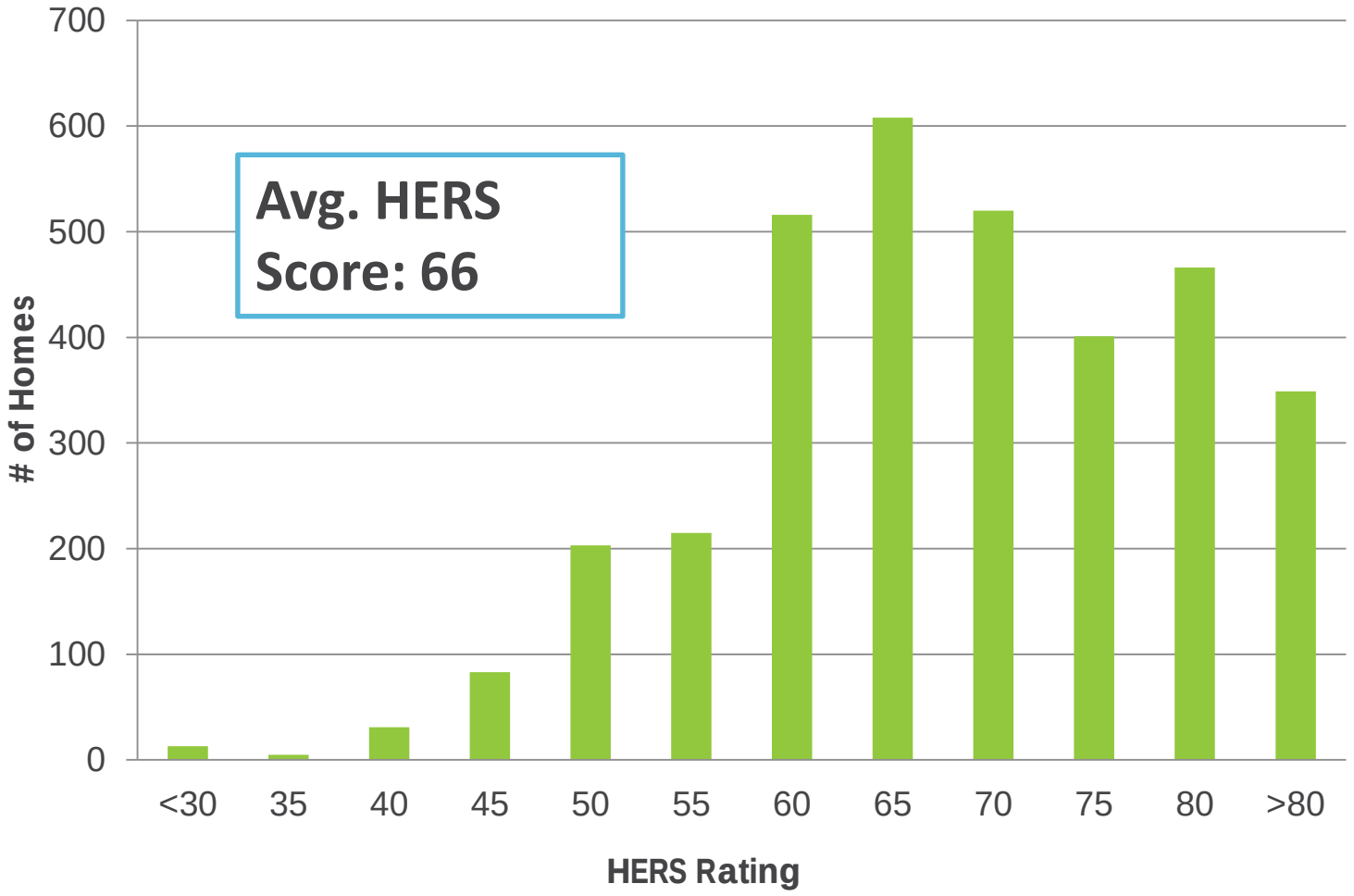
HERS Score Breakdown

All Homes



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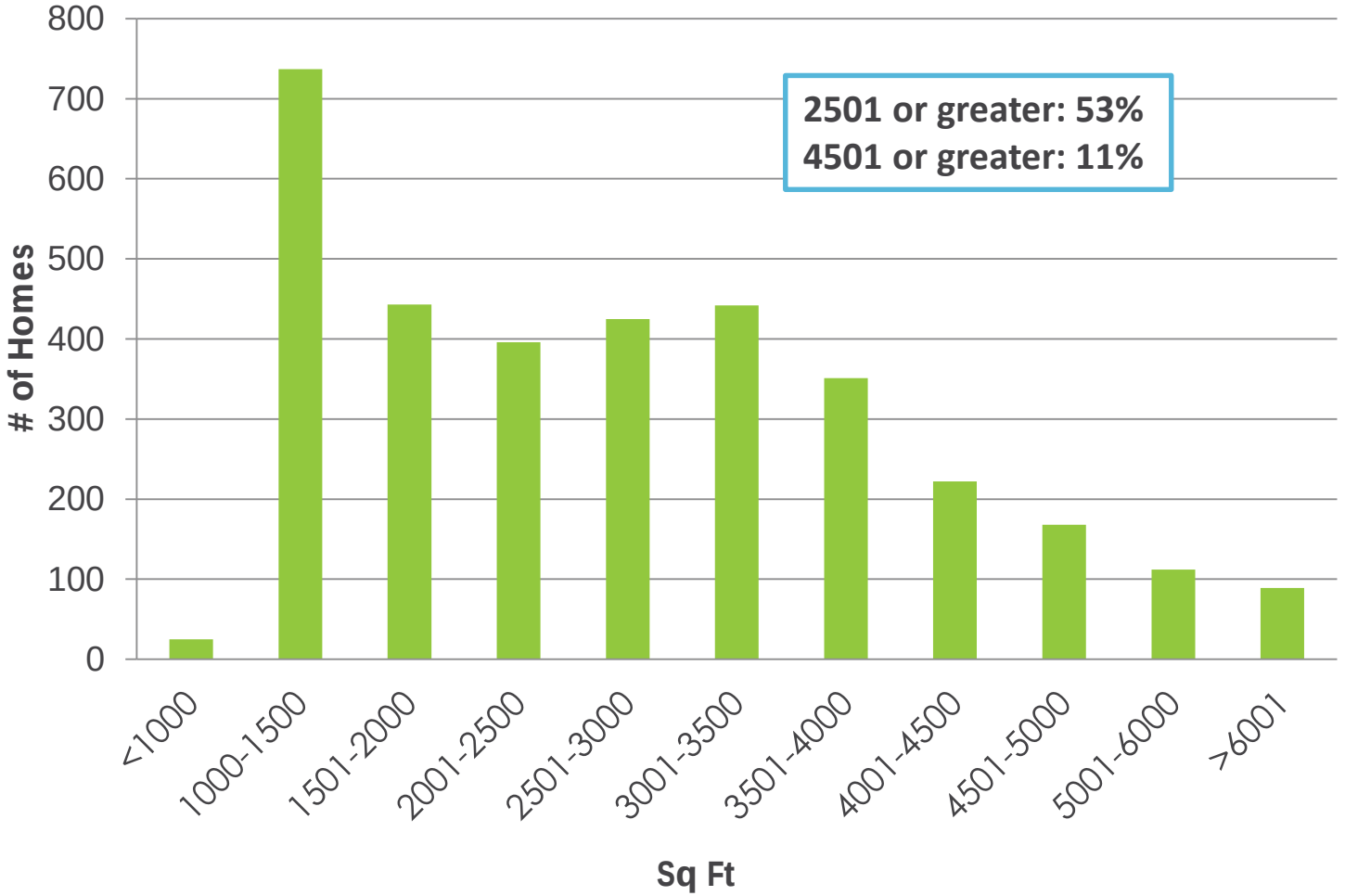
Conditioned Sq. Ft.

All Homes



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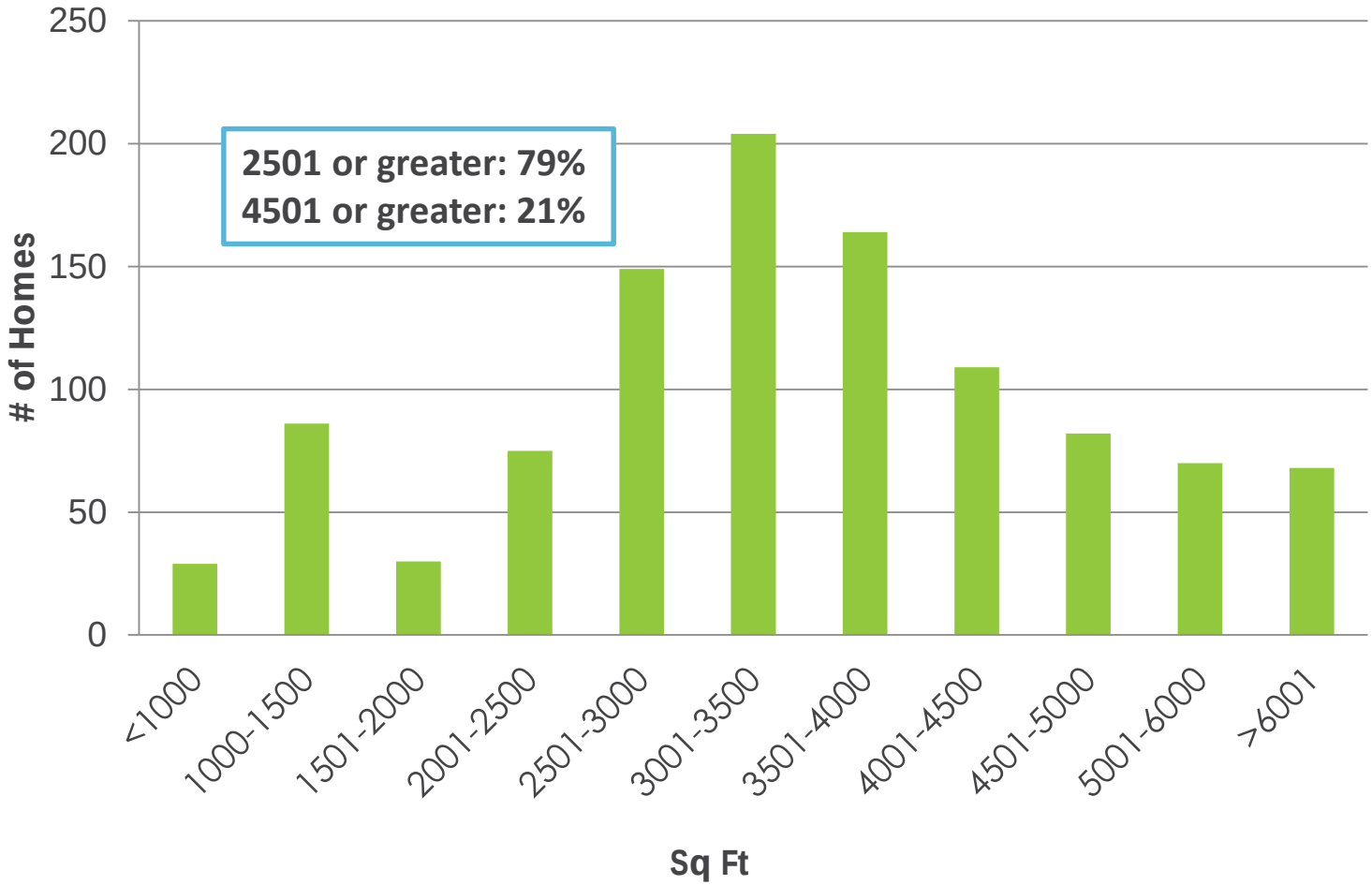
Conditioned Sq. Ft.

HERS ≤ 60



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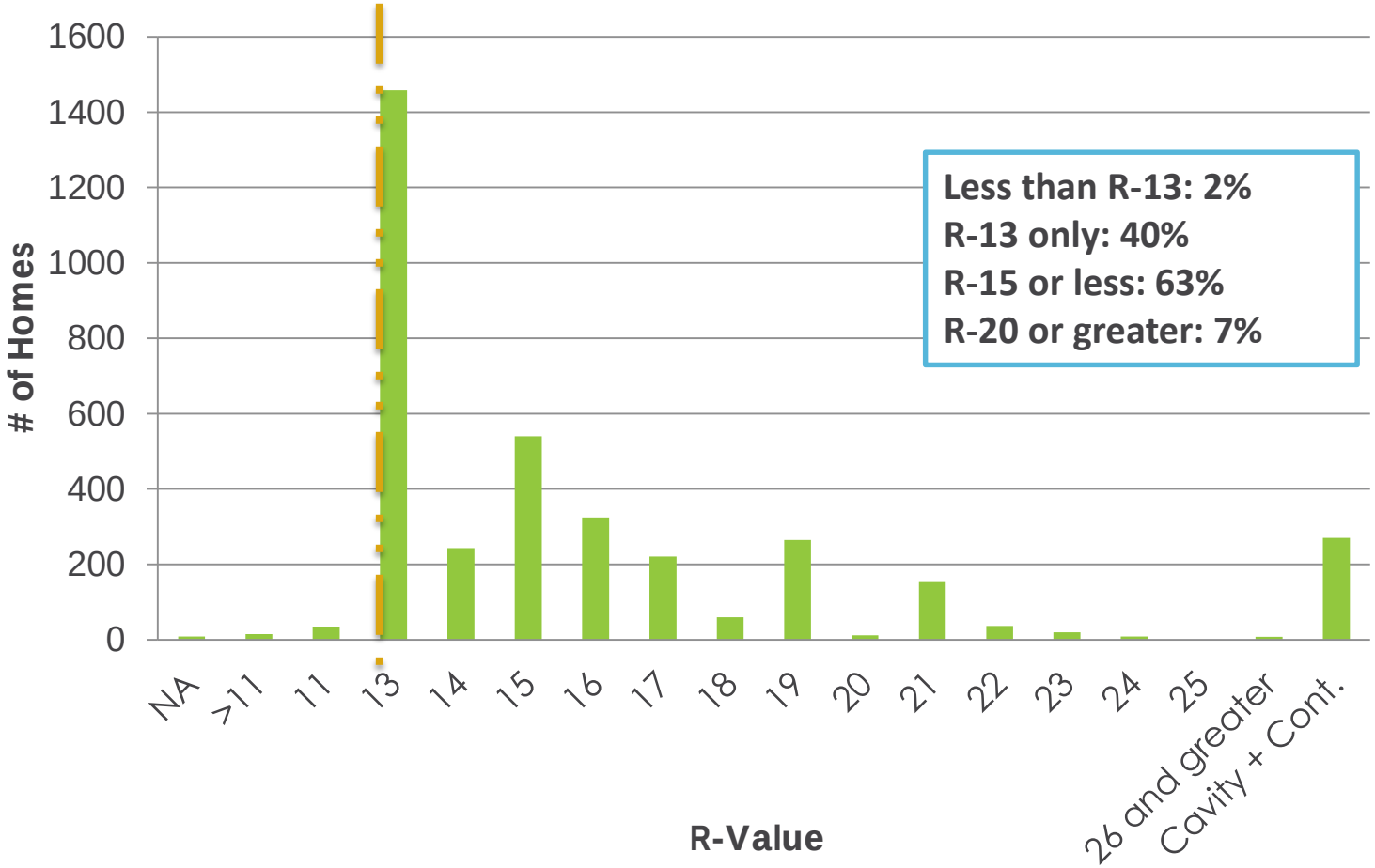
Above Grade Wall Insulation (Cavity Only)

All Homes



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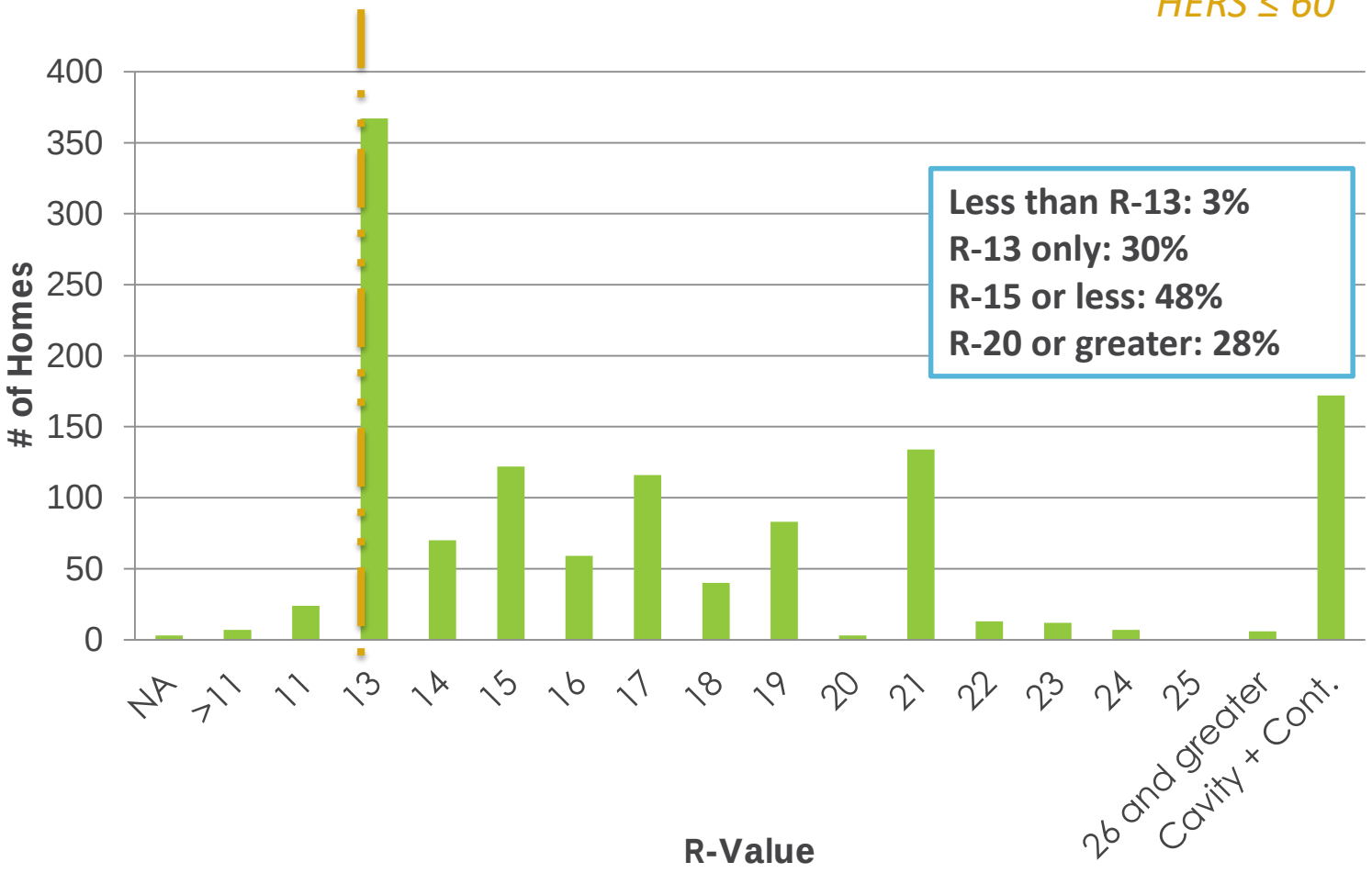
Above Grade Wall Insulation (Cavity Only)

HERS ≤ 60



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Insulation Quality

Percentage of Installations Rated with a Value of 1

Above Grade Wall Insulation Installations: 3,209

Number of Above Grade Wall Insulation Installations Rated as Grade 1: 2,367

Percentage of Above Grade Wall Insulation Installations Rated as Grade 1: 69%

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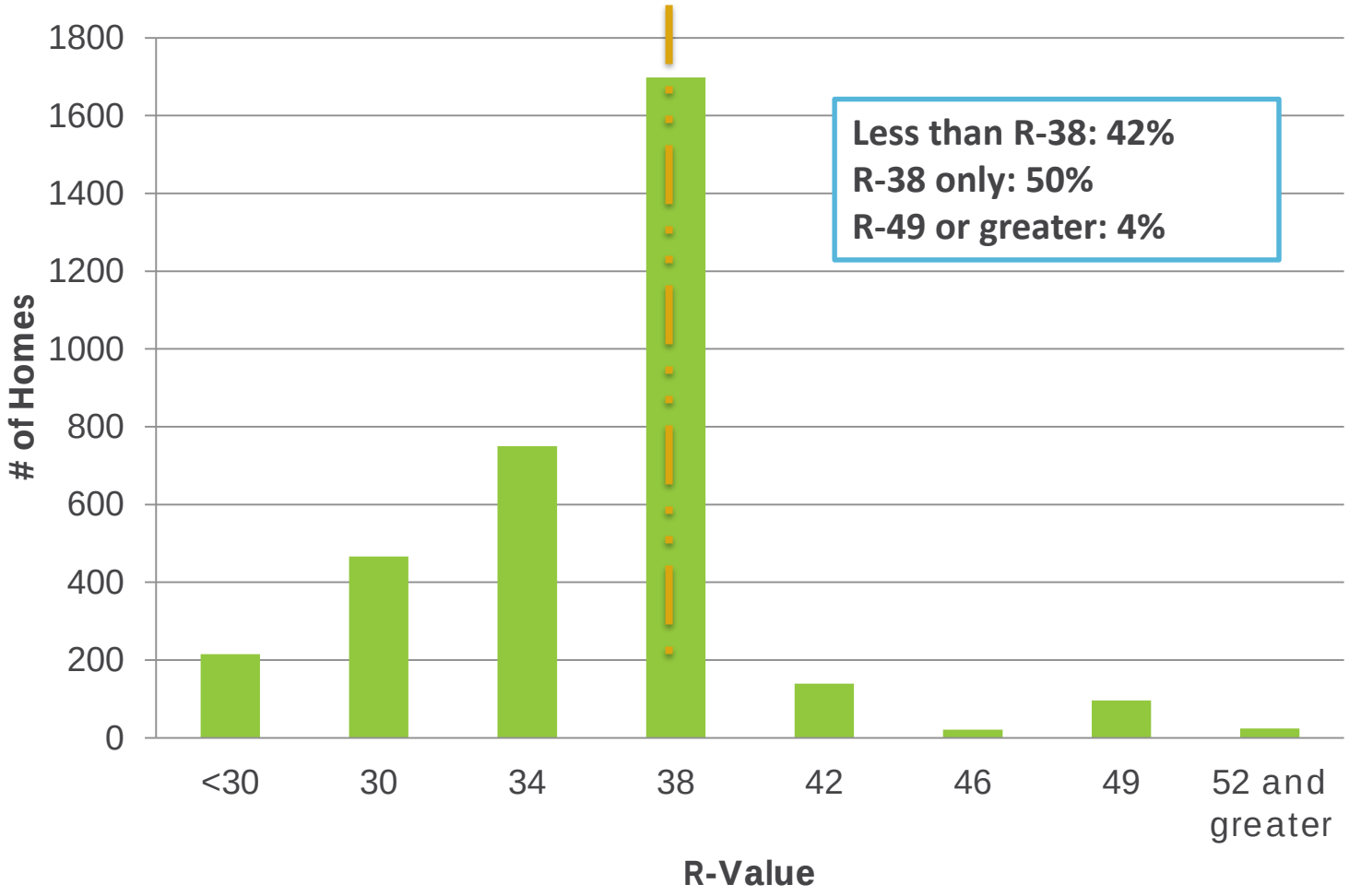
Ceiling Insulation

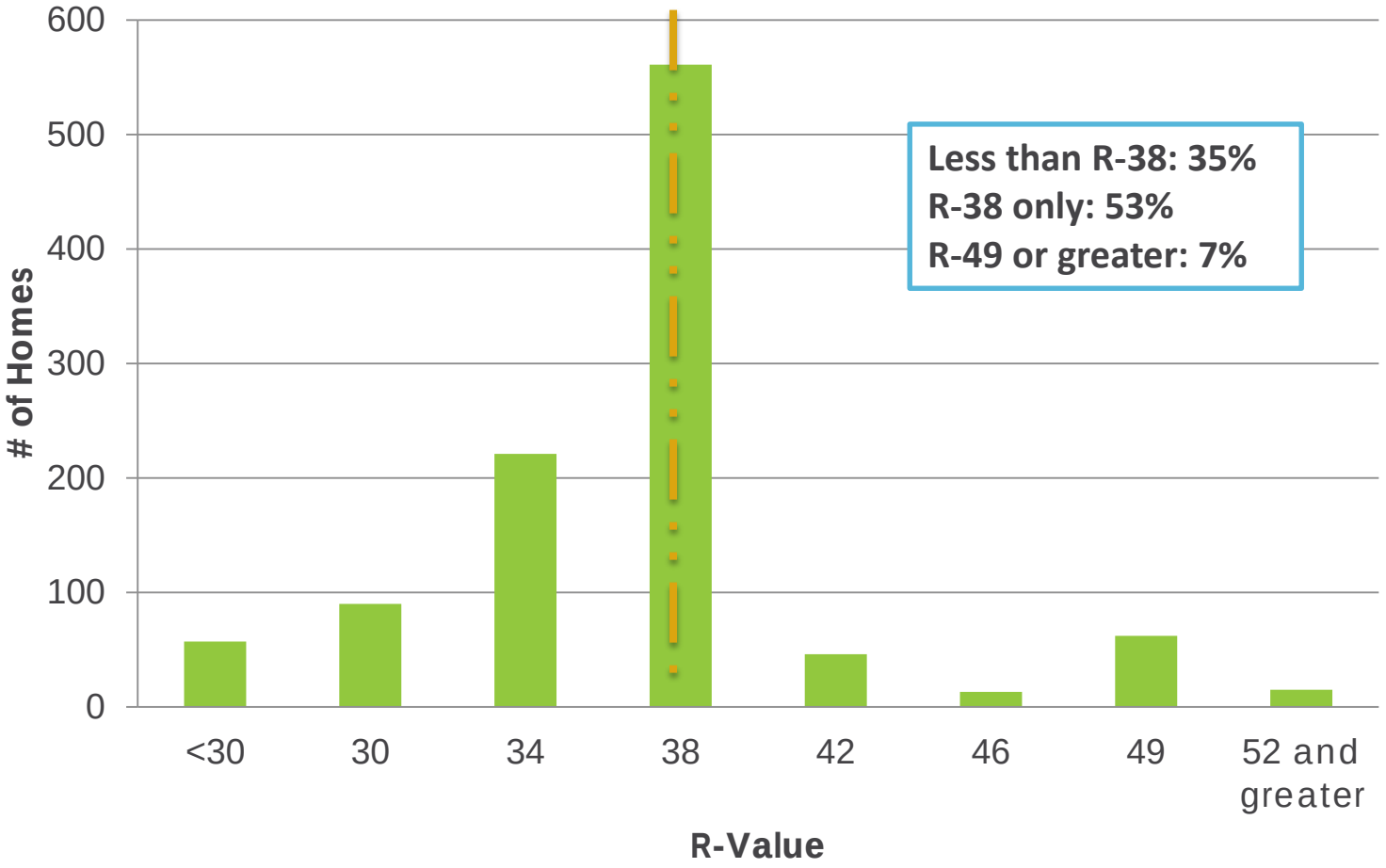
All Homes



MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

Ceiling Insulation

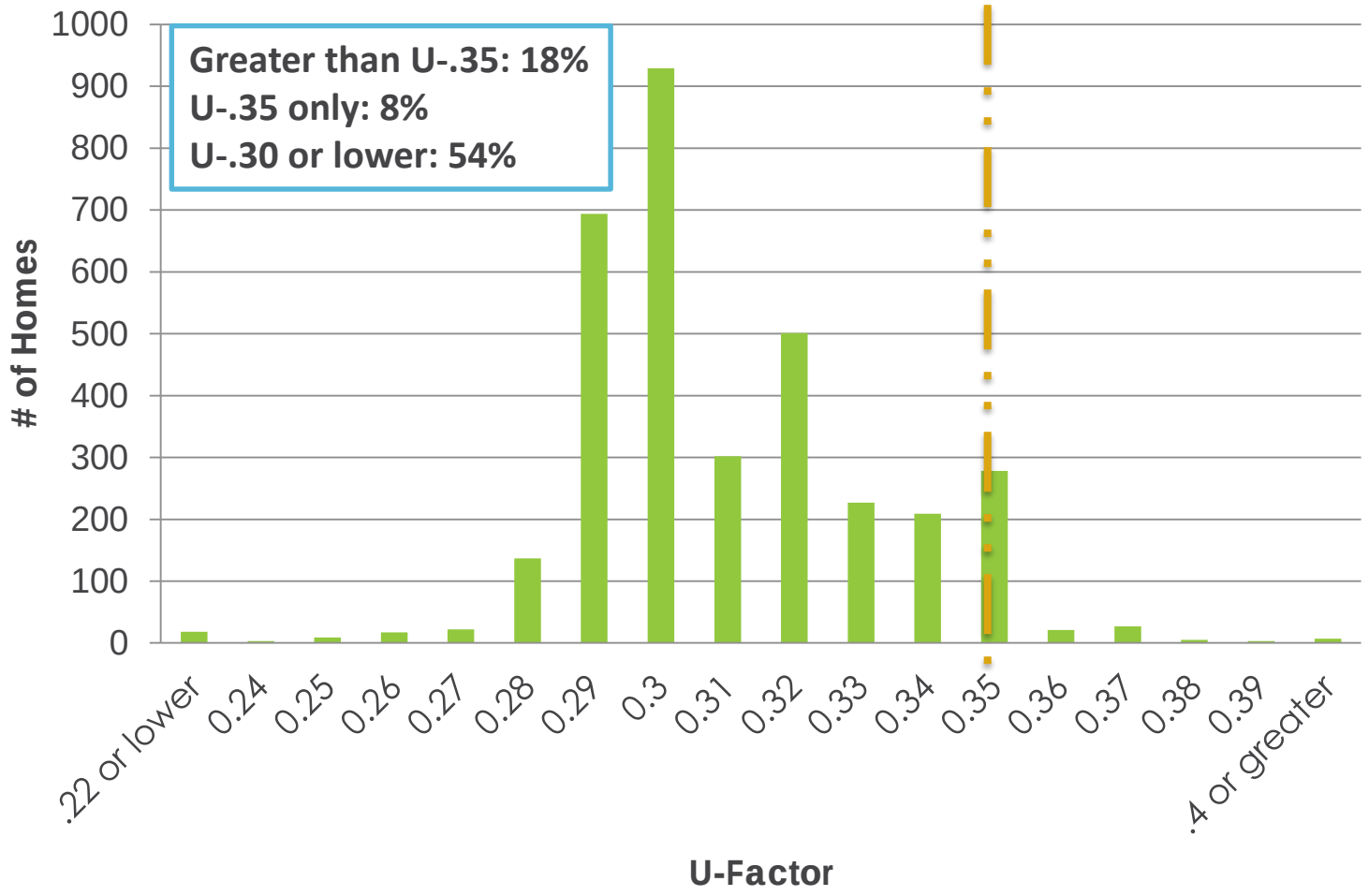
HERS ≤ 60



MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

Window U-Factor

All Homes



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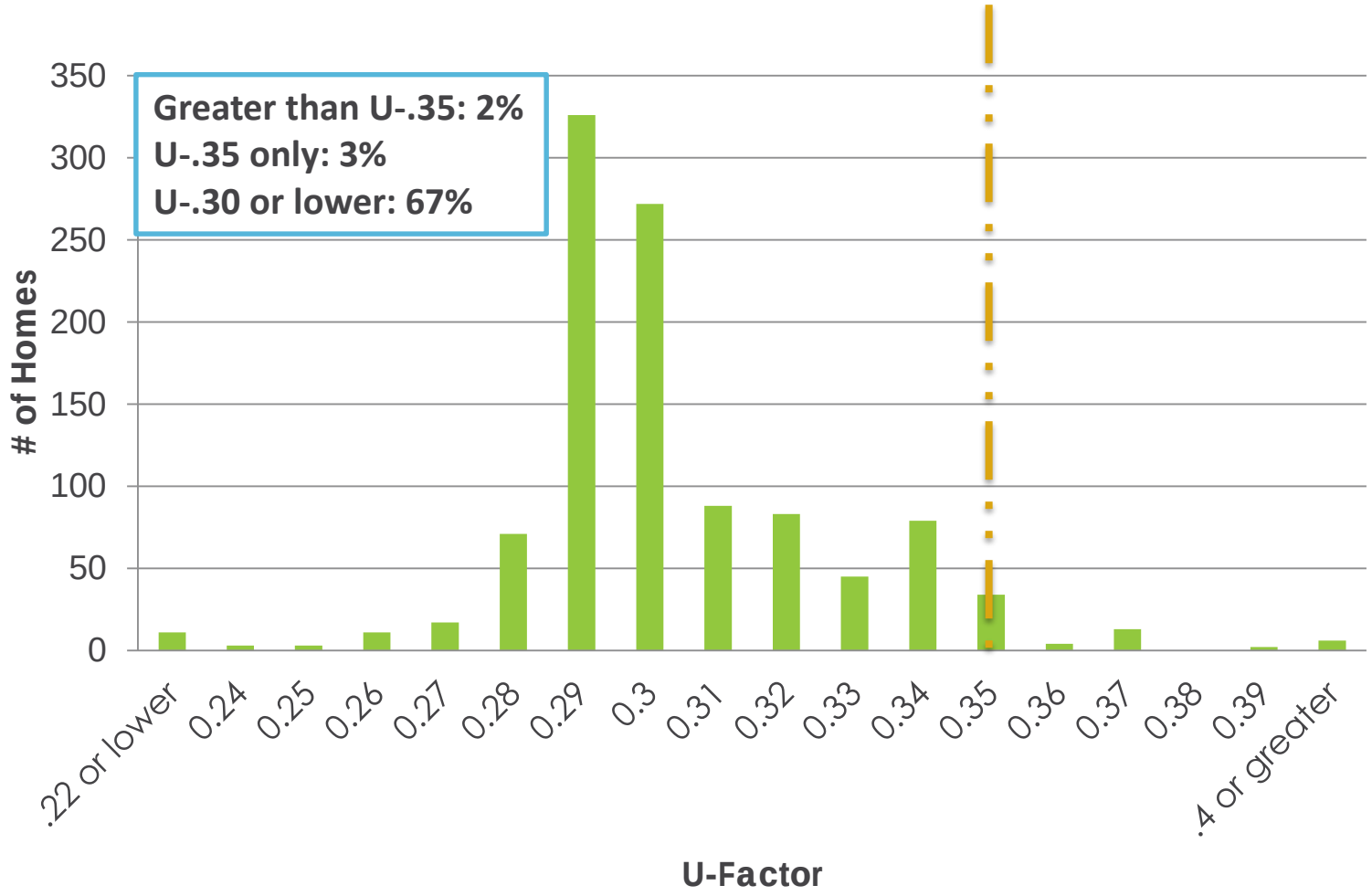
MIDWEST ENERGY EFFICIENCY ALLIANCE

Window U-Factor

HERS ≤ 60



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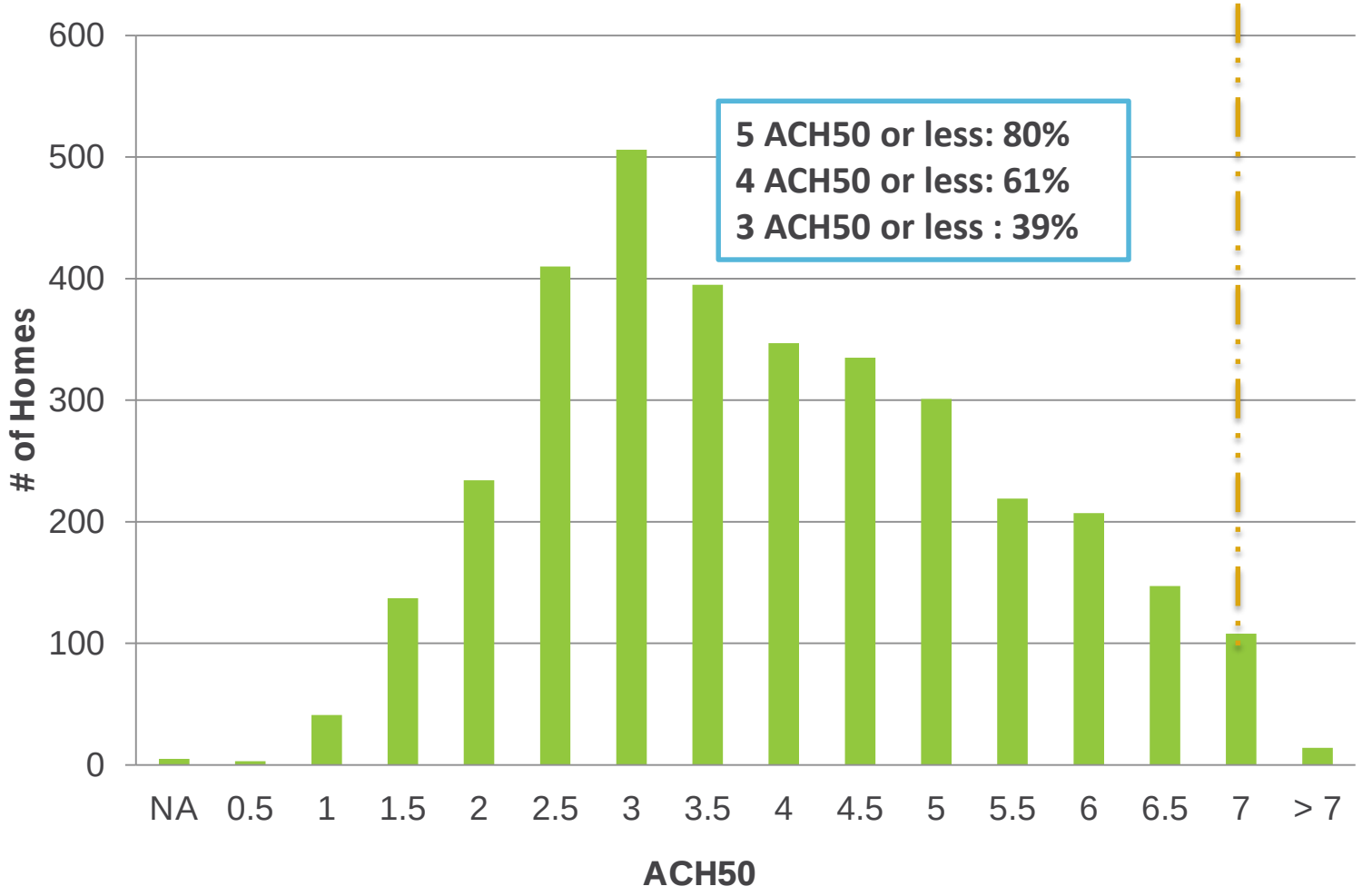
Air Leakage (ACH50)

All Homes



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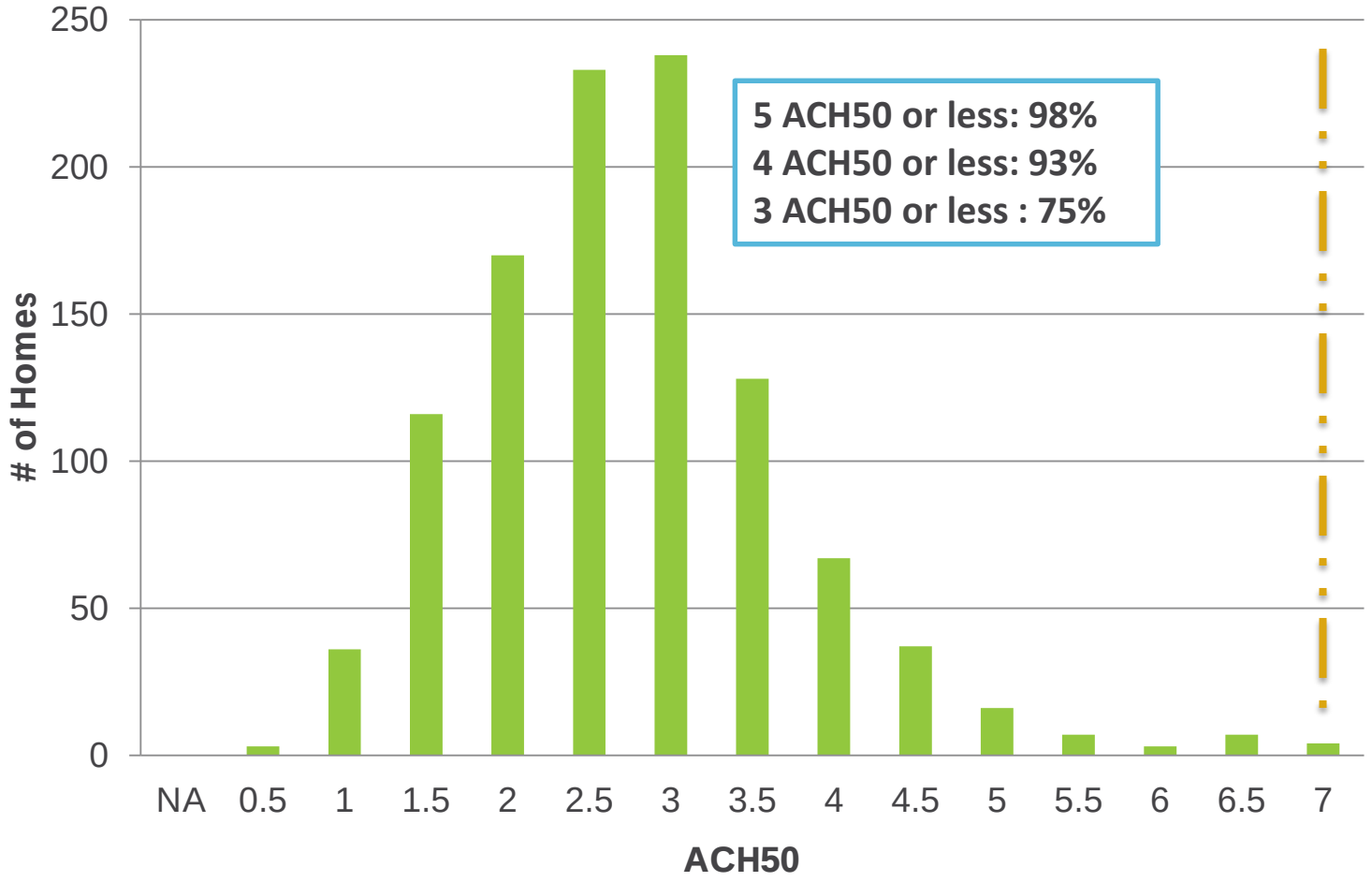
MIDWEST ENERGY EFFICIENCY ALLIANCE

Air Leakage (ACH50)

HERS ≤ 60



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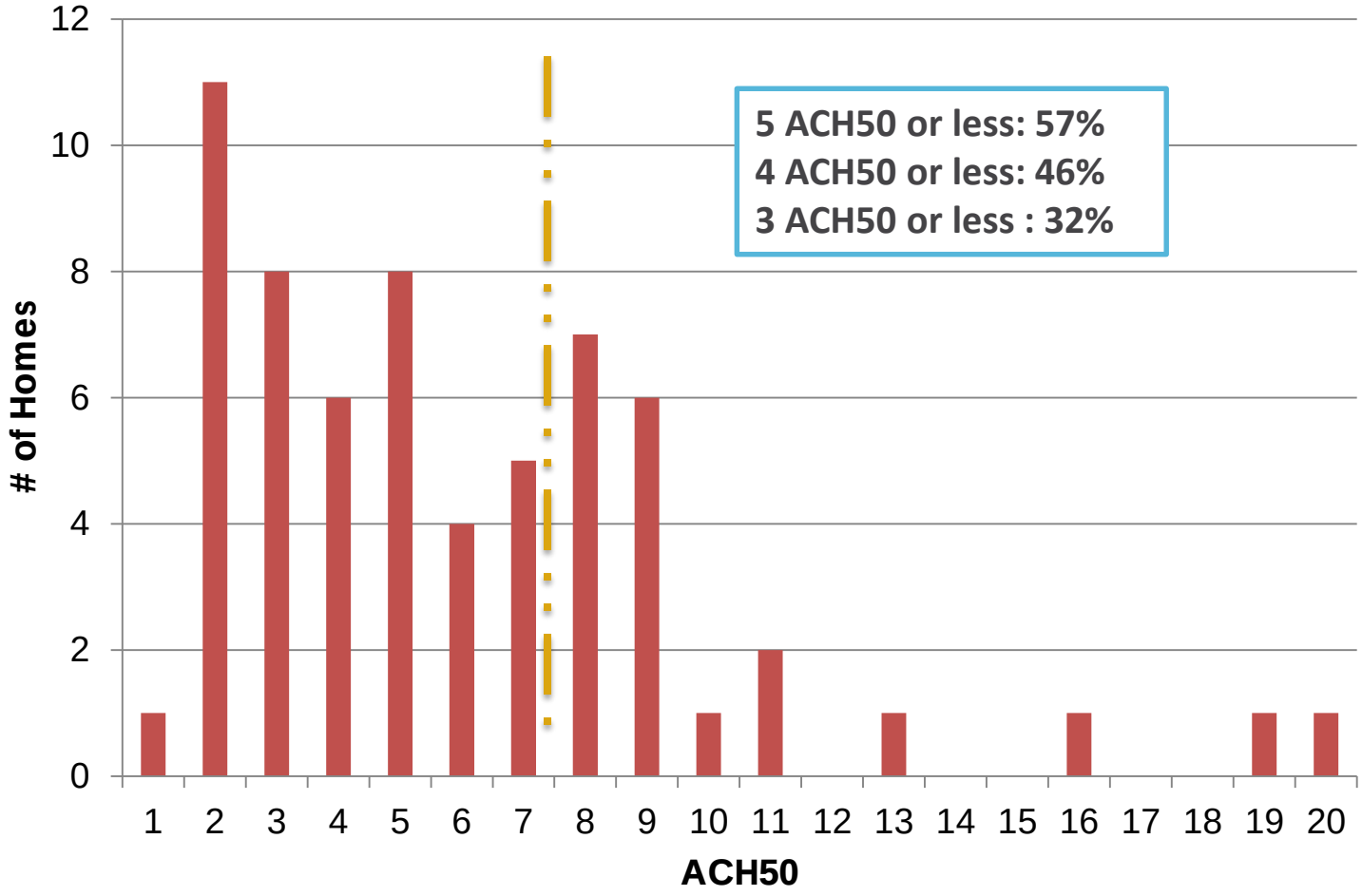
Air Leakage (ACH50)

Kentucky Phase 1 Results



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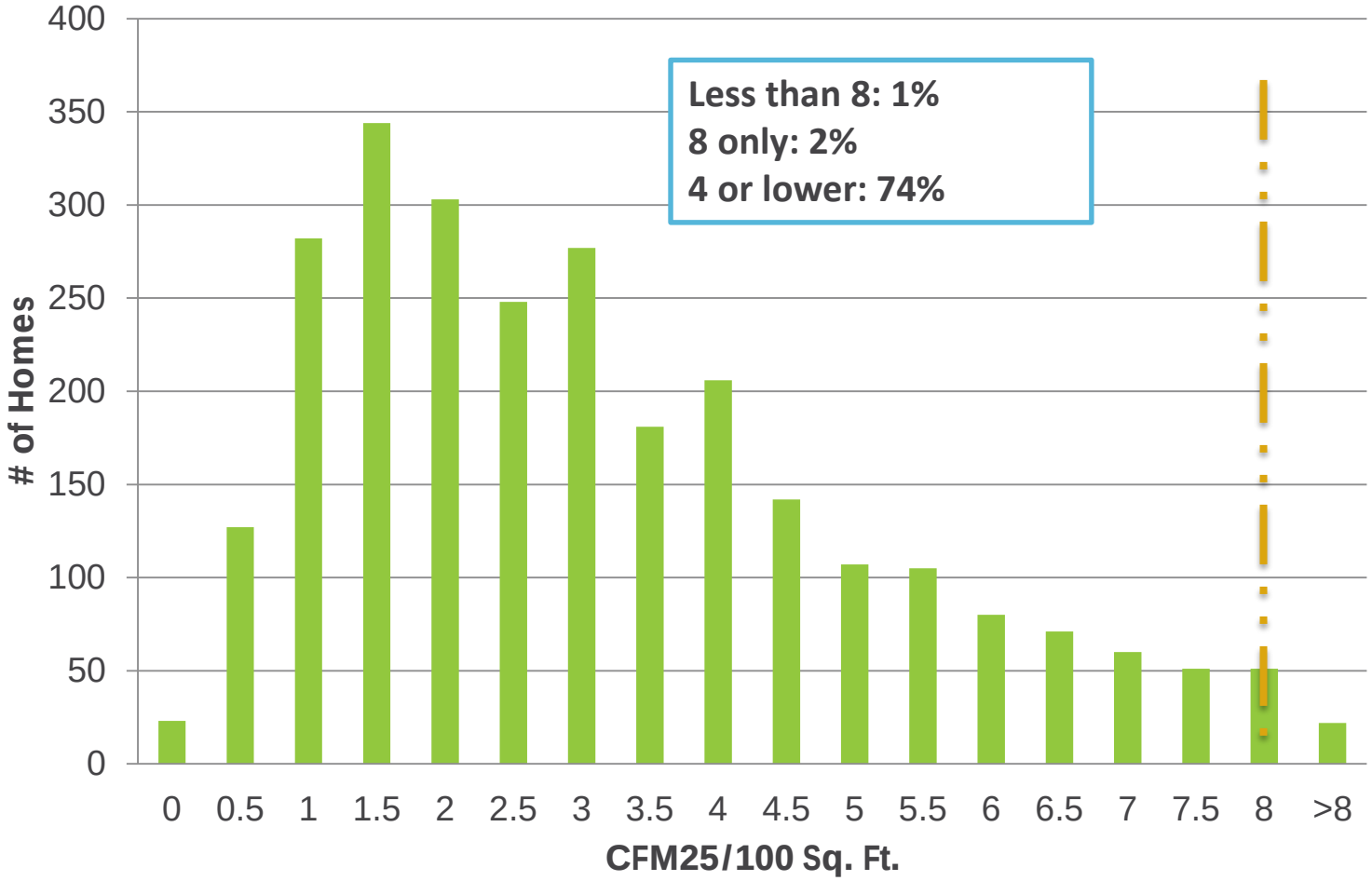
Duct Leakage to Outside

All Homes



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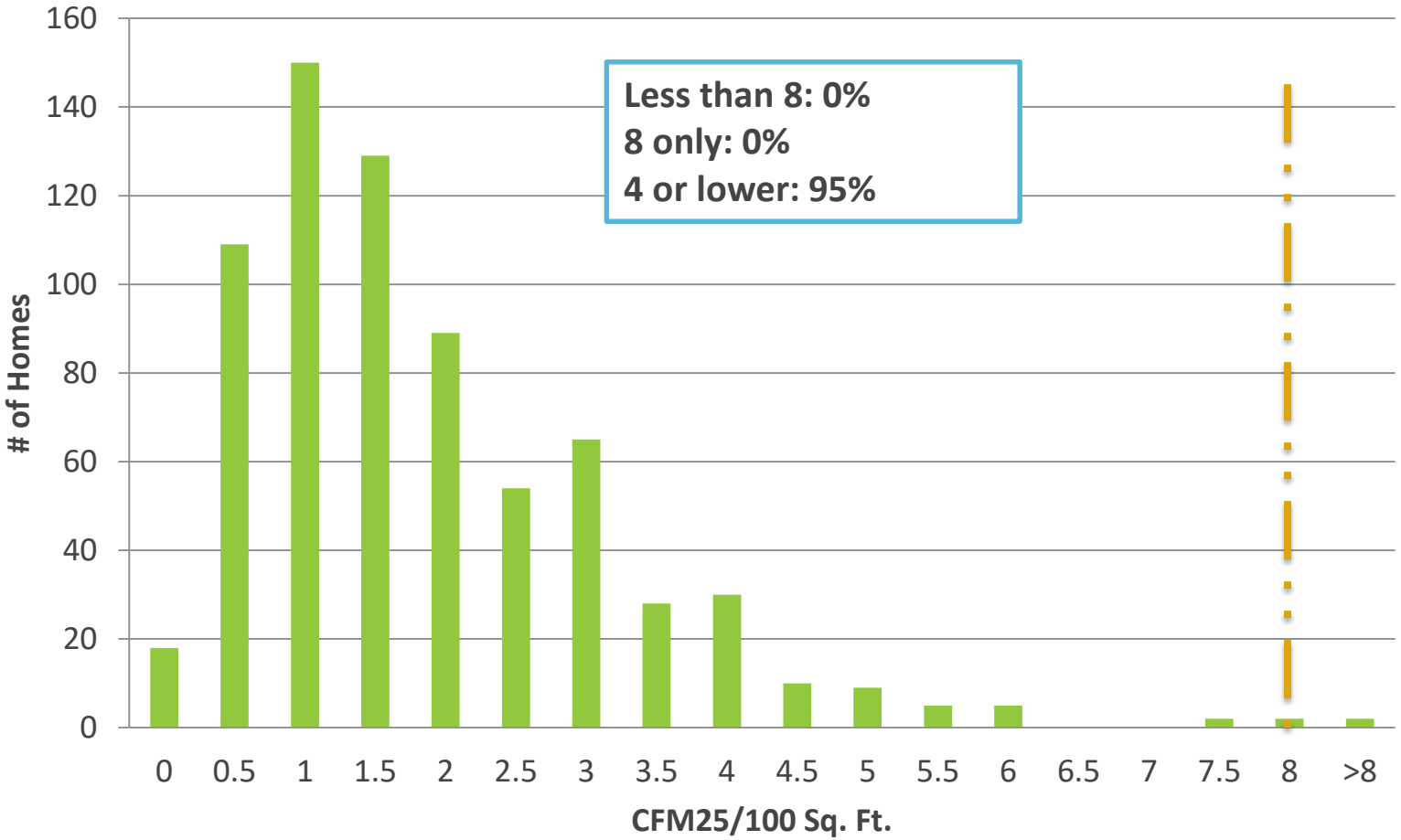
Duct Leakage to Outside

HERS ≤ 60



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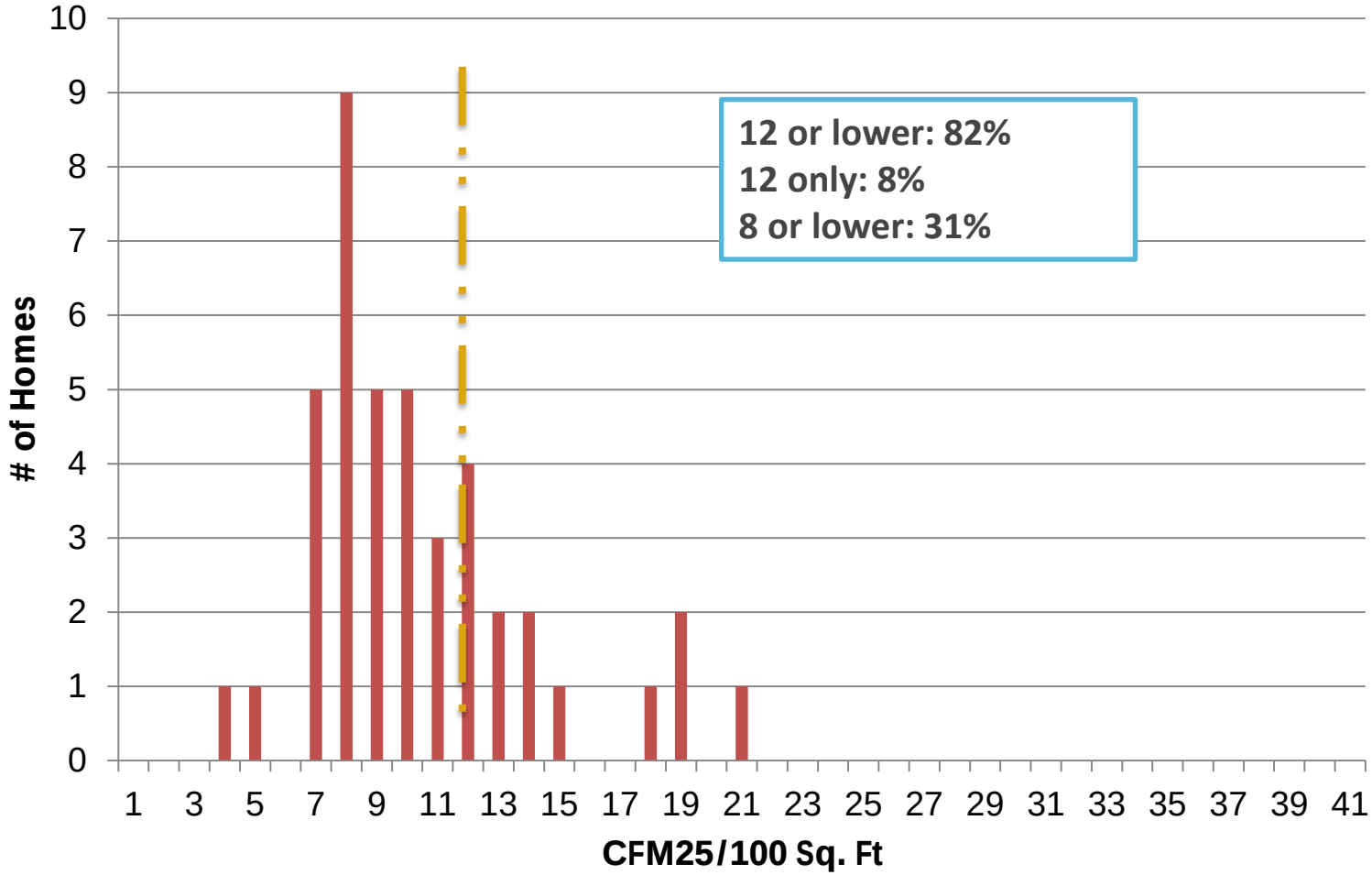
Total Duct Leakage (unconditioned space)

Kentucky Phase 1 Results



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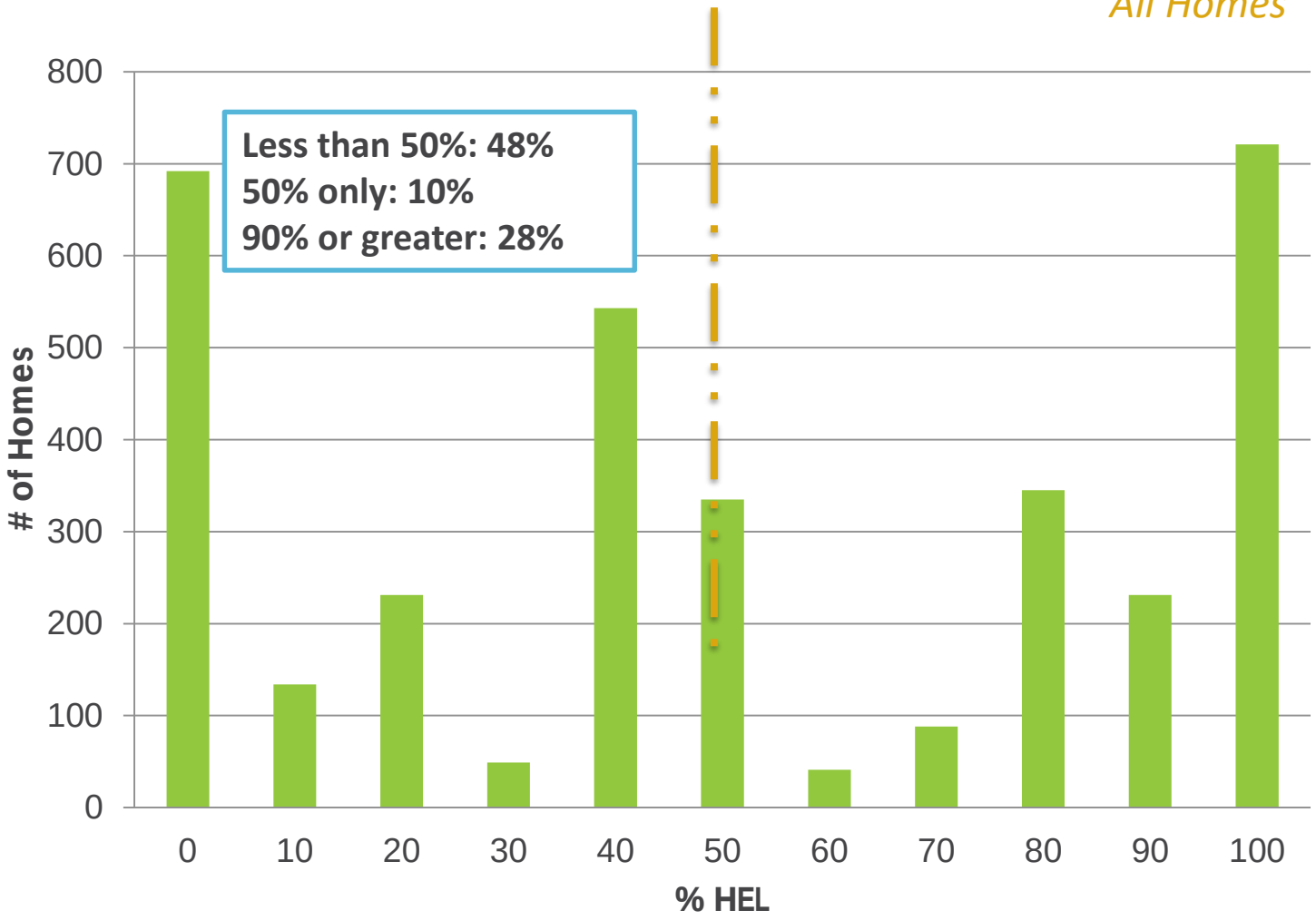
High Efficacy Lighting

All Homes



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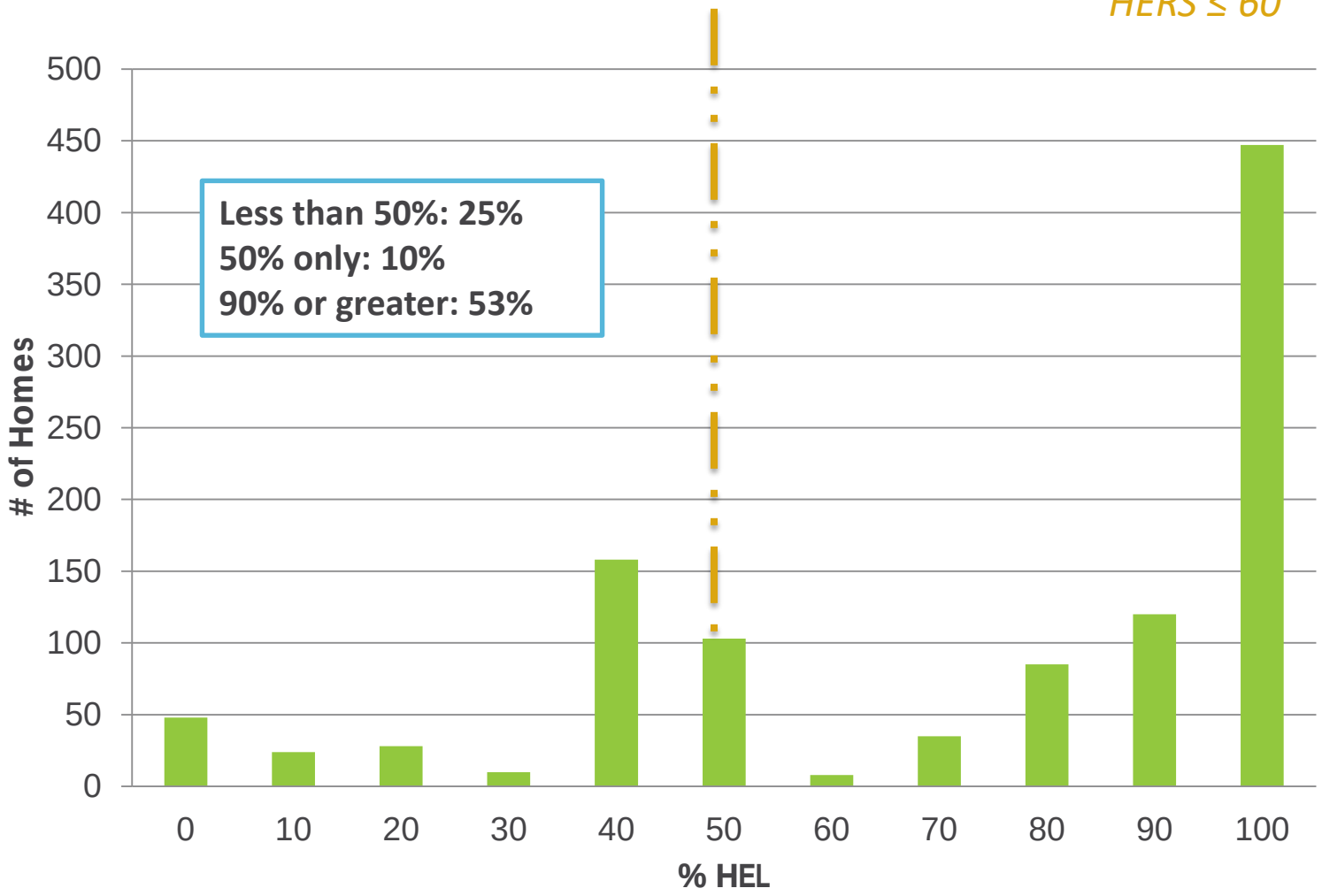
High Efficacy Lighting

HERS ≤ 60



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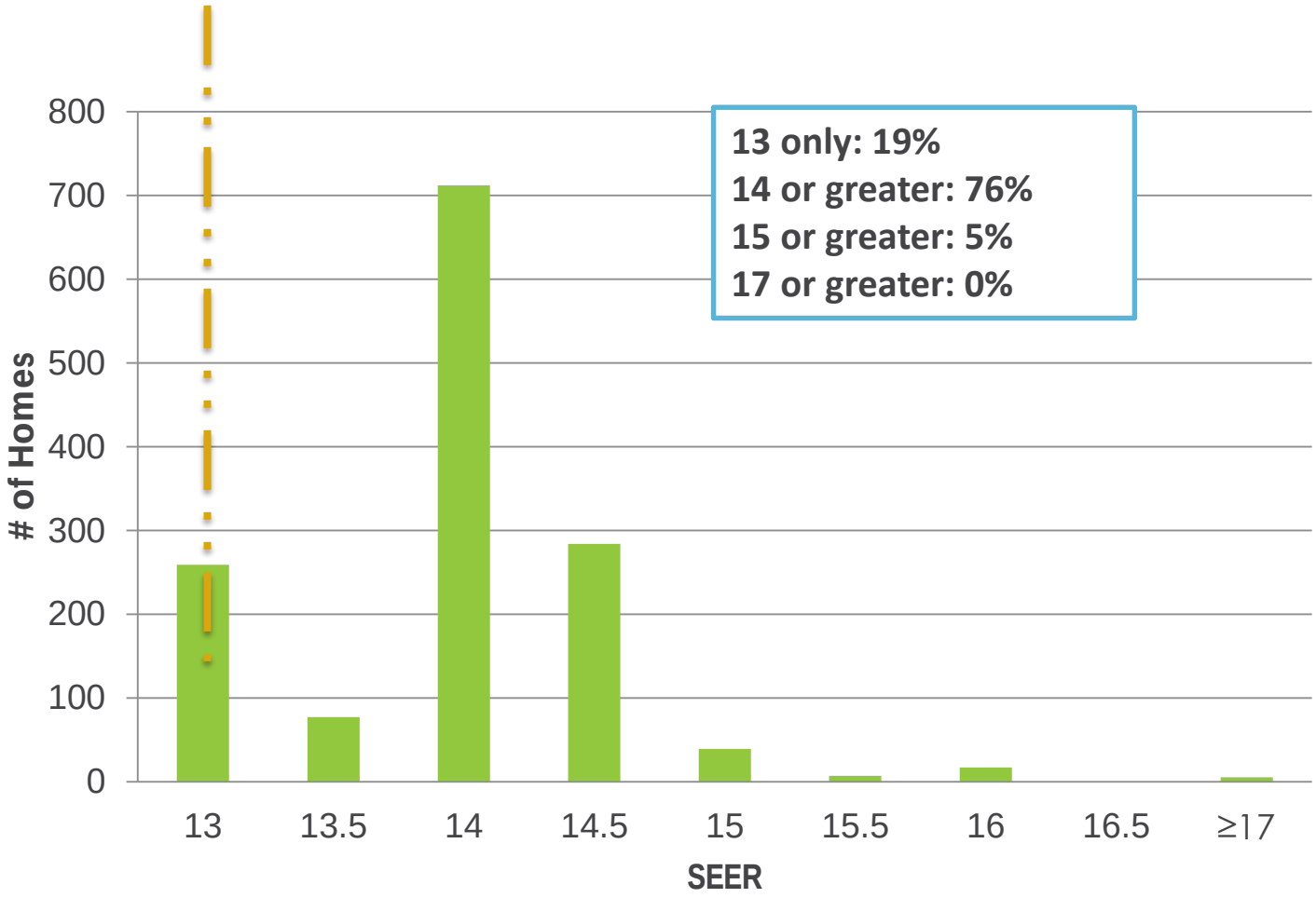
Cooling Efficiency (SEER)

All Homes



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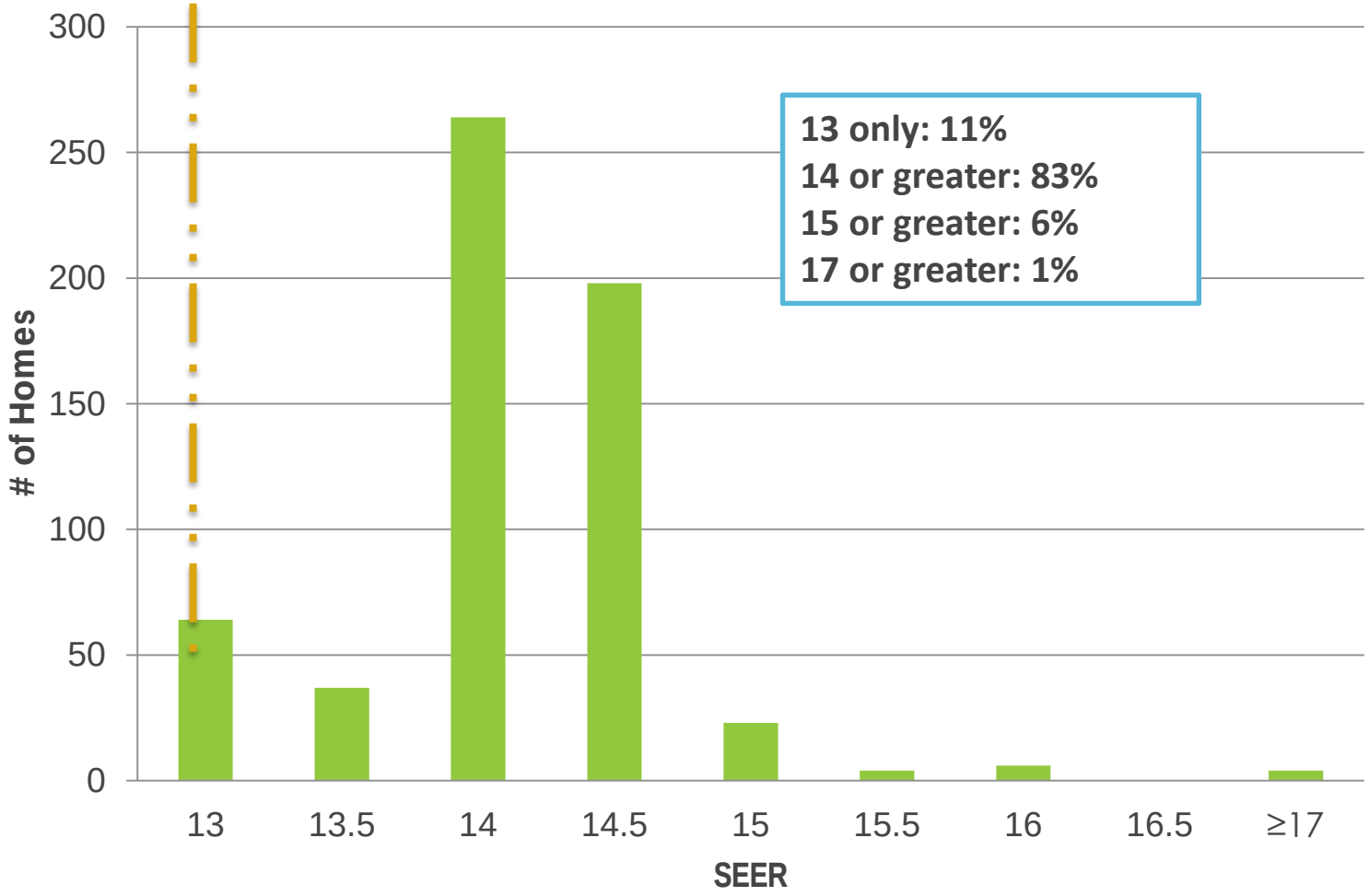
MIDWEST ENERGY EFFICIENCY ALLIANCE

Cooling Efficiency (SEER)

HERS ≤ 60



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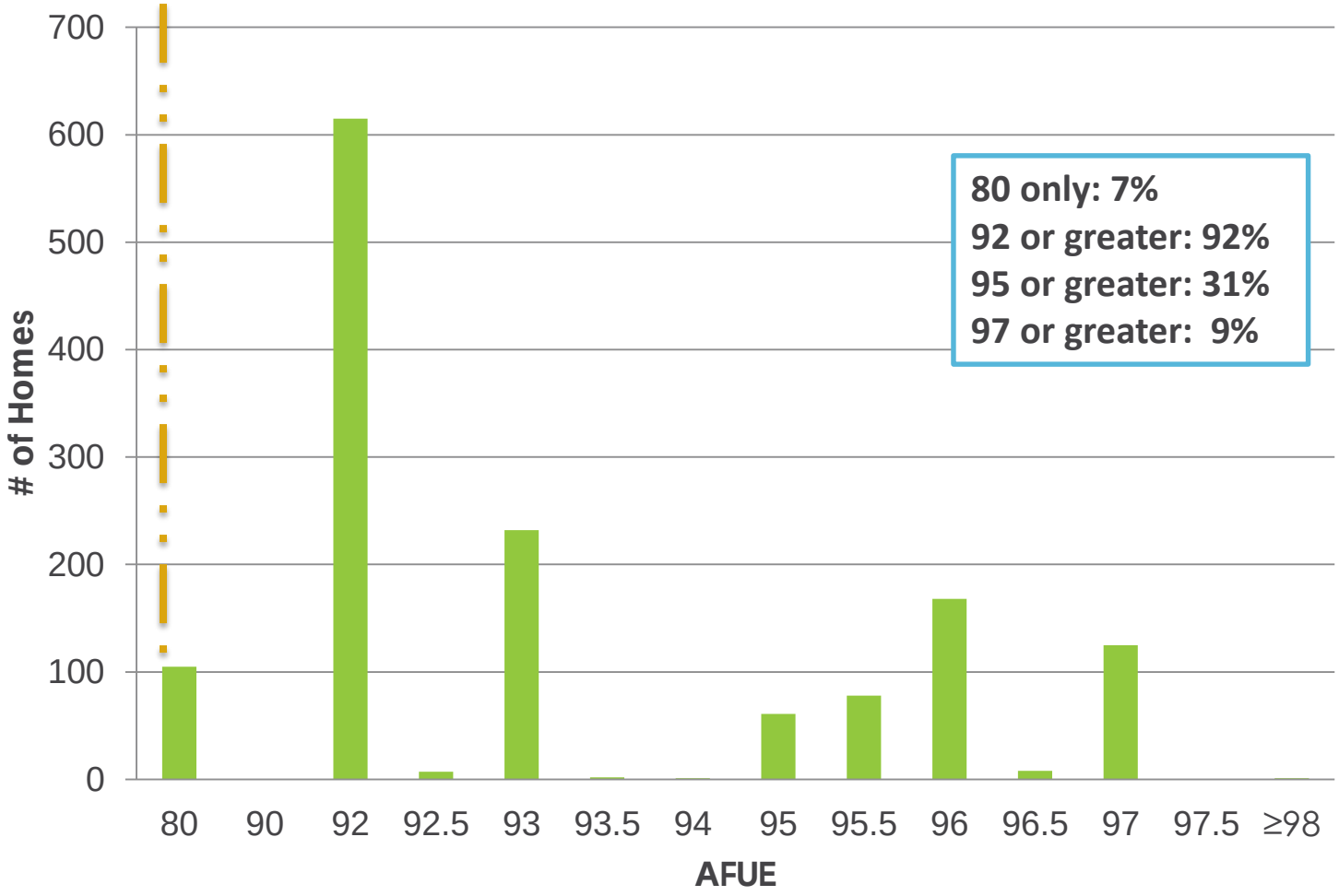
Heating Efficiency (AFUE)

All Homes



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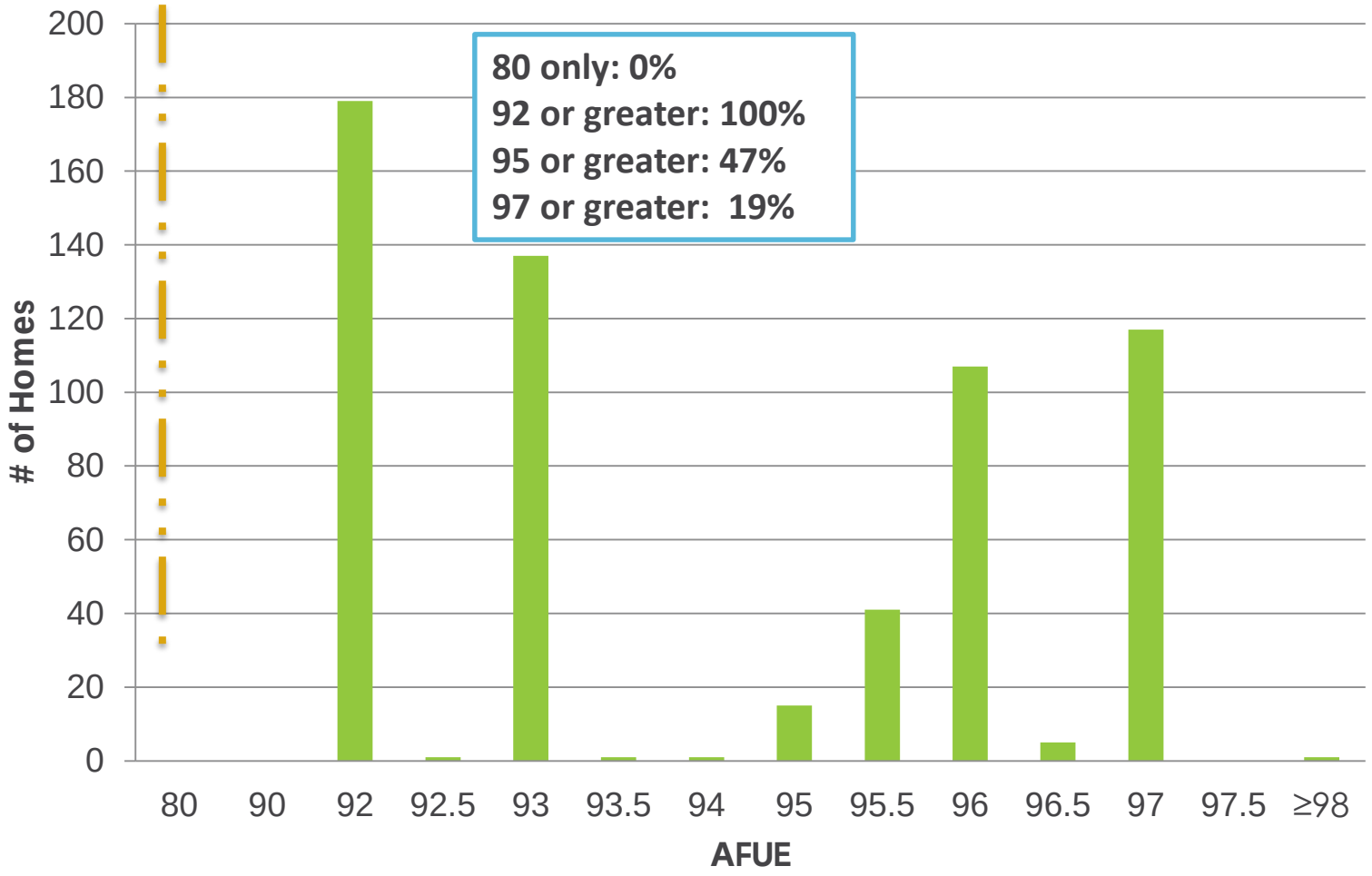
MIDWEST ENERGY EFFICIENCY ALLIANCE

Heating Efficiency (AFUE)

HERS ≤ 60



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MIDWEST ENERGY EFFICIENCY ALLIANCE

HERS 60

Home Components

Ex. Homes	1	2	3	4	5	Avg. Home Components	CZ 4 2009 IECC
Cond. Area (sq. ft.)	5016	4470	3830	2758	2054	3355	
BSMT: Cont.	0	7	0	5	NA	6	
BSMT: Batt	4	5	6.5	0	NA	2	10/13
AGW: Cont.		2				1	
AGW: Batt	13.5	10	13	17	19	16	13
Ceiling: Blown	36	38	39	37	39	37	38
Window: U-Factor	.3	.29	.32	.34	.29	.30	.35
Air Leakage	1.8	2.7	2.4	3	2.3	2.8	7
Duct Leakage	Cond.	1.4	Cond.	3	1.8	1.3	8
HEL: %	40	30	40	100	50	58	50
AC (SEER)	14	14	13	14.5	14	14	13
Furnace (AFUE)	93	96	93	93	92	93	80

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New Business

- KY Manual D Analysis
- MO Manual J Analysis
- Upcoming Conferences
  - Midwest Energy Solutions
    - Chicago – Next Week!
  - Midwest Residential Energy Conference
    - Lexington, KY, March 7-8
  - Better Buildings Summit
    - Washington, DC, May 9-11
  - National Energy Codes Conference
    - Pittsburgh, PA, July 18-20

Next Steps

- Continue Circuit Rider Program
- Final Two In-Person Trainings
- Continue Promoting Online Videos
- Preparations For Phase 3
- DOE State Report

Adjournment

Thank you for your participation!