BUILDING TECHNOLOGIES OFFICE

U.S. Department of Energy

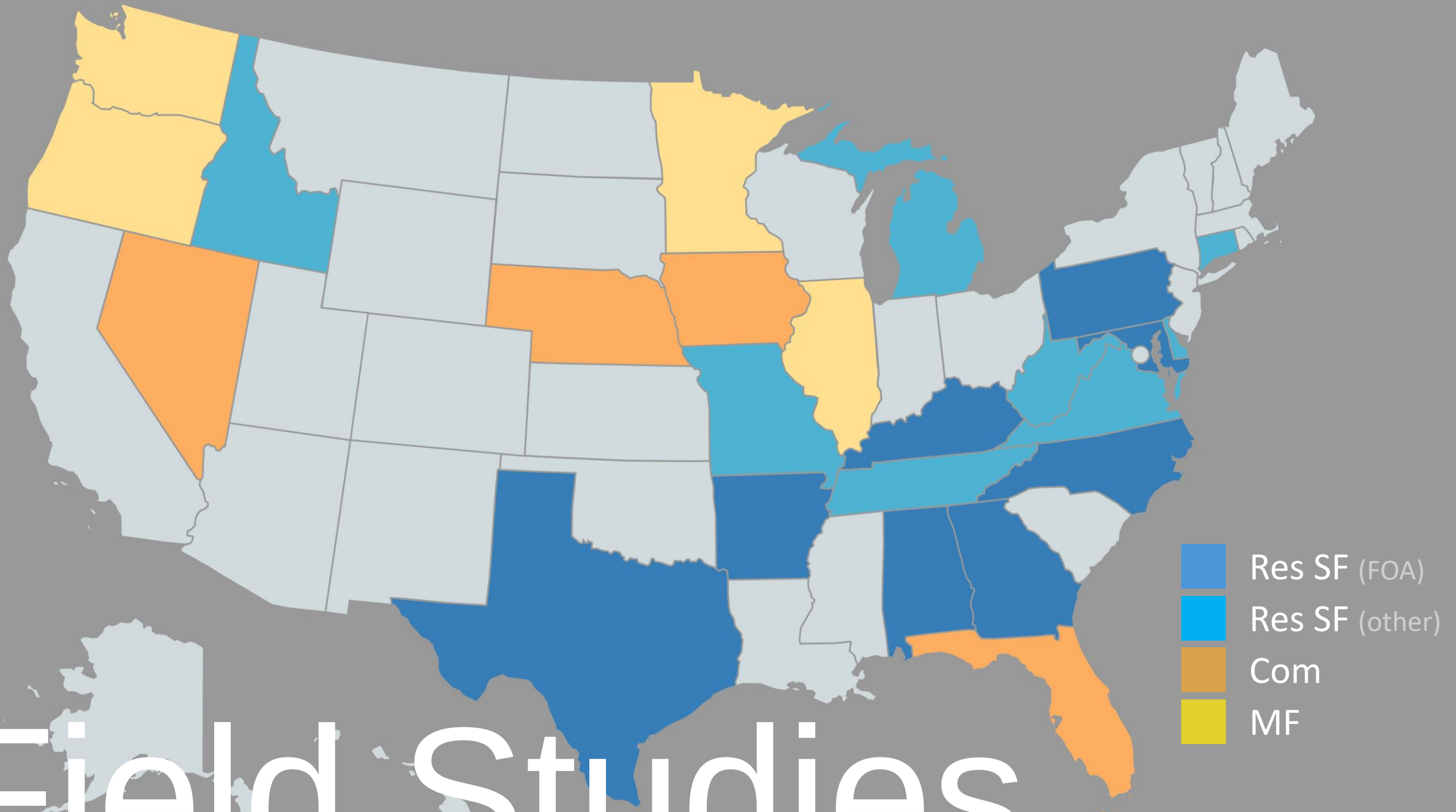
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Midwest Energy Codes Conference

November 2018

Introduction

+ Primer: Residential Field Studies
+ What's New: A review of the pilots and new state data
+ What's Next: What we're ultimately hoping to accomplish



Field Studies

QUICK PRIMER

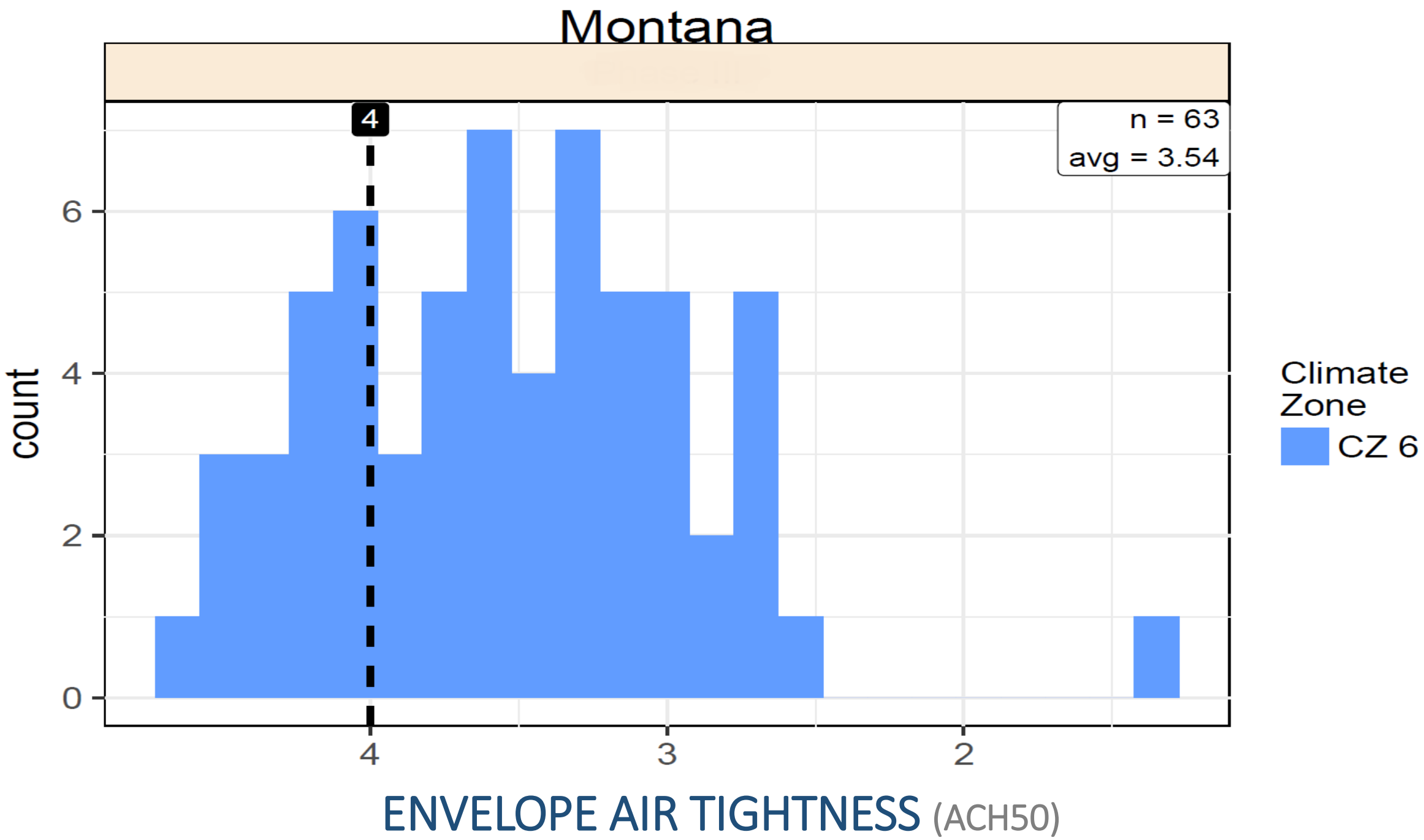
(what we think we might know so far)

Objectives: Energy Code Field Studies

1. Develop a **methodology** to help states assess code implementation + equate to *energy*

2. Establish a set of **empirical data** based on observations in (new) real homes

3. Highlight the **business case** for investment to increase code savings



ENVELOPE AIR TIGHTNESS (ACH50)

Key Items	TX**	AL	GA	AR	NC	KY	MD**	PA	Heat Map
									Red=bad Green=good
Climate Zone***	2	2,3	2,3,4	3,4	3,4	4	4	4,5	
Exterior wall insulation*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	1.00
Duct tightness	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	1.00
Lighting	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	1.00
Envelope tightness	Yes	Yes	None	Yes	Yes	Yes	Yes	None	0.75
Ceiling insulation*	Yes	None	Yes	None	None	None	Yes	None	0.38
Foundation Insulation*	None	None	None	None	Yes	Yes	None	Yes	0.38
Window SHGC	None	Yes	None	Yes	None	None	None	None	0.25
Window U-factor	None	None	None	None	None	None	None	None	0.00
No. of Key Items with Savings	5	5	4	4	5	5	5	4	0.58

*Includes insulation installation quality

** 2015 IECC

***As sampled

Trends Across States [phase 1]

Envelope & Duct Tightness: Similar ranges regardless of requirement—envelope results better than some predicted (e.g. 3-5 ACH)

Wall & Ceiling Insulation: Typically meet label R-values—generally weaker installation quality

Windows: Almost all observations exceed requirement—most better than U-factor=0.35 regardless of CZ (similar trend for SHGC)

Lighting: No consistent trend—surprisingly low compliance

Average Statewide Energy Use [phase 1]

State	Current State Code	Expected EUI (kBtu/ft²)	Observed EUI (kBtu/ft²)	Differential (%)
AL	2009 IECC	22.40	19.67	-12.8%
AR	2014 AR Energy Code (amended 2009 IECC)	33.12	28.21	-14.8%
GA	Georgia Energy Code (amended 2009 IECC)	28.52	26.52	-7.0%
KY	2009 IECC	33.98	31.31	-7.9%
MD	2015 IECC	27.56	30.49	+10.6%
NC	2012 NC Energy Code (amended 2009 IECC)	23.79	22.96	-3.5%
PA	2009 IECC (2009 IRC)	45.48	40.73	-10.4%
TX	2009 IECC	25.94	20.95	-19.2%

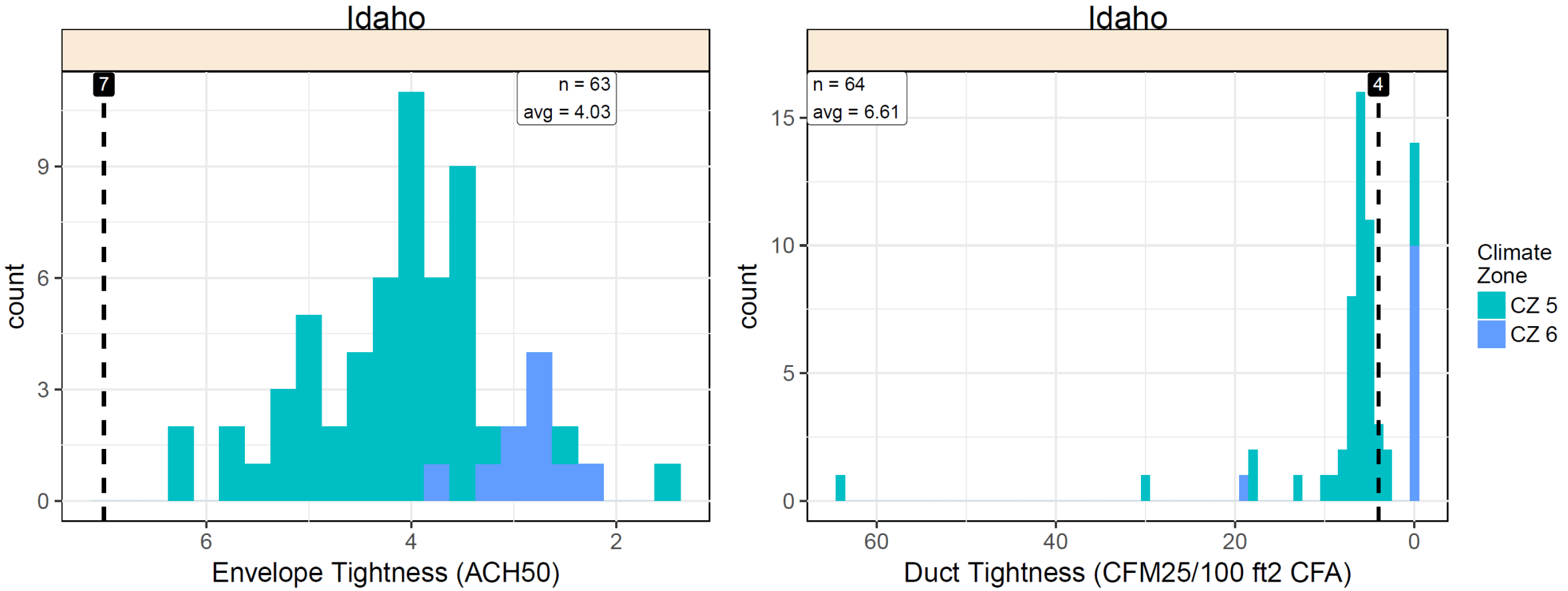
Measure Savings Potential [phase 1]

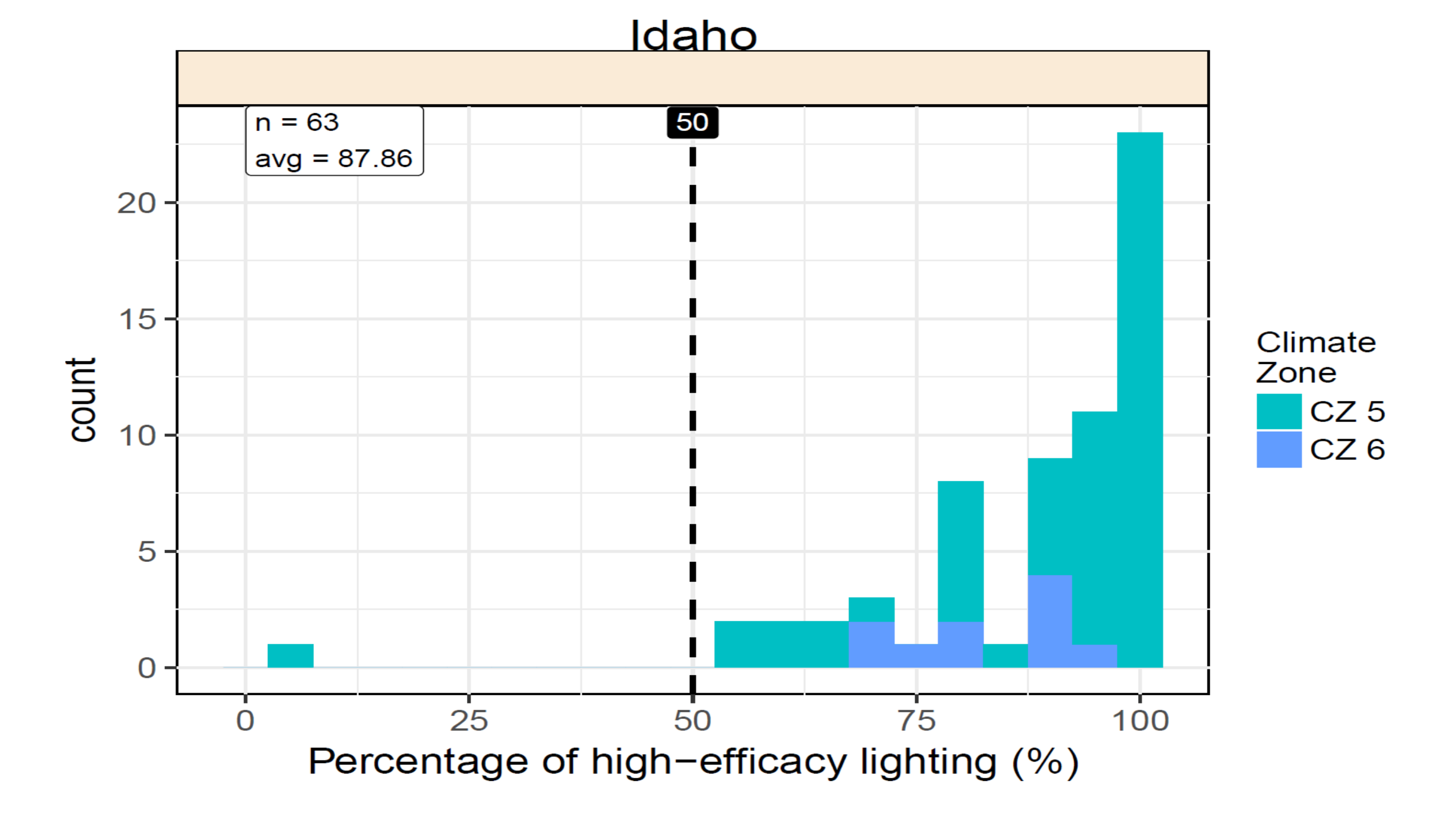
State	Envelope Tightness	Duct Tightness	Wall Insulation	Lighting
AL	$263,089	$395,063	$201,105	$385,451
AR	$104,022	$110,524	$74,792	-
GA	-	$685,683	$1,151,262	$799,065
KY	$9,558	$327,731	$223,954	$137,883
MD	$754,946	$146,619	$401,480	$195,378
NC	$211,315	$334,527	$390,827	$520,839
PA	-	$1,360,493	$798,031	$365,254
TX	$4,656,869	$3,582,893	$5,029,864	$2,774,421
Total	**$5,999,799**	**$6,943,533**	**$8,271,315**	**$5,178,291**

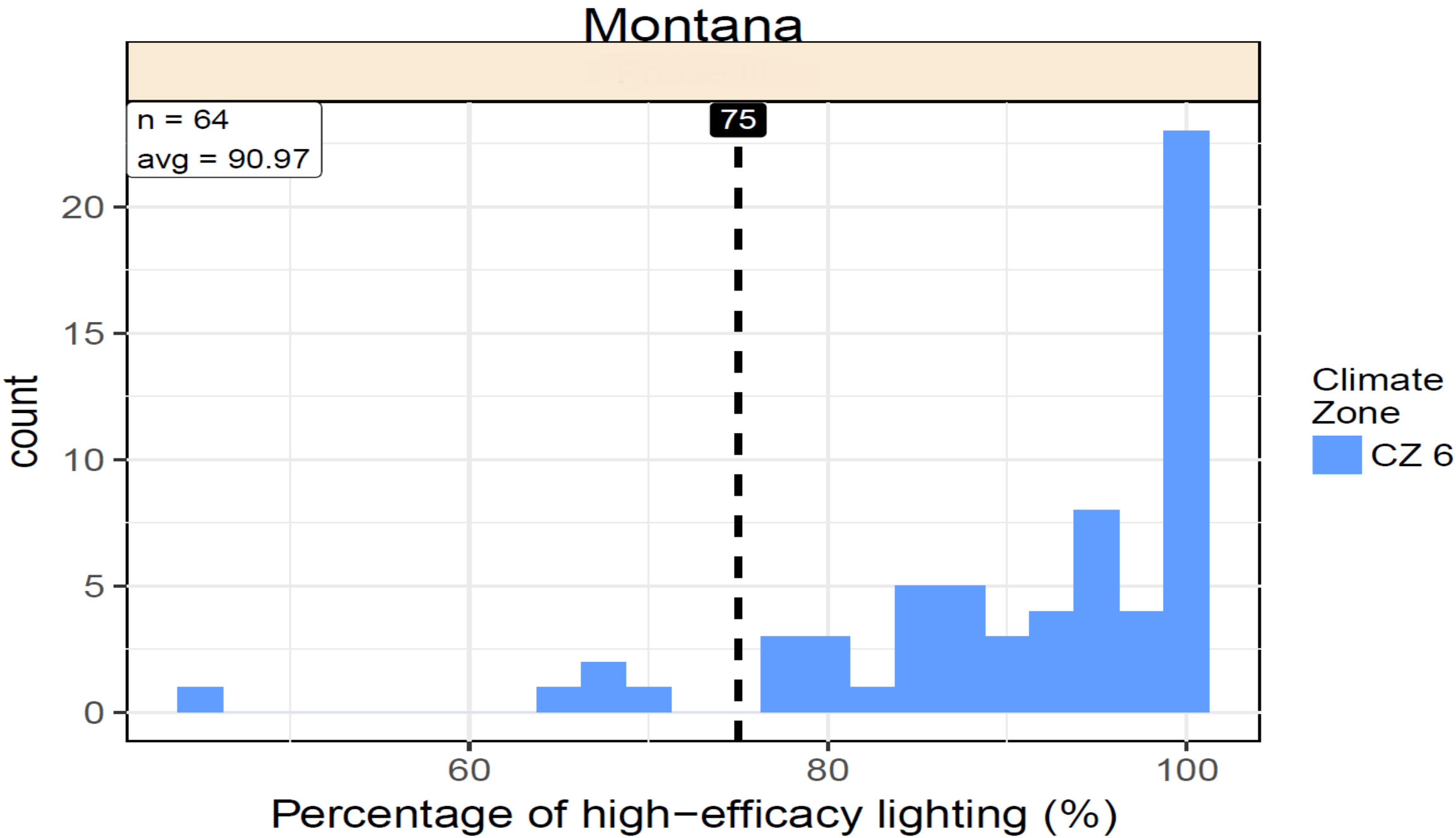
WHAT'S NEW?

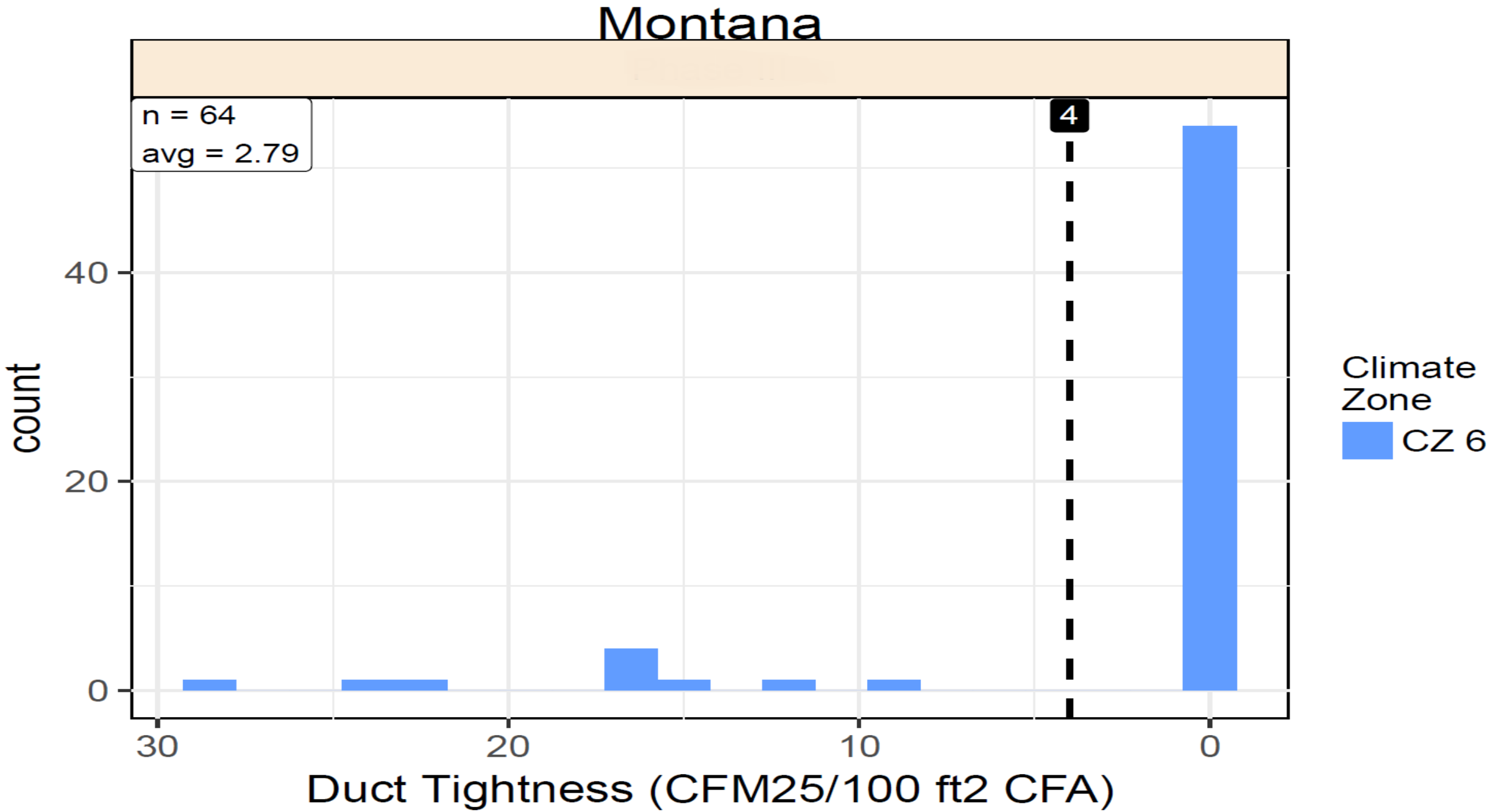
Several New States

(and here are the newest)


Idaho
7
n = 63
avg = 4.03
count
0
3
6
9
6
4
2
Envelope Tightness (ACH50)
Idaho
4
n = 64
avg = 6.61
count
0
5
10
15
60
40
20
0
Duct Tightness (CFM25/100 ft2 CFA)
Climate Zone
CZ 5
CZ 6


Idaho
n = 63
avg = 87.86
50
20
15
10
5
0
count
0
25
50
75
100
Percentage of high−efficacy lighting (%)
Climate Zone
CZ 5
CZ 6

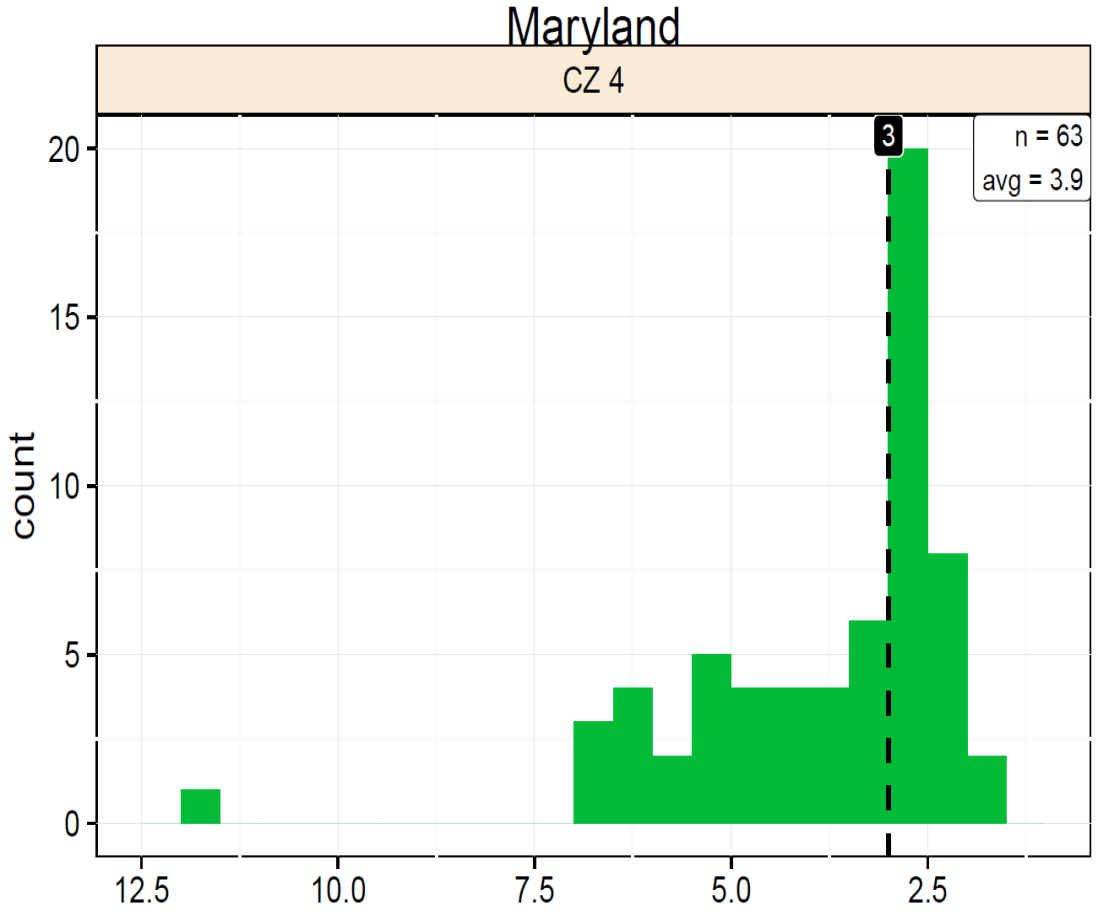

Montana
n = 64
avg = 90.97
75
20
15
10
5
0
count
60
80
100
Percentage of high−efficacy lighting (%)
Climate Zone
CZ 6


Montana
n = 64
avg = 2.79
4
40
20
0
count
30
20
10
0
Duct Tightness (CFM25/100 ft2 CFA)
Climate Zone
CZ 6

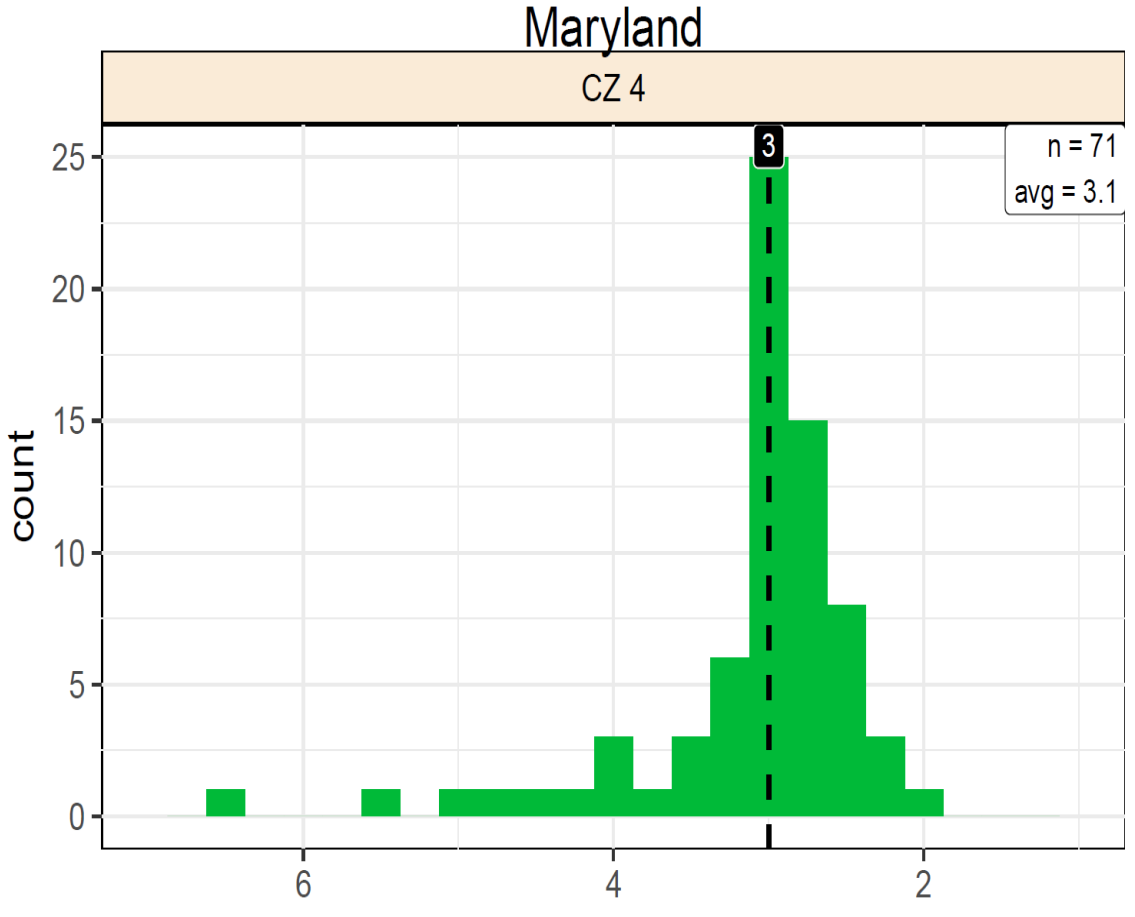
Pilots: Phase 3

(re-measure)

ENVELOPE AIR TIGHTNESS (ACH50)

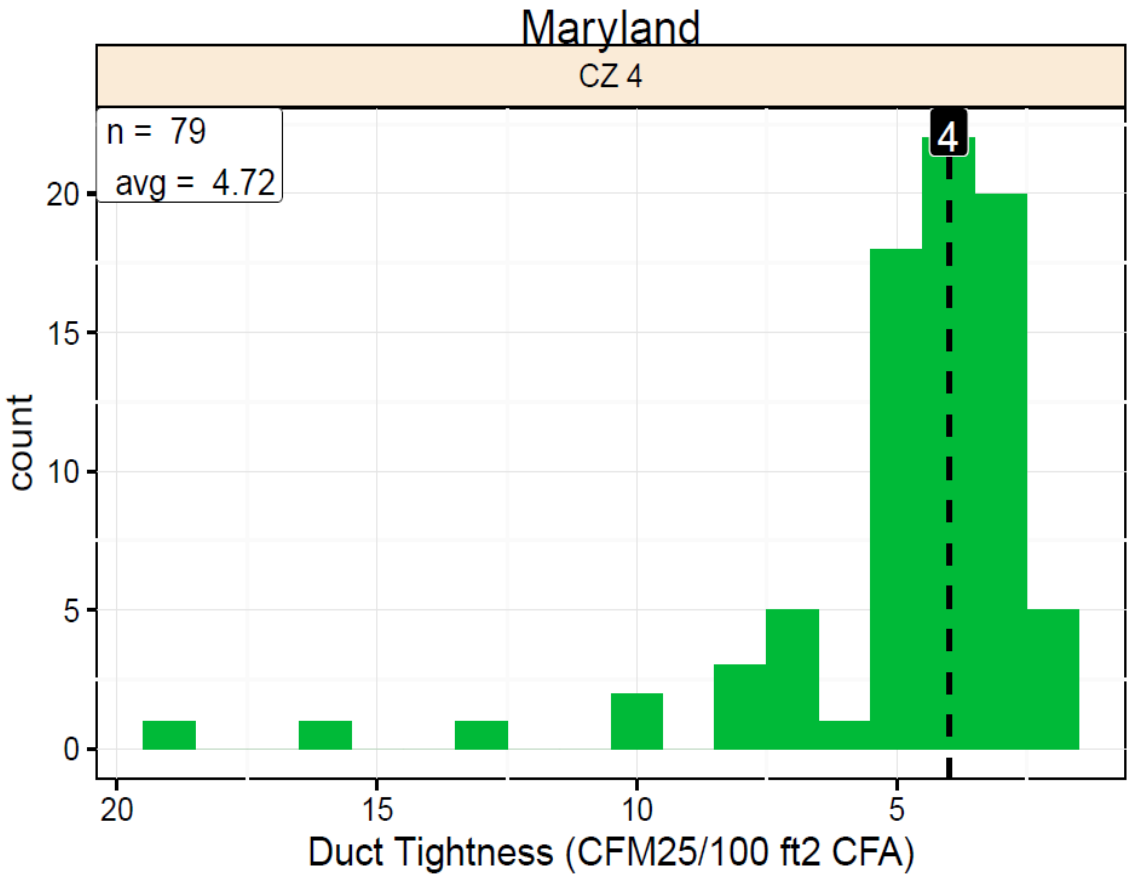


Phase I

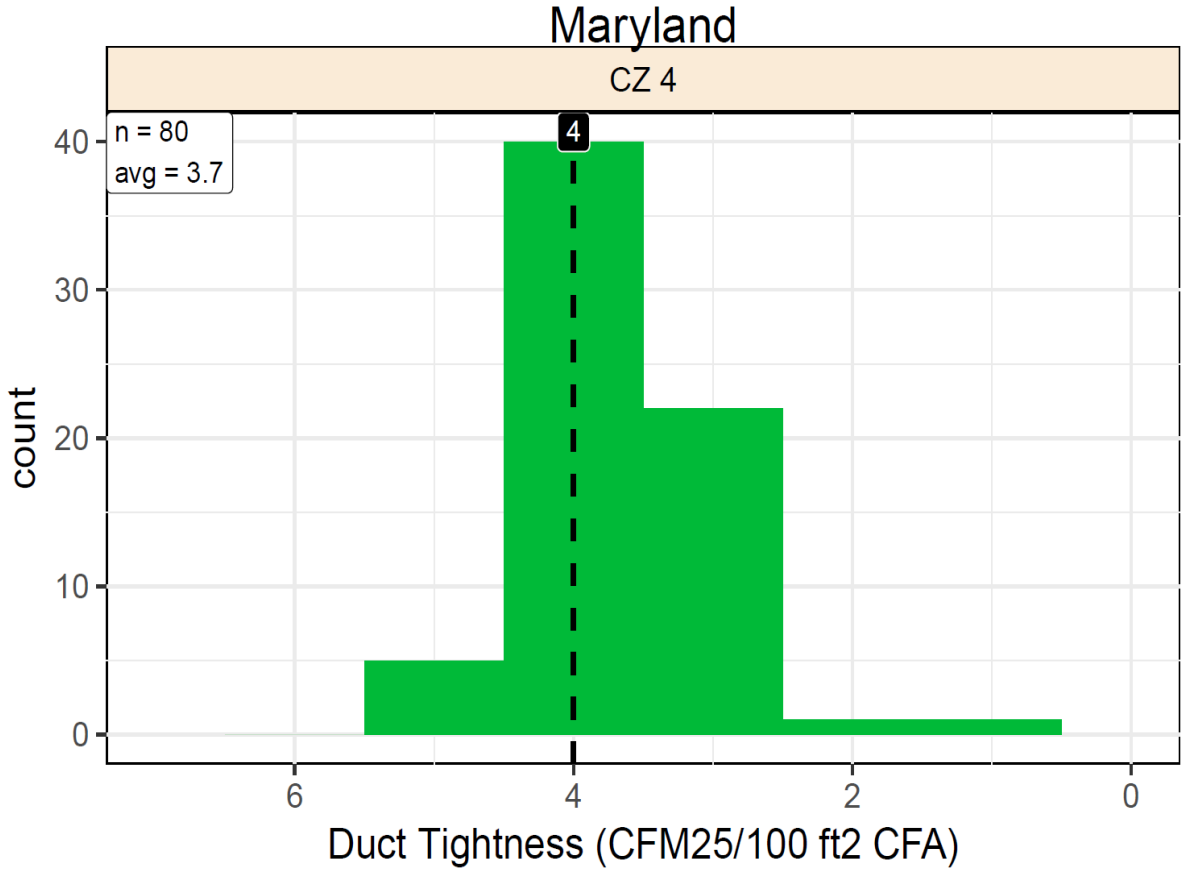


Phase III

DUCT TIGHTNESS (cfm25/100sf cfa)

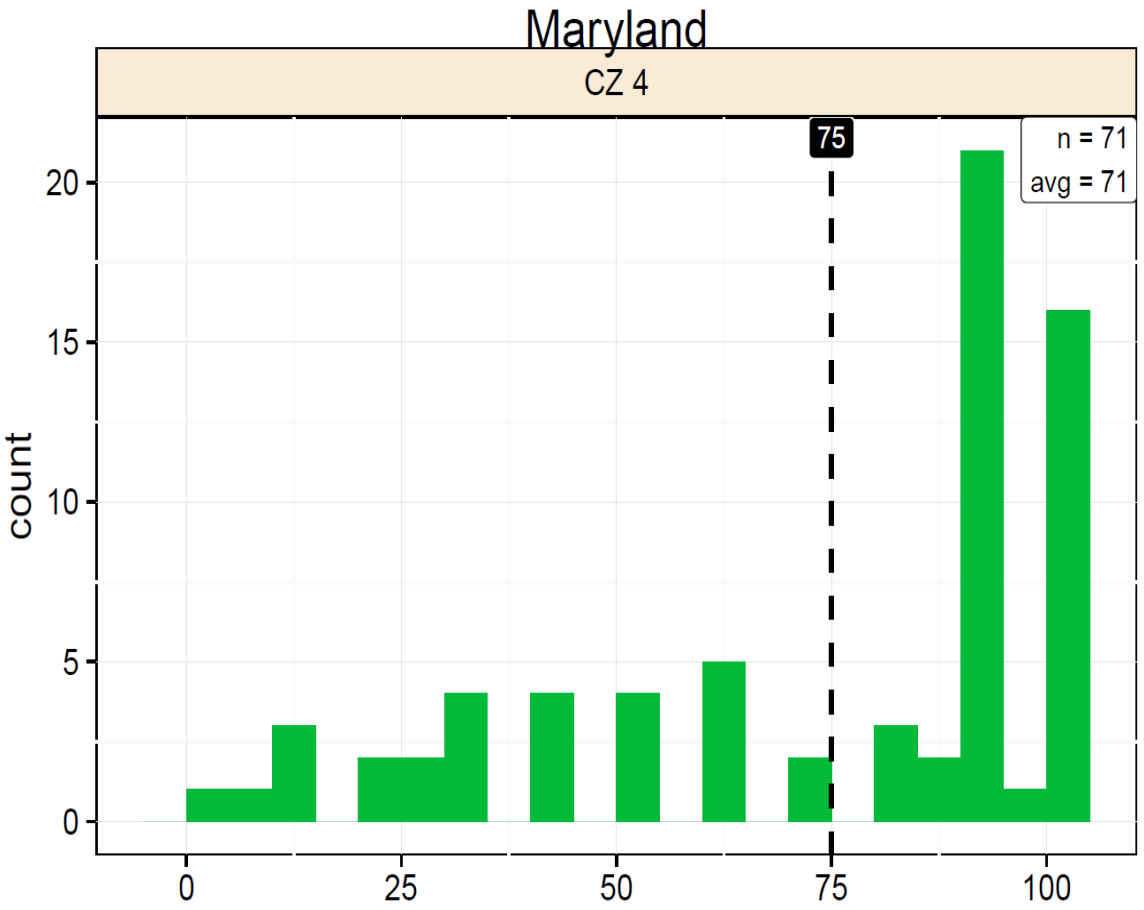


Phase I

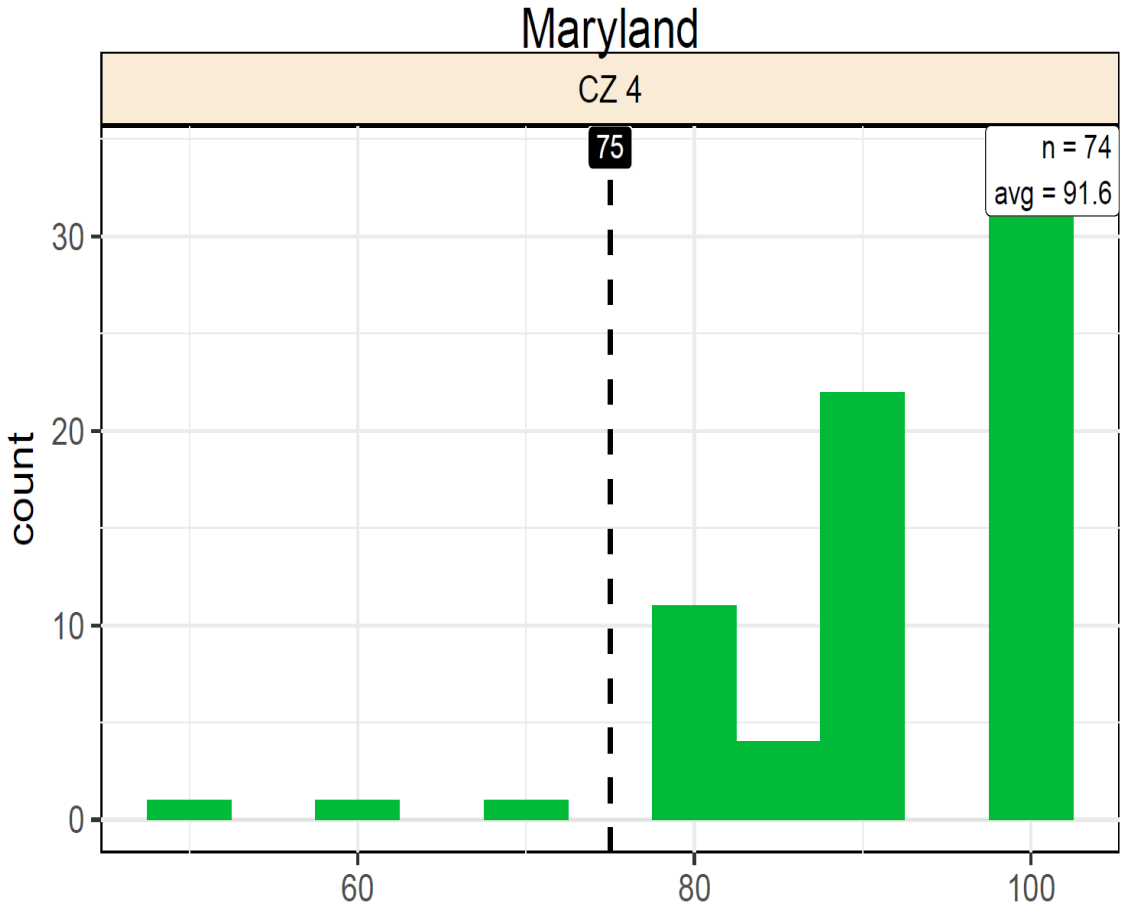


Phase III

LIGHTING (% high efficacy)

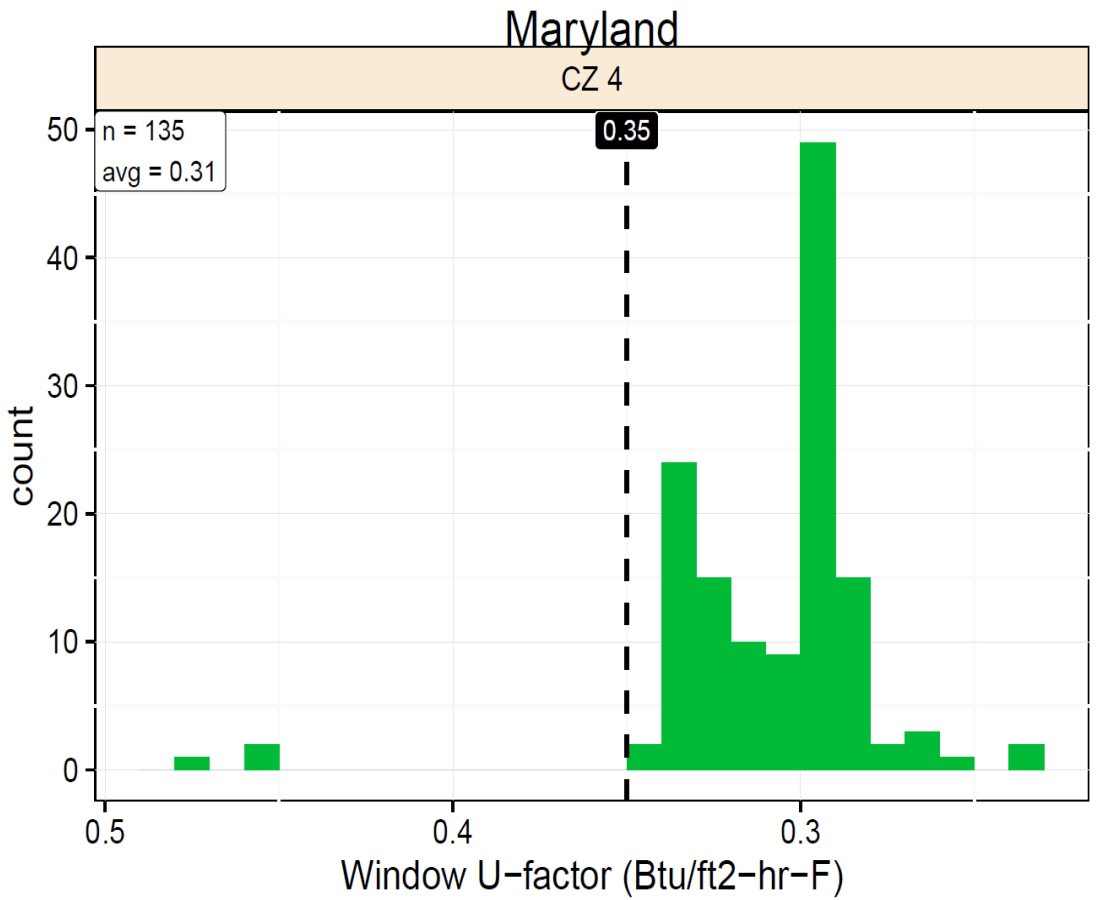


Phase I

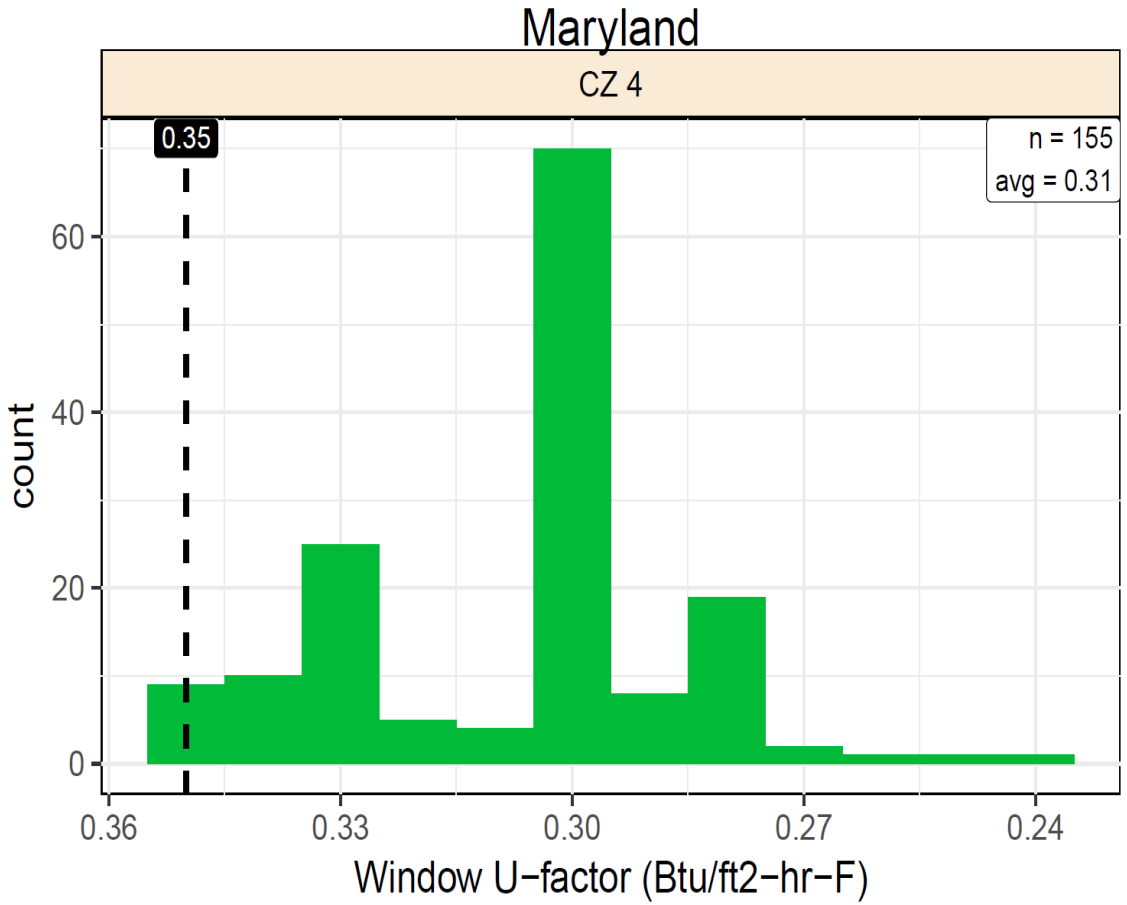


Phase III

WINDOWS (u-factor)

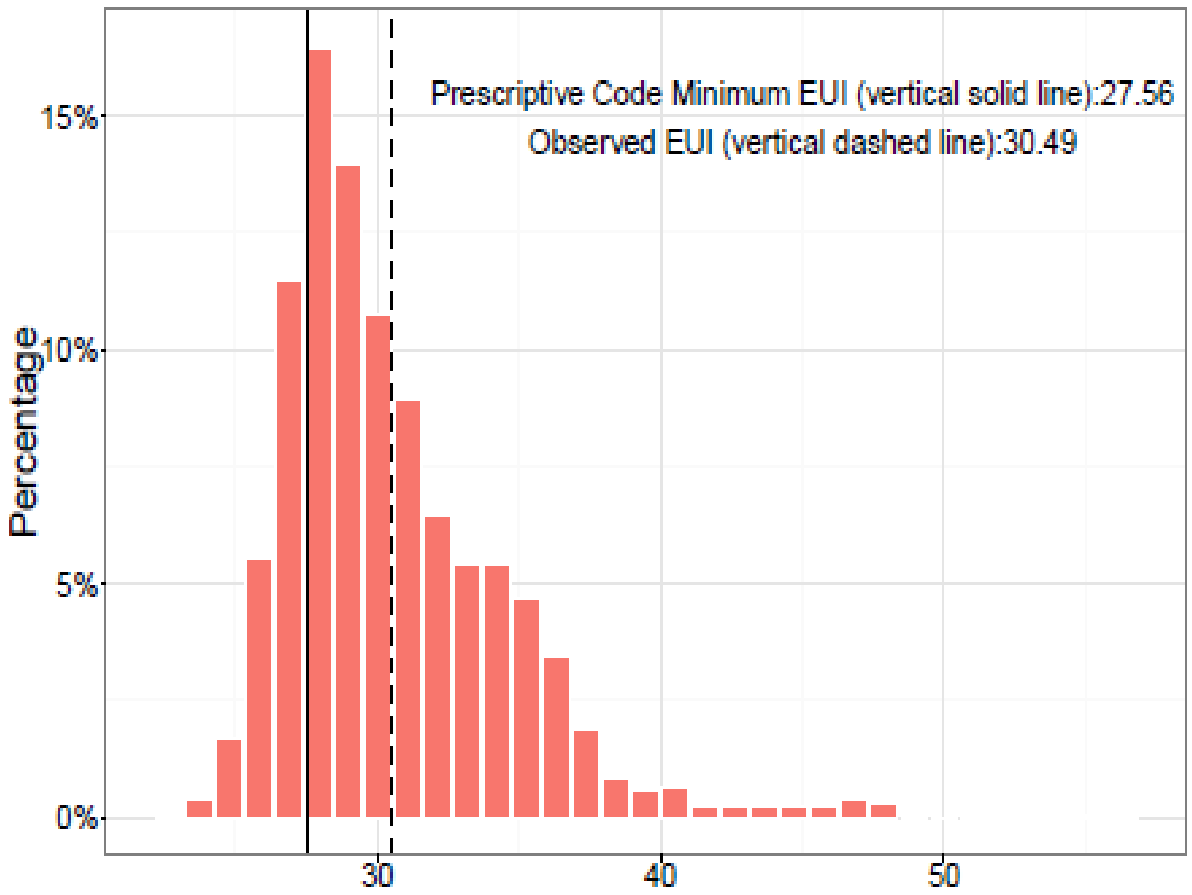


Phase I

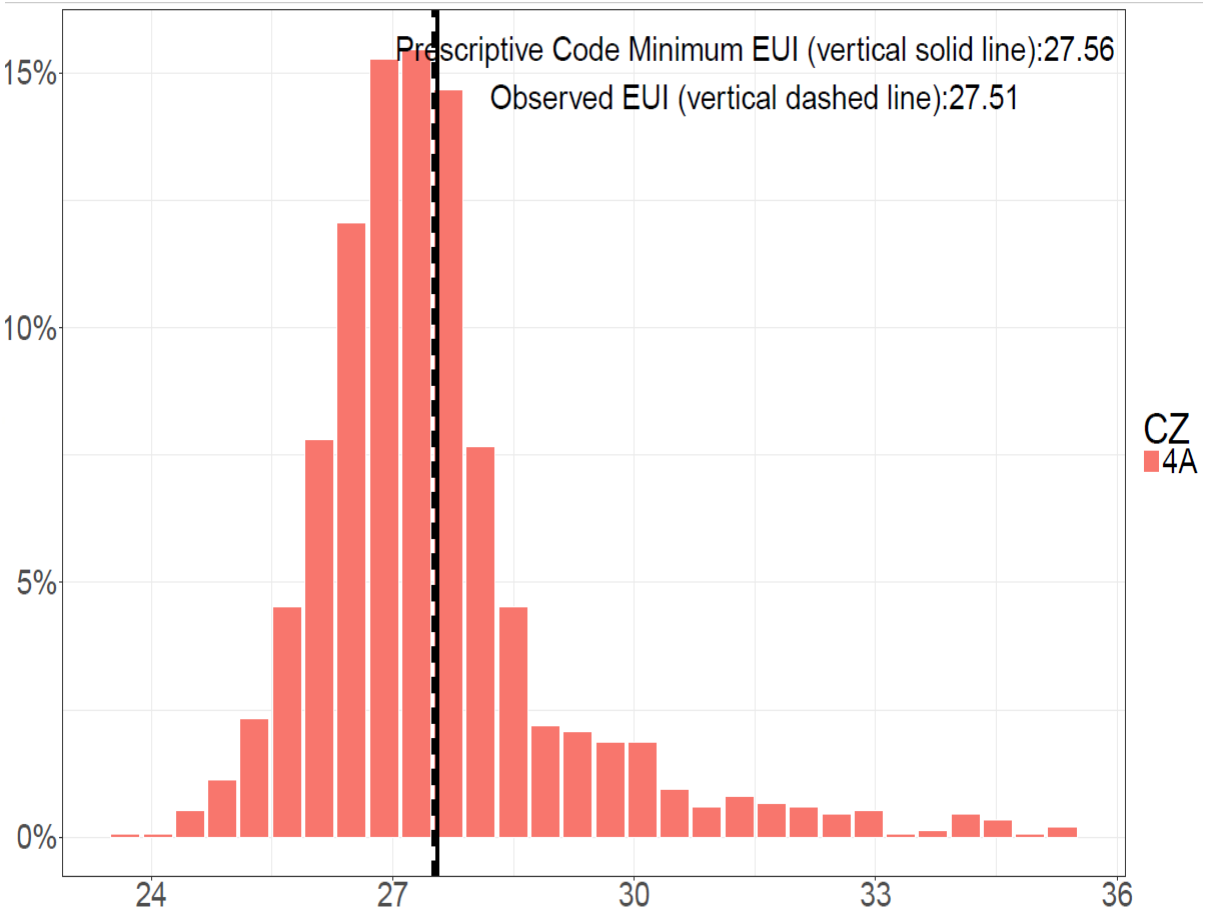


Phase III

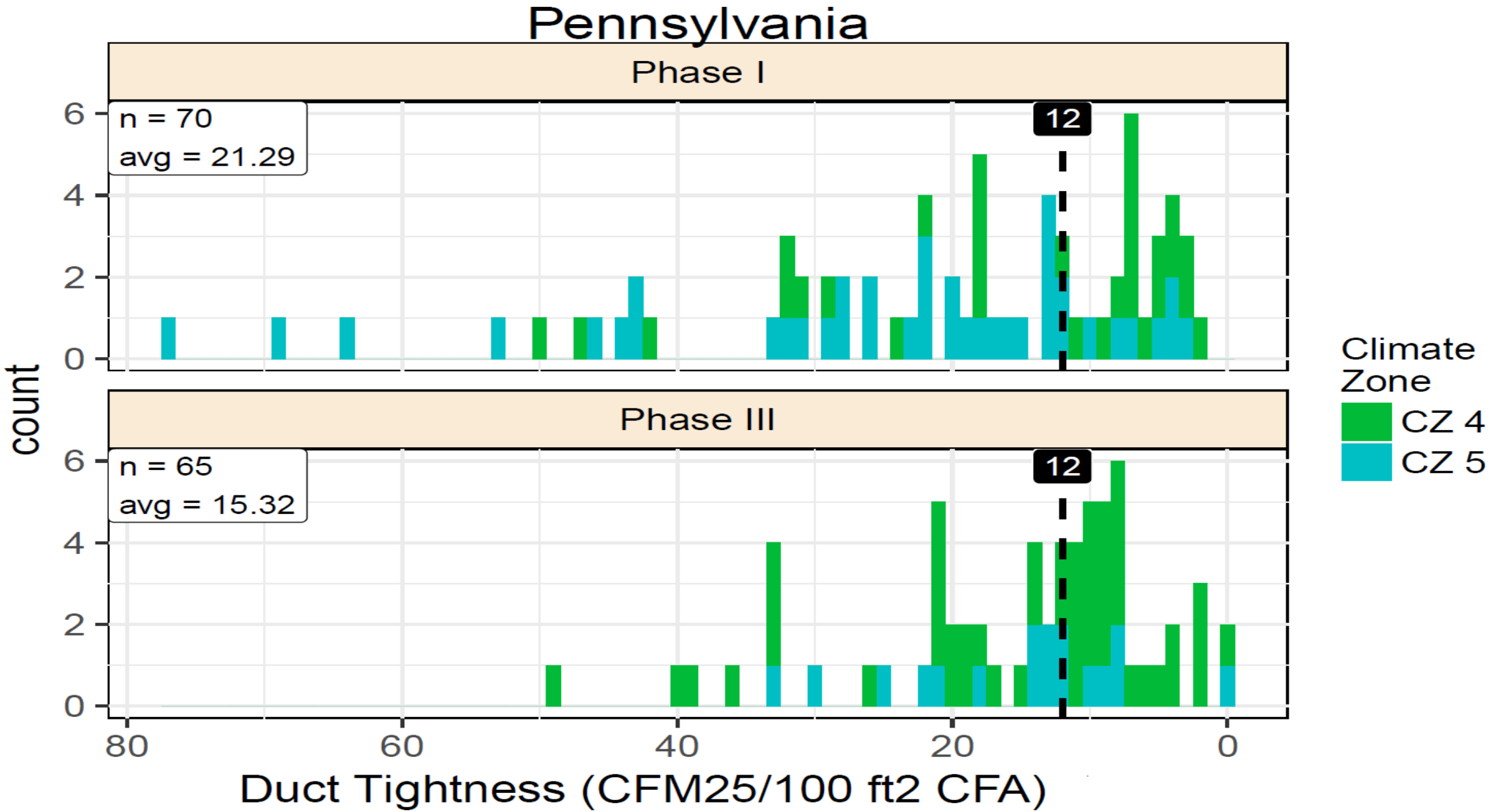
STATEWIDE AVERAGE EUI (kBtu/sf)

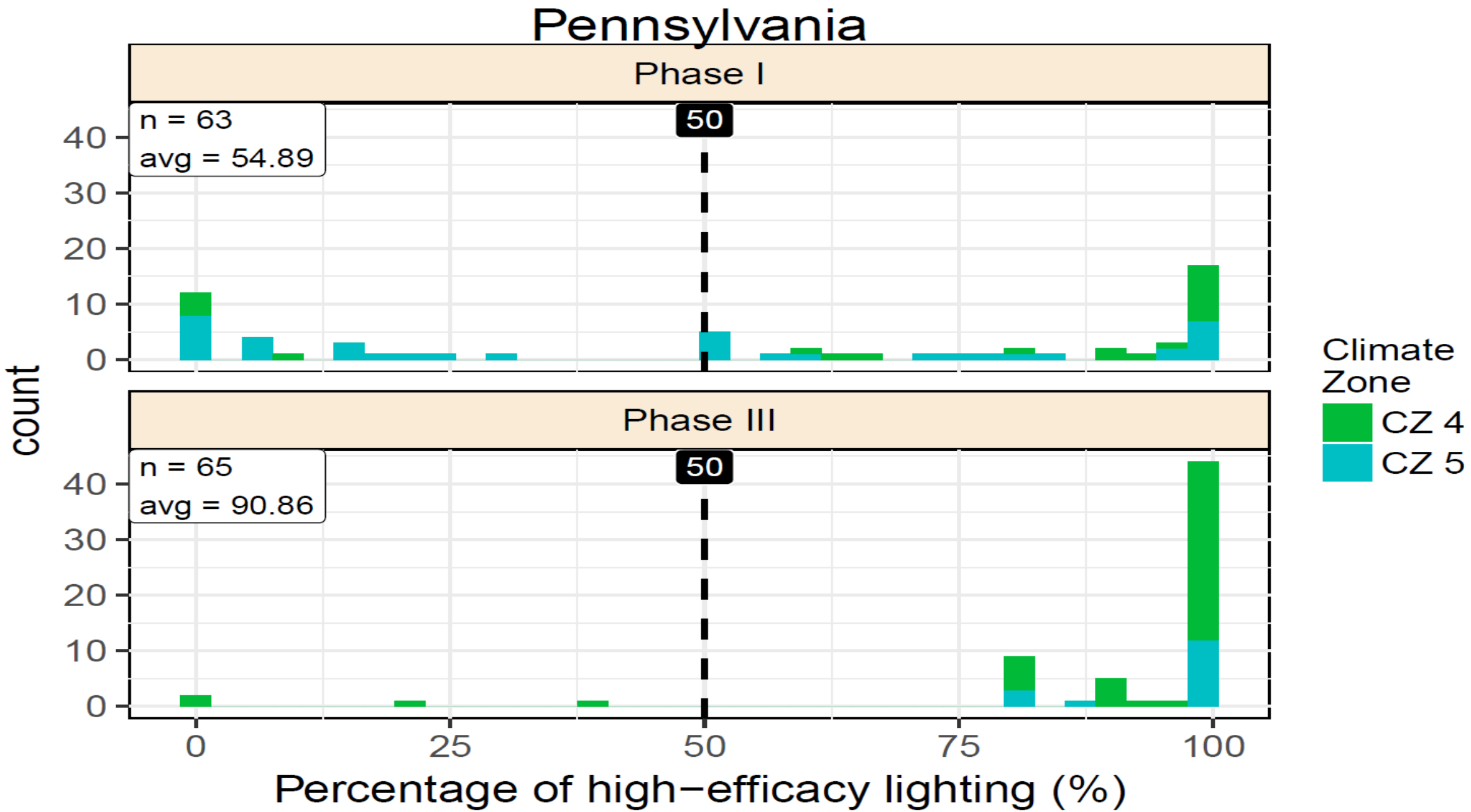


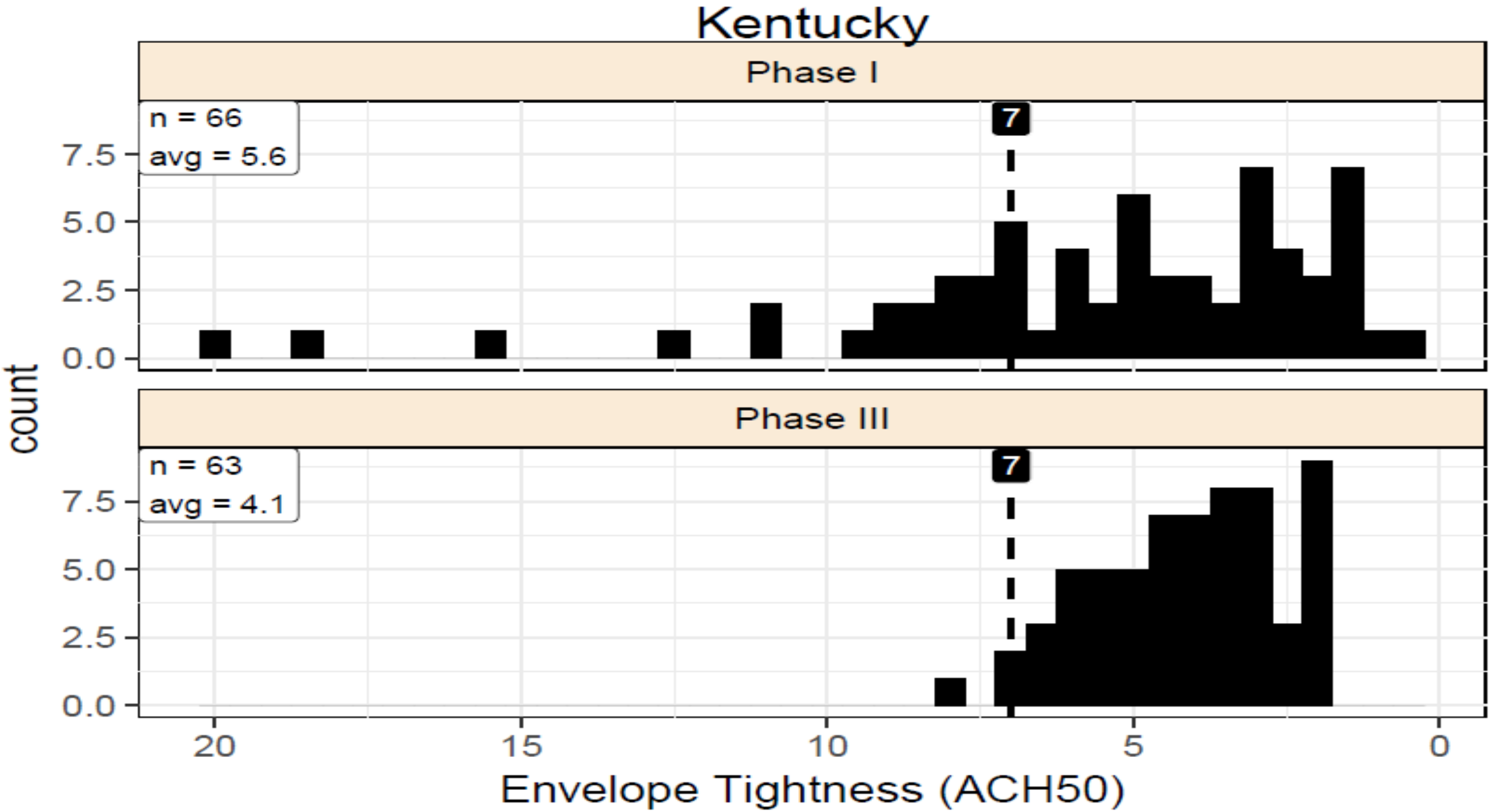
MD Phase I



MD Phase III


Pennsylvania
Phase I
n = 70
avg = 21.29
12
Phase III
n = 65
avg = 15.32
12
count
0
2
4
6
80
60
40
20
0
Duct Tightness (CFM25/100 ft2 CFA)
Climate Zone
CZ 4
CZ 5


Pennsylvania
Phase I
n = 63
avg = 54.89
50
Phase III
n = 65
avg = 90.86
50
count
0
10
20
30
40
0
25
50
75
100
Percentage of high−efficacy lighting (%)
Climate Zone
CZ 4
CZ 5


Kentucky
Phase I
n = 66
avg = 5.6
7
Phase III
n = 63
avg = 4.1
7
count
7.5
5.0
2.5
0.0
20
15
10
5
0
Envelope Tightness (ACH50)

CHANGE IN AVERAGE STATEWIDE ENERGY USE (EUI)

State	Baseline Code	Observed EUI (kBtu/sf)		Differential (Phase III vs. I)	
		Phase I	Phase III	EUI (kBtu/sf)	% Change
AL	2015 AL Code	19.81	19.12	-0.69	-3.48%
KY	2009 IECC	31.31	29.49	-1.82	-5.81%
MD	2015 IECC	30.49	27.51	-2.98	-9.77%
PA	2009 IRC	41.04	43.61	+2.57	+6.26%

WHAT'S NEXT?

Preliminary Conclusions [phase one]

+ Builders and building officials are generally doing a good job implementing state codes and advancing requirements
+ Homes are using less energy on average than would be expected based on prescriptive code requirements alone (majority of states)
+ There is still significant savings potential by focusing programs on target measures (millions of dollars)
+ Findings suggest that targeted programs can lead to a significant and measurable reduction in statewide energy use

…and several studies still in progress.

Key Takeaways

+ Field studies are critical to understanding what's happening in the industry—in real homes—and the resulting impact on energy efficiency
+ Inform ongoing education & training efforts to improve compliance—lay the foundation for advanced topics (e.g. hands-on, building science, etc.) and better ROI
+ High interest from states & utilities—better data equates to better baselines—lots of useful data sitting in the raw data set (e.g., lighting, thermostats)
+ Encouraging more states to conduct studies—and to do so as part of regular tracking activities (every 3-5 years)
+ DOE Methodology and PNNL analysis is available *free of charge* to anyone interested in taking up a similar study

DOE Building Energy Codes Program

For more information:

Visit: energycodes.gov

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