



UTAH
ENERGY
CODE

Getting up to Code

Energy Talks with Brent Ursenbach

DOE Compliance Study – October 13, 2022

Supporting Utah Energy Code Training



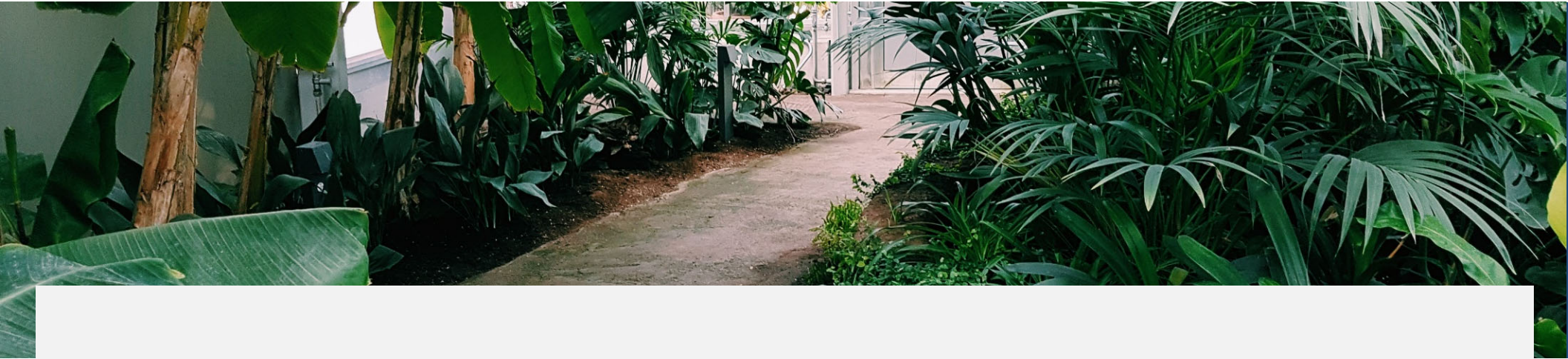
———— UTAH OFFICE OF ————
ENERGY DEVELOPMENT

DOE Residential Codes Field Study: Results and Training Plan



Updated October 13, 2022

Agenda



Introductions, Project Overview and Updates

Data Analysis Results

Discuss Education and Training Phase

Project Team

Project Management

- Jake Duncan, Institute for Market Transformation

Field Team

- Katy Milliken, Nexant
- Chris Anjewierden, Nexant
- Troy Preslar, Building Science West

Advisory

- Kevin Emerson, UT Clean Energy
- Jim Meyers, SWEEP

Education and Training

- Brent Ursenbach, West Cost Codes Consultants

Additional Support

- Pacific Northwest National Laboratory
- Department of Energy
- Rocky Mountain Power
- Dominion Energy



Project Overview and Updates

Goals of the Field Study



Collect field data to generate baseline compliance rate across two states (Arizona and Utah)



Develop targeted education programs to address key measures that will result in the largest savings



Reminder: **Key Measures**

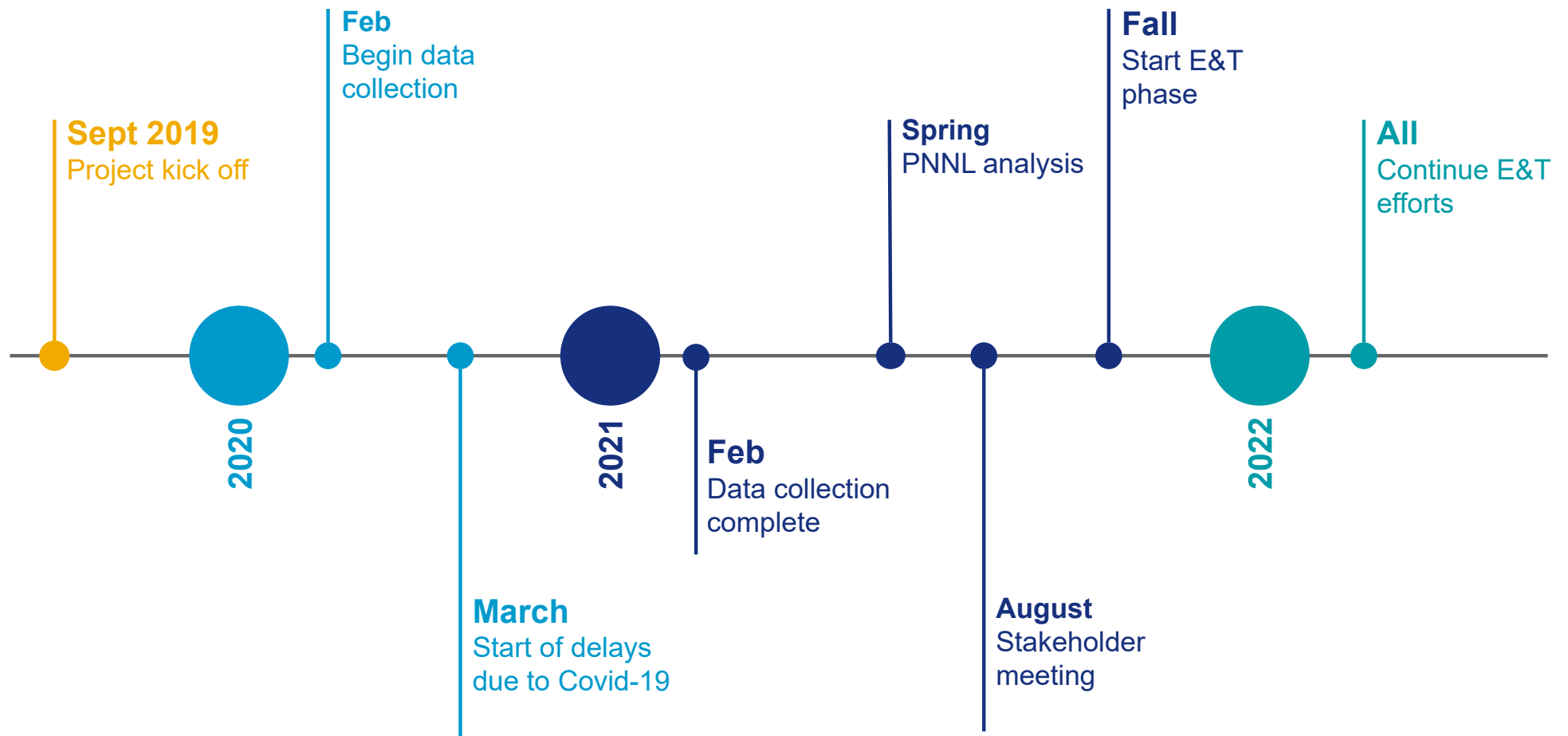
1. Envelope tightness
2. Windows (U-factor and SHGC)
3. Wall insulation
4. Ceiling insulation
5. Lighting
6. Foundation insulation
7. Duct tightness

Location	Count
Herriman, Salt Lake County	7
Lehi, Utah County	3
St. George, Washington County	5
South Jordan, Salt Lake County	3
Eagle Mountain, Utah County	3
Saratoga Springs, Utah County	3
Vineyard town, Utah County	2
Washington, Washington County	2
Bluffdale, Salt Lake County	1
West Jordan, Salt Lake County	3
Hurricane, Washington County	2
Cache County Unincorporated Area, Cache County	1
Wasatch County Unincorporated Area	
Spanish Fork, Utah County	2
Syracuse, Davis County	1
American Fork, Utah County	2
Orem, Utah County	4
Riverton, Salt Lake County	1
Cedar City, Iron County	1
Heber, Wasatch County	1
Kaysville, Davis County	1
Mapleton, Utah County	1
Ivins, Washington County	1
North Ogden, Weber County	2
Clinton, Davis County	1
Plain City, Weber County	1
Roy, Weber County	
Pleasant Grove, Utah County	1
Salem, Utah County	1
Tremonton, Box Elder County	1
Hyrum, Cache County	
Pleasant View, Weber County	1
Hooper, Weber County	1
Ogden, Weber County	1
Park City, Summit County	1
Enoch, Iron County	1
Nibley, Cache County	1
Total	63

Reminder: Sampling Plan

- Generated based on stakeholder input to reflect dispersion of construction activity while considering geography, climate, and demographics
- At least 63 total observations per each key item = 126 sites visited
- Construction sites selected randomly using building permit data, and only one visit per site
- No personally identifiable information shared with DOE or PNNL

Project Timeline





Measure Level Results

Observed Code Distribution

Year	Code	Sample Count	Sample Percent
2015	IECC Utah	84	65%
2015	IECC	46	35%
Total		130	100%

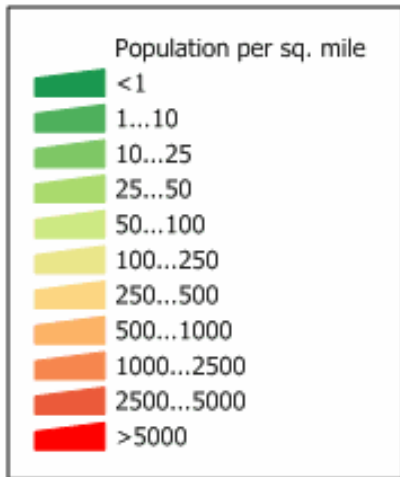
We used the IECC 2015 amended Utah Code as the baseline for the analysis.

Site Participation in Utility EE Programs

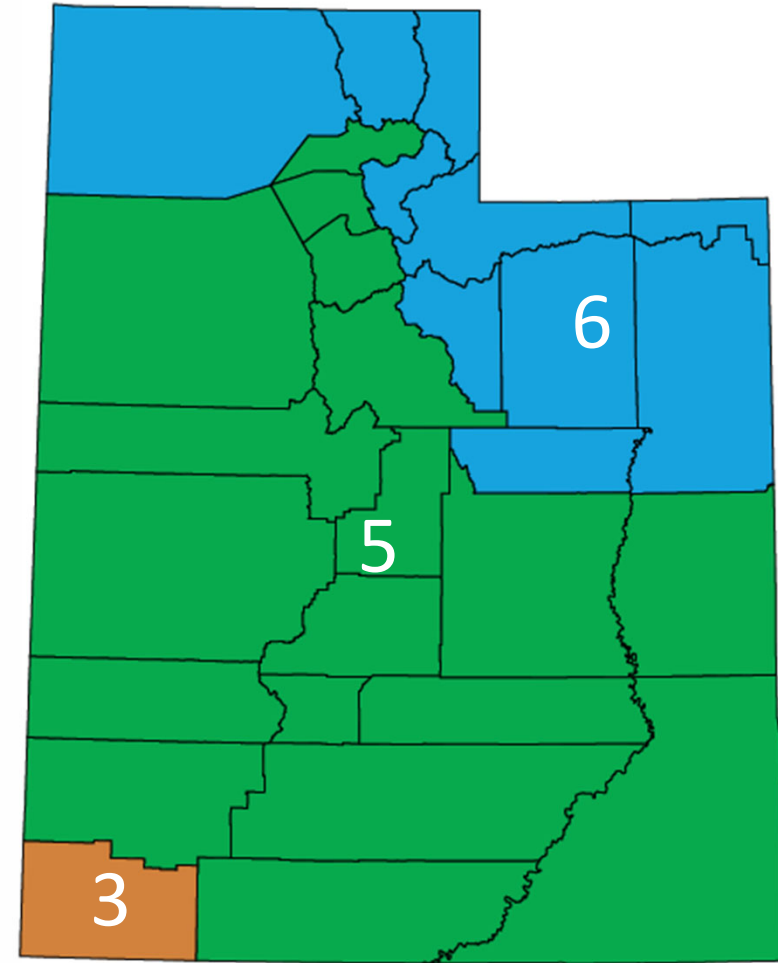
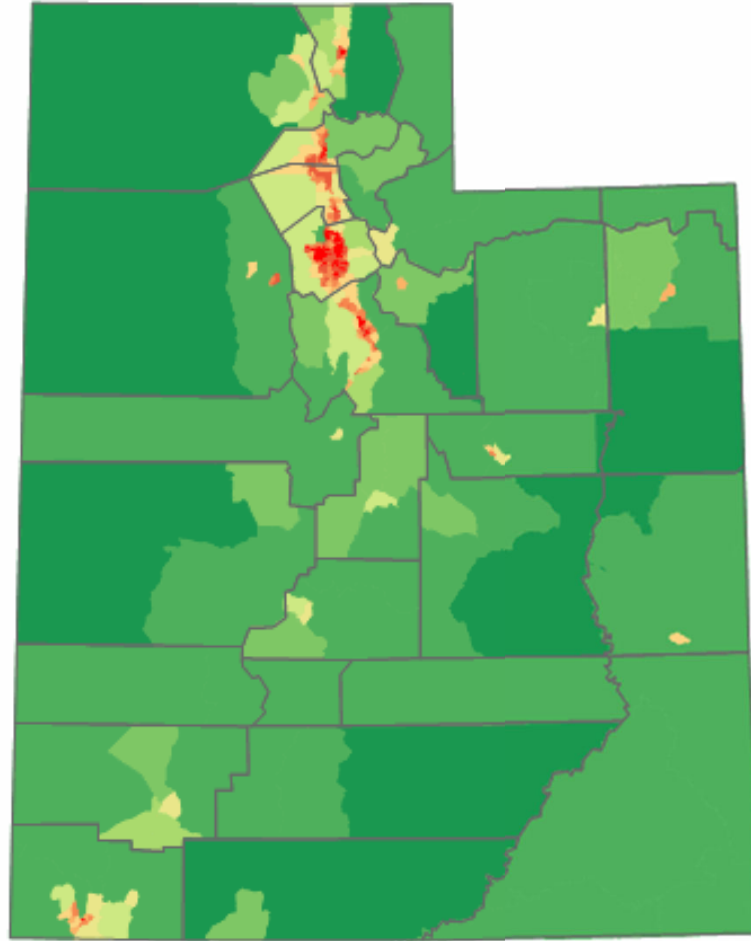
Category	Number	Percent
Sites participating in at least one program	73	57%
Sites participating in gas programs	55	43%
Sites participating in electric programs	45	35%
Sites participating in both gas and electric programs	27	21%
Sites receiving a whole-home performance incentive	26	20%

- High participation in EE programs
- Is this representative or does this bias the results?

Climate Zones and Population Density



Source: U. S. Census Bureau
Census 2000 Summary File 1
population by census tract.

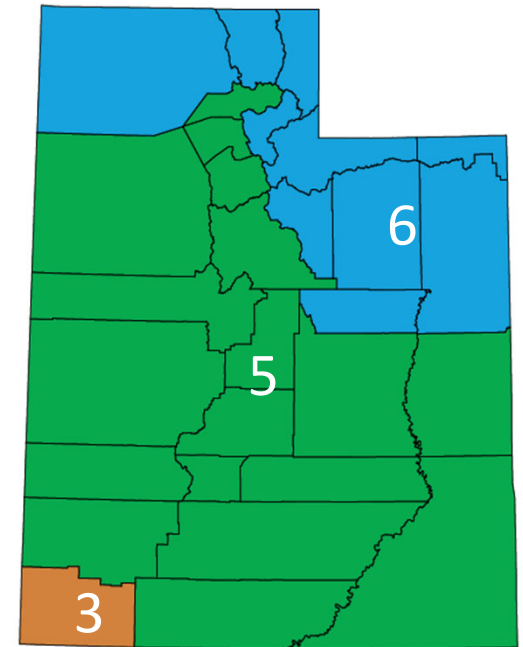


Statewide Savings Potential of \$1.3 Million Annually

Measure	Elec Savings kWh/yr-home	Gas Savings therms/yr-home	Total Energy Savings (MMBtu)	Total Energy Cost Savings (\$)
Exterior Wall Insulation	121	29	59,000	\$620,000
Duct Leakage	49	11	23,000	\$241,000
Heated Basement Wall Insulation	-62	21	30,000	\$164,000
Ceiling Insulation	22	4	9,000	\$99,000
Envelope Air Leakage	4	5	9,000	\$76,000
Window U-Factor	0	4	6,800	\$53,000
Window SHGC	35	0	179	\$46,000
High Efficacy Lighting	6	0	219	\$10,000

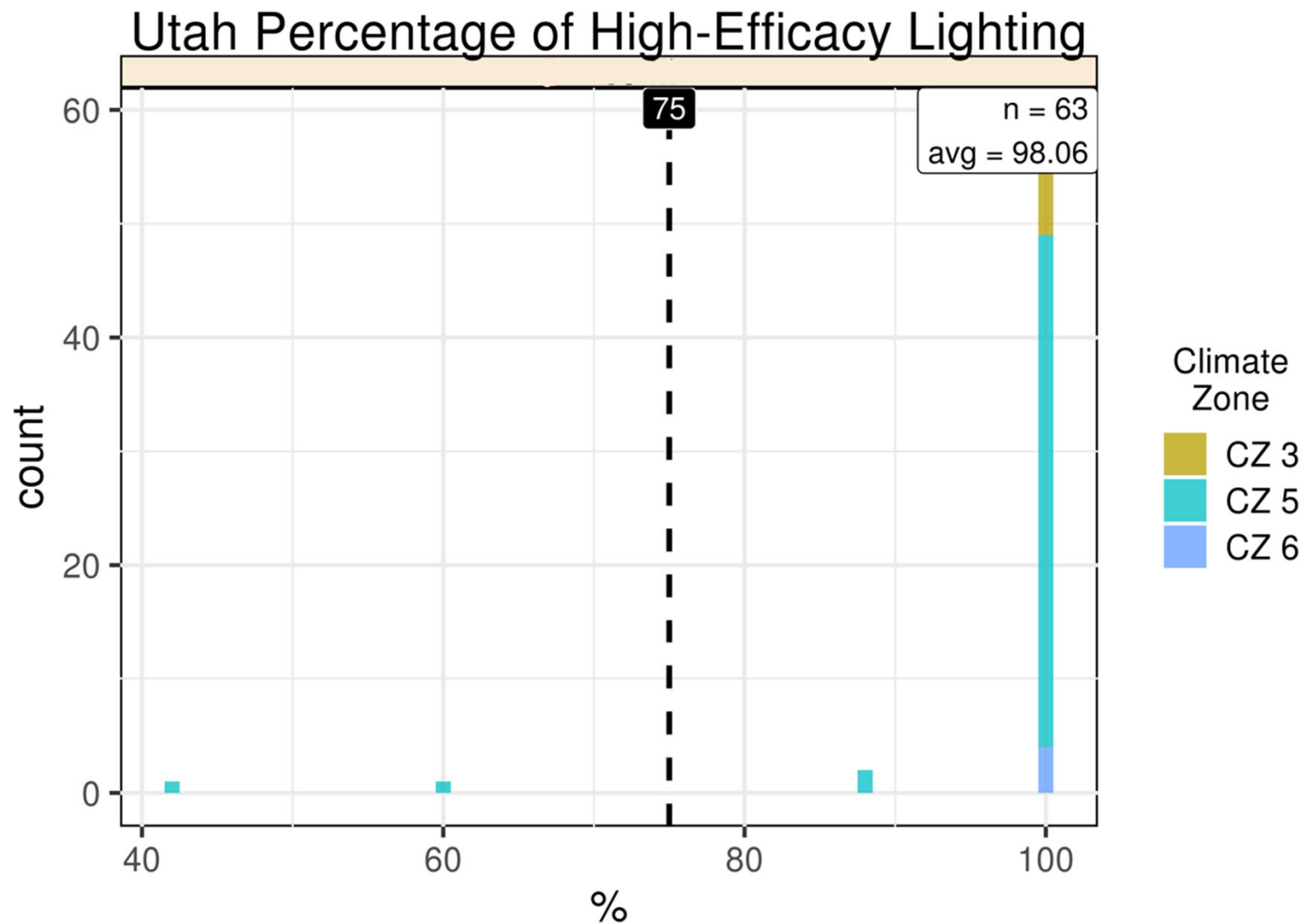
Key takeaways

- Field Study Measures are envelope focused
 - HVAC systems, ventilation efficiency, others, not measured
- Exterior wall insulation and duct leakage are responsible for ~70% total savings potential
- Off the shelf key measures (windows and lighting) are highly compliant, while skilled installation-based measures (wall insulation and duct tightness) have room for improvement.
- Air Leakage is quite low, generally across all Climate Zones
 - **Raises a mechanical ventilation concern**
- Ceiling/Attic insulation generally close to compliant
 - Trade-offs may result in compliance
- Basement wall R-12 average R-value fails to comply (R-15 CI)
 - Trade-offs



Key Measures

1. Envelope tightness
2. Windows U-factor
3. Windows SHGC
4. Wall insulation
5. Ceiling insulation
6. Lighting
7. Foundation insulation
8. Duct tightness



Left of the dotted line is **below code**

Right of the dotted lined is **above code**

*There may be multiple dotted lines, reflecting different CZ standards



Draft Training Plan

Targeted Training

2. Design Professionals

1. Building Officials

- Plans Examiners, Inspectors

3. Home Builders

4. Sub-Contractors

- Skilled Workers, Tradespersons
- Insulation Installers, HVAC, Crew Leaders, Superintendents

5. Suppliers

6. Others?



Current Plan (Previous to this Study)

Training Goals - based on Training, Requests, Hundreds of Questions, Observations in the Field

Current amended code for 5 + years, 2 to go?

- Progress made but room for improvement
- Focus on compliance with current codes

Level of enforcement

- Uniform level of enforcement across the state

Construction Documents

- Compliance Option
- Compliance begins with Plan Review
 - Simple with complete plans – Design Professionals
- Load Calculations



Comments

Field Study Based on the two available REScheck and the Prescriptive Table

- Many would pass if Trade-off and Modeling Option used

Exterior Walls

- Utah amendments allow a weak wall
 - Equipment trade-off – Utah 2012 REScheck

Option to Blower Door Test or Air Barrier Insulation Checklist

- Mechanical Ventilation is not Triggered without a Blower Door Test

TABLE R402.1.2
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT^a

CLIMATE ZONE	FENESTRATION U-FACTOR ^b	SKYLIGHT ^c U-FACTOR	GLAZED FENESTRATION SHGC ^{d,e}	CEILING R-VALUE	WOOD FRAME WALL R-VALUE	MASS WALL R-VALUE ^f	FLOOR R-VALUE	BASEMENT ^g WALL R-VALUE	SLAB ^h R-VALUE & DEPTH	CRAWL SPACE ⁱ WALL R-VALUE
1	NR	0.75	0.25	30	13	3/4	13	0	0	0
2	0.40	0.65	0.25	38	13	4/6	13	0	0	0
3	0.32	0.55	0.25	38	20 or 13+5 ^h	8/13	19	5/13 ⁱ	0	5/13
4 except Marine	0.32	0.55	0.40	49	20 or 13+5 ^h	8/13	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.30	0.55	NR	49	20 or 13+5 ^h	13/17	30 ^f	15/19	10, 2 ft	15/19
6	0.30	0.55	NR	49	20+5 ^h or 13+10 ^h	15/20	30 ^f	15/19	10, 4 ft	15/19
7 and 8	0.30	0.55	NR	49	20+5 ^h or 13+10 ^h	19/21	38 ^f	15/19	10, 4 ft	15/19

NR = Not Required.

For SI: 1 foot = 304.8 mm.

a. R-values are minimums. U-factors and SHGC are maximums. Where insulation is installed in a cavity that is less than the label or design thickness of the insulation, the installed R-value of the insulation shall be not less than the R-value specified in the table.

b. The fenestration U-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

c. Exception: In Climate Zones 1 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.

d. "10/13" means R-10 continuous insulation on the interior or exterior of the home or R-13 cavity insulation on the interior of the basement wall.

e. "15/19" means R-15 continuous insulation on the interior or exterior of the home or R-19 cavity insulation at the interior of the basement wall. Alternatively, compliance with "15/19" shall be R-13 cavity insulation on the interior of the basement wall plus R-5 continuous insulation on the interior or exterior of the home.

f. R-5 insulation shall be provided under the full slab area of a heated slab in addition to the required slab edge insulation R-value for slabs, as indicated in the table. The slab edge insulation for heated slabs shall not be required to extend below the slab.

g. There are no SHGC requirements in the Marine Zone.

h. Basement wall insulation is not required in warm-humid locations as defined by Figure R301.1 and Table R301.1.

i. Alternatively, insulation sufficient to fill the framing cavity and providing not less than an R-value of R-19.

j. The first value is cavity insulation, the second value is continuous insulation. Therefore, as an example, "13+5" means R-13 cavity insulation plus R-5 continuous insulation.

k. Mass walls shall be in accordance with Section R402.2.5. The second R-value applies where more than half of the insulation is on the interior of the mass wall.

From the Study: Increased/Improved Education For:

Design Professionals – Architects and Designers

- Improve Plans

Builders – Production and Custom

- Improve Understanding – Identify Benefits
 - Reduce complaints/callbacks
 - Satisfied Customers

Sub-Contractors

- Framers, Insulation, HVAC, Plumbers & Electricians

Code Officials

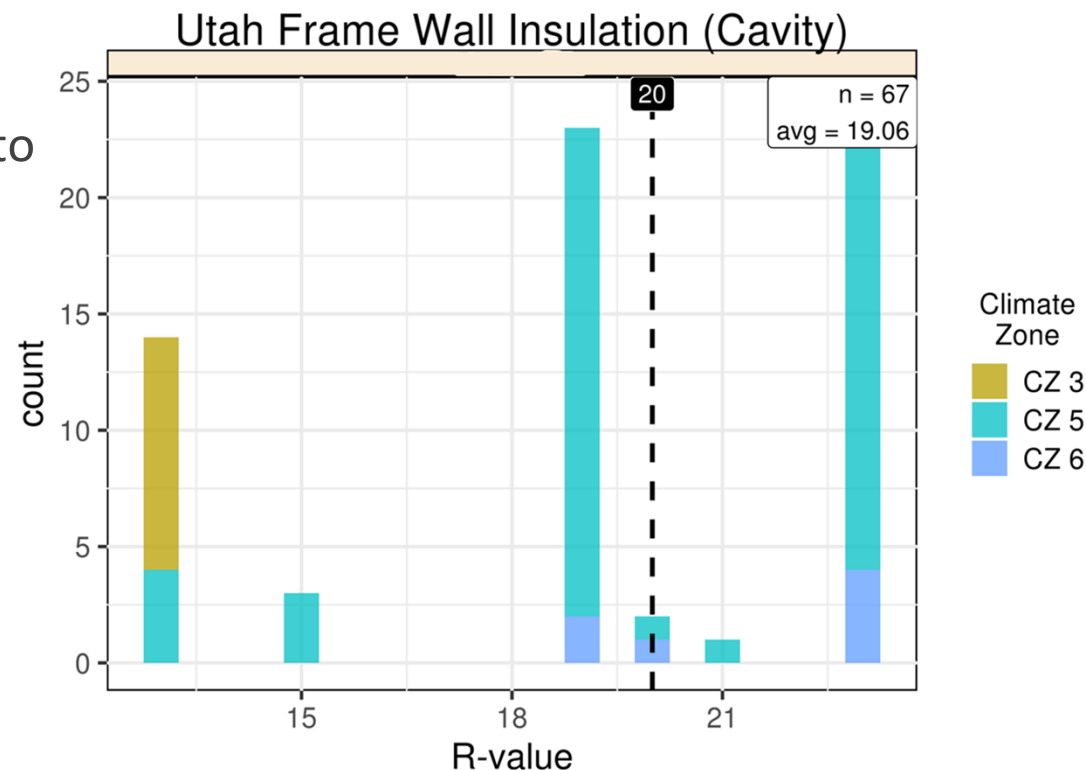
- Plan Review – Ensure documents approved for IECC compliance
- Inspectors – Typically Checklists are discouraged; however, recently many have requested energy



#1. Exterior Wall Insulation *(sequential order based on potential savings)*

Education to Increase Focus on:

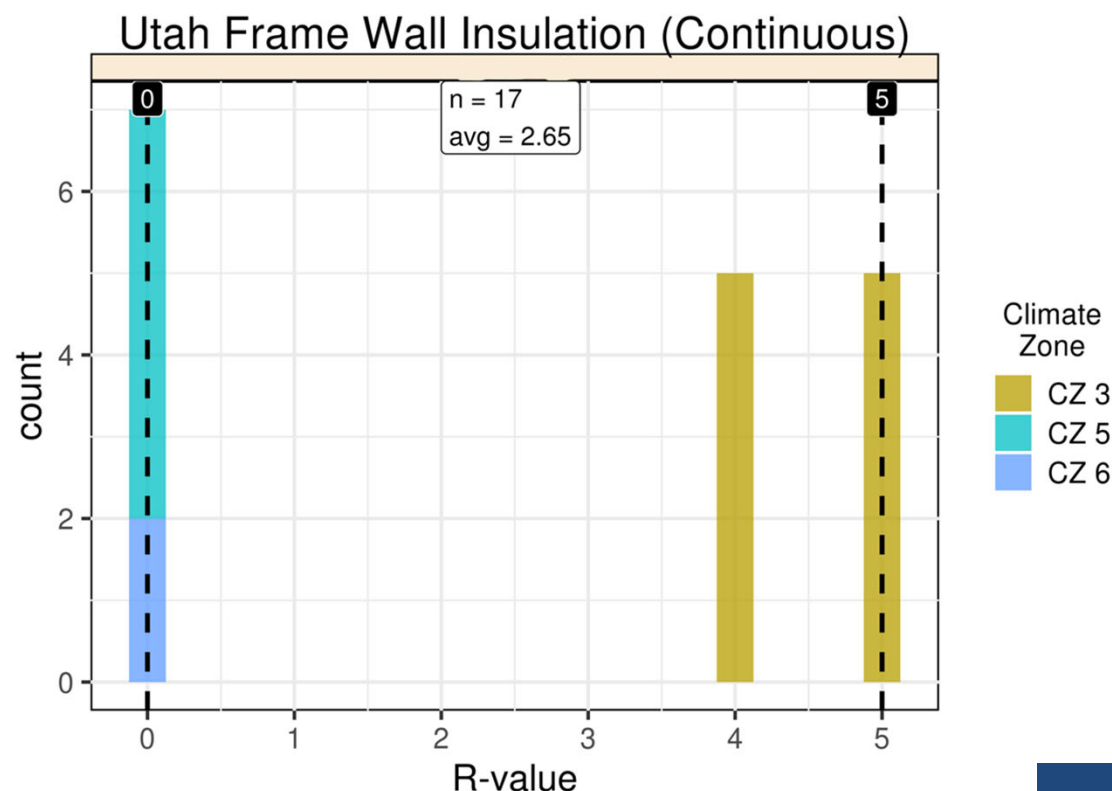
- **Efficient Framing**
- **Wall Insulation Options – Cavity or CI**
- **Insulation Installation Quality**
 - Batts typically poorly installed – time to address
- **Bibb Systems – Net and Blow**
- **Spray Polyurethane Foam (SPF)**
 - Highest R-value/inch in a cavity
 - Rim Joist – virtually only option



#1. Exterior Wall Insulation Part 2: Continuous Insulation (CI)

Education to Increase Focus on CI Benefits

- Observed in 17 CZ 3 Homes
- Greatest Benefit in CZ 5 & 6
 - Prescriptive Requirement in CZ 6
- Continuous Insulation – Foam Sheathing
 - *Condensation Prevention*
 - R-value Calculators – CI may be less costly than cavity Closed cell spray polyurethane foam (SPF)



R-15 + R-5

10:52

More
R-Value Calculator

Framing Percentage
Stud-wood

☐ 21% (24 in. O.C.)
☒ 2x4 R-Value 3.71

☒ 25% (16 in. O.C.)
☐ 2x6 R-Value 5.83

☐ Custom
 %

Exterior Insulation R-Value *

5

Cavity Insulation R-Value *

15

Total Wall R-Value

16.06

This calculation assumes the following:

Outside air film: 0.17
Cladding (generic): 0.62
1/2" OSB: 0.62
1/2" gypsum: 0.45
Interior air film: 0.68

R-21 + R-5

11:04

More
R-Value Calculator

Framing Percentage
Stud-wood

☐ 21% (24 in. O.C.)
☐ 2x4 R-Value 3.71

☒ 25% (16 in. O.C.)
☒ 2x6 R-Value 5.83

☐ Custom
 %

Exterior Insulation R-Value *

5

Cavity Insulation R-Value *

21

Total Wall R-Value

20.26

This calculation assumes the following:

Outside air film: 0.17
Cladding (generic): 0.62
1/2" OSB: 0.62
1/2" gypsum: 0.45
Interior air film: 0.68

R-30 SPF

10:50

More
R-Value Calculator

Framing Percentage
Stud-wood

☐ 21% (24 in. O.C.)
☐ 2x4 R-Value 3.71

☒ 25% (16 in. O.C.)
☒ 2x6 R-Value 5.83

☐ Custom
 %

Exterior Insulation R-Value *

0

Cavity Insulation R-Value *

30

Total Wall R-Value

17.27

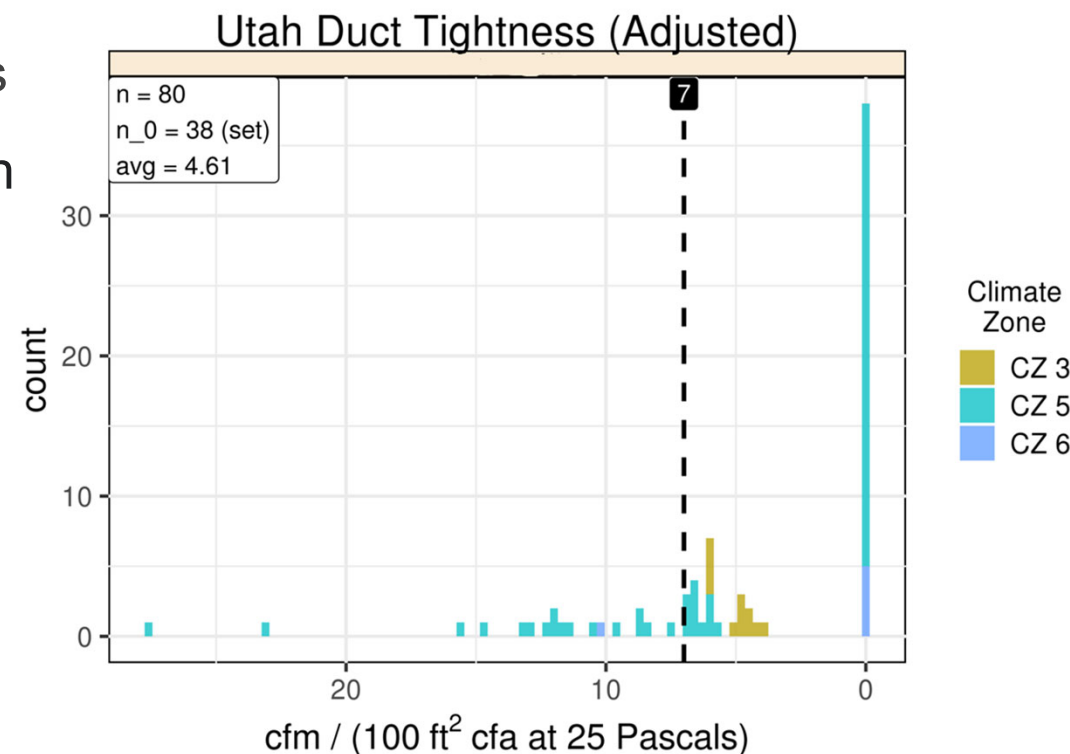
This calculation assumes the following:

Outside air film: 0.17
Cladding (generic): 0.62
1/2" OSB: 0.62
1/2" gypsum: 0.45
Interior air film: 0.68

#2. Duct Leakage (+Insulation & Location)

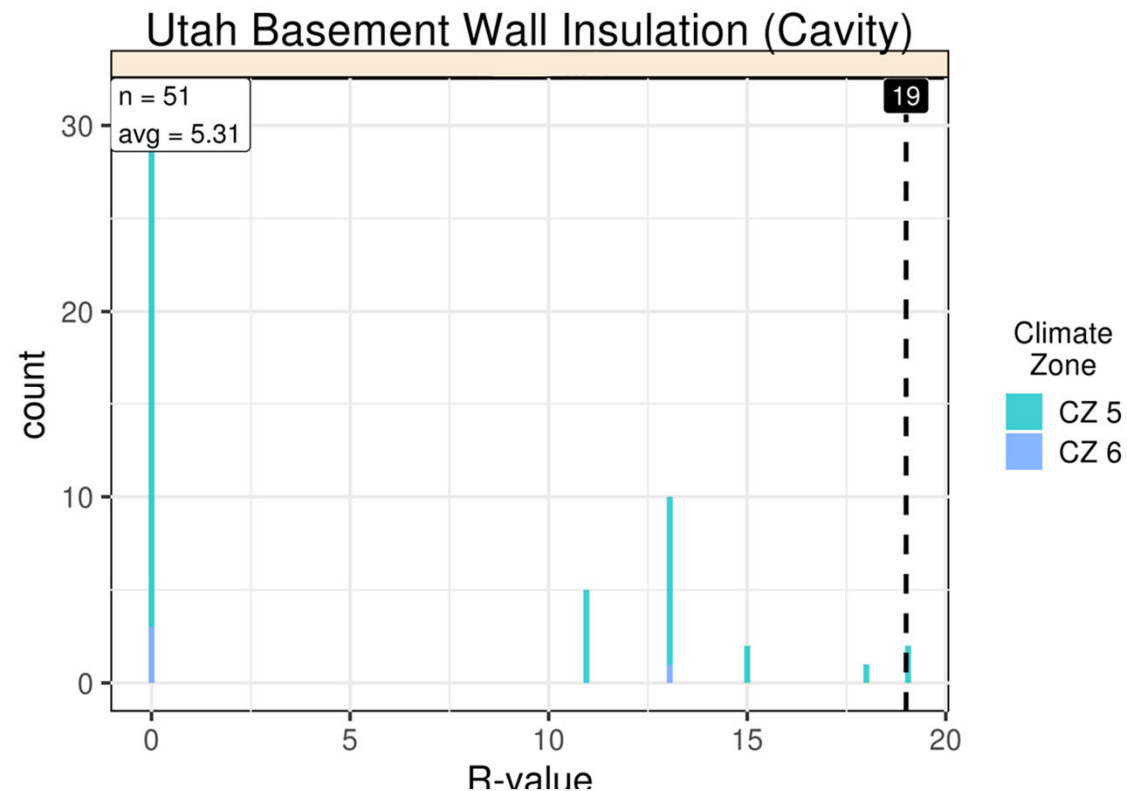
Greatest Savings in Cooling Expense

- Encourage Moving Ducts and Air Handlers Inside
- Code Officials Must Require Testing – note on plans
- Bury Ducts in Attic Insulation
- Benefits from Encapsulating Attic Ducts
 - Closed cell spray polyurethane foam (**SPF**)
 - 2018 IECC finally recognizes benefits Buried Ducts
 - Adopted by amendment
 - Seals and Improves Insulation



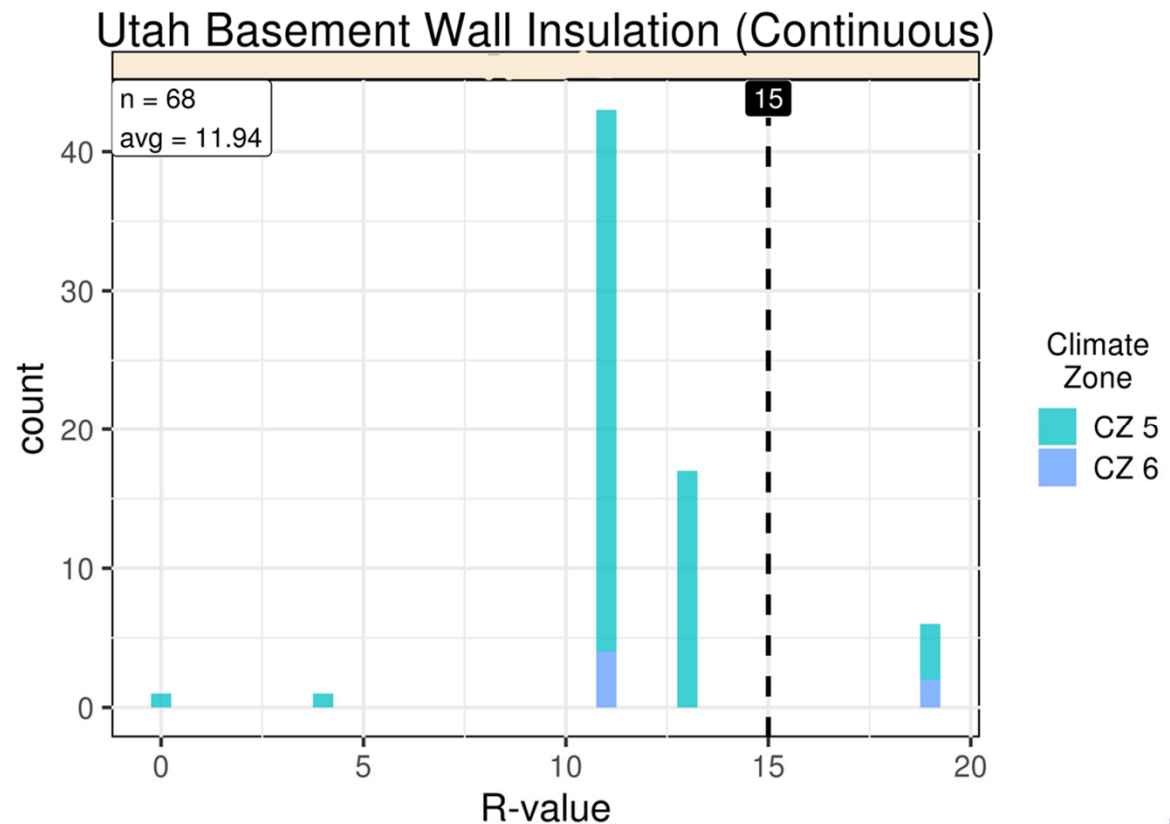
#3. Basement Wall Insulation – Part One – Cavity Insulation

- Typically, Unfinished Basements are Indirectly Conditioned
- Rim Joist Area is Wall Area
 - Must include Air Barrier - SPF
- Basement Blanket Insulation
 - Correct R-value
 - Installation quality
 - SPF or Sheet Foam
 - Condensation Control



#3. Basement Wall Insulation – Part Two – Continuous Insulation

- Typically, Unfinished Basements are Indirectly Conditioned
- Basement Blanket Insulation
 - Correct R-value
 - Installation quality
 - SPF or Sheet Foam
 - Condensation Control



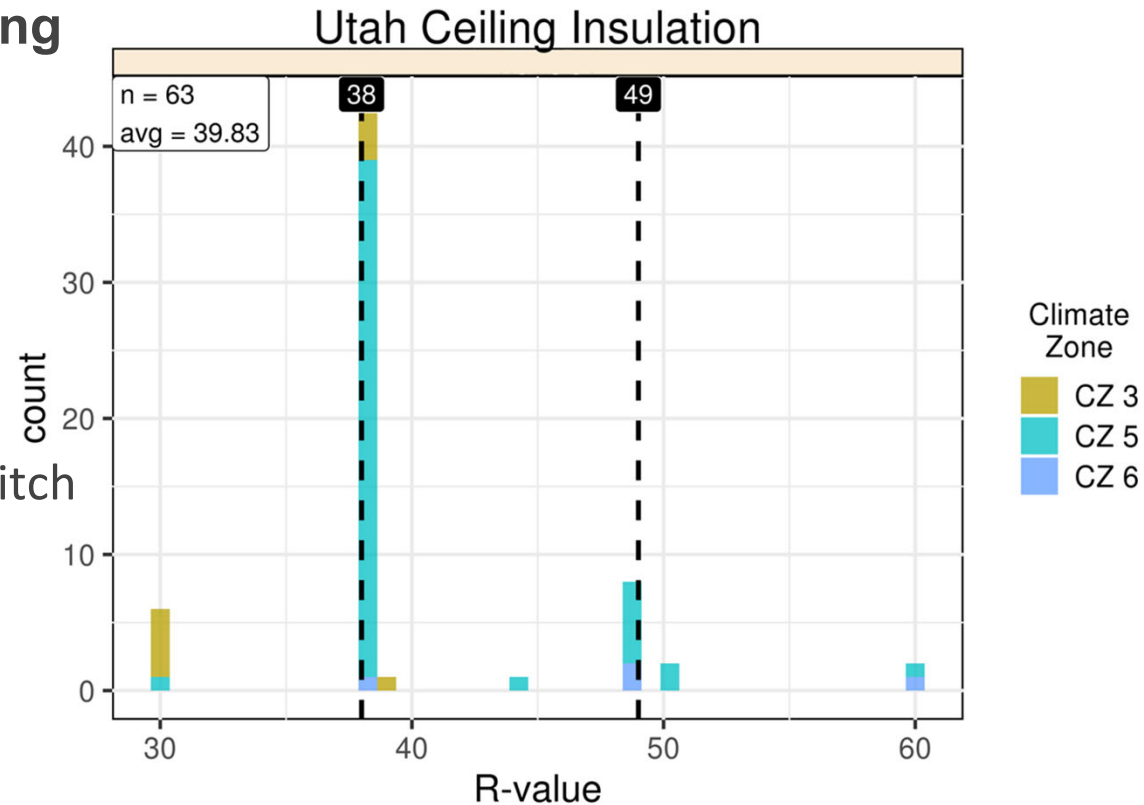
#4. Ceiling/Attic Insulation

Combined With #2 Ducts, Greatest Impact CZ 3

- CZ 5 & 6 have a significant cooling requirement; however, Heating dominates energy use

Greatest Savings Realized in Cooling

- Increase Awareness
 - High Heel Trusses
 - Reduce risk of Ice Dams, Condensation
 - Best Practices – especially in low pitch roofs and scissor trusses
 - Net and blow tight areas
- Insulation Certificates

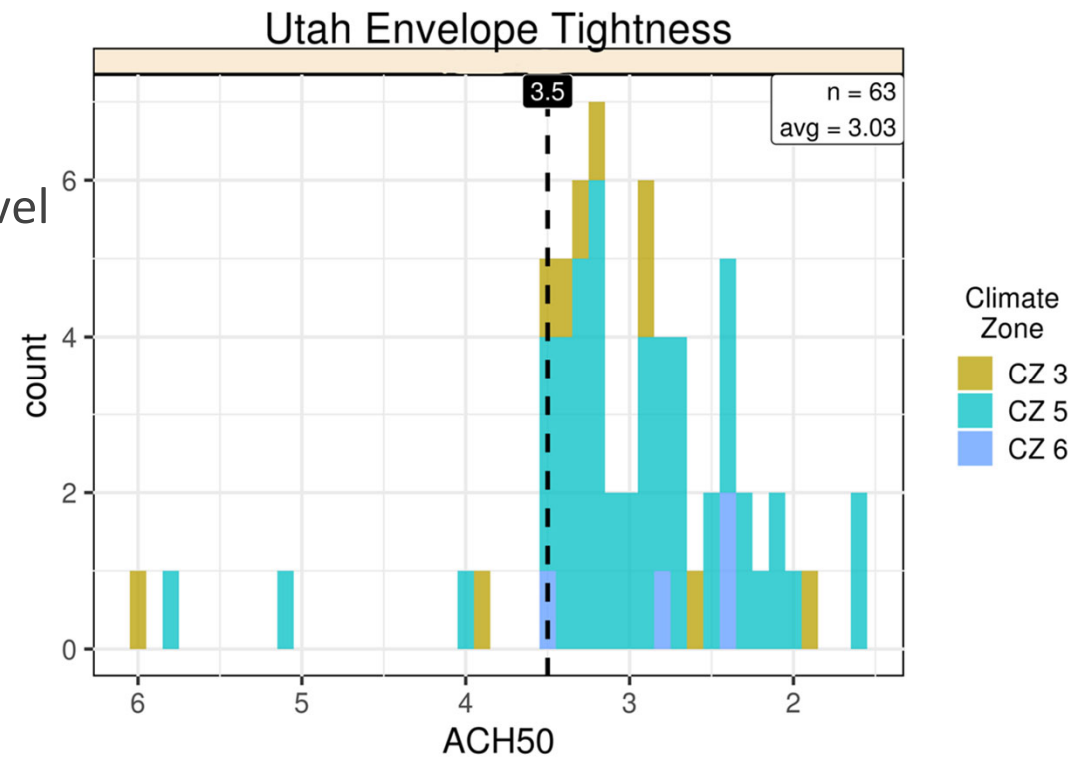


#5. Envelope Air Leakage – Wonderful! Or Is It?

Most Significant Result

Vast Majority ≤ 3.5 ACH@50pa

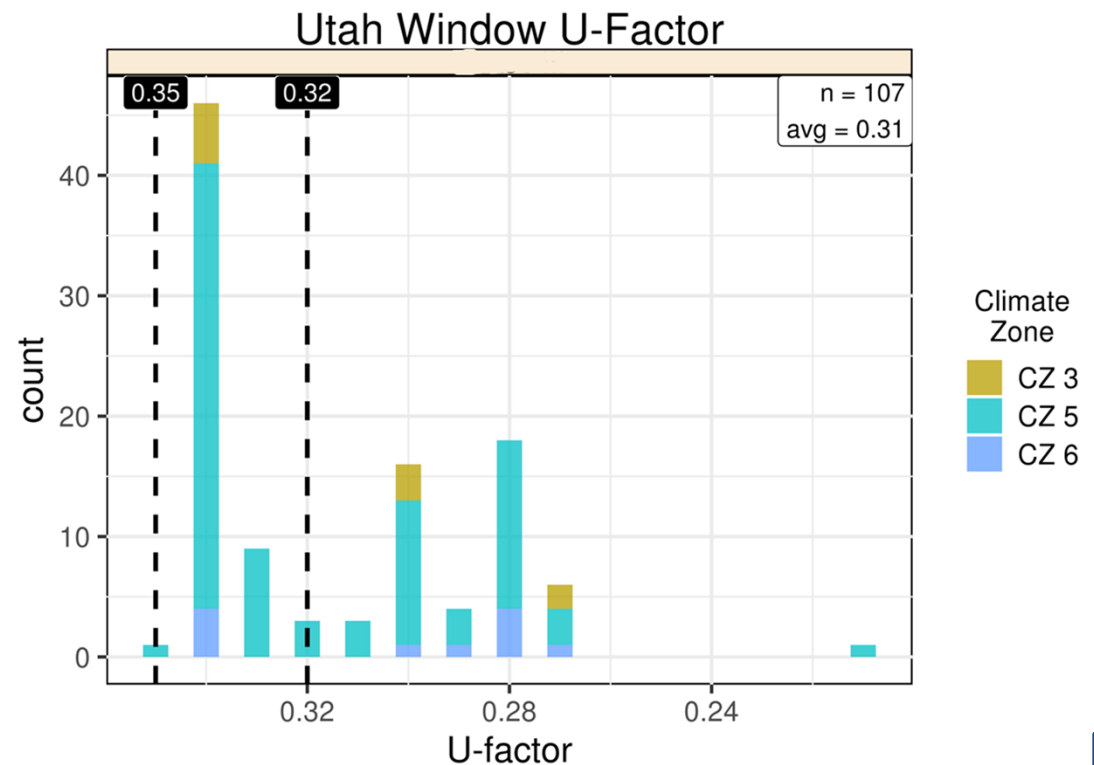
- State Amendments
 - Blower Door Test OR
 - Insulation-Air Barrier Inspection Checklist
 - No BD test – no trigger for mechanical ventilation
- Mechanical Ventilation required at this level
- Most homes do not include MV
 - Not tested – no trigger
 - Jurisdiction does not enforce, doesn't know or care?
- Poor Air Quality, Moisture Issues, Health Concerns



#6. Window U-Factor

All CZs Often Fail to Comply Prescriptively (2018)

- 2015 IECC – CZ 3 requirement 0.35
- Easy to comply with the Utah 2012 REScheck
- Can also be traded of in 2015 REScheck, other options

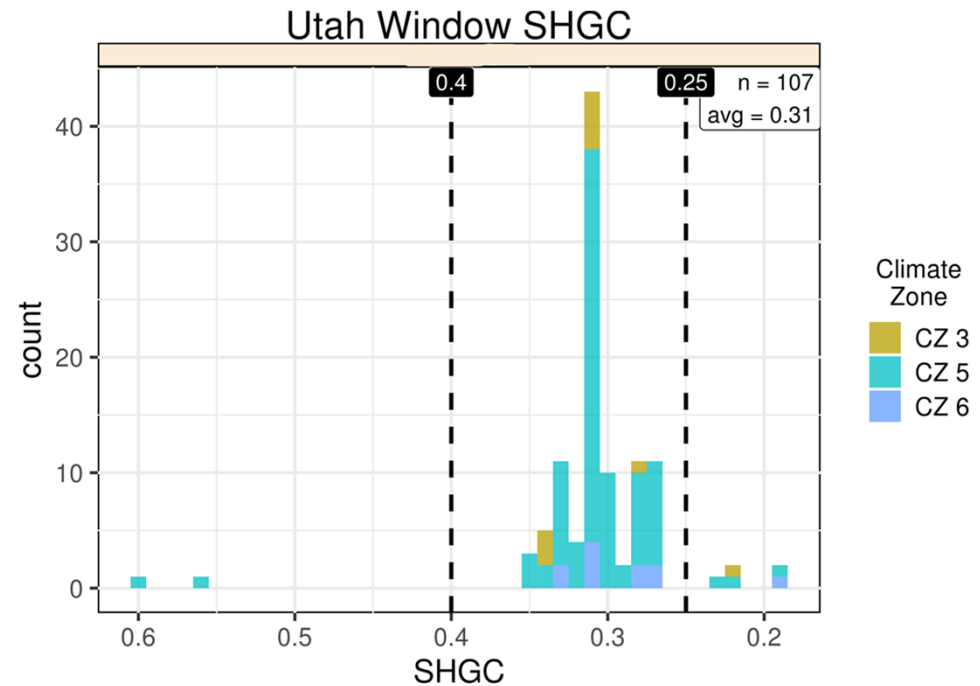


#7. Window SHGC

CZ 5 and 6 Have No Requirement

CZ 3 Needs to Improvement

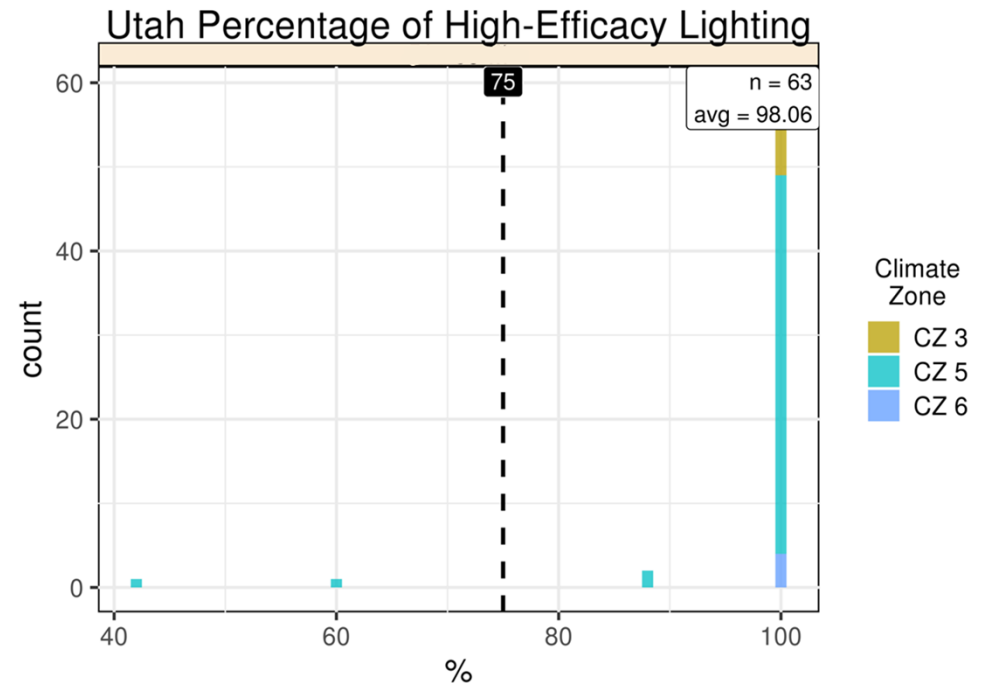
- 0.25 SHGC Requirement slightly lower than typical LowE window (~0.30)
- Readily available
- All CZ's need to understand the benefit during cooling
- The 0.6 and 0.5 SHGCs – where did they purchase these windows?



#8. High Efficacy Lighting

LED Lighting Technology Solved This Issue

- Inspectors Typically do Not Inspect This Item



Training format(s)

Face-to-face

- Lively Informative Discussion
- Experience and Expertise from Group
- Ability to Address Questions not Covered in Presentation
- Simple to update curriculum – add or modify

Live on-line

- Limited interaction
- Allows distance attendance
- Technology Challenges

Face-to-face + Live on-line – Best?

On-demand on-line

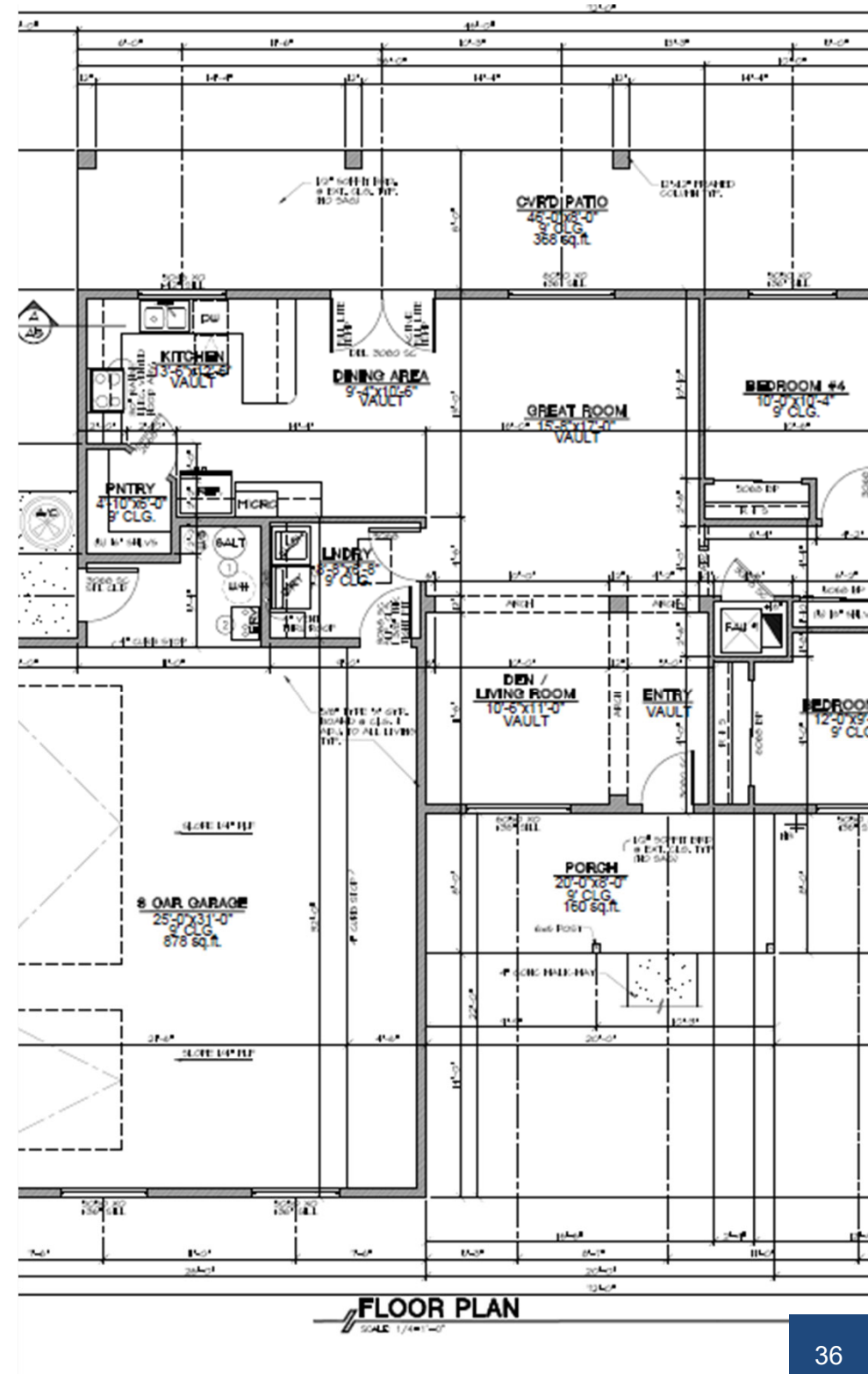
- Update difficult
- Convenient



Discussion Comments? Questions?

Send your brilliant ideas to:

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Thank You

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