

STANDARD




ANSI/ASHRAE/IES Standard 90.1-2013
(Supersedes ANSI/ASHRAE/IES Standard 90.1-2010)
Includes ANSI/ASHRAE/IES Addenda listed in Appendix F

Energy Standard for Buildings Except Low-Rise Residential Buildings (I-P Edition)

See Appendix F for approval rates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, the IES Board of Directors, and the American National Standards Institute.

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IL Energy Code Compliance

Field Studies Update

June, 2019



Agenda

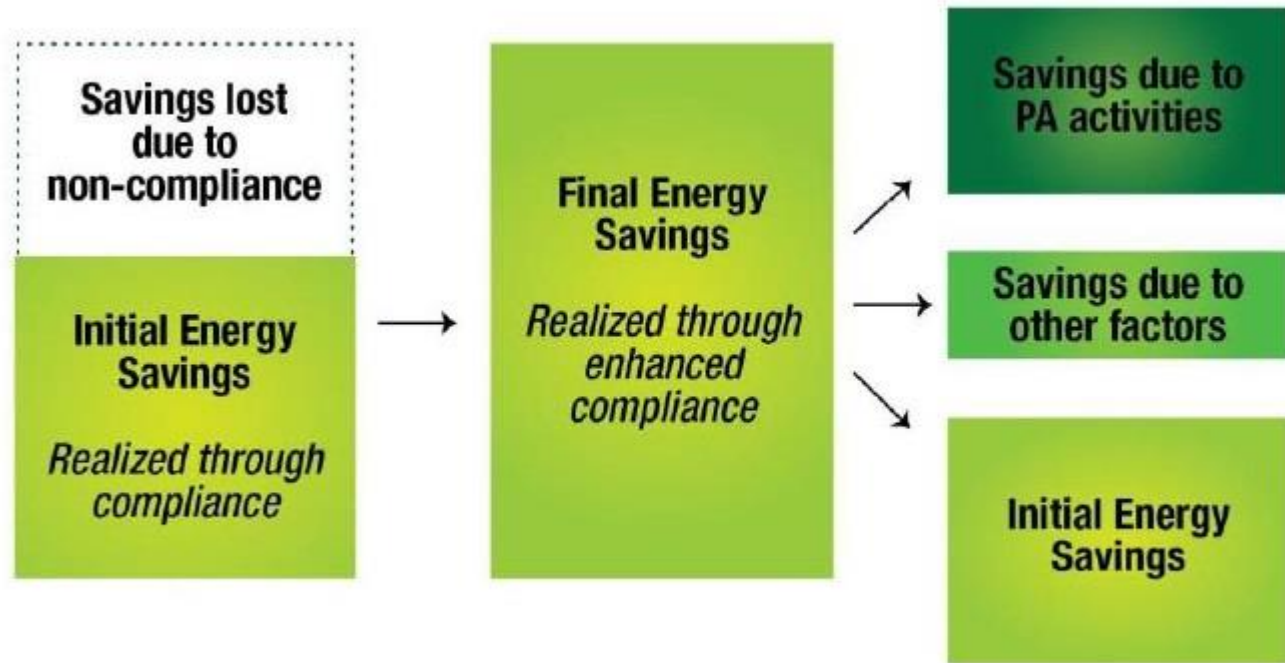
9:00am-12:00pm

- Update on residential field study, including trends we are seeing so far based on preliminary data
- Update on commercial field study
- Overview of the US DOE Energy Code field studies
- Existing construction as it relates to our studies and energy code compliance
- Discussion about programs and incentives



Opportunities for Claimed Savings

Energy Code Compliance



Source: *Attributing Building Energy Code Savings to Energy Efficiency Programs (2013)*, Institute for Market Transformation, Institute for Electric Innovation, Northeast Energy Efficiency Partnerships

What and Why

Understanding Energy Code Compliance

✓	What		Why	Residential Baseline Field Study
✓	What		Why	Commercial Baseline Field Study
	What	✓	Why	Illinois Energy Codes Compliance Collaborative

What and Why

Understanding Energy Code Compliance

✓	What		Why	Residential Baseline Field Study
✓	What		Why	Commercial Baseline Field Study
	What	✓	Why	Illinois Energy Codes Compliance Collaborative

✓ Who

✓ How

✓ How
Much



Illinois

Energy Codes

Compliance

Collaborative

Update and Upcoming Meetings



What and Why *Energy Codes Compliance Collaboratives*

- **What:** A group of stakeholders that come together on a regular basis to explore common interests and address obstacles related to **energy code compliance**
- **Why:** To establish a forum for identifying and tackling obstacles to improving energy code compliance (eventual goal 100%)

Collaborative Goals

- Inform stakeholders baseline studies for recruitment
- Gather feedback on noncompliance
- Identify next steps for the key areas of energy code noncompliance
- Gain commitment for future participation in programs

Illinois

Upcoming Collaborative Meetings

- In-person meeting: O'Fallon, IL - June 4th
- In-person meeting: East Peoria, IL - June 5th
- In-person meeting: Oak Park, IL - June 11th
- Commercial Collaborative Update (by phone): Week of October 7th
- In-person Final Collaborative updates (both Residential and Commercial): Week of November 4th

Residential Field Study



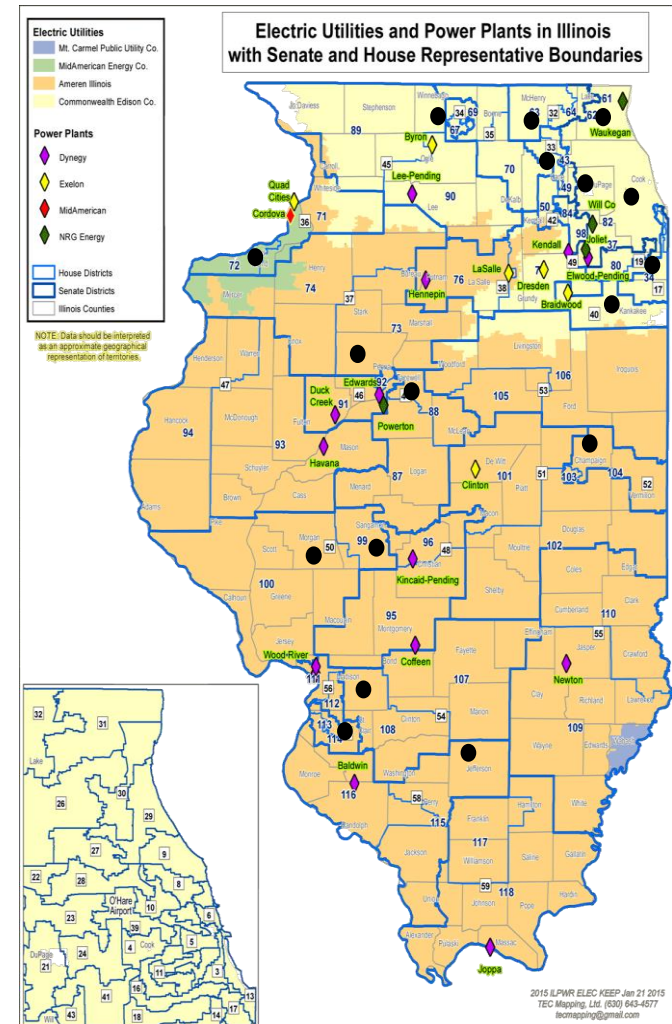
Residential Study

Background

- In 2014 the US Department of Energy funded 3-year **residential energy code studies** in eight states
- Study goals
 - Establish compliance baseline, and **calculate potential savings**
 - Determine if **focused training & support** can improve compliance
- **Statistically significant** results at state level
- Collected data will be **anonymous**

Illinois Residential Sampling Plan

County	Samples Needed
Adams	1
Champaign County	2
Clinton County	2
Cook County	11
DuPage County	3
Grundy County	1
Kane County	9
Kendall County	4
Lake County	5
Madison County	3
McHenry County	2
McLean County	1
Monroe County	1
Peoria County	1
Rock Island County	1
Sangamon County	1
St. Clair County	2
Will County	11
Williamson	1
Winnebago County	1



Residential Study

Data Collection Process

- DOE established a **data collection protocol**
 - Randomized Sampling Plan
 - Key Items Must be Observed
 - Minimum of 63 Observations of Each Key Item
 - Single Visit to a Given Home
- Survey teams spend about **4-6 months** collecting field data
- Collaborative will **provide feedback and guide** the project

Residential Study

Key Items

- **Envelope Tightness**
(ACH50)
- **Window Solar Heat Gain Coefficient**
- **Window U-factor**
- **Wall Insulation**
(R-value and Quality)
- **Ceiling Insulation**
(R-value and Quality)
- **Foundation Insulation**
(R-value and Quality)
- **High Efficacy Lighting**
- **Duct Leakage**
(CFM25)
- **Manual J Data**
(not a DOE key item)
- **Manual D Data**
(not a DOE key item)



Residential Survey

Progress To Date

- Survey team is currently **recruiting buildings** by contacting jurisdictions and scheduling site visits
- **Currently in the field** as of late September 2018
- Targeting data collection completion for ~**June 2019** *



Residential Study

**Data Collection Progress*

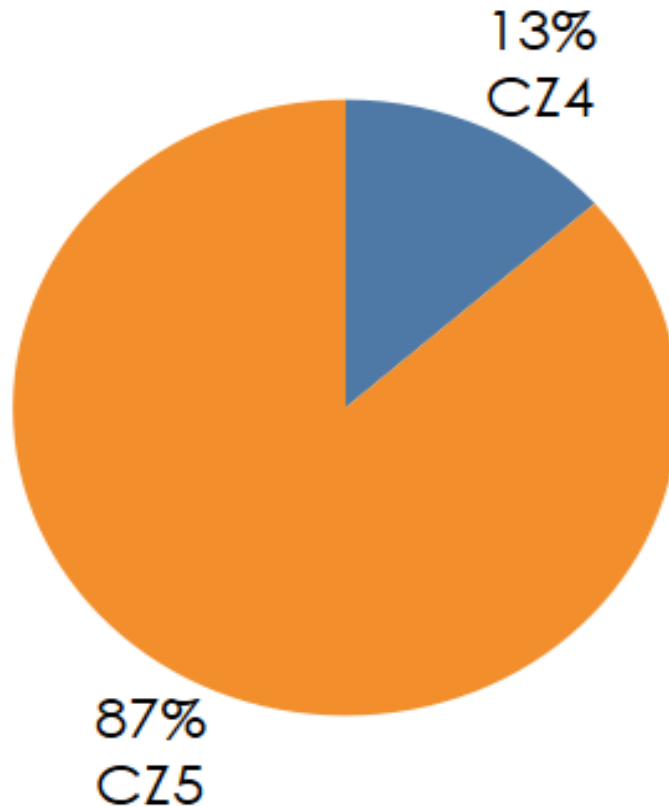
- Target Data Collection Date was end of May
- Late start overall (contracts were signed later than anticipated)
- Weather has caused extensive delays (snow, rain, flooding)
- Recruitment has been positive all across the state but homes are not at the right stage
- Slowed construction is a trend across Illinois in 2019
- Manual D home recruitment has been challenging

Residential Study

Trends based on available data

susceptible to change

Climate Zone

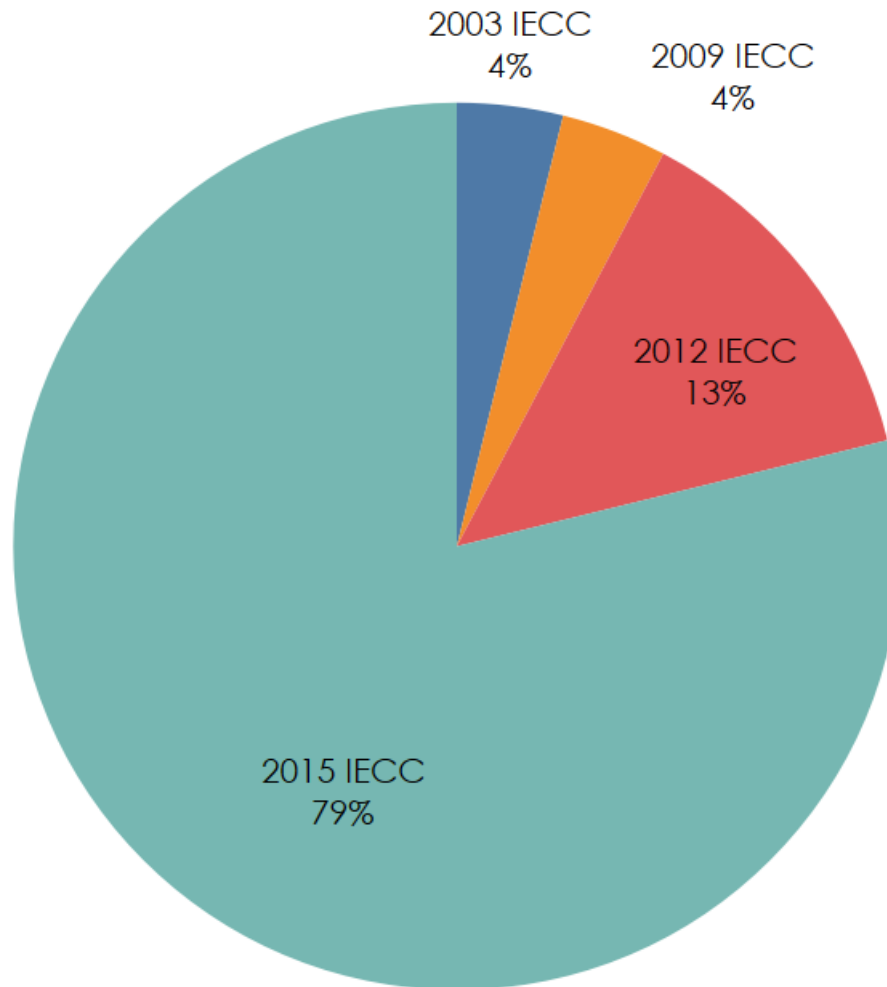


44% data collection has been completed till date.

Residential Study

Trends based on available data

susceptible to change

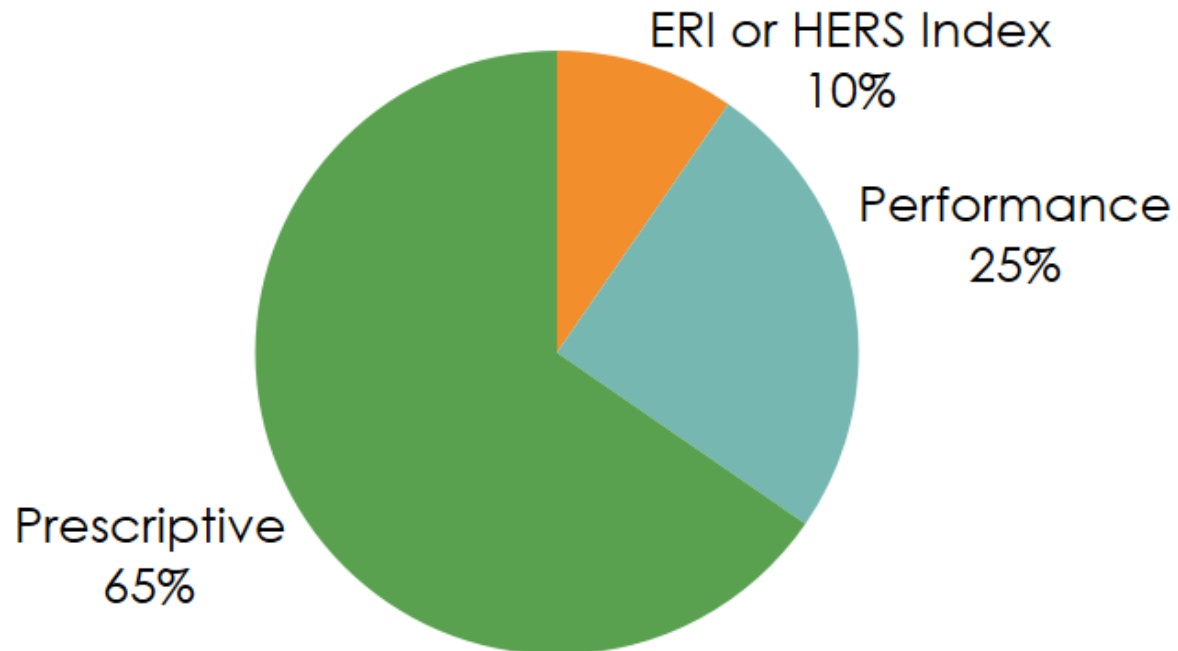


Residential Study

Trends based on available data

susceptible to change

Compliance Path

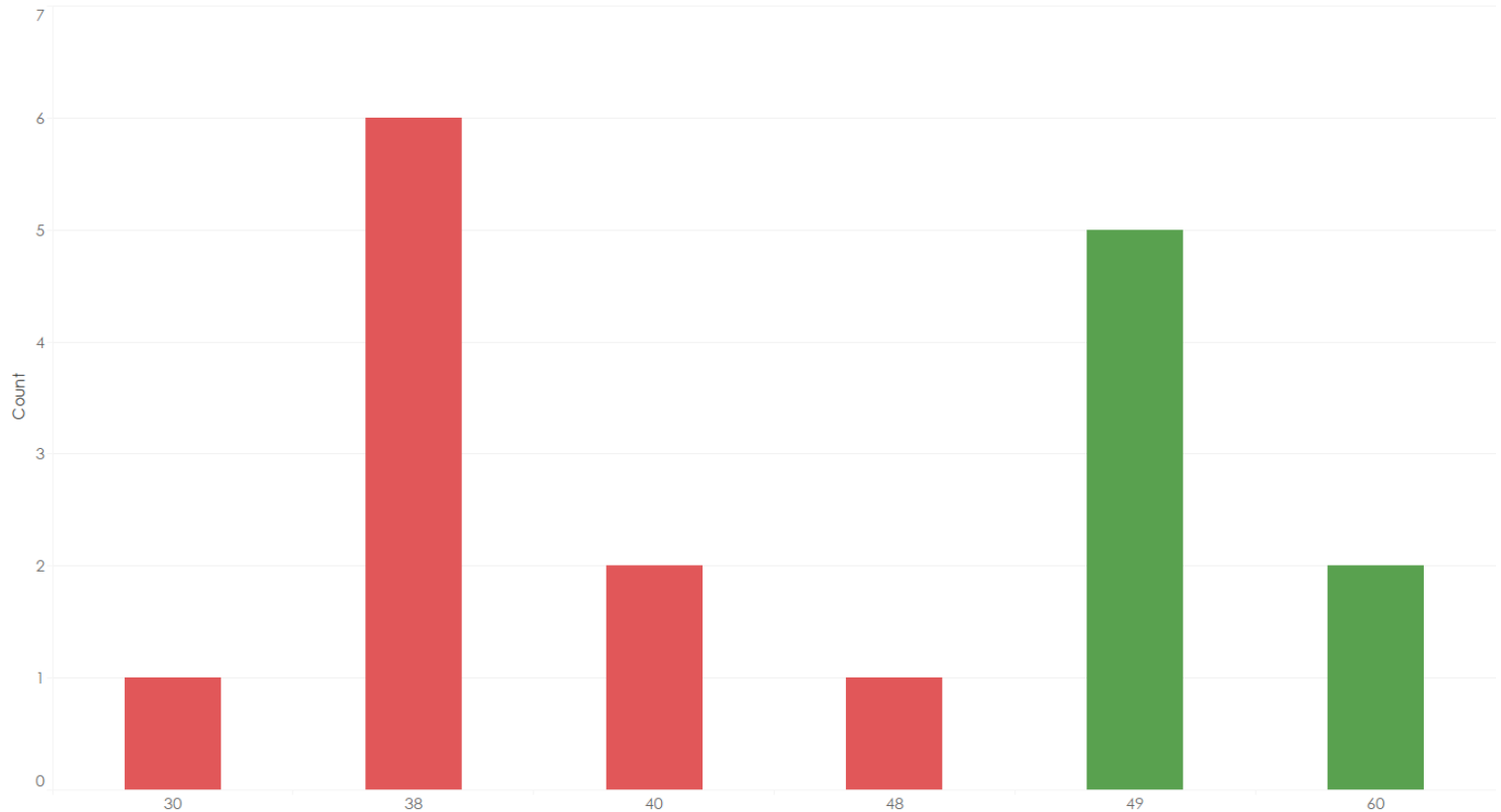


Residential Study

Trends based on available data

susceptible to change

Ceiling Insulation R-Value



Ceiling Insulation R Value Legend

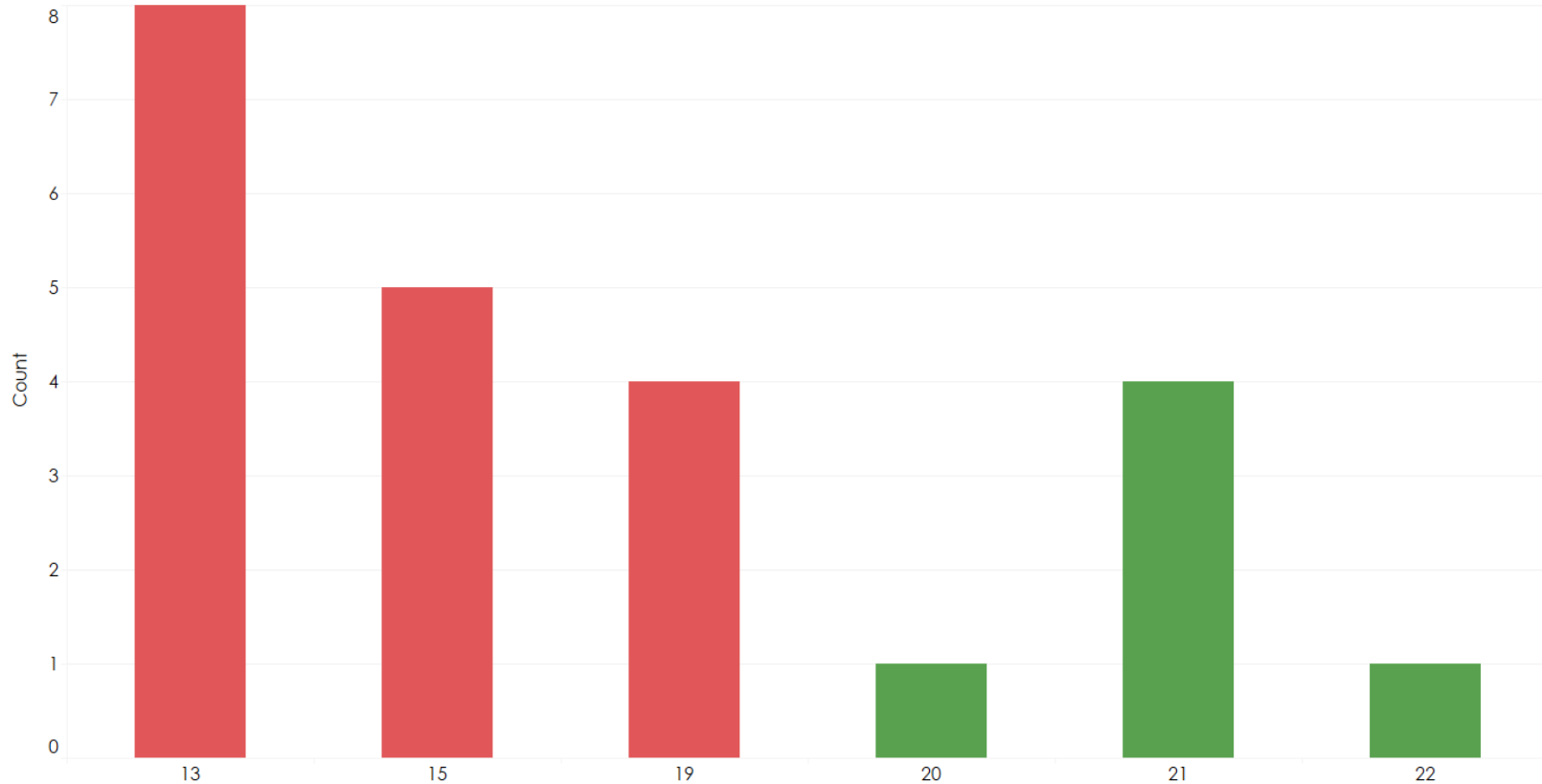
- Compliant
- Non-Compliant

Residential Study

Trends based on available data

susceptible to change

Framed Wall Cavity Insulation R-Value



Frame Wall Cavity Insulation R value Legend

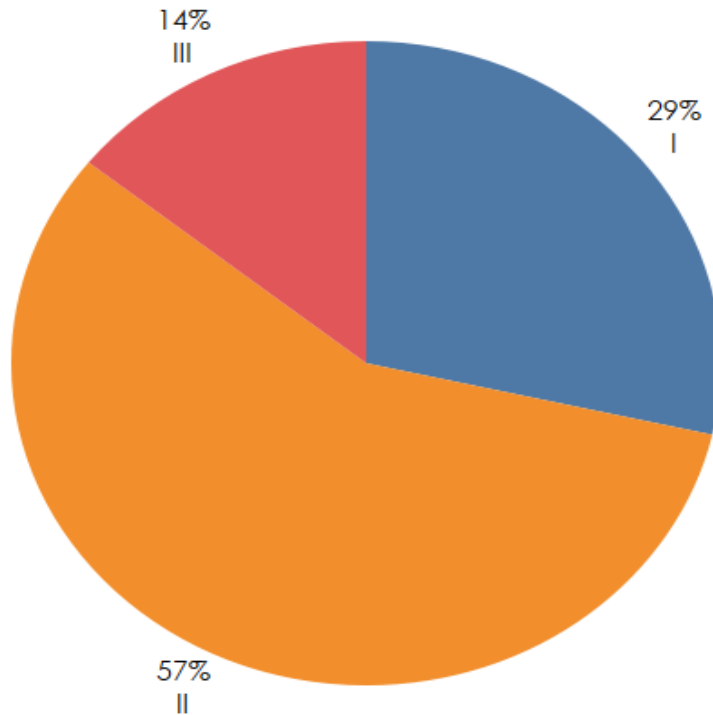
- Compliant
- Non-Compliant

Residential Study

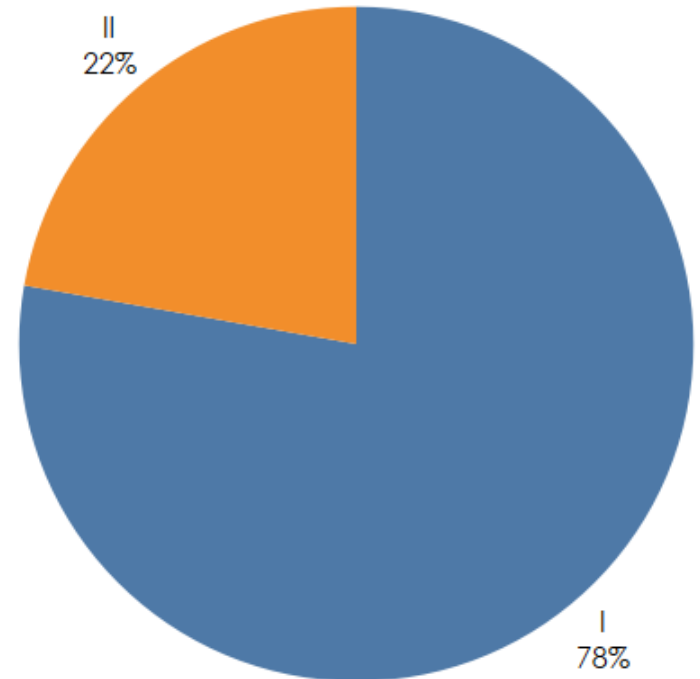
Trends based on available data

susceptible to change

Knee Wall Insulation Quality



Basement Wall Insulation Quality

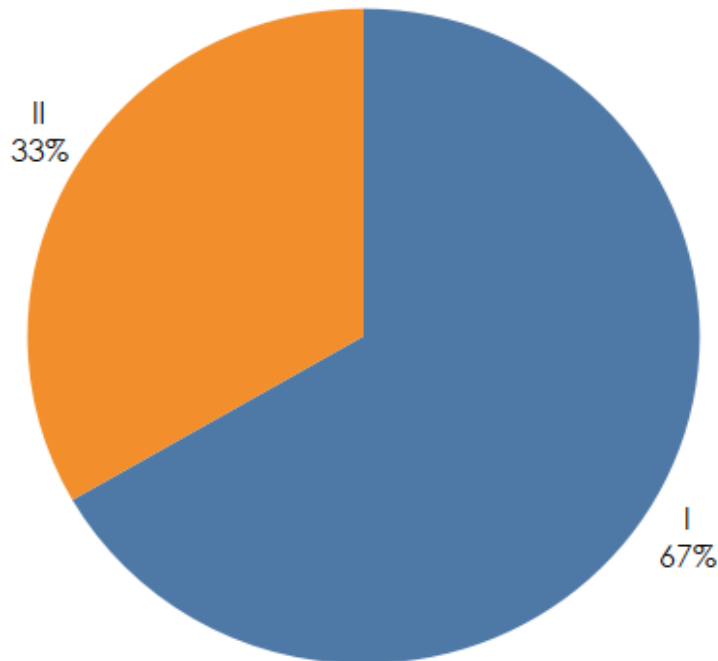


Residential Study

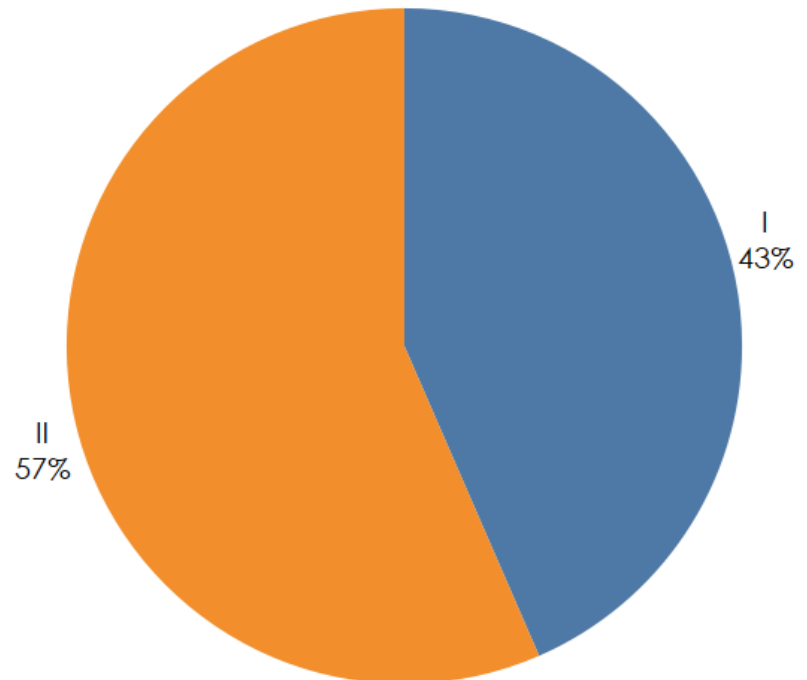
Trends based on available data

susceptible to change

Roof Cavity Insulation Quality



Framed Wall Insulation Quality

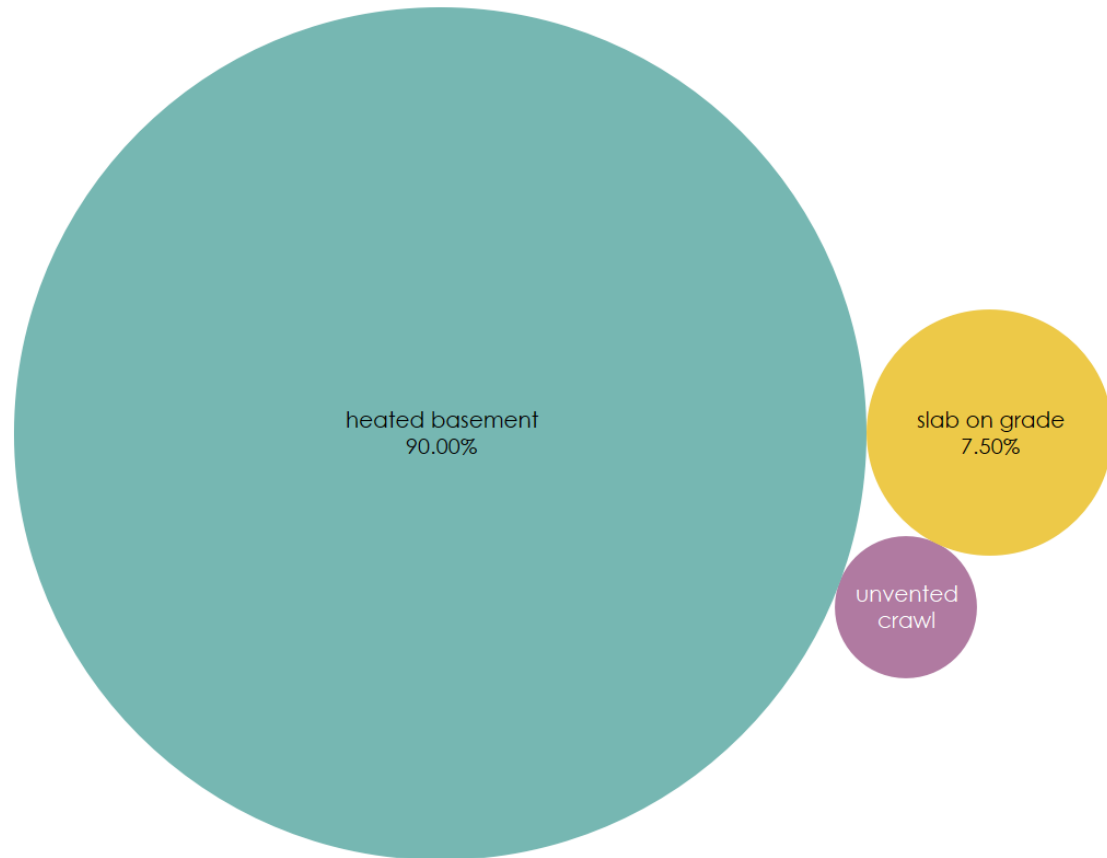


Residential Study

Trends based on available data

susceptible to change

Predominant Foundation Type



Residential Study

Trends based on available data

susceptible to change

Glazed Fenestration SHGC Value



Residential Study

Trends based on available data
susceptible to change

Window NFRC Rated U factor



Window U Factor Legend

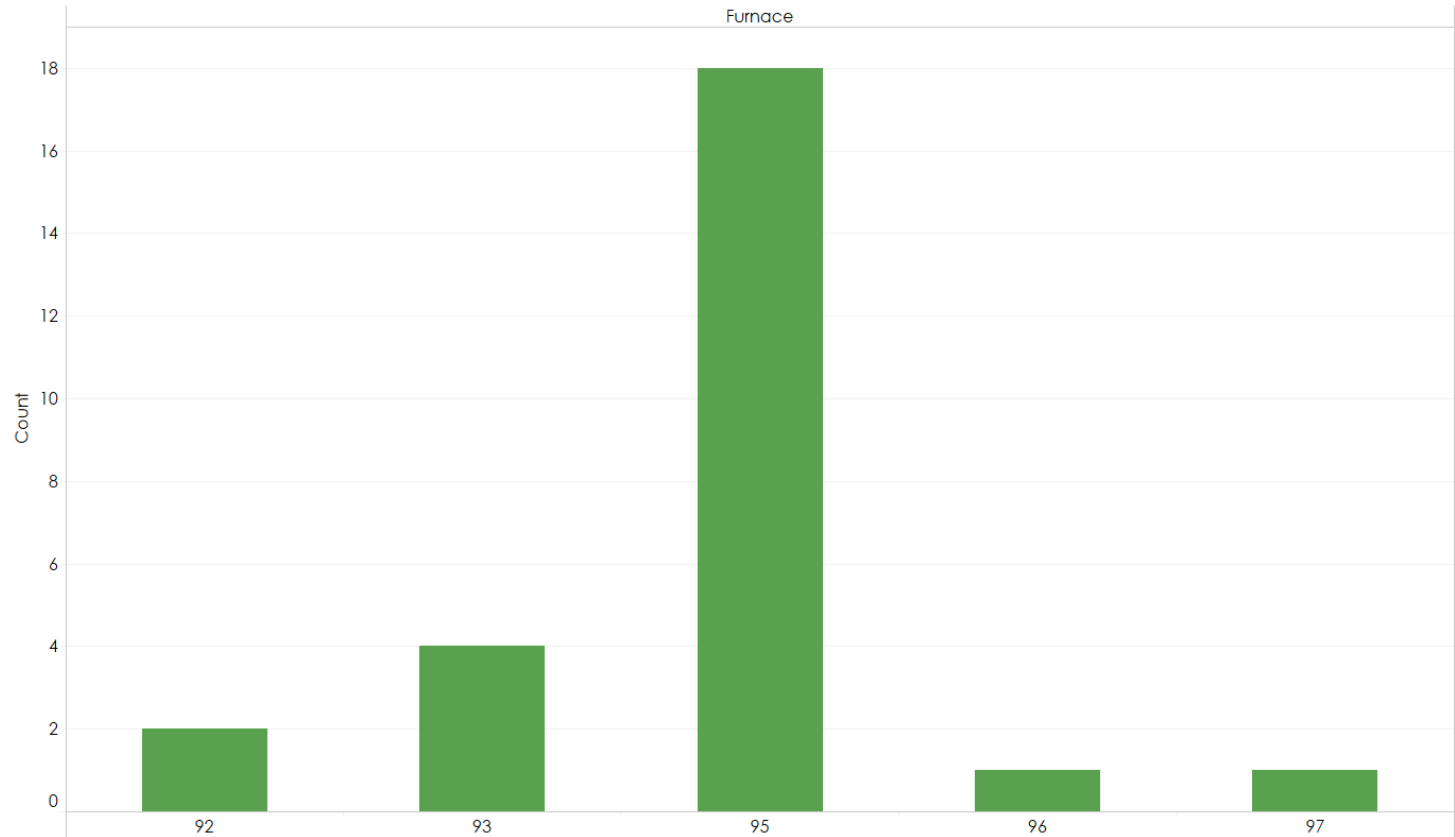
- Compliant
- Non-Compliant

Residential Study

Trends based on available data

susceptible to change

Heating System Efficiency %



Heating System Efficiency Legend

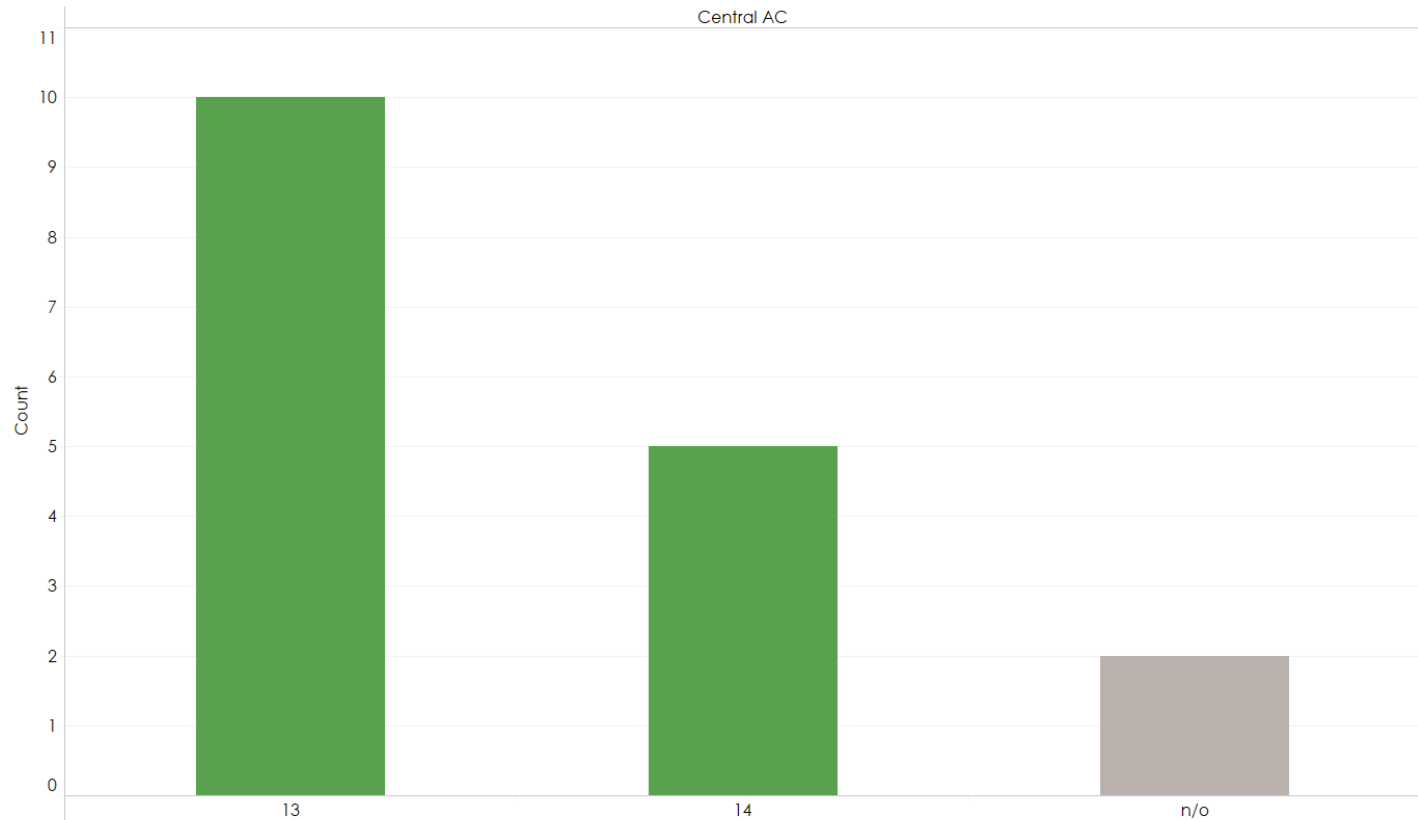
■ Compliant

Residential Study

Trends based on available data

susceptible to change

Cooling System Efficiency (SEER)



Cooling system efficiency Legend

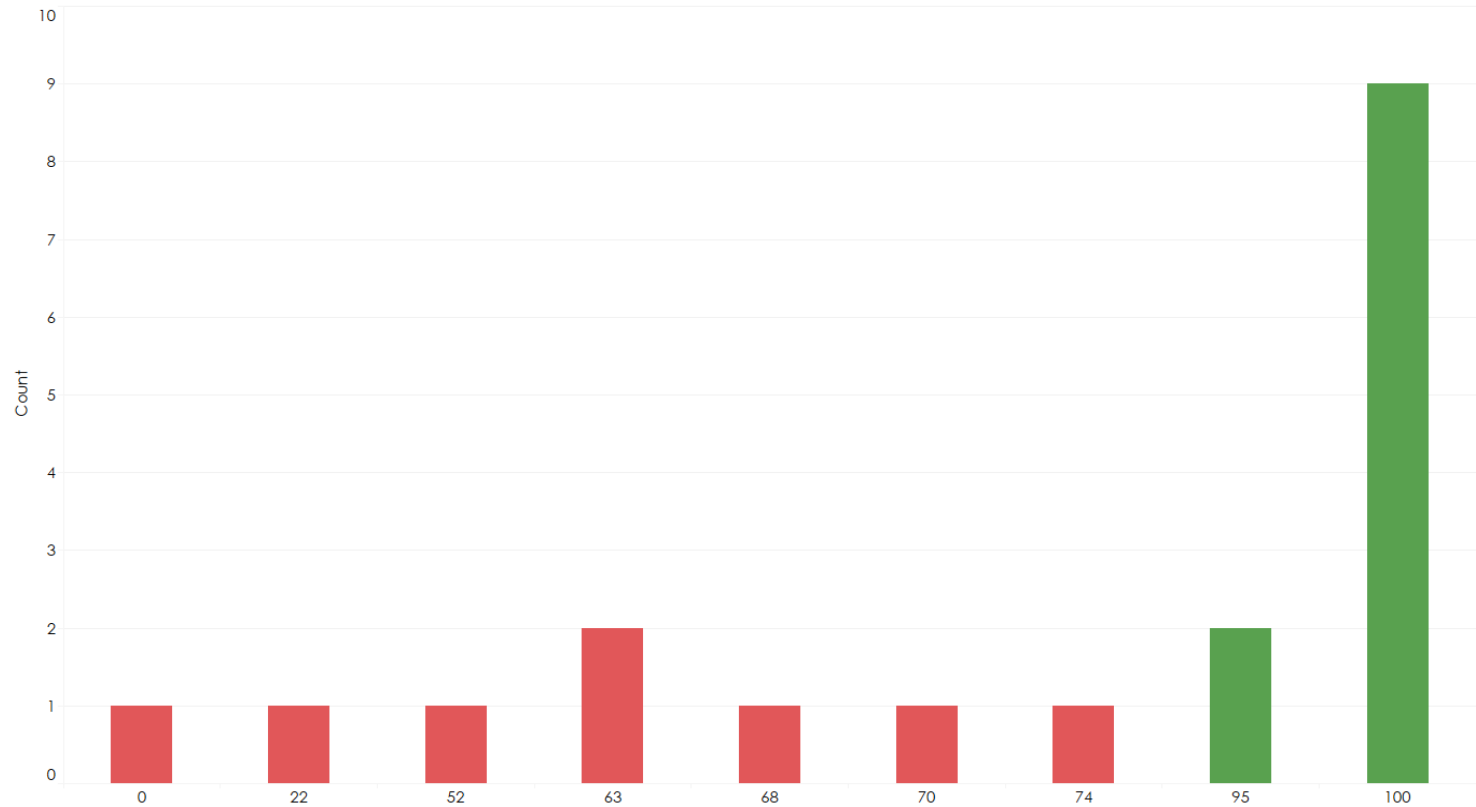
- n/o
- Compliant

Residential Study

Trends based on available data

susceptible to change

% Fixtures with High-Efficiency Lamps



% Fixture with high efficiency lamps Legend

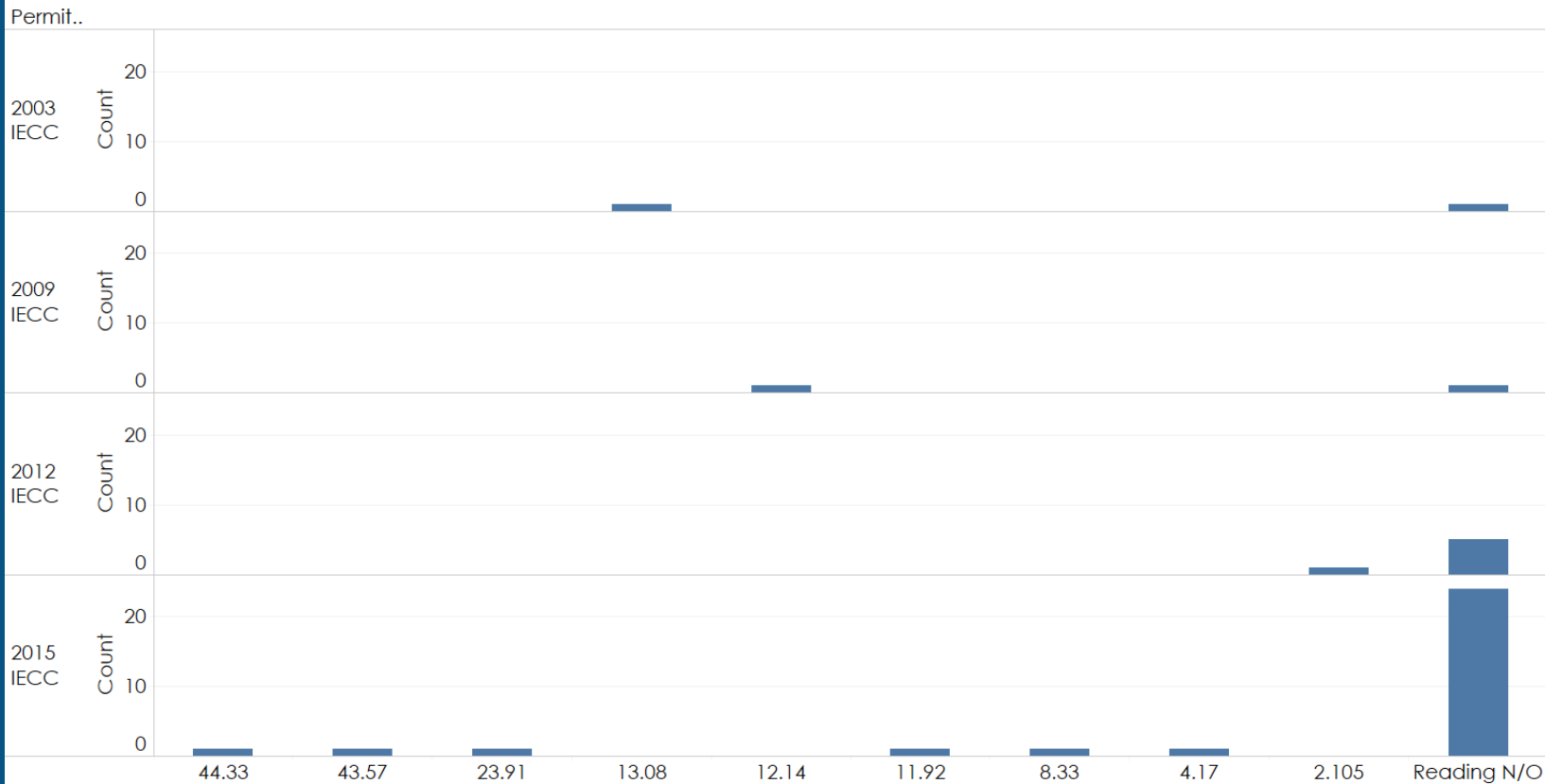
- Compliant
- Non-Compliant

Residential Study

Trends based on available data

susceptible to change

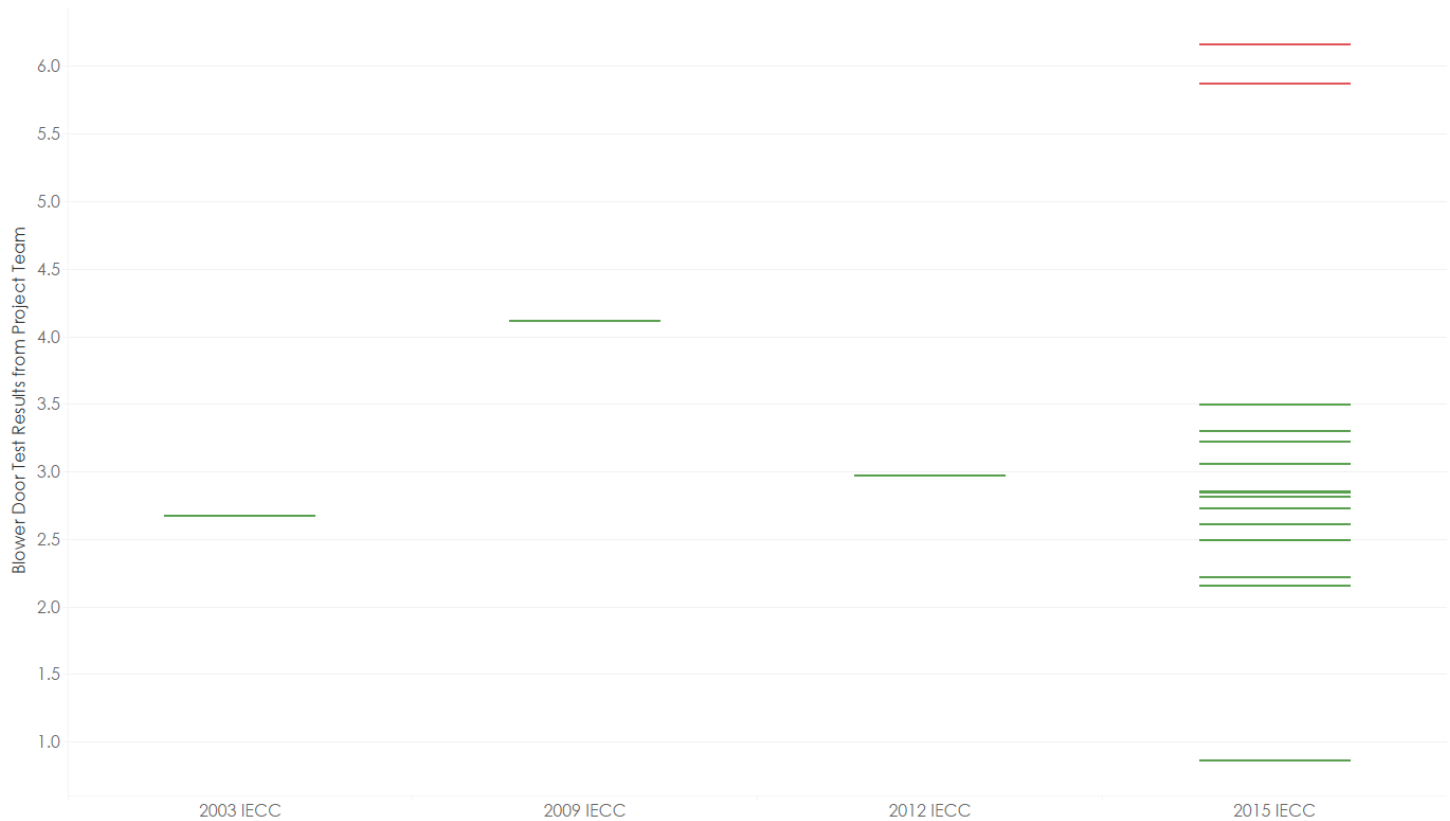
Duct Tightness Test Result (CFM 25/100ft2)



Residential Study

Trends based on available data
susceptible to change

Blower Door Test Result (ACH)



Blower Door Test Result Legend
■ Compliant
■ Non-Compliant

Summary of Residential Trends

Could change with more data

- Blower door rates are compliant with 2015 and 2018 IECC – but are all builders testing?
- Lighting compliance is good
- Ceiling, frame wall cavity insulation high noncompliance
- Quality and installation of insulation can improve
- Performance path utilized more than anticipated
- Some jurisdictions not enforcing the current state code at all

Summary of Residential Trends

Could change with more data

- Window U-factor and Glazed fenestration SHGC is compliant
- Duct systems are leaky
- Heated basements are not insulated properly

Commercial Field Study



Commercial Survey

Overview

- Similar to the residential study, the commercial study will **survey high impact measures** and analyze the results
- Unlike the residential survey, the commercial survey is **not intended** to achieve the “statistical significance” label
 - **Too much variation** in use types and size to cost effectively survey
- Will survey 40-45 of the **most common** building use types
- Analysis is designed to identify **measure-level savings opportunities**

Illinois Commercial Sampling Plan

Proposed Commercial Building Distribution

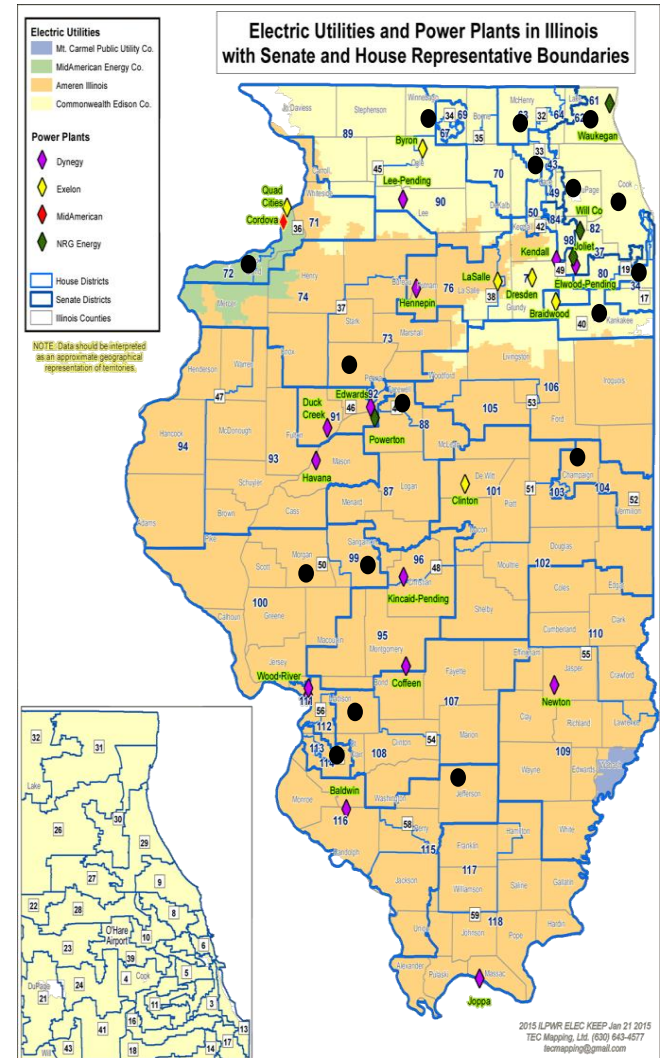
Building Type	Small	Medium	Large	Total
Education	3	3	3	9
Multifamily	3	3	3	9
Office	3	3	3	9
Retail	3	3	3	9
Other	1	2	1	4
Total	13	14	13	40

Proposed Commercial Building Size

Category	Size Range (sq.ft.)
Small	<25,000
Medium	25,000 - 60,000
Large	60,001 - 250,000
X-Large	250,001 - 500,000
XX-Large	>500,000

Illinois Commercial Sampling Plan

County	Sample Count
Cook	8
Lake	3
Sangamon	2
DuPage	4
Will	3
Winnebago	3
Rock Island	1
McHenry	2
Saint Clair	2
Kankakee	2
Kane	4
Madison	2
Champaign	2
Morgan	2
Tazewell	2
Peoria	2
Jefferson	1



Commercial Study

Data Collection

- Review Building Plans and Specs
 - Record values for ~35 key items
- Identify Compliance Path
- Collect Field Data
 - Building Insulation and Fenestration
 - Mechanical System and Controls
 - Lighting and Controls
- Blower door tests for smaller buildings (< 4,000 sf)



Commercial Study Process

Identify and Recruit Buildings

Obtain Permitting Data and Plans

Conduct Site Visits

Analyze Building- and Measure-
level Energy Impacts

Aggregate Results to Population

Commercial Study

Energy Impact Analysis

1

- Rely on DOE code-compliant prototype building EnergyPlus models to manage level of effort

2

- Simulate prototype building using as-built characteristics to estimate total energy impact

3

- Simulate prototype building with each key measure as-built to estimate measure energy impact

4

- Combine and weight building results to estimate population impacts

Commercial Study

Key Items

Items:

- Building Plans
- Compliance Path
- Building Insulation and Fenestration
- Mechanical system and controls
- Lighting and controls

Commercial Study

Multifamily

- **Only high-rise** multifamily will be included in commercial study
 - Low-rise is being covered by DOE study led by EcoTope and Seventhwave
- Will consider multifamily building **utility programs**

Commercial Survey

Work to Date

- Sampling plan has been finalized
- Finalized key items and energy analysis strategy
- Recruitment has been extremely positive
- Survey team to be in the field last week of May 2019
 - 17 buildings recruited so far
 - Complete data collection ~October 2019



Commercial Survey

Other Studies

- DOE Study
 - Baseline study looking at **Office and Retail Buildings**
 - Climate zones 3A and **5A**
 - Currently in NE and IA, but **IL survey likely**

Commercial Recruitment

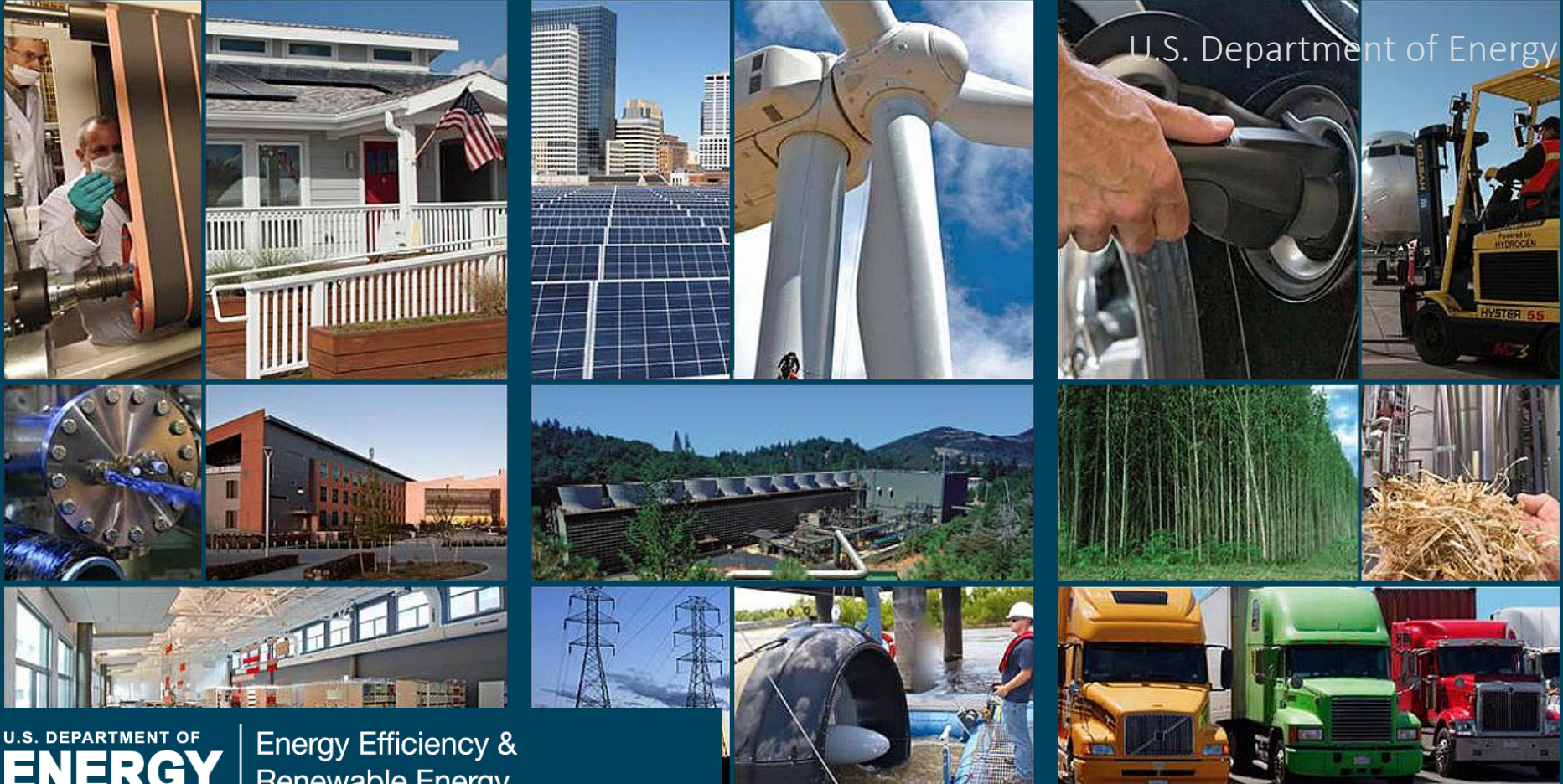
Process and Summary

- Our team made at least a single call and reached out to about 240 project owners, contractors, architects, engineers in Illinois to make direct contact with them.
- Created 17 leads
- Some people were interested but did not have anything within project time frame or have declined participation.
- Currently our team focused on Northeast IL for recruitment, will approach other jurisdictions soon

US DOE Field Studies



BUILDING TECHNOLOGIES OFFICE



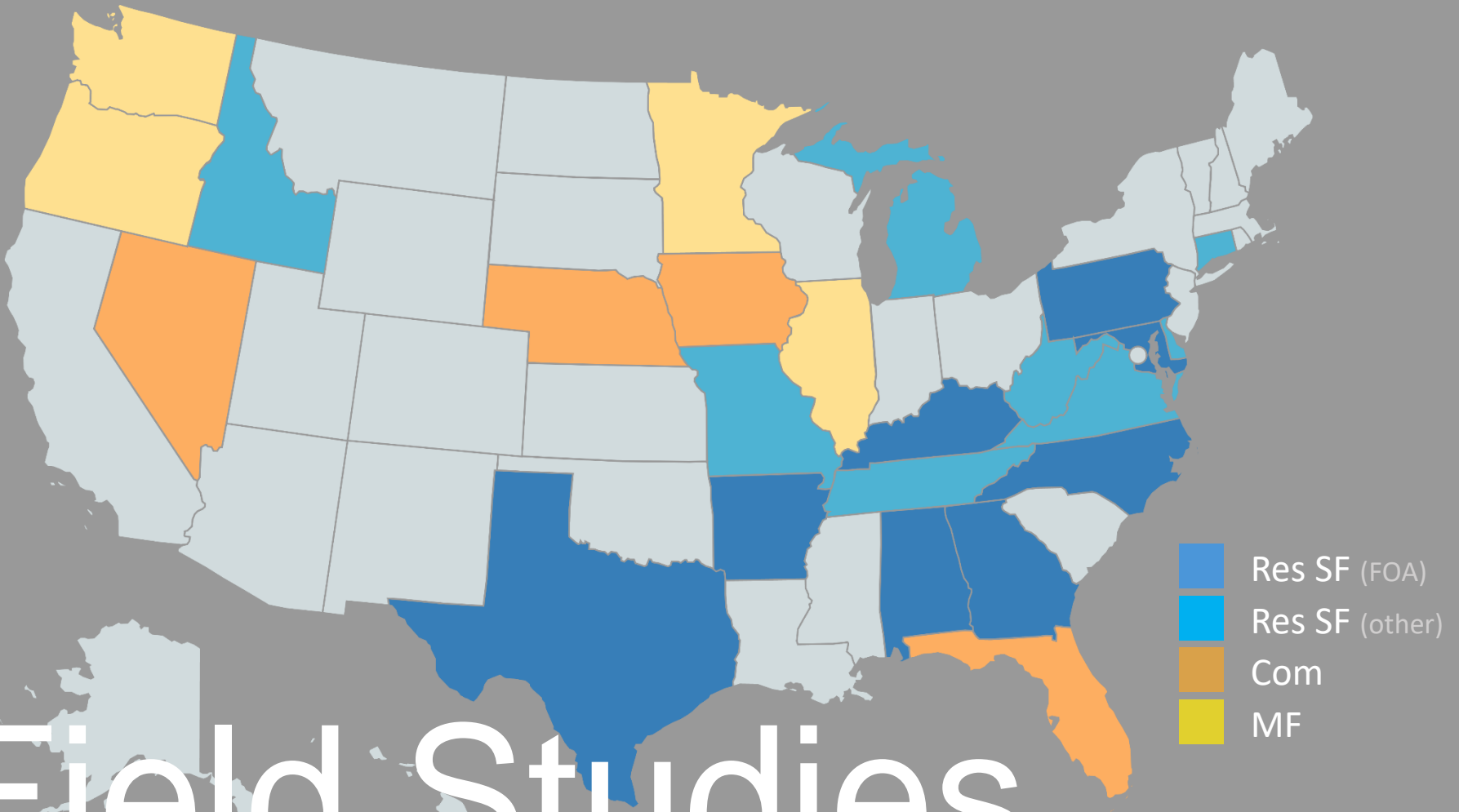
U.S. Department of Energy

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

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ENERGY

Energy Efficiency &
Renewable Energy



Field Studies

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

Key Items	TX**	AL	GA	AR	NC	KY	MD**	PA	Heat Map
Climate Zone***	2	2,3	2,3,4	3,4	3,4	4	4	4,5	Red=bad Green=good
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 $U\text{-factor}=0.35$ regardless of CZ (similar trend for SHGC)

Lighting: No consistent trend—surprisingly low compliance

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)

Discussion

Summary of Residential Trends

Could change with more data

- Blower door rates are compliant with 2015 and 2018 IECC – but are all builders testing?
- Lighting compliance is good
- Ceiling, frame wall cavity insulation high noncompliance
- Quality and installation of insulation can improve
- Performance path utilized more than anticipated
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Summary of Residential Trends

Could change with more data

- Window U-factor and Glazed fenestration SHGC is compliant
- Duct systems are leaky
- Heated basements are not insulated properly

Benefits

Why utilities are interested in energy codes

- **Short term**
 - Portfolio savings
 - Less low-hanging fruit
- **Long term**
 - Ever-accruing demand savings
 - Less stress on the grid
 - Better buildings
 - Opportunity to engage customers in a new way

Residential Study

KY Measure-Level Analysis

Measure	Phase I Non-Compliance	Phase III Non-Compliance	Percentage Point Improvement
Envelope Air Leakage	32%	2%	+30
Ceiling Insulation (quality)	58%	40%	+18
Exterior Wall Insulation (quality)	66%	58%	+8
Foundation Insulation (R-value)	19%	30%	-11
Foundation Insulation (quality)	86%	76%	+10
High Efficacy Lighting	67%	60%	+7
Duct Leakage (conditioned space)	80%	65%	+15
Duct Leakage (unconditioned space)	32%	39%	-7

KY Residential Study – Results

Phase I

Phase III

Measure	Total Energy Savings (MMBtu)	Total Energy Cost Savings (\$)	Total State Emissions Reduction (MT CO2e)	Total Energy Savings (MMBtu)	Total Energy Cost Savings (\$)	Total State Emissions Reduction (MT CO2e)
Envelope Air Leakage	27,182	484,314	3,092	581	\$10,321	65
Ceiling Insulation	11,372	215,656	1,080	4,835	\$91,786	595
Exterior Wall Insulation	9,277	171,044	1,102	8243	\$151,974	976
Foundation Insulation	6,800	108,156	668	11,676	\$178,905	1,075
Lighting	5,742	197,544	1,427	4,454	\$153,383	1,130
Duct Leakage	2,135	43,142	284	17,151	\$342,217	2,251
TOTAL	62,508	\$1,219,856	7,653	46,941	\$928,585	6,093
SAVINGS				25%	24%	20%

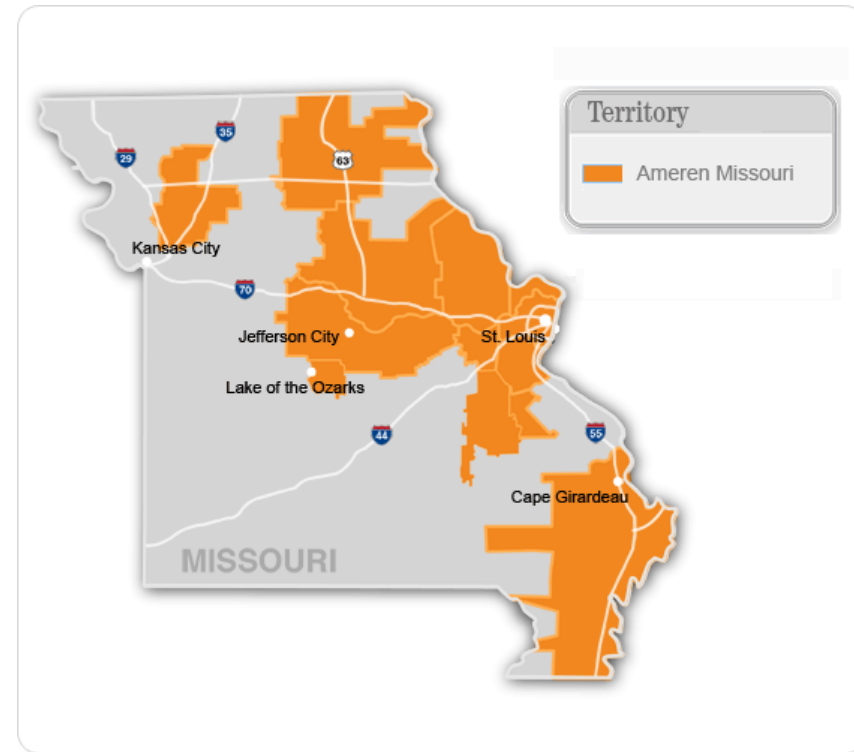
*Based on 7,345 annual new homes

Utility Programs Underway

Energy Code Compliance

Missouri

- Funded by Ameren MO; Missouri Energy Efficiency Investment Act (MEEIA)
- Ameren MO territory
- Residential baseline study completed
- Residential Compliance Program 2019
- Collaborative
- Homerule state; no statewide code





Additional Thoughts?

Questions?

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