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Idaho Residential Code Compliance Evaluation

Methods and Results

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Executive Summary

Introduction

In 2023, NEEA commissioned an evaluation of the market's response to the International Energy Conservation Code (IECC) 2018 with Idaho amendments. NEEA selected a consulting team led by Industrial Economics, Inc. (IEc), with subcontractors Resource Refocus LLC and Momentum, LLC, to conduct the evaluation. The main study objective was to assess statewide compliance with the IECC 2018 with Idaho amendments. Additional objectives were to provide statewide findings regarding the proportion of homes with gas versus electric primary space heating, the proportion of homes with gas versus electric water heating, and the proportion of homes with above-code elements.

Methodology

The study follows the sampling methodology specified in the U.S. Department of Energy (DOE)'s Residential Building Energy Code Field Study: Data Collection & Analysis. DOE's methodology requires 63 observations for each of seven key measures (listed below), which are to be collected through on-site inspections at newly constructed homes. Because some measures can only be observed during the rough-in or final stage of construction, the number of inspections always exceeds the required number of observations and can therefore be time-consuming and costly. NEEA sought to understand whether building permit data can be used as an alternative to on-site inspections to assess energy code compliance in Idaho. Therefore, this study includes both an analysis of permit data and on-site inspection data from newly constructed single-family homes across the state. The main body of this report explains the uses and limitations of the permit data.

The study assesses statewide compliance levels for the following seven key measures in DOE's methodology:

1. Envelope tightness (air changes per hour (ACH) at 50 Pascals).
    - For envelope tightness only, the study provides statewide findings as well as findings for urban (within city limits) and rural (outside of city limits) jurisdictions separately. This was to address anecdotal reports suggesting differences in envelope tightness between urban and rural areas.
2. Windows (U-factor and solar heat gain coefficient (SHGC)).
3. Wall insulation (assembly U-factor).
4. Ceiling insulation (R-value).
5. Lighting (percent high-efficacy).
6. Foundation insulation (including floor insulation, basement wall insulation, crawlspace wall insulation, and slab insulation R-values).
7. Duct tightness (expressed in cubic feet per minute (cfm) per 100 sq. ft. of conditioned floor area (CFA) at 25 Pascals).

Using data collected on the seven individual code requirements, the study provides estimates of statewide energy code compliance based on the share of the homes that meet the minimum code requirements from an energy consumption perspective.

The analysis was split into three main components:

- **Statistical analysis** to identify compliance trends of individual measures.
- **Modeling analysis** to estimate the energy consumption of both an observed and code-compliant population of homes.
- **Savings analysis** to project the potential savings with improved energy code compliance relative to the 2018 IECC with Idaho amendments.

Results

This study provides insight into 2018 IECC with Idaho amendments code compliance both at a measure and whole home level. Two IECC climate zones are found in Idaho: climate zone 5B cool dry (CZ5) and climate zone 6B cold dry (CZ6). On average, CZ6 has more heating degree days than CZ5. As a result, some of the envelope prescriptive requirements are more stringent in CZ6 as compared to CZ5. More detailed information about the code requirements can be found in the Idaho Residential Code section below.

Key observations from the statistical analysis include:

- Ninety-six percent of the space heating systems are natural gas furnaces, while 4% are some form of electric. 90% of the domestic hot water (DHW) heating uses natural gas, while 10% is electric.
- There continue to be high rates of compliance at the state level for window U-factor, ceiling insulation, lighting, and unvented crawlspace wall insulation.
- Compared to compliance under Idaho's previous code (IECC 2015 with Idaho amendments),[1]
    - There is notably improved compliance in floor insulation, basement insulation, and duct leakage statewide, as well as wall insulation in CZ5.
    - There are lower rates of compliance for window U-factor and wall insulation in CZ6, which both had more stringent requirements as compared to the previous code cycle.
- Under the current code (2018 IECC with Idaho amendments), external wall insulation has the lowest rate of compliance and the highest potential for energy savings if the non-compliant homes were brought to code-minimum levels. Two key areas for improvement are insulation installation quality (IIQ) statewide and insulation R-value in CZ6.
- There was not a notable difference in envelope tightness compliance in urban vs. rural populations. It is possible there may be a difference in compliance for measures with lower compliance rates, such as external wall insulation. Future studies could expand the scope of the rural vs. urban analysis to other measures.

The energy analysis results are shown in the histogram below (**Figure ES-1**), which estimates that the average home in Idaho uses *less* energy than would be expected relative to a home built to the current minimum state code requirements. However, these results include a mix of measures that consistently outperform code requirements (for example, lighting efficacy) and others that had lower rates of compliance. So, while the average home performs better than expected, there is still the potential for savings for some measures.

Based on the observed data set, the average regulated energy use intensity (EUI) is 36.1 kBtu/ft^2-yr (dashed blue line). In comparison, homes exactly meeting minimum prescriptive energy code requirements have an average EUI of 39.4 kBtu/ft^2-yr (solid blue line). **The results estimate that the average home in Idaho uses 8% *less* energy than the average home that exactly meets code requirements.**

From a whole-home EUI perspective, the weighted modeling results predict 97.8% compliance statewide. Note, the simulated population includes homes with above-code measures,

[1] The Pacific Northwest National Laboratory (PNNL)'s 2019 *Idaho Residential Energy Code Field Study* summarized compliance under Idaho's previous code (IECC 2015 with Idaho amendments).

outweighing the impact of below-code measures. This is why the average home outperforms the code-compliant average by 8%, but there is still 2.2% non-compliance.

In the chart below, the results for CZ5 are shown in orange and the results for CZ6 are shown in blue. As noted above, CZ6 is a colder climate than CZ5, which is reflected in the higher overall energy use. The statewide EUI analysis shows a bimodal distribution for each climate zone. The results with lower EUI values include models with heat pumps and conditioned basements. This is because heat pumps are more efficient than gas furnaces and conditioned basements have a larger conditioned floor area, resulting in lower EUIs.

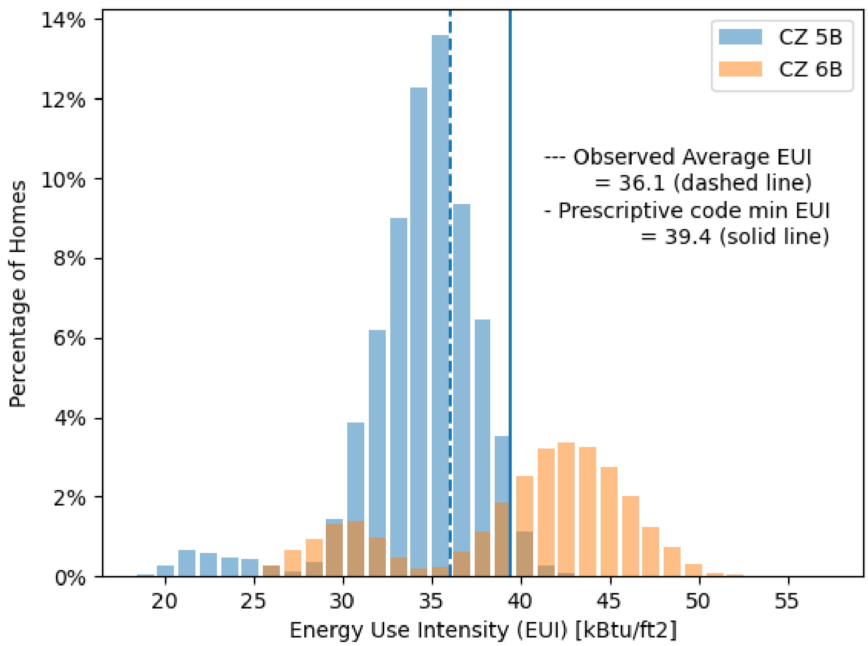

Figure ES-1. Statewide EUI analysis for Idaho

Table ES-1 below summarizes the potential measure-level savings that could be the target for future education, training, and outreach activities. **Potential statewide annual energy savings are 15,161 MMBtu, which results in $157,692 in energy cost savings and 834 MT CO_{2e} in emission reductions.** Over a 30-year period, this would save 7 million MMBtu, $73 million, and 387,902 MT CO_{2e}.

Table ES-1. Annual statewide savings potential

Key Measure	Annual Savings		
	Energy (MMBtu)	Cost ($)	Carbon (MT CO2e)
Frame Wall U-Factor	11,873	127,720	657
Window U-factor	1,405	12,394	75
Envelope Leakage (ACH50)	1,360	11,824	73
Adjusted Duct Leakage	412	5,026	23
Foundation Insulation	111	728	5.7
TOTAL	15,161 MMBtu	$157,692	834 MT CO2e

Availability and Use of Permit Data

As noted above, a goal for this evaluation was to understand the extent to which NEEA can rely on permit data for code compliance evaluations in Idaho. The evaluation team requested permit data from a total of 55 jurisdictions (20 urban and 35 rural) and received useable permit data from 13 jurisdictions (nine urban and four rural). The team reviewed 70 urban permits and 70 rural permits. The permits rarely provided information on envelope tightness and lighting and contained no duct tightness values. The permits consistently provided information on four measures: ceiling insulation, windows, wall insulation, and foundation insulation. However, the team determined that foundation and wall insulation values could not be extracted solely from the permits due to a lack of information on insulation installation quality (IIQ), which is not specified in code but can affect overall assembly performance and energy use. The 2019 Idaho *Residential Energy Code Field Study* found that 100% of the ceiling IIQ observations were Grade I (the best quality installation), but only one third of the wall and foundation installation observations were. The on-site observations for the current study again showed variations in installation quality for wall and foundation insulation.[2] Therefore, the team determined that only the two remaining measures – windows (U-factor and SHGC) and ceiling insulation – could be extracted from permit data and used in the analysis. Analysis for the remaining measures used on-site data.

Recommendations

Recommendations to improve code compliance and recommendations for future studies are summarized below. The main body of the report provides additional detail for each recommendation.

Recommendations to Improve Code Compliance

Wall insulation: Improving external wall insulation compliance represents about 80% of the potential savings. Two key areas on which to focus outreach and education efforts are IIQ and meeting the updated R-22 requirement in CZ6.

Window U-factor, envelope leakage, duct leakage, foundation insulation: There are also modest potential savings for window U-factor, envelope leakage, duct leakage, and foundation insulation. Window U-factor, envelope leakage, and foundation insulation all have more stringent

[2] In this study, two thirds of the external wall observations were Grade I, while over 90% of the foundation observations were, which is an improvement from the previous study. In the future, NEEA could consider using on-site data for external wall insulation and permit data for foundation insulation.

requirements under the 2018 IECC with Idaho amendments as compared to the previous code cycle, so this could be a secondary focus for outreach and education efforts.

Education and outreach for code changes: Focus education and outreach efforts on key measures that have more stringent requirements as compared to the previous code cycle, especially when requirements vary by climate zone.

Recommendations for Future Studies

Sampling

Substitutions: Future studies should consider allowing more flexibility in jurisdiction data substitutions to conserve time and resources.

Data sources: If studies use multiple data sources, they should coordinate across data sets to maintain the appropriate sample sizes in each jurisdiction and ensure that above-code homes are weighted proportionally to their share of the population.

Data Collection

IIQ: Future studies could consider only using on-site insulation data for the external wall insulation.

Lighting: Future studies should consider loosening the data collection requirements for high-efficacy lighting.

Duct tightness: Confirm duct tightness is documented in CFM/100 ft^2 of CFA at 25 Pascals (rather than in CFM).

On-site inspections: If on-site inspections are included, consider focusing on envelope tightness, duct tightness, and external wall IIQ.

1 Introduction

Background and Study Objectives

Residential building energy codes have the potential to significantly affect energy consumption throughout the Northwest (Idaho, Montana, Oregon, and Washington). In collaboration with regional stakeholders, the Northwest Energy Efficiency Alliance (NEEA) identifies new potential energy code measures, participates in the public process by providing data and analysis, and works with state code bodies to support code implementation. To assess the extent to which the energy savings goals of these efforts are realized in the market, NEEA commissions evaluation studies measuring the market's response to updated building energy codes in the residential new construction sector in the Northwest.

In 2023, NEEA commissioned an evaluation of the market's response to the International Energy Conservation Code (IECC) 2018 with Idaho amendments. NEEA selected a consulting team led by Industrial Economics, Inc. (IEc), with subcontractors Resource Refocus LLC and Momentum, LLC, to conduct the evaluation. This report describes the evaluation's objectives, methods, and results.

The main study objective was to assess statewide compliance with the IECC 2018 with Idaho amendments. The study follows the methodology specified in the U.S. Department of Energy (DOE)'s Residential Building Energy Code Field Study: Data Collection & Analysis. Based on an analysis of permit and on-site data from newly constructed single-family homes across the state, the study assesses statewide compliance levels for the following seven key code elements:

1. Envelope tightness (ACH at 50 Pascals).
2. Windows (U-factor and solar heat gain coefficient (SHGC)).
3. Wall insulation (assembly U-factor).
4. Ceiling insulation (R-value).
5. Lighting (percent high-efficacy).
6. Foundation insulation (including floor insulation, basement wall insulation, crawlspace wall insulation, and slab insulation R-values).
7. Duct tightness (expressed in cubic feet per minute (cfm) per 100 sq. ft. of conditioned floor area (CFA) at 25 Pascals).

Using data collected on individual code requirements, the study provides estimates of statewide energy code compliance based on the share of the homes that meet the minimum code requirements from an energy consumption perspective.

This report includes results from the:

- **Statistical analysis** to identify compliance trends of individual measures.
- **Modeling analysis** to estimate the energy consumption of both an observed and code-compliant population of homes.
- **Savings analysis** to project the potential savings with improved energy code compliance relative to the 2018 IECC with Idaho amendments.

In addition, this report provides statewide findings regarding:

- Proportion of homes with gas versus electric primary space heating.
- Proportion of homes with gas versus electric water heating.
- Proportion of homes with above-code elements.

Idaho Residential Code

This study assesses compliance for homes built under the IECC 2018 with Idaho amendments, which went into effect in July 2021. This serves in part as an update to the Pacific Northwest National Laboratory's (PNNL) 2019 *Idaho Residential Energy Code Field Study,* which summarized compliance under Idaho's previous code (IECC 2015 with Idaho amendments). For the remainder of the report, PNNL's 2019 field study will be referred to as the "previous study."

Two IECC climate zones are found in Idaho: climate zone 5B cool dry (CZ5) and climate zone 6B cold dry (CZ6). On average, CZ6 has more heating degree days than CZ5. As a result, some of the envelope prescriptive requirements are more stringent in CZ6 as compared to CZ5. More detailed information about the code requirements can be found in the Idaho Residential Code section below.

Table 1 summarizes the differences between the two code cycles. Of note, window U-factor, wall insulation, basement and crawlspace wall insulation, envelope tightness, and lighting all have more stringent requirements under the 2018 IECC with Idaho amendments.

Table 1. 2015 IECC with Idaho amendments vs. 2018 IECC with Idaho amendments

IECC Code Section	Component	Climate Zone	2015 IECC with Idaho amendments	2018 IECC with Idaho amendments	Units
R402.4.1.2	Envelope tightness	all	**7 ACH50**	**5 ACH50**	ACH at 50 Pa
R402.1	Window U-factor	5B	**0.35**	**0.32**	Btu/h-ft^2-F
		6B	**0.35**	**0.3**	
	Window SHGC	all	No requirement	No requirement	
	Wood-framed wall R-value	5B	20 or 13+5 (0.060)	20 or 13+5 (0.060)	h-ft^2-F/Btu
		6B	**20 or 13+5 (0.060)**	**22 or 13+5 (0.057)**	
	Mass wall R-value	5B	13/17 (0.082)	13/17 (0.082)	
		6B	15/19 (0.060)	15/20 (0.060)	
	Ceiling R-value	5B	38 (0.030)	38 (0.030)	
		6B	49 (0.026)	49 (0.026)	
R404.1	Lighting equipment	all	**50% high-efficacy**	**75% high-efficacy**	lumens & watts
R402.1	Floor R-value	5B	30 (0.033)	30 (0.033)	h-ft^2-F/Btu
		6B	30 (0.033)	30 (0.033)	
	Basement wall R-value	5B	**10/13 (0.059)**	**15/19 (0.050)**	
		6B	15/19 (0.050)	15/19 (0.050)	
	Crawlspace wall R-value	5B	**10/13 (0.065)**	**15/19 (0.055)**	
		6B	**10/13 (0.065)**	**15/19 (0.055)**	
	Slab R-value and depth	5B	10, 2 ft	10, 2 ft	
		6B	10, 4 ft	10, 4 ft	
R403.3.1	Duct insulation	all		Insulation required only in attic	
R403.3.3	Duct leakage (mandatory)	all		Measured with 1 inch w.g./25 Pa	
R403.3.4	Duct leakage (prescriptive)	all	4	4	cfm per 100 ft^2 of CFA at 25 Pa
R403.3.6&7	Duct insulation in conditioned space	all	No requirement	No requirement	

2 Methodology

Overview

Based on the DOE's Residential Building Energy Code Field Study: Data Collection & Analysis, the following seven key variables were assessed for code compliance:

- Envelope tightness (ACH at 50 Pascals)
    - For envelope tightness, the study provides statewide findings as well as findings for urban and rural jurisdictions separately. NEEA requested this breakout to understand how code compliance may differ between urban versus rural areas.
- Windows (U-factor & solar heat gain coefficient).
- Wall insulation (assembly U-factor).
- Ceiling insulation (R-value).
- Lighting (percent high efficiency).
- Foundation insulation (including floor insulation, basement wall insulation, crawlspace wall insulation, and slab insulation; R-value).
- Duct tightness (expressed in cfm per 100ft^2 of conditioned floor area at 25 Pascals).

To complete the statewide savings calculations, two additional required data points were:

- Heating type: electric resistance, gas furnace, oil furnace, or heat pump.
- Foundation type: slab, crawlspace, heated basement, unheated basement.

To collect data to measure statewide compliance, the team used two primary methods of data collection: 1) permit reviews and 2) on-site inspections.

NEEA continually seeks methodological refinement to ensure effective and efficient achievement of study objectives. Therefore, the team also sought to answer the following research questions to help inform compliance estimates as well as future code compliance evaluation studies in Idaho:

- How feasible is permit data for measuring statewide compliance?
    - If permit data are not feasible to assess compliance for all seven key measures, what measures, if any, can be assessed from permit data?
    - Are there specific sub-areas of the state where permit data can be more feasibly used to measure compliance than others (for example, urban areas, greater Boise only)?
    - Can the AXIS database of above-code and energy-rated/certified homes be used to create a better understanding of code compliance from existing data?[3]
- Can interviews with homebuilders and code officials provide validation and context for the code compliance findings from the permit reviews and on-site inspections?

The remainder of this section details the methodology for each of the following activities:

- Permit reviews.
- On-site inspections.
- AXIS database review.
- Interviews with code officials and builders.
- Analysis.

[3] The AXIS data in Idaho includes above-code homes incented by utilities, above-code homes with no utility incentive, and code homes that used an energy rater.

Permit Review

Sampling and Data Collection Process

The IEc team initially set out to gather and review single-family residential new construction permits to inform an initial estimate of code compliance for the seven key measures identified above. This included a planned review of available permit data in both urban and rural areas (70 permits from each for a total of 140) to address any key differences between these geographic groups, where urban areas are defined as those designated as incorporated by the U.S. Census and rural defined as unincorporated areas.

Using DOE's field study methodology, IEc drew an initial weighted random sample of 20 urban and 20 rural areas across the state based on the number of permits issued over the past three years (2020-2022), with the initial goal of reviewing 70 total permits from each of these jurisdictional types (urban and rural) issued under the 2018 IECC code with Idaho amendments. The team began outreach to local code officials and building departments to attempt to obtain permit information that could be used to extract data for the seven key code elements.

For each initially sampled jurisdiction, the IEc team sent a minimum of two emails and made two phone calls to request permit data. In jurisdictions where public records requests were available, the team submitted records requests to unresponsive jurisdictions. **Table 2** summarizes the outreach efforts and responses, including which jurisdictions provided data, which responded with initial plans/willingness to share data before becoming unresponsive, which did not have data or opted not to share data, and which did not respond at all. Urban/incorporated jurisdictions tended to be more responsive and were more likely to share information, with nine urban jurisdictions providing permit data compared to just four in rural areas. Only one urban jurisdiction did not respond at all to the team's outreach compared to 16 rural jurisdictions.[4] Urban jurisdictions were likely more prone to respond to requests and share usable permit data due to factors including:

- Additional staff and resources to respond to requests.
- Additional staff and resources to maintain permit records, conduct inspections, and issue permits.
- More e-permitting and online records.
- Greater familiarity with NEEA (several code officials who provided data in urban jurisdictions had worked with NEEA staff on various projects in the past).

[4] This includes three non-responses from the initial outreach and 13 from a subsequent group of rural jurisdictions that IEc and NEEA agreed to contact via email after the initial outreach to rural jurisdictions returned limited data.

Table 2. Summary of Permit Outreach and Responses

Jurisdiction Type	Jurisdictions Contacted					Permits Received	
	Total	Provided Data	Responded but Did Not Provide Data	Contacted with No Response	Do not have Data or Declined	Total Reviewed[1]	Total Received[2]
Urban	20	9	4	1	6	70	175
Rural[3,4]	35	4	4	16	11	70	176
Total	55	13	8	17	17	140	351

1. IEc initially reviewed the number of permits in the sample plan for each jurisdiction that provided data. Because IEc requested data going back to the start of 2023, many jurisdictions provided additional permits that IEc did not initially review when they exceeded the allocation target. IEc worked with NEEA to determine replacement jurisdictions based on similar characteristic (urban vs. rural, geographic location, population, and level of building activity) for jurisdictions that did not provide permit data and extracted information from permits in these similar areas to reach the target of 70 rural and 70 urban observations.
2. The total number of permits corresponds to those from the nine urban and four rural jurisdictions who provided data.
3. After several follow-up requests by phone and email to the initial 20 rural jurisdictions in the sampling plan, IEc contacted 15 additional rural jurisdictions to see if any would respond and be suitable replacement jurisdictions. These jurisdictions generally did not respond and none of them provided permit data, although the team submitted fewer requests to them than to the initial 20 in the sample.
4. Sixty-eight permits come from unincorporated Ada County (Boise's County); although "rural," they are likely to be less representative of remote rural areas than other parts of the state. An additional 60 permits from Bingham County include only wall and ceiling insulation values.

Although the initial outreach yielded enough permits to review 70 urban and 70 rural homes, only 13 of the initial 40 target jurisdictions provided data. To account for the unresponsive jurisdictions, IEc worked with NEEA to develop a list of replacement jurisdictions with similar characteristics. The goal was to use permits from the replacement jurisdictions to substitute for the original (unresponsive) jurisdictions. The specific characteristics that the team used to identify suitable replacements included:

- Level of building activity (top, middle, or bottom third of single-family permits issued for urban or rural jurisdictions, respectively, based on the number of permits issued according to the U.S. Census buildings data).
- Population (top, middle, or bottom third of the population for urban or rural jurisdictions, respectively, based on U.S. Census data).
- Location (in or outside of the greater Boise area).

The team attempted to match jurisdictions on all three characteristics to find suitable replacements for unresponsive jurisdictions. For example, the sample plan called for three permits to be reviewed from a particular jurisdiction that did not provide permit data. The team replaced the three observations for this unresponsive jurisdiction with three excess permits from another jurisdiction, who provided more permits than the sample plan required of them. Both jurisdictions "matched" each other by being in the top third of the population, the middle third of building activity, and outside the Greater Boise area. While the team was able to match eight of 11 urban jurisdictions that needed to be replaced on all three replacement criteria, only two of the 16 rural replacements matched on all three criteria. To try to create additional replacement options, the team contacted 15 more rural jurisdictions that were not in the initial sample plan, but none of these localities ultimately provided permit data.

Data Collected from Permit Review

After receiving permit data and developing replacement options, the team conducted the review of 70 urban and 70 rural permits. **Table 3** shows the number of observations for each of the key measures that could be obtained from permits.

Based on initial observations, the permits consistently contained enough data to assess ceiling insulation, windows, wall insulation, and foundation insulation (although additional permits would be required for foundation insulation to reach the minimum number of 63 observations across urban and rural areas to assess the state as a whole). Ceiling insulation was the measure most frequently present in the permits reviewed (93%), ahead of windows (78%), wall insulation (52%) and foundation insulation (38%). Envelope tightness and lighting were rarely present in the permits (1% and 2%, respectively), and the permits contained no duct tightness values.[5]
Urban permits more often included information on windows, lighting, and envelope tightness, while ceiling insulation, wall insulation, and foundation insulation were found more frequently in rural permits. However, it should be noted that this is only based on observations from jurisdictions who provided permit data. Because more urban jurisdictions provided permit data than rural jurisdictions, a higher percentage of all measures would be represented in urban permit data if non-responsive jurisdictions were included in the calculations.

Table 3. Observations from the Permit Data for Key Measures

Measure	Urban Count	Urban %	Rural Count	Rural %	Total Count	Total %
Envelope tightness	1	1%	0	0%	1	1%
Windows	65	93%	44	63%	109	78%
Wall insulation	10	14%	63	90%	73	52%
Ceiling insulation	61	87%	69	99%	130	93%
Lighting	3	4%	0	0%	3	2%
Foundation insulation	13	19%	40	57%	53	38%
Duct tightness	0	0%	0	0%	0	0%

Despite finding four measures to be frequently present in the permit data, the team determined that foundation and wall insulation values could not be extracted solely from the permits due to a lack of information on insulation installation quality (IIQ).[6] The previous Idaho field study found that 100% of the ceiling IIQ observations were Grade I, but only one third of the wall and foundation installation observations were. Therefore, this study used permit data for ceiling insulation, but on-site data for wall and foundation insulation as installation quality can have a significant impact on energy efficiency. In addition to the results from the prior field study, the on-site observations for the current study again showed variations in installation quality for wall and foundation insulation.

[5] In some cases, permit or permit data portals indicated that an inspection had been conducted and a home complied with the envelope and/or duct tightness requirements without showing an actual value.

[6] Minimum R-values are specified in code, but IIQ is not. However, improper installation can affect overall assembly performance. To accurately model performance, DOE recommends using IIQ as a modifier to calculate assembly U-factors (Bartlett et al 2022). Following the RESNET assessment protocol for cavity insulation, Grade I is the best quality installation and Grade III is the worst (RESNET 2024).

The team determined that the two remaining measures (windows and ceiling insulation) could be extracted from permit data and used in analysis. Window U-factors and SHGCs were frequently present in both urban and rural permits, as were ceiling insulation R-values.[7]

Limitations

Table 4 shows a summary of the limitations the IEc team faced when collecting permit data, along with the way each was addressed during the course of data collection, compilation, and analysis. It also shows the reason(s) that the team determined five of the seven key measures could not be extracted from permits for this or future studies in Idaho.[8]

As the table shows, beyond limitations leading to windows and ceiling insulation being the only key measures that could be reliably extracted from permits, the need to replace a number of jurisdictions led to fewer jurisdictions feeding into the analysis than would be ideal. Although the IEc and NEEA teams determined that replacement jurisdictions were suitable for backfilling missing permits from localities that were non-responsive and/or lacked usable permit data, this did lead to a sample plan that was not truly random as the sample plan initially intended. Although this may not have had any effects on measuring statewide compliance from the measures drawn from permits, it is possible that the jurisdictions with usable data may vary slightly from non-responding jurisdictions (for example, there might be higher rates of compliance in areas where permit data are better managed and stored), which could mean that the jurisdictions that provided data were not fully representative of all those across the state.

Table 4. Limitations for Using Permit Data

Limitation	Action to Address	Impact in this and Future Studies
Lack of response and/or usable permit data from initial sample targets	Excess permits from similar jurisdictions used to “replace” the localities without usable data from the initial sample plan Requested data from additional rural jurisdictions	Analysis of permit data is limited to jurisdictions that provided data, meaning some deviation from the original sample plan Results from permit data may not have same level of accuracy due to less variability across jurisdictions when using replacements
Lack of data on key measures in permit data	Dropped envelope tightness, duct tightness, and lighting from the list of measures that could be assessed using permits due to lack of data	Envelope tightness, duct tightness, and lighting included in analysis were not drawn from permit data and likely cannot be feasibly extracted from permits alone in future studies
Lack of qualifying information for measures represented in permit data	Dropped wall and foundation insulation from the list of measures that could be assessed using permit data due to lack of data on installation quality	Wall and foundation insulation values included in analysis were not drawn from permit data and likely cannot be feasibly extracted from permits alone in future studies

[7] Although modeling ceiling insulation is contingent on installation quality, the team determined that due to the consistently high insulation installation quality, these values could be extracted from the permits without the need for additional information. This is discussed further in the Statistical Analysis Results section below.

[8] These limitations did not affect the DOE/PNNL on-site data collection effort. As described in the following section, DOE/PNNL’s on-site data collection methodology consists entirely of site visits and does not attempt to use permit data.

On-Site Inspections

Overview

The on-site data collection followed DOE's [Residential Building Energy Code Field Study: Data Collection & Analysis](). Highlights of the DOE methodology for single-family residential buildings include:[9]

- Results based on an energy metric and reported at the state level.
- A focus on individual energy efficiency measures within new single-family homes.
- Data confidentiality built into the experimental design – no identifiable data is shared.
- Designed around a single site visit prioritizing key items.
- Designed with statistically significant results in mind at the state-wide level.

The fieldwork prioritized the seven key code elements listed in Section 1 of this report, while collecting as much additional information as possible from each site.

DOE's methodology requires at least 63 observations of each of the key items with the observations distributed across the area to reflect recent construction activity. **Appendix A – State Sampling Plan** provides the sample plan used in the current study. The team selected the sample plan from among the 10 sample plan options provided by DOE, with input from a Technical Advisory Group (TAG) convened by IEc and NEEA.[10]

The DOE methodology allows one site visit per home. As homes are in varying stages of construction when inspected (rough-in or final), the total number of homes inspected is always larger than the minimum number of observations required, as data on all seven required items will not be available for collection during any given inspection due to the varying phase at which they can be observed. The team conducted a total of 164 inspections to obtain at least 63 observations for each key measure.

Limitations

The on-site inspections following DOE's methodology provide a statistically representative view of compliance in the state. However, on-site inspections can be costly and time-consuming to conduct. Therefore, one of NEEA's goals for this study was to test the extent to which permit data can be used to assess compliance. As explained in Section 3 below, this analysis includes both types of data.

Because DOE's sample plans are weighted toward areas with the highest levels of building activity, they tend not to represent more rural areas of the state. The permit data collection for this study aimed to represent rural and urban areas.

Interviews

Overview/Purpose

To help provide ground-truthing for the permit and on-site results, and as a supplemental source of information to give insight into code compliance across the State, the IEc team conducted

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[9] Residential Building Energy Code Field Study: Data Collection & Analysis Methodology. September 2022. https://www.energycodes.gov/sites/default/files/2022-09/bto-Res-Field-Study-Methodology--updated.pdf

[10] Convening a TAG is a standard recommended step in DOE's methodology. TAG participants for this study included representatives from City of Ammon; Office of Energy and Mineral Resources; City of Boise; Idaho Energy Circuit Rider; Idaho Power; Idaho Division of Building Safety; and City of Nampa.

interviews with code officials and builders across Idaho. The team initially targeted five interviews from each group. Ultimately, the team was only able to speak to two builders in addition to five code officials (described further in the Recruitment challenges subsection below). The interviews focused on asking builders and code officials about the following topics:

- Difficulties builders face to complying with the seven key measures or any other aspects of the energy code (for example, costs of obtaining materials, installation costs, availability of skilled labor, rigor of enforcement of the building energy code, clarity of code requirements, and pressure from homeowners).
- How the compliance/permitting process differs across jurisdictions (for builders working in multiple jurisdictions only)
- If building departments have hosted any trainings/workshops or shared materials with builders seeking additional guidance to help with energy code compliance (code officials only)
- Department size (FTEs)/level of effort required for enforcement activities (code officials only)

Sample, Approach, and Limitations

The team worked with NEEA to develop a list of 17 code officials to target for interviews. This list contained a combination of high building activity urban areas (like Boise and Post Falls) and rural, unincorporated areas. The team contacted the full list, albeit with the intent to balance respondents from each of these areas. The team was able to conduct interviews with code officials from five jurisdictions that provided a good balance of urban and rural areas: two large urban areas, one well-populated but unincorporated county area, and two smaller unincorporated areas. The interviews lasted for roughly 20-30 minutes, following the interview guide that IEc developed in collaboration with NEEA.

Although the team contacted over 20 builders, only two participated in an interview. Several factors most likely led to these low response rates, including:

- Difficulty in finding specific names/contact information for individual builders – in many cases the team had to reach out to general email addresses at a company or call the main phone number to try to find a suitable builder or their contact information. In some cases, the only avenue for outreach that the team found was to fill out a contact specific section of the builder's website.
- The timing of the outreach was mostly during the active building season (August through October), meaning builders likely had limited availability for interviews. However, the team continued follow ups in November through February with limited increased success.
- Hesitancy from builders to engage with a compliance study, where they may feel they are being "checked on" from an outside organization.

The two builders the team was able to interview were both recommended by contacts at NEEA. Each interview took approximately 20 minutes to complete, and builders were provided with a $175 incentive.

AXIS

Overview

AXIS serves as a centralized data collection, storage, and sharing hub with integrated workflow management and messaging functionality.[11] It is utilized in a number of states in the Northwest and Arizona and serves as a database for whole home data and inspection results for certified above-code homes and energy-rated code homes. AXIS contained highly relevant information for this study – values from verified on-site inspections for all seven key measures. The team initially planned to combine AXIS data with permit and on-site data, weighting AXIS data appropriately so as not to over-represent above-code homes in the sample.

Limitations

The team found only 1 out of 164 homes from on-site inspections to be present in AXIS, and no homes from the 140 permits reviewed were present in AXIS. It became apparent that the time between homes being constructed and their entry into AXIS was too long and variable to confirm whether homes from the permit and on-site data were above-code homes. In other words, despite only finding 1 of 164 inspected homes (and none from the permit review) in AXIS, it is possible that more homes will be entered into AXIS in the future. As a result, the team chose not to use the AXIS data for this study.[12] In future studies, an investigation into additional ways to cross-reference AXIS data with homes in the study would be beneficial to allow use of this highly relevant data source.

Data Analysis

Following the DOE methodology, data analysis was split into three phases, which are described in the following sections:

- **Statistical analysis** to identify compliance trends of individual measures.
- **Modeling analysis** to estimate the energy consumption of both an observed and code-compliant population of homes.
- **Savings analysis** to project the potential savings with improved energy code compliance relative to the 2018 IECC with Idaho amendments.

Statistical Analysis

The statistical analysis assessed compliance trends at the measure level based on observations from the permit and on-site data sets. Observed distributions were plotted on histograms for each of the key measures in both climate zones. In addition, summary tables provide information on the range, average, and compliance rates for the key measures, at both the climate zone and statewide levels. The histograms and summary tables provide insight into the prevalence of installed measures and the range of below-code and above-code observations, which can help identify areas for improvement.

Energy Analysis

Following the DOE methodology, this study uses an energy metric to assess compliance. As described in DOE's 2022 *DOE Residential Building Energy Code Field Study: Data Collection & Analysis Methodology*, earlier studies only tracked whether a measure complied or not, which did not provide information on the level of noncompliance nor the resulting energy impact. An energy

[11] https://www.pivotalenergysolutions.com/

[12] Because these were drawn to be a representative sample of the state, homes ultimately present in AXIS should be statistically represented proportionally.

metric provides information on the energy saving potential by measure, which can inform more fine-tuned training and education efforts. As described in the methodology, "An energy metric has the further benefit of allowing the results to be compared against different baseline and across geographic regions, which is of significant interest to utilities, government agencies, and others supporting energy-efficiency programs…. Ultimately, the results are used to identify household savings opportunities, develop more effective and targeted training programs, create and validate more accurate energy forecasts, inform industry consensus processes, and serve as a baseline for broader energy-efficiency programs and Research and Development (R&D) efforts."

To complete the energy analysis, the measure distributions from the statistical analysis were used as inputs into a large-scale Monte Carlo energy modeling analysis. Monte Carlos are a general group of algorithms that all contain some stochastic element. They are often implemented with calculations where there is uncertainty in input variables, interactions between variables, and/or an interest in doing a sensitivity analysis. For this study, a Monte Carlo analysis was used to simulate a representative sample of potential measure combinations without having full sets of measure inputs from any given home (due to permit data, site visit, and construction schedule limitations).

The team developed a set of custom EnergyPlus models based on PNNL's 2018 residential prototype models for the foundations, HVAC types, and climate zones observed in Idaho. The team first developed a code-minimum set of models (exactly meeting minimum code requirements). Modeling details are included in the EnergyPlus and OpenStudio section in **Appendix C – Modeling Methodology**. These custom code-compliant models were then used as inputs for the OpenStudio Parametric Analysis Tool to simulate the as-built conditions observed for the key measures.[13] This resulted in upwards of 13,500 simulations within the state.

The output of this task was a histogram that compares the actual statewide average energy consumption to a code-compliant baseline, which mirrors the previous Idaho field study. Specifically, a histogram shows the weighted average regulated energy use intensity (EUI) of the observed data set (from permit and on-site data) compared to the expected weighted average regulated consumption based on homes that exactly met the prescriptive code requirements.[14]

Savings Analysis

The savings analysis summarized which of the seven key measures frequently did not meet code requirements. Potential savings were calculated for each of these measures individually. Another set of models was analyzed to compare the code-compliant EUI to that of a building where all measures are compliant except for the individual measure being studied. The difference in energy use represents the savings potential of increased compliance for that measure. The savings analysis reported the potential energy savings at the level of the individual home, climate zone, and state, as well as statewide energy cost and emissions savings. Savings were weighted using construction starts in each climate zone to obtain the average statewide energy savings potential. In addition, Idaho-specific fuel prices and emission factors were used to calculate the potential energy cost and emission savings. Details on the energy cost and emission factor assumptions are included in the Idaho Fuel Prices and Emission Factors section in Appendix C.

[13] OpenStudio uses the EnergyPlus simulation engine and the EnergyPlus files generated can be extracted.
[14] Regulated end uses include heating, cooling, lighting (interior + exterior), fans, and domestic hot water. The weights were defined by the frequency of field-observed heating system and foundation type combinations (which is how the PNNL prototype files are differentiated).

Limitations

In general, the data collected for each individual home is an incomplete data set, so it is not possible to determine whether individual homes are compliant. As discussed above, this study relies on an energy compliance metric instead.

The prototype Monte Carlo modeling approach means that no individual home from the permit and on-site data sets were modeled. As a result, site-specific variables such as size, height, orientation, window area, and floor-to-ceiling height are not included in the analysis. Further, these variables are not a component of the Idaho code.

The savings analysis methodology does not account for interactive effects between measures. However, isolating the savings potential by measure will help stakeholders to prioritize where they should focus their efforts to increase compliance. As an illustrative example of interactive effects, high-efficacy lighting lowers the lighting energy use, but it can also result in higher heating and lower cooling demand. As noted in the *DOE Residential Building Energy Code Field Study,* “In a typical real building, the savings potential might be higher or lower; however, additional investigation indicated that the relative impact of such interactions is very small and could safely be ignored without changing the basic conclusions of the analysis.”

3 Compliance Results

Statistical Analysis Results

This section summarizes compliance results for homes built under the IECC 2018 with Idaho amendments, which went into effect in July 2021.

Table 5 summarizes the number of observations, and the data source for each key item.[15]

The results in this section summarize the permit data for window U-factor, window SHGC, and ceiling insulation. A comparison of permit vs. on-site data is available in **Table 32. On-site inspection sample** plan

Location	Number of Measures
Ada County	20
Canyon County	12
Kootenai County	6
Bonneville County	4
Teton County	3
Payette County	3
Twin Falls County	2
Valley County	2
Madison County	2
Minidoka County	2
Bannock County	1
Jefferson County	1
Gem County	1
Bonner County	1
Franklin County	0*
Jerome County	1*
Cassia County	1
Nez Perce County	1

* The team replaced the Franklin County observation with nearby Jerome County because the field inspectors were able to find only one home under construction in Frankin County.

[15] The team requested an equal number of permits from urban and rural areas, and data are therefore weighed to account for different levels in building activity between these groups. On-site data are not weighted as the inspection sample plan takes level of building activity into account.

Appendix B – Additional Data. All other measures reported in this section are based on data collected from on-site inspections. All observations in the previous study were collected from on-site inspections.

As noted above, window U-factor, wall insulation, basement and crawlspace wall insulation, envelope tightness, and lighting all have more stringent requirements under the 2018 IECC with Idaho amendments compared to the previous code cycle (2015 IECC with Idaho amendments).

Key observations from the analysis include:

- There continue to be high rates of compliance at the state level for window U-factor, ceiling insulation, lighting, and unvented crawlspace wall insulation.
- Compared to the 2015 IECC with Idaho amendments, compliance rates under the 2018 IECC with Idaho amendments show:
    - There is notably improved compliance in floor insulation, basement insulation, and duct leakage statewide, as well as wall insulation in CZ5.
    - There are lower rates of compliance for window U-factor and wall insulation in CZ6, which both had more stringent requirements as compared to the previous code cycle.
- Under the current code (2018 IECC with Idaho amendments), external wall insulation has the lowest rate of compliance and the highest potential for energy savings if the non-compliant homes were brought to code-minimum levels. Two key areas for improvement are IIQ statewide and insulation R-value in CZ6.

Ninety-one percent of the individual observations were compliant. However, since the data collected for each individual home is an incomplete data set, it is not possible to determine whether the homes are compliant as a whole from the individual observations. As discussed above, this study relies on an energy compliance metric instead. Those results are included in the **Energy Analysis Results** section below.

More detailed results for each of these key measures are included in the sections below.

Table 5. Observation counts and data sources

Measure	Number of Observations CZ 5	CZ 6	Statewide	Data Source
Envelope Tightness	49	14	**63**	On-site
Window U-factor	82	6	**88**	Permit
Wall Insulation R-value	44	19	**63**	On-site
Wall Insulation U-factor	44	18	**62**	On-site
Ceiling Insulation	75	11	**86**	Permit
Lighting	49	14	**63**	On-site
Floor insulation R-value	31	7	**38**	On-site
Floor insulation U-factor	28	6	**34**	On-site
Basement wall R-value	1	3	**4**	On-site
Unvented Crawl R-value	13	5	**18**	On-site
Unvented Crawl U-factor	11	4	**15**	On-site
Raw Duct Tightness	48	15	**63**	On-site
Adjusted Duct Tightness	48	15	**63**	On-site

Foundation, Space Heating, and Domestic Hot Water Types

The two main foundation types observed in Idaho were floors over vented crawlspaces (61.3%) and unvented crawlspaces (29.0%), as shown in **Table 6**. Slabs were only observed in CZ5, representing 3.2% of the foundations statewide. Basements were more common in CZ6 than CZ5, representing 6.5% of the foundations statewide.

Table 6. Idaho foundation types

	Foundation Type CZ5	CZ6	Statewide
Unvented Crawlspace	27.7%	33.3%	29.0%
Vented Crawlspace	66.0%	46.7%	61.3%
Slab	4.3%	0.0%	3.2%
Basement	2.1%	20.0%	6.5%

Ninety-six percent of the space heating systems are natural gas furnaces, while 4% are some form of electric as shown in **Table 7**.

Table 7. Idaho space heating fuel source and type

		Space Heating		
		CZ5	CZ6	Statewide
Fuel Source	Gas	96.5%	92.6%	95.7%
	Electric	3.5%	7.4%	4.3%
Type	Furnace	97.2%	92.0%	96.2%
	Heat Pump	2.8%	4%	3.0%
	Electric Heater	0.0%	4%	0.8%

Ninety percent of the domestic hot water (DHW) heating uses natural gas, while 10% is electric as shown in **Table 8**. Eighty-eight percent of the observations were tank systems and 12% were tankless systems.

Table 8. Idaho domestic hot water fuel source and type

		Domestic Hot Water		
		CZ5	CZ6	Statewide
Fuel Source	Gas	89.8%	93.3%	90.5%
	Electric	10.2%	6.7%	9.5%
Type	Tank	84.9%	100.0%	87.9%
	Tankless	15.1%	0.0%	12.1%

Key Elements

The following sections include histograms and summary tables for the key measure observations. **Figure 1** shows the elements of an example histogram. The x-axis shows the value of key measure metric observed, while the y-axis shows the number of observations with that value. Observations in CZ5 are shown in blue and observations in CZ6 are shown in orange. The box in the upper right shows the total number of observations and the statewide distribution average. The vertical dotted lines show the code requirement. Some measures have different requirements in CZ5 and CZ6; code requirements are noted in a summary table below each histogram.

For insulation observations, two sets of results are shown throughout the results section. The first is the wall R-value and the second is the expected assembly U-factor, which also accounts for the insulation installation quality (IIQ) grades observed on-site. IIQ is discussed in more detail in Impact of Insulation Installation Quality section. The R-value results indicate whether the correct R-value insulation is installed. The U-factor results show whether the combination of the installed R-value and the IIQ grade meet the U-factor requirements. Non-compliance for insulation may result from the wrong amount of insulation, improper installation, or a combination of both.

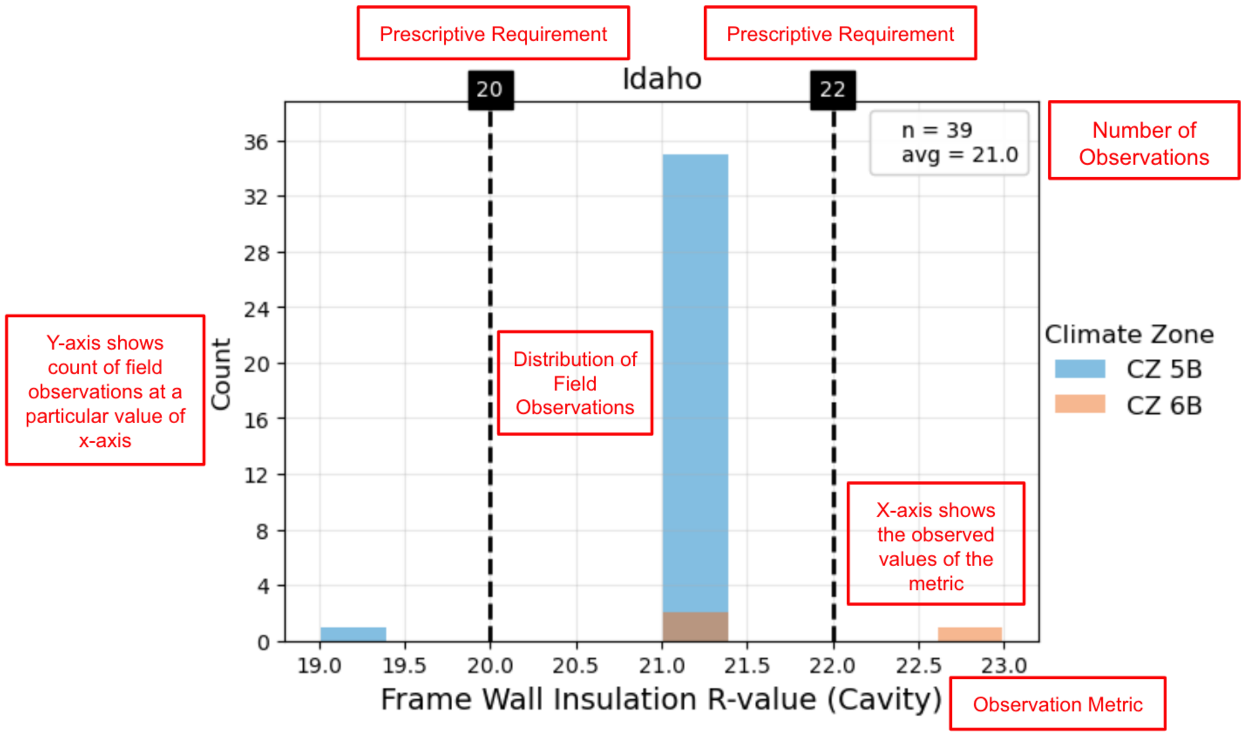

Figure 1. Example histogram

Envelope Tightness

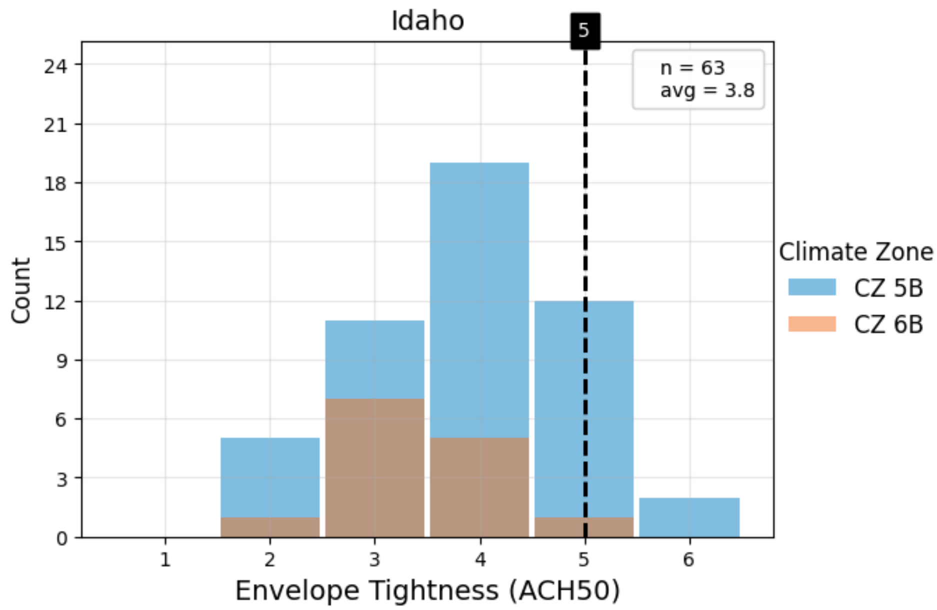

Figure 2. Envelope tightness (ACH50) by CZ

Table 9. Envelope tightness (ACH50) by CZ

Climate Zone	CZ5	CZ6	Statewide
Number	49	14	63
Range	1.7 to 6.1	2.1 to 5.0	1.7 to 6.1
Average	3.8	3.5	3.8
Requirement	5	5	5
Compliance Rate	46 of 49 (94%)	14 of 14 (100%)	60 of 63 (95%)

Interpretations:

- Sixty of the 63 observations met or exceeded the prescriptive code requirement for envelope tightness.
- The distribution shows significantly lower air leakage (tighter envelope) than expected based on the current code requirement, with a statewide average of 3.8 ACH as compared to the required 5 ACH.
- The current Idaho code lowered the ACH requirement from 7 ACH to 5 ACH. The previous analysis had 100% compliance with an average of 4 ACH statewide. While the statewide compliance for the current code is slightly lower (95% vs. 100%), the overall statewide average air leakage has minimally improved (3.8 vs. 4 ACH).

As noted above, in addition to climate zone differences, NEEA also wanted to test whether air tightness compliance rates differ between urban (within city limits) and rural (outside of city limits) jurisdictions. This was to address anecdotal reports suggesting differences in envelope tightness between urban and rural areas.

In the chart and table below, the same data set is separated by urban vs. rural homes (rather than CZ5 vs. CZ6). Ninety-six percent of the urban homes were compliant, while 92% of the rural homes were compliant, so there is not a notable difference in envelope tightness for rural vs. urban homes. Statewide, only 5% of the homes did not meet the ACH requirements. Of the non-compliant homes, two are urban and one is rural.

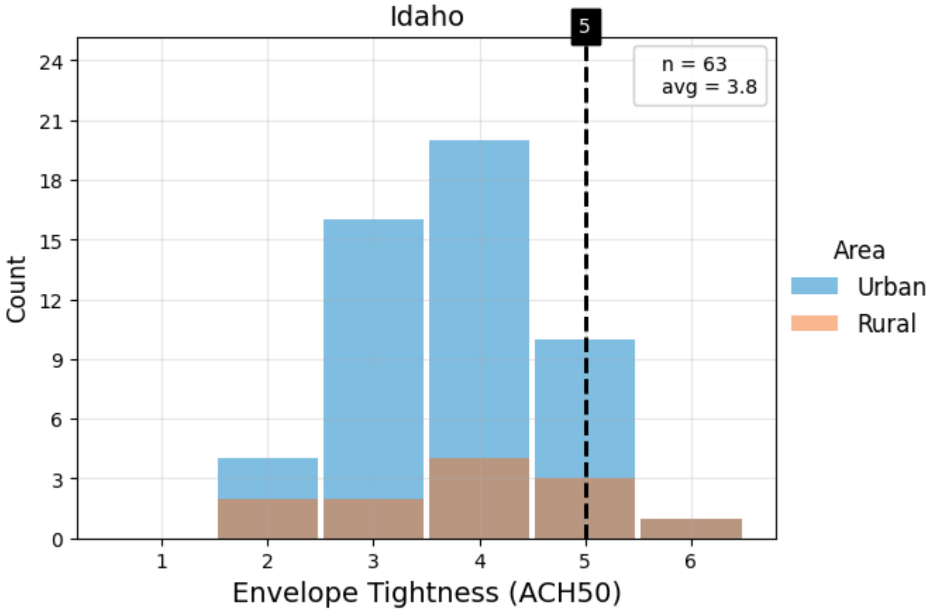

Figure 3. Envelope tightness (ACH50) in urban vs. rural homes

Table 10. Envelope tightness (ACH50) in urban vs. rural homes

Area	Urban	Rural	Statewide
Number	51	12	63
Range	2.1 to 5.5	1.7 to 6.1	1.7 to 6.1
Average	3.7	3.8	3.8
Requirement	5	5	5
Compliance Rate	49 of 51 (96%)	11 of 12 (92%)	60 of 63 (95%)

Windows

U-factor

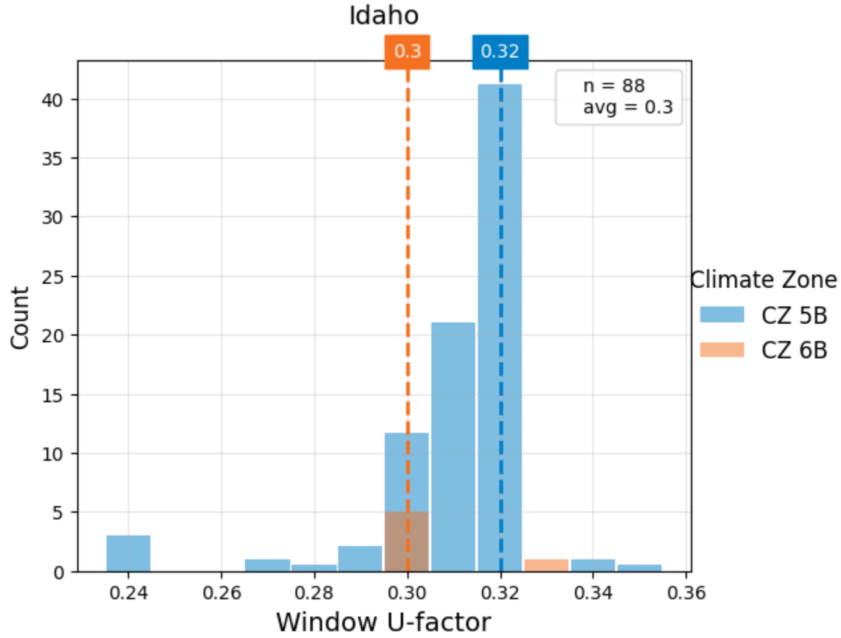

Figure 4. Window U-factor

Table 11. Window U-factor

Climate Zone	CZ5	CZ6	Statewide
Number	82	6	88
Range	0.24 to 0.35	0.30 to 0.33	0.24 to 0.35
Average	0.31	0.30	0.31
Requirement	0.32	0.30	Varies
Compliance Rate	81 of 82 (99%)	5 of 6 (83%)	86 of 88 (98%)

Interpretations:

- Eighty-six of the 88 observations met or exceeded the prescriptive code requirement (98%) for window U-factor.
- The previous Idaho code required a window U-factor of 0.35 in both CZs, which had 100% compliance in the previous analysis. The current Idaho code has more stringent requirements of 0.32 in CZ5 and 0.30 in CZ6.
- Ninety-nine percent of the observations in CZ5 complied, while only 83% of those in CZ6 did, so window U-factor in CZ6 is a potential area for modest improvement.

Solar Heat Gain Coefficient

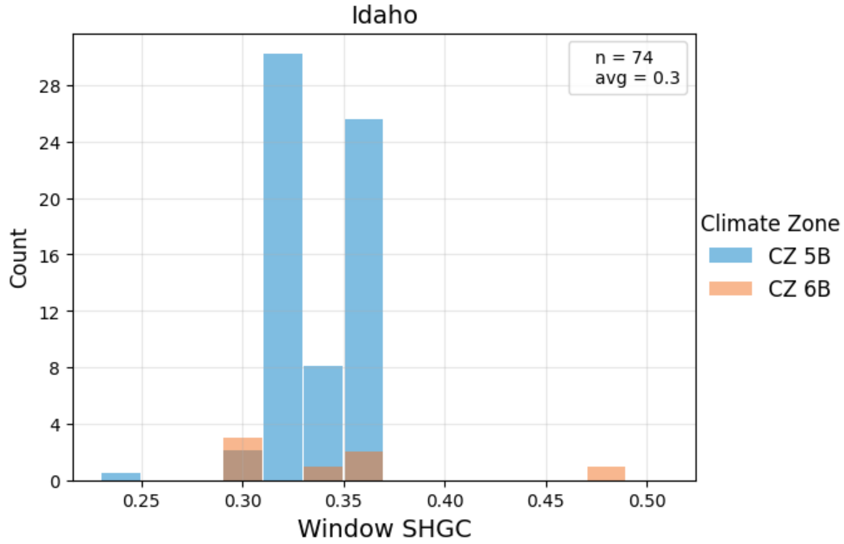

Figure 5. Window SHGC

Table 12. Window SHGC

Climate Zone	CZ5	CZ6	Statewide
Number	67	7	74
Range	0.24 to 0.35	0.30 to 0.48	0.24 to 0.48
Average	0.33	0.35	0.33
Requirement	NR	NR	NR
Compliance Rate	NA	NA	NA

Interpretations:

- There is no SHGC requirement in CZs 5 and 6, but the values ranged from 0.24 to 0.48 with a statewide average of 0.33.
- In comparison, the values ranged from 0.2 to 0.41 with a statewide average of 0.306 in the previous study.

Wall Insulation

For insulation observations throughout the results section, two charts are shown. The first is the wall R-value and the second is the expected assembly U-factor, which also accounts for the IIQ grades observed on-site.

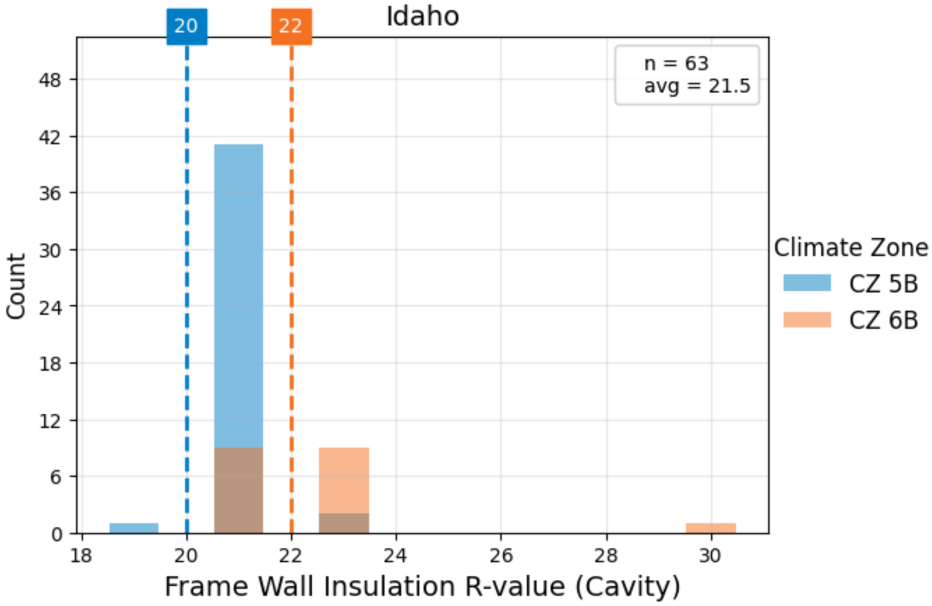

Figure 6. Wall R-values

Table 13. Wall R-values

Climate Zone	CZ5	CZ6	Statewide
Number	44	19	63
Range	19 to 23	21 to 30	19 to 30
Average	21.0	22.4	21.5
Requirement	20	22	Varies
Compliance Rate	43 of 44 (98%)	10 of 19 (53%)	53 of 63 (84%)

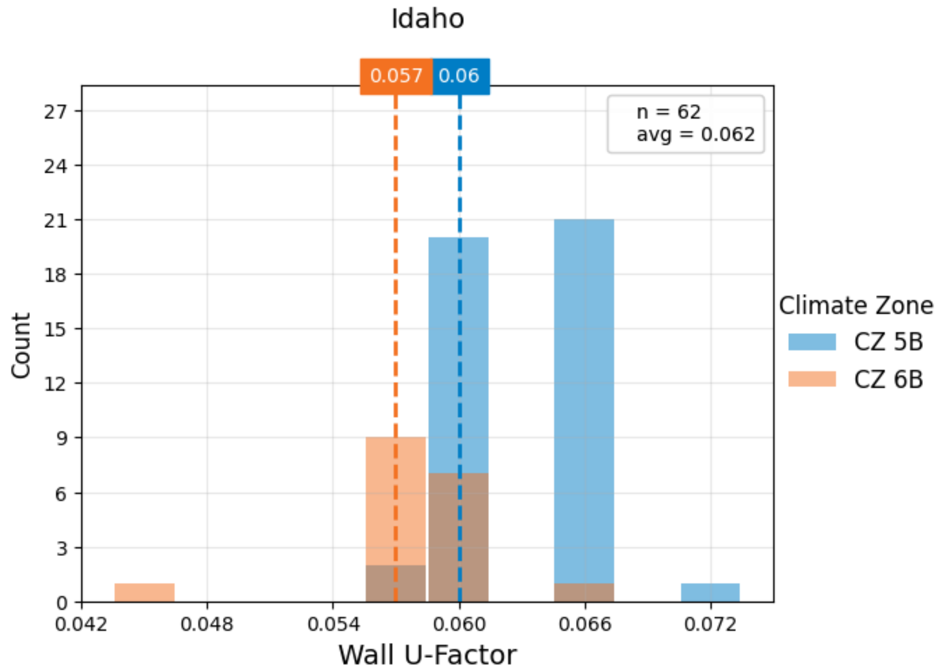

Figure 7. Wall U-factor

Table 14. Wall U-factor

Climate Zone	CZ5	CZ6	Statewide
Number	44	18	62
Range	0.056 to 0.072	0.045 to 0.067	0.045 to 0.072
Average	0.063	0.058	0.062
Assembly U-Factor (expected)	0.060	0.057	Varies
Compliance Rate	22 of 44 (50%)	10 of 18 (56%)	32 of 62 (52%)

Interpretations:

- Fifty-three of the 63 observations met or exceeded the prescriptive code requirement (84%) for wall insulation R-value.
- The current Idaho code requires R-22 wall insulation in CZ6, which is more stringent than the previous code. This is important to note because batt insulation is not available in R-22 for a 2x6 wall assembly; R-22 requires blown-in insulation or some other advanced assembly.
- While 98% of the observations in CZ5 complied for the wall R-value, only 50% complied for the expected U-factor when accounting for IIQ, so this is an area for improvement.
- Ten of the 19 observations in CZ6 complied (53%) for the wall R-value and 10 of the 18 observations with insulation installation data (56%) complied for the expected U-factor when accounting for IIQ.
- Wall R-value in CZ6 is an area for improvement, especially if builders are mistakenly using R-21 batt rather than blown-in R-22 insulation.
- Insulation installation quality statewide is another potential area for improvement.

Ceiling Insulation

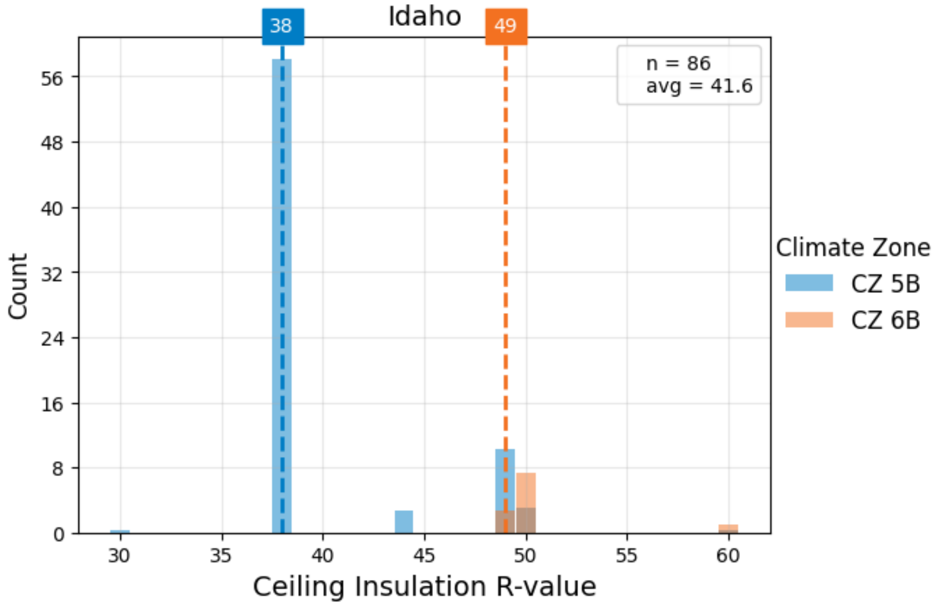

Figure 8. Ceiling R-value

Table 15. Ceiling R-value

Climate Zone	CZ5	CZ6	Statewide
Number	75	11	86
Range	30 to 60	49 to 60	30 to 60
Average	40.3	50.7	41.6
Requirement	38	49	Varies
Compliance Rate	74 of 75 (99%)	11 of 11 (100%)	85 of 86 (99%)

Interpretations:

- Eighty-five of the 86 observations met or exceeded the prescriptive code requirement (99%) for ceiling insulation R-value.
- This is similar to the previous study which found 100% compliance.

Lighting

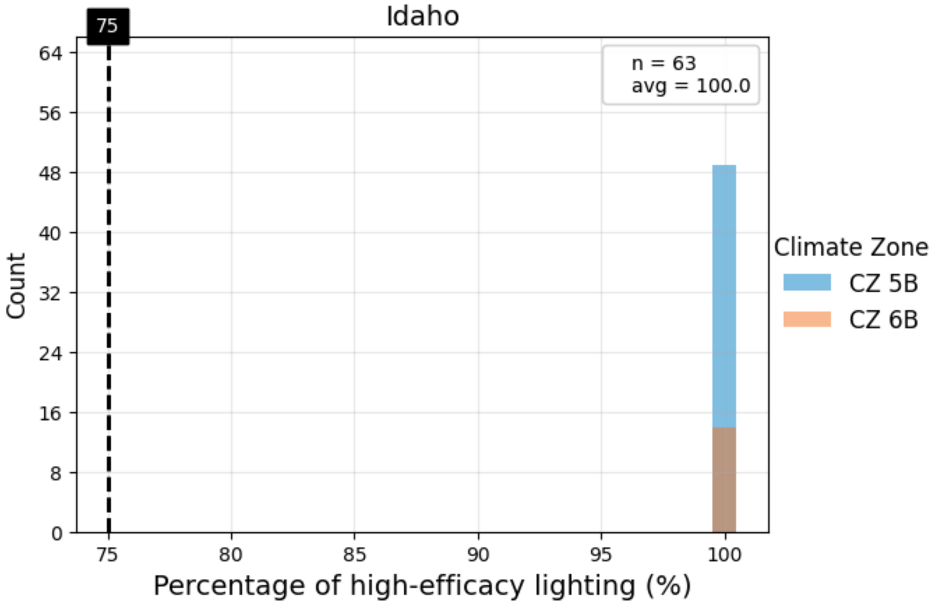

Figure 9. High-efficacy lighting percentage

Table 16. High-efficacy lighting percentage

Climate Zone	CZ5	CZ6	Statewide
Number	49	14	63
Range	100.0 to 100.0	100.0 to 100.0	100 to 100
Average	100.0	100.0	100
Requirement	75	75	75
Compliance Rate	49 of 49 (100%)	14 of 14 (100%)	63 of 63 (100%)

Interpretations:

- All of the observations installed 100% high-efficacy lighting, which exceeds the current requirement of 75%.
- The previous code only required 50% high-efficacy lighting. In the previous study, 98% of the observations met this requirement. It is notable that the previous results ranged from 4 to 100%, with a statewide average of 88% high-efficacy lighting.
- The results indicate a noticeable improvement in the percentage of high-efficacy lighting.

Foundation Insulation

The four foundation types observed in Idaho were vented crawlspaces (61.3%), unvented crawlspaces (29.0%), heated basements (6.5%), and slabs (3.2%). The two slab observations had incomplete insulation information, so slab insulation is not reported.

Insulation in Floors Over Unconditioned Spaces

Following DOE's methodology, insulation in floors over unconditioned spaces includes both vented crawlspaces and unheated basements. There were no unheated basements observed, so the results below are from homes with vented crawlspaces, which were the most common foundation type.

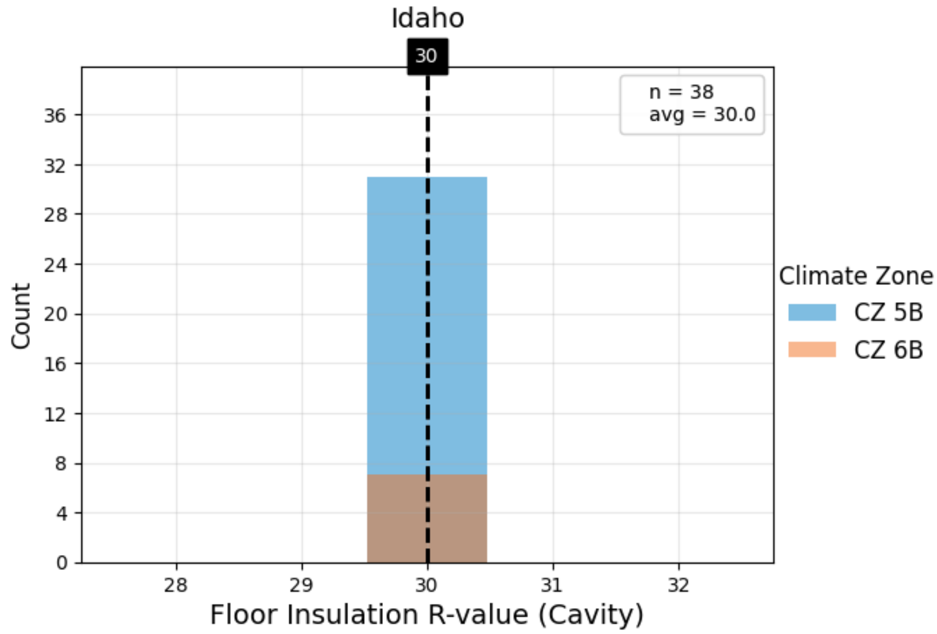

Figure 10. Floor R-value

Table 17. Floor R-value

Climate Zone	CZ5	CZ6	Statewide
Number	31	7	38
Range	30 to 30	30 to 30	30 to 30
Average	30.0	30.0	30.0
Requirement	30	30	30
Compliance Rate	31 of 31 (100%)	7 of 7 (100%)	38 of 38 (100%)

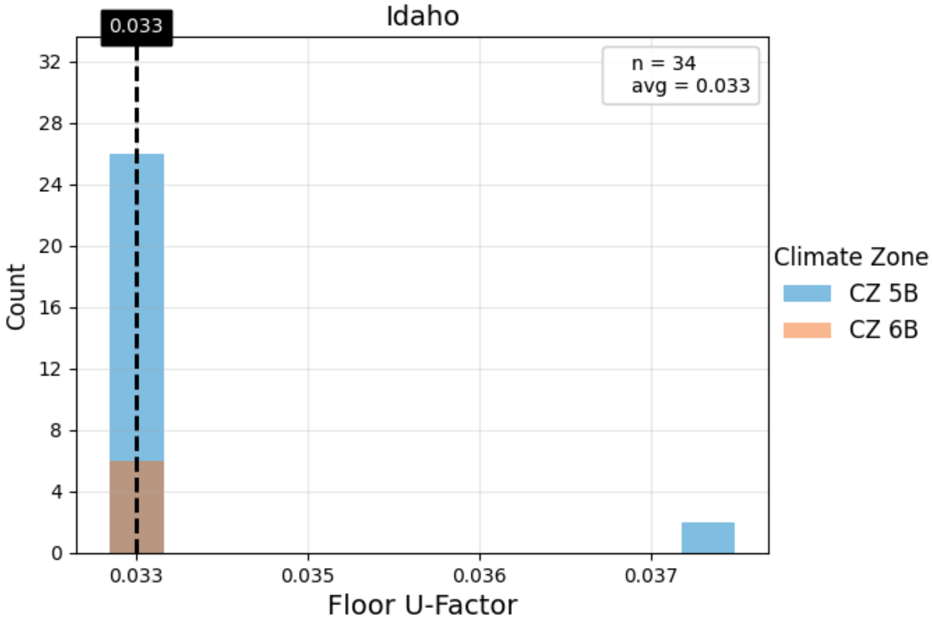

Figure 11. Floor U-factor

Table 18. Floor U-factor

Climate Zone	CZ5	CZ6	Statewide
Number	28	6	34
Range	0.033 to 0.038	0.033 to 0.033	0.033 to 0.038
Average	0.033	0.033	0.033
Assembly U-Factor (expected)	0.033	0.033	0.033
Compliance Rate	26 of 28 (93%)	6 of 6 (100%)	32 of 34 (94%)

Interpretations:

- All of the observations met the floor insulation R-value requirement exactly. All but two of these observations had Grade I IIQ, so the U-factor results are similar (94% statewide compliance).
- The previous study also found that 100% of the observations met or exceeded the floor insulation R-value requirement. However, only 50% of the observations met the expected floor U-factor when accounting for the IIQ, so there is a notable improvement in floor insulation IIQ.

Basement Wall Insulation (Conditioned Basements)

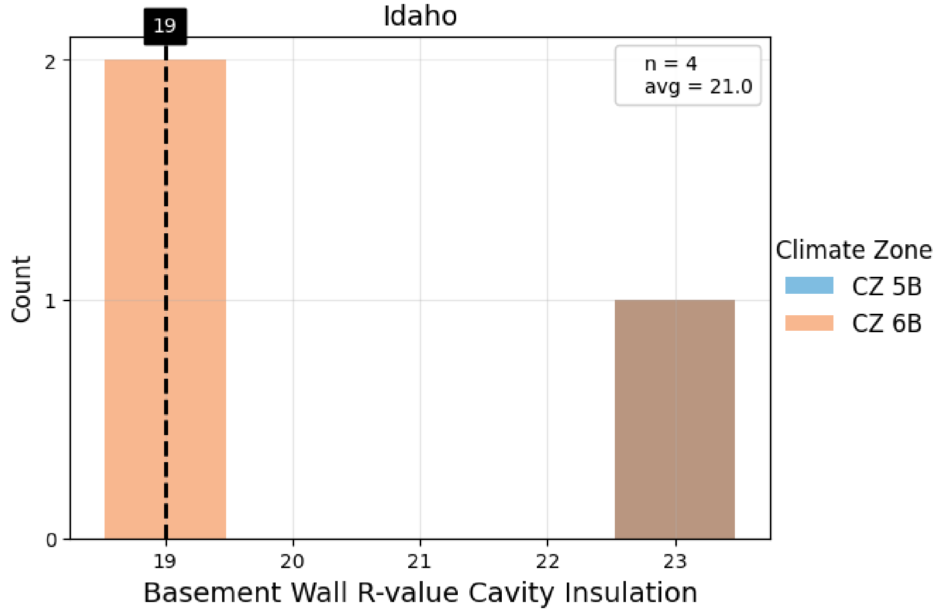

Figure 12. Basement wall R-value

Table 19. Basement wall R-value

Climate Zone	CZ5	CZ6	Statewide
Number	1	3	4
Range	23 to 23	19 to 23	19 to 23
Average	23.0	20.3	21.0
Requirement	19	19	19
Compliance Rate	1 of 1 (100%)	3 of 3 (100%)	4 of 4 (100%)

- Basements were uncommon (four total; 6.5% of the foundations statewide), but all of the observations met or exceeded the basement wall R-value requirement. This is especially notable because the CZ5 requirement increased from R-13 to R-19.
- All four observations had Grade I IIQ, so the U-factor results have the same distribution.
- The previous study found that only 27% of the observations met or exceeded the basement R-value requirement, so this is a notable improvement.

Unvented Crawlspace Wall Insulation

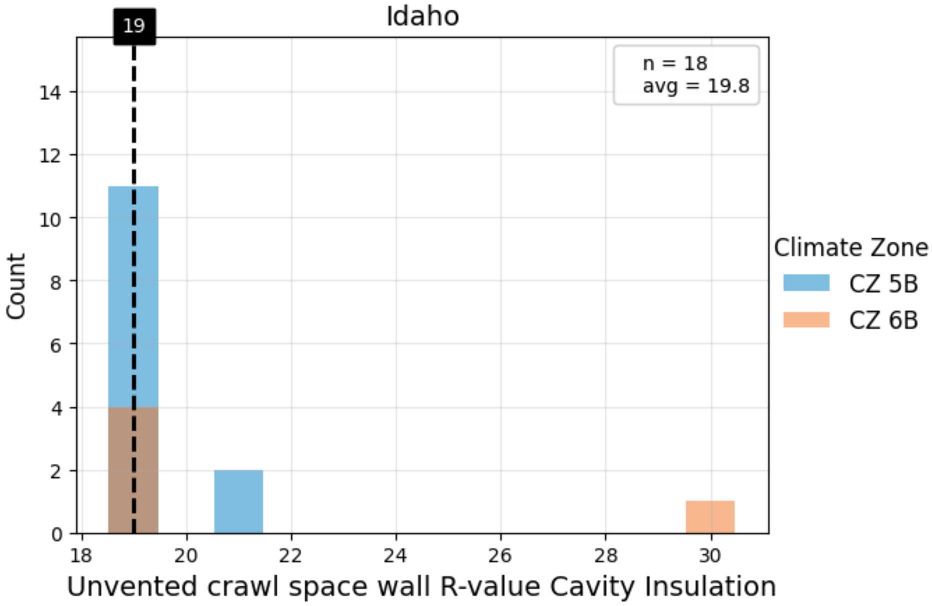

Figure 13. Unvented crawlspace wall R-value

Table 20. Unvented crawlspace wall R-value

Climate Zone	CZ5	CZ6	Statewide
Number	13	5	18
Range	19 to 21	19 to 30	19 to 30
Average	19.3	21.2	19.8
Requirement	19	19	19
Compliance Rate	13 of 13 (100%)	5 of 5 (100%)	18 of 18 (100%)

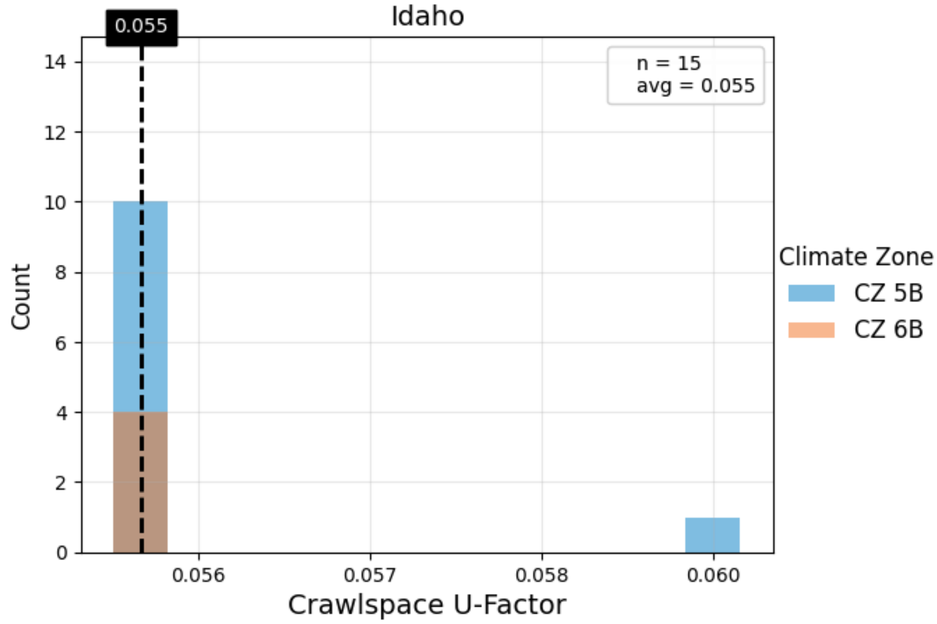

Figure 14. Unvented crawlspace wall U-factor

Table 21. Unvented crawlspace wall U-factor

Climate Zone	CZ5	CZ6	Statewide
Number	11	4	15
Range	0.055 to 0.060	0.055 to 0.055	0.055 to 0.060
Average	0.055	0.055	0.055
Assembly U-Factor (expected)	0.055	0.055	0.055
Compliance Rate	10 of 11 (91%)	4 of 4 (100%)	14 of 15 (93%)

Interpretations:

- All 15 of the observations met or exceeded the unvented crawlspace wall cavity R-value requirement, even though the requirement increased from R-13 to R-19.
- Of these results, one had Grade II IIQ with R-19 insulation, so the CZ5 U-factor compliance drops slightly to 93%.
- The previous study also found that 100% of the observations met or exceeded the requirement, although the majority of those installed continuous insulation rather than cavity insulation.

Duct Tightness

This section summarizes the duct tightness results for both raw duct leakage and adjusted duct leakage. The raw duct leakage is the value observed on-site. Adjusted duct leakage accounts for ducts in conditioned spaces. For ducts entirely in conditioned space, the adjusted duct leakage is set to zero, regardless of the observed on-site value. Tests are not required if the ducts are entirely in conditioned space, so the adjusted duct leakage is the more accurate metric for compliance rates.

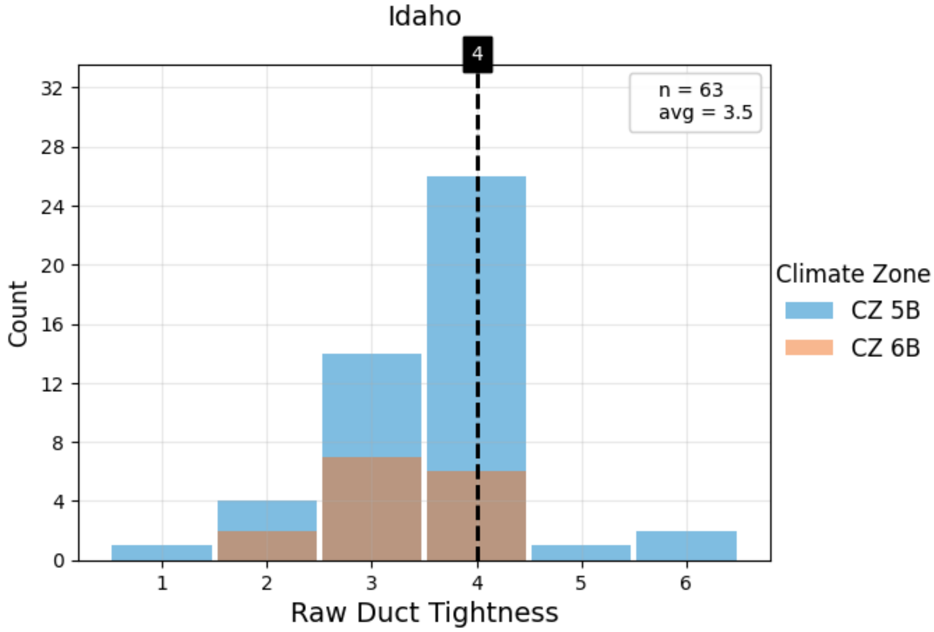

Figure 15. Raw duct tightness

Table 22. Raw duct tightness

Climate Zone	CZ5	CZ6	Statewide
Number	48	15	63
Range	1 to 6	2 to 4	1 to 6
Average	3.6	3.2	3.5
Requirement	4	4	4
Compliance Rate	41 of 48 (85%)	15 of 15 (100%)	56 of 63 (89%)

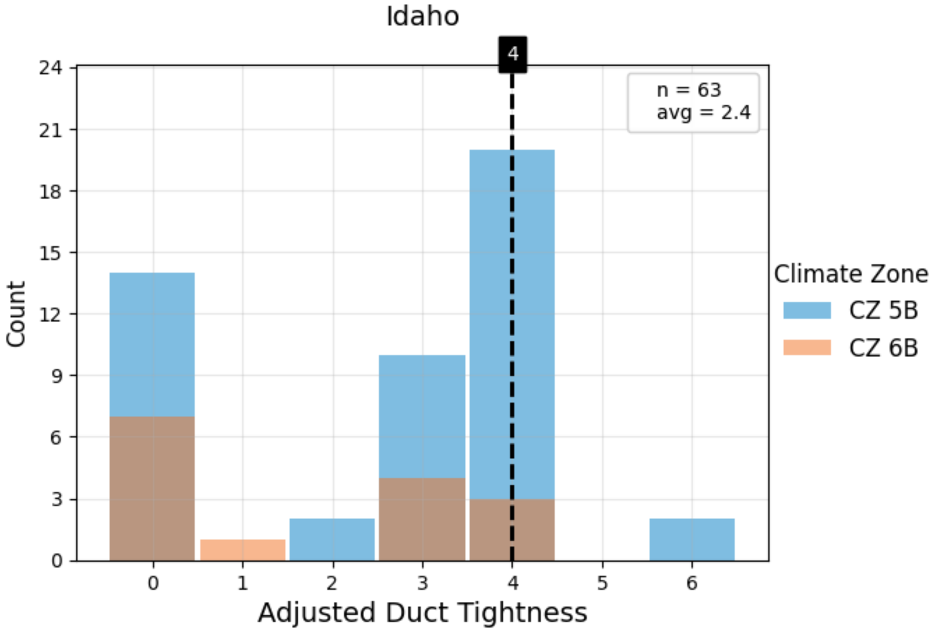

Figure 16. Adjusted duct tightness

Table 23. Adjusted duct tightness

Climate Zone	CZ5	CZ6	Statewide
Number	48	15	63
Range	0 to 6	0 to 4	0 to 6
Average	2.6	1.6	2.4
Requirement	4	4	4
Compliance Rate	43 of 48 (90%)	15 of 15 (100%)	58 of 63 (92%)

Interpretations:

- All of the raw observations in CZ6 meet the Idaho code requirement for duct tightness and 85% did in CZ5, resulting in 89% compliance statewide for raw duct leakage.
- When adjusting for ducts in conditioned spaces, compliance increases to 90% in CZ5, and 92% statewide, indicating that some homes include ducts entirely in conditioned space.
- Duct tightness compliance has improved significantly since the previous study. In the previous study, only 5% of the raw observations and 37% of the adjusted observations met the Idaho code requirement for duct leakage statewide. However, 91% of the adjusted duct tightness values in CZ6 met the requirement, also indicating that many homes installed ducts in conditioned space.
- Reducing duct leakage in unconditioned spaces is an area for modest improvement in CZ5.

Impact of Insulation Installation Quality

The DOE *Residential Building Energy Code Field Study: Data Collection & Analysis Methodology* states that:

At the start of the project, IIQ was noted as a particular concern among project teams and stakeholders as it plays an important role in the energy performance of envelope assemblies. However, insulation installation is not a requirement in the model energy codes and is not a key item by itself. Data on cavity IIQ was collected in the field and used in the analyses to modify the energy contribution from ceiling, wall, and foundation insulation.

Table 24 shows the IIQ for the observed envelope assemblies. Eighty-two percent of the observations (145 out of 176) had Grade I IIQ. Thirty-seven percent of the frame wall observations were Grade II, representing about three quarters of the Grade II observations overall. External wall IIQ is a concern and a likely target for training and education.

Table 24. Insulation installation quality

Assembly	Grade I	Grade II	Grade III	Total Observations
Ceiling	57	1	0	58
External wall	39	23	0	62
Floor over unconditioned space	32	2	0	34
Basement wall	2	2	0	4
Unvented crawlspace wall	15	3	0	18

Energy Analysis Results

The results of the statistical analysis were used as inputs into a large-scale Monte Carlo energy modeling analysis. This task compared the weighted average regulated energy consumption of the observed data set (from permit and on-site data) to the expected weighted average regulated consumption based on homes that exactly met the prescriptive code requirements. From the modeling results, regulated end uses include heating, cooling, lighting (interior + exterior), fans, and domestic hot water.

The results are shown in the histogram below, which estimates that the average home in Idaho uses *less* energy than would be expected relative to a home built to the current minimum state code requirements. Based on the observed data set, the average regulated EUI is 36.1 kBtu/ft^2-yr (dashed blue line). In comparison, homes exactly meeting minimum prescriptive energy code requirements have an average EUI of 39.4 kBtu/ft^2-yr (solid blue line). The EUI for a “typical” home in the state uses about 8% less regulated energy than a code compliant home.

Each of the models generated in the Monte Carlo analysis was compared to a minimally code-compliant model with the same heating and foundation type. In this comparison, 97.8% of the observed models had a regulated EUI less than or equal to the code compliant model. This means that the analysis predicts 97.8% compliance statewide. Note, the simulated population includes homes with above-code measures, outweighing the impact of below-code measures. This is why the average home outperforms the code-compliant average by 8%, but there is still 2.2% non-compliance.

The statewide EUI analysis shows a bimodal distribution for each climate zone. The results with lower EUI values include models with heat pumps and conditioned basements. This is because heat pumps are more efficient than gas furnaces and conditioned basements have a larger conditioned floor area, resulting in lower EUIs.

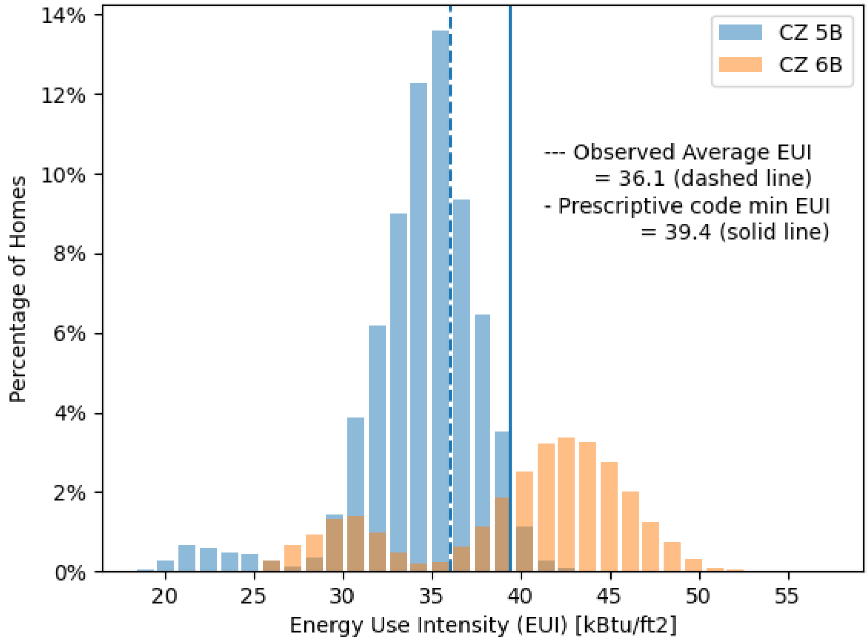

Figure 17. Statewide EUI analysis for Idaho

Savings Analysis Results

The following section summarizes the potential energy, energy cost, and emissions savings for key measures with below-code observations. Potential savings were calculated for the following key measures:[16]

Table 25. Key measures with savings potential

	2018 Idaho Code (% compliant)		
	CZ 5	CZ 6	Statewide
Envelope Tightness*	94%	100%	**95%**
Window U-factor*	99%	83%	**98%**
Wall Insulation U-factor**	50%	56%	**52%**
Floor insulation U-factor	93%	100%	**94%**
Unvented Crawl U-factor*	91%	100%	**93%**
Adjusted Duct Tightness	90%	100%	**92%**

Notes: *Current code is more stringent than the previous code statewide. **Current code is more stringent than the previous code in CZ6.

[16] Savings potential was calculated for key measures with more than 5% of observations not meeting the prescriptive code requirement in either a climate zone or statewide. For insulated assemblies, the U-factor observations are used.

The estimated savings are shown in **Table 26**. Energy savings are shown both per home and statewide, while energy cost and emissions saving are statewide. The results are shown in order of highest to lowest total savings. The foundation insulation savings include both floor insulation over heated basements and wall insulation in unvented crawlspaces. **Table 27** shows the savings breakdown by foundation type. **Table 28** shows the total statewide savings that would accumulate over 5, 10, and 30 years of construction.

Table 26. Statewide annual measure-level savings for Idaho

Measure	Climate Zone	Electricity Savings (kWh/ home)	Natural Gas Savings (Therms/ home)	Energy Savings (kBtu/ home)	Number of Homes	Total Energy Savings (MMBtu)	Total Energy Cost Savings ($)	Associated Emissions (MT CO2e)
Frame Wall U-Factor	5B	30	10	1091	8,397	9,163	99,657	508
	6B	16	7	764	3,546	2,710	28,063	149
	State Total	**26**	**9**	**994**	**11,943**	**11,873**	**127,720**	**657**
Window U-factor	5B	-0.1	0.2	23	8,397	190	1,540	10
	6B	1.8	3.4	343	3,546	1,215	10,854	65
	State Total	**0.5**	**1.2**	**118**	**11,943**	**1,405**	**12,394**	**75**
Envelope Leakage (ACH50)	5B	0.4	1.6	162	8,397	1,360	11,824	73
	State Total	**0.4**	**1.6**	**162**	**8,397**	**1,360**	**11,824**	**73**
Adjusted Duct Leakage	5B	**2.1**	0.4	49	8,397	412	5,026	23
	State Total	**2.1**	**0.4**	**49**	**8,397**	**412**	**5,026**	**23**
Foundation Insulation	5B	-0.3	0.2	14	7,861	111	728	5.7
	State Total	-0.3	**0.2**	**14**	**7,861**	**111**	**728**	**5.7**
TOTAL		**28**	**12**	**1,269**	**11,943**	**15,161**	**157,692**	**834**

Notes: Negative values mean that savings or reductions decrease if the measure is brought up to code. See Table 27 below for annual measure-level savings results by foundation type.

Table 27. Statewide annual measure-level savings by foundation type for Idaho

Measure	Climate Zone	Electricity Savings (kWh/ home)	Natural Gas Savings (Therms/ home)	Energy Savings (kBtu/ home)	Number of Homes	Total Energy Savings (MMBtu)	Total Energy Cost Savings ($)	Associated Emissions (MT CO2e)
Floor U-Factor	5B	-0.4	0.2	20	5,538	109	714	5.64
	State Total	**-0.4**	**0.2**	**20**	**5,538**	**109**	**714**	**5.64**
Crawlspace Wall U-Factor	5B	0.0	0.0	0.7	2,323	1.6	14	0.09
	State Total	**0.0**	**0.0**	**0.7**	**2,323**	**1.6**	**14**	**0.09**
TOTAL		**-0.3**	**0.2**	**14**	**7,861**	**111**	**728**	**5.72**

Notes: Increased insulation results in lower natural gas usage in the winter but higher electricity usage in the summer. For foundation measures, the total number of homes is multiplied by the foundation share for each foundation type and is therefore smaller than the total number of homes shown for other measures.

Table 28. Five-, ten-, and thirty-year cumulative annual statewide savings for Idaho

Measure	Total Energy Savings (MMBtu)			Total Energy Cost Savings ($)			Associated Emissions (MTCO2e)		
	5yr	10yr	30yr	5yr	10yr	30yr	5yr	10yr	30yr
Frame Wall U-Factor	178,097	653,023	5,521,011	1,915,798	7,024,592	59,389,735	9,856	36,139	305,540
Window U-factor	21,068	77,249	653,109	185,904	681,649	5,763,035	1,129	4,141	35,008
Envelope Leakage (ACH50)	20,407	74,826	632,624	177,357	650,308	5,498,057	1,091	4,002	33,835
Adjusted Duct Leakage	6,185	22,677	191,725	75,395	276,448	2,337,240	350	1,284	10,858
Foundation Insulation	1,664	6,103	51,598	10,923	40,051	338,609	86	315	2,661
Total	**227,422**	**833,879**	**7,050,067**	**2,365,377**	**8,673,048**	**73,326,677**	**12,513**	**45,881**	**387,902**

Above-Code Observations

Overall, about half of the individual observations exceeded the prescriptive code requirements. **Table 29** summarizes the percentage of above-code observations for each key measure. Of particular note, 95% of the envelope tightness, 100% of the lighting, and 92% of the adjusted duct tightness observations exceeded the prescriptive code requirements statewide. Eighty-four percent of the external wall insulation R-values exceeded code, but only 19% of the U-values did when accounting for IIQ.

Table 29. Summary of above-code observations

	% of above-code observations		
	CZ 5	CZ 6	Statewide
Envelope Tightness	94%	100%	**95%**
Window U-factor	48%	0%	**44%**
External wall R-value	98%	53%	**84%**
External wall U-factor	5%	56%	**19%**
Ceiling R-value	21%	73%	**28%**
Ceiling U-factor	11%	0%	**9%**
High-efficacy lighting	100%	100%	**100%**
Floor R-value	0%	0%	**0%**
Floor U-Factor	0%	0%	**0%**
Basement R-value	100%	33%	**50%**
Basement U-factor	100%	33%	**50%**
Crawlspace R-value	15%	20%	**17%**
Crawlspace U-factor	0%	0%	**0%**
Adjusted duct tightness	90%	100%	**92%**

Comparison to the 2015 IECC with Idaho Amendments

The results of the current study are also compared to the previous study to track how compliance rates have changed since the last code cycle. **Table** summarizes the measure level compliance rates for the previous study and the current results. Red text indicates a lower compliance rate and green text indicates a higher compliance rate for the current study as compared to the previous study. Key measures with similar compliance levels are black. Envelope tightness, lighting, and basement and unvented crawlspace wall insulation requirements are more stringent statewide. Wall insulation requirements are more stringent in CZ 6.

Table 300. Comparison of measure level compliance rates under the 2015 and 2018 IECC with Idaho Amendments

	2015 Idaho Code (% compliant)			2018 Idaho Code (% compliant)		
	CZ 5	**CZ 6**	**Statewide**	**CZ 5**	**CZ 6**	**Statewide**
Envelope Tightness*	100%	100%	**100%**	94%	100%	**95%**
Window U-factor*	100%	100%	**100%**	99%	83%	**98%**
Wall Insulation R-value**	21%	100%	**83%**	98%	53%	**84%**
Wall Insulation U-factor**	30%	82%	**39%**	50%	56%	**52%**
Ceiling Insulation	100%	100%	**100%**	99%	100%	**99%**
Lighting*	98%	100%	**98%**	100%	100%	**100%**
Floor insulation R-value	58%	N/A	**58%**	100%	100%	**100%**
Floor insulation U-factor	58%	N/A	**58%**	93%	100%	**94%**
Basement wall R-value*	50%	22%	**27%**	100%	100%	**100%**
Unvented Crawl R-value*	100%	100%	**100%**	100%	100%	**100%**
Unvented Crawl U-factor*	94%	100%	**94%**	91%	100%	**93%**
Raw Duct Tightness	6%	0%	**5%**	85%	100%	**89%**
Adjusted Duct Tightness	32%	91%	**37%**	90%	100%	**92%**

Notes: *Current code is more stringent than the previous code statewide. **Current code is more stringent than the previous code in CZ6.

Table provides an overall comparison of the results in both studies. The only key measures that had lower compliance rates in the current study were window U-factor and wall insulation in CZ6. In both cases the current code was more stringent than the previous code. Compliance remained high for envelope leakage, ceiling insulation, lighting, and unvented crawlspace wall insulation. Duct tightness and floor and basement wall insulation all shifted from low to high compliance in the current study. When looking at the actual measure values for each, in general the current study has similar or higher efficiency levels, with especially notable improvement in lighting efficacy, basement wall insulation, and duct tightness.

The EUI for a "typical" home in the state uses about 8% less regulated energy than a code compliant home. In comparison, the previous study found that typical homes used about 15% less regulated energy than a code compliant home.

In the current study, potential statewide annual energy savings are 15,161 MMBtu, which results in $157,692 in energy cost savings and 834 MT CO_2e in emission reductions. In the previous study, the potential annual savings were 46,436 MMBtu in energy savings and $479,819 in energy cost savings. Emissions reductions were not included in the previous study.

Of note, in the previous study, duct tightness was the key measure with the highest potential savings, representing almost two thirds of the savings potential for both energy and cost. The potential annual duct tightness savings were 27,966 MMBtu in energy savings and $307,201 in energy cost savings. With increased compliance, these were 412 MMBtu and $5,026 in the current study. The total potential annual energy savings in the previous study were 31,275 MMBtu higher than the current study; the duct tightness savings were 27,554 higher, so most of the savings potential differences result from duct tightness compliance.

Table 31. Summary of the previous study and the current study results

Key measure	Current vs. previous		Statewide average performance			Stringency
	Compliance	Performance	Prev.	Current	Units	
Envelope leakage	Both high	Higher	4	3.8	ACH at 50 Pa	More stringent (7 to 5)
Window U-factor	Both high in CZ5, Lower in CZ6	Similar	0.31	0.31	Btu/h-ft2-F	More stringent (0.35 in both to 0.32 in CZ5 and 0.30 in CZ6)
Wall insulation U-factor	All low. Higher in CZ5, lower in CZ6	Similar	0.061	0.062	Btu/h-ft2-F	More stringent in CZ6 (0.060 to 0.057)
Ceiling insulation U-factor	Both high	Similar	41.7	41.6	Btu/h-ft2-F	
Lighting	Both high	Higher	88	100	% high-efficacy	More stringent (50 to 75)
Floor insulation U-factor	Shifted from low to high	Higher	0.035	0.033	Btu/h-ft2-F	
Basement wall R-value	Shifted from low to high	Higher	14.5	21	h-ft2-F/Btu	More stringent in CZ5 (0.059 to 0.050)
Unvented crawl wall insulation U-factor	Both high	Lower	0.041	0.055	Btu/h-ft2-F	More stringent (0.065 to 0.055)
Duct tightness	Shifted from low to high	Higher	6.6	3.5	cfm per 100 ft2 of CFA at 25 Pa	

The EUI for a "typical" home in the previous study outperformed the expected code-compliant EUI by 15%; in the current study this value was only 8%. At the same time, the previous study had three times the potential energy and cost savings. It may seem counterintuitive that the comparable energy metric was better in the previous study, while also having significantly higher potential savings. A likely explanation is that the previous study had a higher rate of above-code elements. In the energy analysis, above-code observations can result in a lower average EUI, outweighing the impact of below-code observations for some key measures. As noted above, 91% of the individual observations were compliant in the current study. In comparison, 76% were compliant in the previous study.

4 Interview Results

The team conducted five code official interviews and two builder interviews. This section provides the interview findings, split into results for compliance with key measures and additional findings.

Compliance with Key Measures

During the code official interviews, respondents rated the level of difficulty builders face in complying with each key measure. During the builder interviews, builders rated their own level of difficulty in complying with the code. Respondents provided ratings on a scale of 1 to 5, where 1 meant high compliance/little trouble meeting the code requirement and 5 meant low compliance/significant difficulty in complying. **Figure 18** shows average ratings for each building/code component, overall and broken out for code officials and builders.[17]

Overall, neither the code officials nor builders reported substantial difficulty in complying with any of the code components, as none of the average ratings exceeded a 2 on the 1 to 5 scale. This aligns with the findings from the permit review and on-site study, which generally show high levels of compliance in the key measures across the state.

For each component, code officials provided slightly higher average ratings, potentially meaning that code officials observed greater difficulty with compliance than builders experienced. However, this could be due in part to both the limited number of builders the team was able to interview, along with the fact that both interviewed builders frequently built ENERGY STAR®/above-code homes so were often going above the base requirements.

Both code officials and builders reported that window U-factor and solar heat gain coefficient and percent high efficiency for lighting were the components with the highest compliance/least difficulty in complying. The average rating for windows was just under 1.2, and the average rating for lighting was 1.3. This was generally due to market availability, as most windows on the market meet the code requirements, and almost all lighting available is now LED. One code official commented that they are unsure whether one can buy a window that does not meet the requirement. Similarly, for lighting, many interviewees noted that it is difficult to find a non-high efficiency bulb.

[17] One of the code officials chose not to provide responses for this portion of the interview because they felt they were too new to their role, so responses are averaged across four code officials.

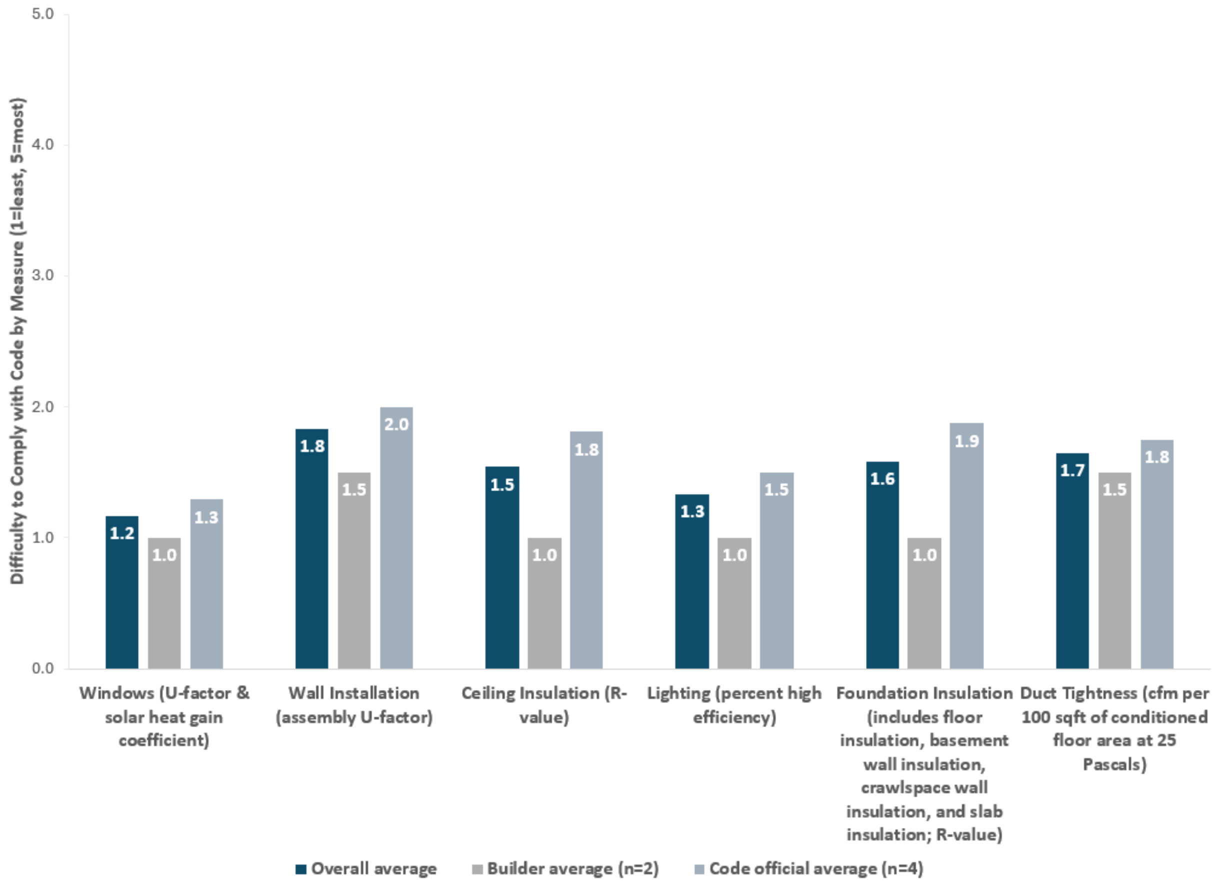

Figure 18. Interviewee ratings for difficulty complying with Idaho building/code components

While interviewees reported that assembly U-factors for wall installation and duct tightness requirements were more difficult to comply with compared to other measures, they still rated these components as fairly easy to comply with overall. Builders' average rating for wall installation was 1.5, while code officials' average rating was 2.0. Builders also rated the level of difficulty complying with duct tightness as 1.5, while code officials rated it a 1.8 on average. Regarding wall installation, one code official noted that construction companies have had difficulty filling positions with qualified personnel, especially after Covid. This has required them to conduct multiple inspections on some homes before passing them on the wall installation standards. For duct tightness, some code officials noted difficulty keeping track of which homes have had the blower door test, since it is required for just 1 in 5 homes, which added a more difficult element to tracking and measuring compliance. However, it was also noted that in many cases builders will conduct the test for every home. No rating above a 3 was reported for any measure, indicating that neither code officials nor builders found any specific elements of the code to be especially difficult for compliance.

While the results from the interviews generally align with what was observed on-site and through permit reviews, the field data suggest that there are some opportunities to improve compliance in windows, despite interviewees reporting this as being the easiest measure to comply with. This could be an area where additional information or resources could be provided to builders and code officials to ensure window requirements are being met. The main reason that respondents gave for ease of compliance was the high market availability of windows that meet or exceed code. Therefore, it is likely that non-compliance is a result of lack of awareness or cost concerns rather than an availability issue that could be readily addresses within the existing market. In other areas where the interviews and field results aligned on challenges in compliance/opportunities for improved compliance rates (for example, envelope tightness, wall insulation/installation quality), additional training would likely be required to educate the existing and new labor pool.

Additional Interview Findings

In addition to asking about experience and challenges in complying with the key measures, builders provided insight into their experiences with the compliance/permitting process across different jurisdictions, while code officials shared details on resources they have seen or provided to builders to help with compliance and the level of effort required to conduct their enforcement activities. The key takeaways from these elements of the interviews include:

Builders reported varying levels of code enforcement when working across different jurisdictions but no changes in their building practices. One builder who worked primarily in Coeur d'Alene and Post Falls, two of the highest areas for building activity in Idaho, did not report substantial differences in enforcement in these areas with both being stringent in enforcing the code. This builder further noted that as his company also works in Washington, which has more stringent code criteria, and they carry the practices they used to comply with Washington code over to Idaho, they were often building above code in Idaho. Another builder working in both the greater Boise area and surrounding counties noted that inspections are less strict outside of the greater Boise area, particularly for blower door testing. The builder reported that resources and certified testers with equipment to conduct blower testing are limited outside of the greater Boise area, so setting up and scheduling tests can be a logistical challenge.[18] However, the builder did not believe that compliance levels would necessarily be lower in the areas that were less strict due to builder experience working in enforced areas and the general ease that he found in meeting the code.

Code officials indicated newer builders may struggle with some code components, and some officials have provided trainings to address these needs. Some code officials mentioned that builders struggled with envelope tightness and meeting blower door test requirements and that they had offered trainings on this in the past. One code official specified that this was an issue due to frequent turnover in contractors' staff. No other code official indicated that they had hosted any trainings, although some expressed a desire to do so. While the lack of available labor could pose a challenge in rural areas to find qualified builders/contractors to perform work that meets energy code, this was not always the case. One code official working in a rural area indicated that due to the area's small builder pool and low turnover, they had fewer issues with new builders struggling with code compliance than they thought they might find in a larger area with more contractors entering the market without energy code knowledge/experience.

Code officials interviewed for this study generally dedicate one to two staff members and less than four hours per home on energy code certification. Code officials reported between 45

[18] In the Fall of 2023 (the same time or shortly after the interviews for this study were conducted), the requirement to conduct a blower door test at every fifth new home was removed as part of Idaho's Zero-based Regulation effort. The change allows a visual inspection of envelope tightness to be conducted in lieu of testing when other specified items are field verified. More information about this change is available at Idaho Building Code Board finalizing changes to energy efficiency regulations | Boise State Public Radio and IDAPA 24 - Division of Occupational and Professional Licenses.book (idaho.gov).

minutes and three hours spent in certifying a home for energy components, requiring one to two staff members, with the exception of one who indicated that they spend roughly eight hours doing a combined inspection of energy and non-energy components of homes. Building departments typically had one to three inspectors. One code official believed that roughly 25-30% of the homes they inspected were not initially compliant in at least one element of the energy code, requiring a re-inspection, but noted that builders were generally good at meeting requirements the first time.

Specific challenges exist for enforcing code in rural areas. Finally, the team was able to conduct one interview with two building department officials in a small county in eastern Idaho who provided substantial insight into the challenges they have faced in enforcing the energy code as a rural area. Specifically, the respondents provided the following details during the interview:

- The "biggest issue" in this jurisdiction has been educating builders about the correct ways to do the building envelope.
- Building plans often miss ventilation, attic, and crawlspace details. Builders have some confusion about ventilation when it comes to properly sealing homes and air exchanges.
- Manual J and S do not contain every county in the State, so it is difficult for this county to use the software because it does not include their jurisdiction.

The code officials expressed a desire for NEEA or another agency to develop a handout for new builders to inform them on what they need to know about energy code compliance. They mentioned they have seen substantial turnover in builders/contractors and do not feel that many of the new hires are being adequately trained. They also expressed interest in reestablishing the energy conferences that used to be held in Idaho to provide training and other opportunities for knowledge exchange.

There are a number of people in the county who build homes to live "off grid" and/or use wood stoves as a heating source. There is some struggle for the code officials to get people to add a second heating source or to correctly indicate that one is present. The energy code has requirements for heated buildings/conditioned spaces, but some builders and residents of these homes push back on these requirements.

5 Conclusions

This study provides insight into code compliance both at a measure and whole-home level under IECC 2018 with Idaho amendments. Gas continues to be the most commonly used fuel for primary space and water heating. Ninety-six percent of the space heating systems are natural gas furnaces, while 4% are some form of electric. Ninety percent of the water heating systems use natural gas, while 10% is electric.

Statewide, the average home uses about 8% less energy than a baseline home that exactly meets code requirements. From a whole-home EUI perspective, the weighted modeling results predict 97.8% compliance statewide.

These results include a mix of measures that consistently outperform code requirements (for example lighting efficacy) and others that had lower rates of compliance. So, while the average home performs better than expected, there is still the potential for savings for some measures. **Table 31** below summarizes the potential measure-level savings that could be the target for future education, training, and outreach activities. Potential statewide annual energy savings are 15,161 MMBtu, which results in $157,692 in energy cost savings and 834 MT CO_{2e} in emission reductions. Over a 30-year period, this would save 7 million MMBtu, $73 million, and 387,902 MT CO_{2e}.
By far, the highest potential for savings is in external wall insulation, which represents about 80% of the potential savings. Non-compliant external wall insulation had two main drivers: lower IIQ ratings and not meeting the more stringent insulation requirements in CZ6 (the colder of the two Idaho climate zones). While 84% of the observations met the required insulation levels statewide, more than a third of these had Grade II IIQ. As a result, only 52% of the observations statewide met the expected U-factor when accounting for IIQ. In parallel, the current Idaho code requires R-22 wall insulation in CZ6, which is more stringent than the previous code. Based on the site visits, it appears that some builders are still installing R-21 batt insulation, which is the highest R-value available for batt insulation in 2x6 wall. R-22 requires blown-in insulation or some other advanced assembly, so this is a key area for outreach and education efforts.

There are also modest potential savings for window U-factor, envelope leakage, duct leakage, foundation insulation. Window U-factor, envelope leakage, and foundation insulation all have more stringent requirements under the 2018 IECC with Idaho amendments as compared to the previous code cycle. The prescriptive code requirement for duct leakage remained at 4 cfm per 100 ft^2 of CFA at 25 Pa. There has been a notable improvement in duct leakage compliance as compared to the previous PNNL study. In the previous study, adjusted duct leakage had 37% compliance statewide. This has increased to 92% in the current analysis.

The study found that there is not a notable difference in envelope tightness compliance in urban vs. rural populations. This study did not explore whether there were differences in urban vs. rural compliance for the other key measures. Since envelope leakage had high compliance in general, urban and rural populations had similar compliance rates. It is possible there may be a difference in compliance for measures with lower compliance rates, such as external wall insulation. Future studies could consider removing this element from the scope of work. If NEEA is still interested in an urban vs. rural analysis, then they should consider expanding the scope of the rural vs. urban analysis and/or updating the sampling plan to include rural jurisdictions in more geographically remote areas than those that were included in the current study.

Table 31. Annual statewide savings potential

Key Measure	Annual Savings		
	Energy (MMBtu)	Cost ($)	Carbon (MT CO2e)
Frame Wall U-Factor	**11,873**	**127,720**	**657**
Window U-factor	**1,405**	**12,394**	**75**
Envelope Leakage (ACH50)	**1,360**	**11,824**	**73**
Adjusted Duct Leakage	**412**	**5,026**	**23**
Foundation Insulation	**111**	**728**	**5.7**
TOTAL	**15,161 MMBtu**	**$157,692**	**834 MT CO2e**

6 Recommendations

Recommendations to Improve Code Compliance

Wall insulation: Improving external wall insulation compliance represents about 80% of the potential savings. Two key areas to focus outreach and education efforts are insulation installation quality and meeting the updated R-22 requirement in CZ6. As noted above, the on-site inspections indicated that some builders are still installing R-21 batt insulation, which is the highest R-value available for batt insulation in 2x6 wall. R-22 requires blown-in insulation or some other advanced assembly. Outreach and education efforts could provide builders with information on wall assemblies that meet the R-22 requirements as well as hands-on training to familiarize them with blown-in insulation and/or advanced framing techniques.

Window U-factor, envelope leakage, duct leakage, foundation insulation: There are also modest potential savings for window U-factor, envelope leakage, duct leakage, foundation insulation. Window U-factor, envelope leakage, and foundation insulation all have more stringent requirements under the 2018 IECC with Idaho amendments as compared to the previous code cycle, so this could be a secondary focus for outreach and education efforts.

Education and outreach for code changes: Focus education and outreach efforts on key measures that have more stringent requirements as compared to the previous code cycle, especially when requirements vary by climate zone. The key measures that had lower compliances rates in the 2018 IECC with Idaho amendments as compared to the previous code cycle, window U-factor and external wall insulation in CZ6, were both measures that had more stringent and CZ-specific requirements. In the case of window U-factor, the requirements used to be the same in CZ5 and CZ6 – both became more stringent, but CZ6 is now even more stringent than CZ5, and CZ6 is where there was decreased compliance. It should be noted that interviewees from both CZs said it was easy to meet window U-factor requirements, but those in CZ6 may not have been aware of the updates. For the external wall insulation, only CZ 6 became more stringent, which is where there was decreased compliance.

Recommendations for Future Studies

Sampling

Substitutions: If a jurisdiction in the sampling plan does not have enough available data to complete the observations in the sample, DOE's methodology allows for substitutions. As noted in the methodology, some jurisdictions may not have enough available data due to a lack of homes under construction, builders who are unwilling to allow on-site inspections, or local code officials' inability to provide a list of homes under construction. Jurisdiction substitutions can be made if both locations have a similar socioeconomic status, are in the same CZ, and have a similar level of enforcement. However, if a substitution is made, it must be for a *complete* set of observations for *all* key measures. While NEEA offered some flexibility on substitutions, the simultaneous data collection for NEEA and DOE meant that the team adhered to DOE's methodology. For example, if the dataset is only missing a few observations for envelope tightness, adding observations from another jurisdiction to complete the set is not acceptable per DOE guidelines. Instead, the study should remove that jurisdiction altogether and use a complete set from a different jurisdiction. This can pose a challenge to the study team because they may be well into the on-site data collection process before they know that they are unable to collect enough datapoints. Substituting an entirely new jurisdiction at this point can result in higher costs and delayed timelines. If a study is collecting data for both DOE and NEEA, then these substitutions requirements need to be met, as was the case in this study. However, if a study is only collecting data for NEEA, there may be more flexibility.

> **Recommendation: Future studies should consider allowing more flexibility in jurisdiction data substitutions to conserve time and resources.**

Data sources: The sampling design in DOE's field study methodology is based on county-level building activity data for the last three years from the U.S. Census. This methodology assumes that on-site inspections are the only data source. Measure distribution data from the on-site inspections feeds into Monte Carlo modeling to develop a set of simulations that are statistically representative of the state's newly constructed homes. If multiple sources of data are used, it is essential to coordinate between the data sets (for example, permits and on-site inspections) to maintain the appropriate sample sizes in each jurisdiction, either by selecting a subset of observations or applying weights to each observation. As an example, care must be taken to not oversample above-code homes if using an above-code database such as AXIS. An additional consideration for AXIS is to better understand the timing of when above-code homes are recorded in AXIS so that observations from other data sources (permits, on-site inspections) can be crosschecked and weighted appropriately with AXIS data.

> **Recommendation: If studies use multiple data sources, evaluators should coordinate across data sets to maintain the appropriate sample sizes in each jurisdiction and ensure that above-code homes are weighted proportionally to their share of the population.**

Data Collection

Insulation installation quality: The previous Idaho field study found that 100% of the ceiling IIQ observations were Grade I, but only a third of the wall and foundation installation observations were. As a result, the current study used permit data for ceiling insulation, but on-site data for wall and foundation insulation to collect IIQ data, which is not available in the permits. A challenge with IIQ on-site inspections is that they need to be conducted before the assemblies are closed. This is earlier in the construction process than envelope or duct tightness testing, so gathering this data can require significantly more site visits. In this study, over 90% of the foundation observations were Grade I, while only 2/3 of the external wall observations were, which is an improvement from the previous study.

Recommendation: Future studies could consider only using on-site insulation data for the external wall insulation.

Lighting: There was no information about the percentage of high-efficacy lighting in the permits, so data for this key measure was collected through on-site inspections. In the previous study this measure had 99% compliance. In the current study, there was 100% high-efficacy lighting at all sites, significantly outperforming the prescriptive requirement of 75% high-efficacy lighting. Given the ubiquitous use of high-efficacy lighting, it is likely that this will be the standard installation moving forward. If on-site collections are done, data on high-efficacy lighting should be gathered, but on-site inspections completed just to complete data collection on lighting are unlikely to change the findings.

Recommendation: Future studies should consider loosening the data collection requirements for high-efficacy lighting.

Duct tightness: After completing an initial round of on-site inspections, the team discovered that duct tightness was documented in cubic feet per minute (CFM) rather than CFM per 100 ft^2 of conditioned floor area (CFA) at 25 Pascals. The testing equipment reports duct leakage in CFM while the DOE collection form requires CFM/100 ft^2 of CFA (which matches the code requirement). The conversion is a minor calculation, but this is a mistake that could easily be made by other inspectors reporting the number shown on their equipment. The team discovered this when the values were an order of magnitude higher than expected and was able to correct the units for data analysis.

Recommendation: Confirm duct tightness is documented in CFM/100 ft^2 of CFA at 25 Pascals (rather than in CFM).

On-site inspections: Completing on-site inspections is a rich source of data. However, they are time intensive and require a significant project budget. As part of this study NEEA was interested in exploring the use of other data sources that are less time- and cost-intensive. In this study, on-site inspections were used for all key measures except window specifications and ceiling insulation. As noted above, future studies may want to consider using permit data for foundation insulation and lowering the requirements for lighting-efficacy data collection.

Recommendation: If on-site inspections are included, consider focusing on envelope tightness, duct tightness, and external wall IIQ.

Appendix A – State Sampling Plan

Table 32 shows the final sample plan that the team used to conduct the on-site inspections. As described in Section 2, this plan was selected from ten options provided by DOE/PNNL by the IEc team in conjunction with the Idaho TAG. The team was able to follow the sample plan exactly, with only one deviation (replacing Franklin County with nearby Jerome County) due to a lack of new construction in Franklin County. IEc coordinated with NEEA to determine that these counties were demographically similar and suitable for substitution.

Table 32. On-site inspection sample plan

Location	Number of Measures
Ada County	20
Canyon County	12
Kootenai County	6
Bonneville County	4
Teton County	3
Payette County	3
Twin Falls County	2
Valley County	2
Madison County	2
Minidoka County	2
Bannock County	1
Jefferson County	1
Gem County	1
Bonner County	1
Franklin County	0*
Jerome County	1*
Cassia County	1
Nez Perce County	1

* The team replaced the Franklin County observation with nearby Jerome County because the field inspectors were able to find only one home under construction in Frankin County.

Appendix B – Additional Data

Permit vs. On-site Data

This study used permit data for window U-factor, window SHGC, and ceiling insulation, however data on these measures was also collected during on-site visits. The results in this section summarize the available on-site data for window U-factor, window SHGC, and ceiling insulation and how the on-site data set compares to the permit data set.

In general, permit data showed slightly higher rates of compliance as compared to the on-site data, especially in CZ 6 (which has more stringent requirements than CZ5). It should be noted that the CZ6 population is oversampled in the on-site data. Since the study opted to use permit data for these key measures, it did not track CZ-specific sampling requirements for these measures. It is unclear what causes the differences between the permit and on-site data sets.

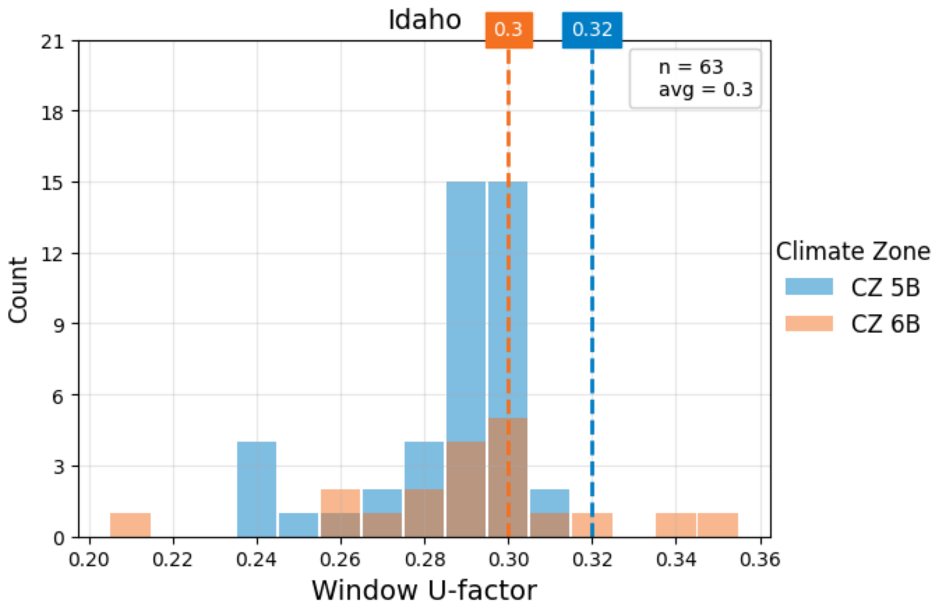

Figure 19. Window U-factor (from site data)

Table 33. Window U-factor (from site data)

Climate Zone	CZ5	CZ6	Statewide
Number	44	19	63
Range	0.24 to 0.31	0.21 to 0.35	0.21 to 0.35
Average	0.29	0.29	0.29
Requirement	0.32	0.30	Varies
Compliance Rate	44 of 44 (100%)	15 of 19 (79%)	59 of 63 (94%)

Compliance rates for window U-factor from permit and on-site data are similar statewide. However, compliance is slightly lower in climate zone 6B for the on-site data. For the on-site data, 15 of the 19

(79%) observations were compliant, while 5 of the 6 (83%) permit observations were. Comparing permit data to on-site data for window U-factor, it is worth noting that on-site data is oversampled in CZ6. It is unclear whether the difference in compliance rates is related to sampling differences. Regardless, both sets of data indicate that this is an area for improvement.

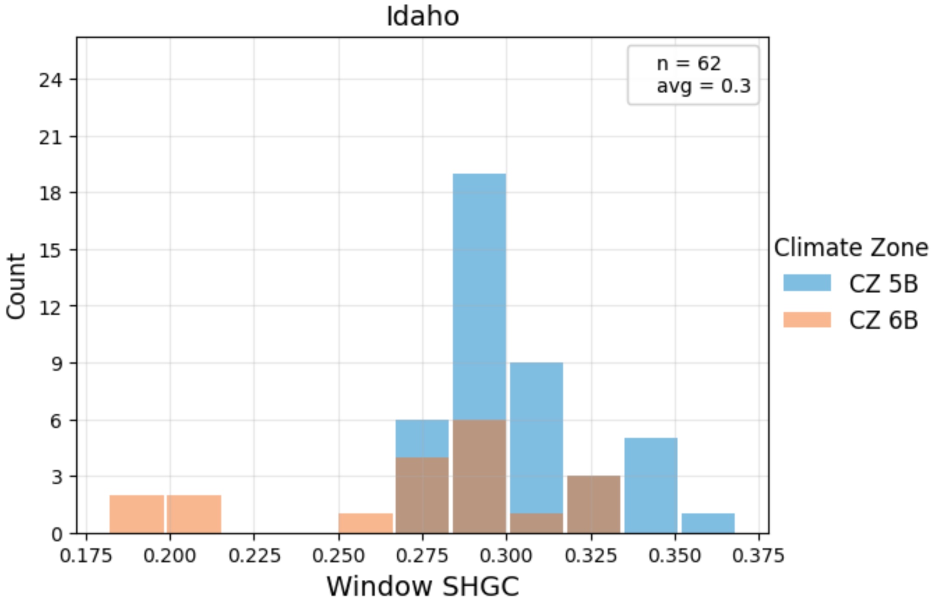

Figure 20. Window SHGC (from site data)

Table 34. Window SHGC (from site data)

Climate Zone	CZ5	CZ6	Statewide
Number	43	19	62
Range	0.27 to 0.36	0.19 to 0.33	0.19 to 0.36
Average	0.30	0.27	0.29
Requirement	NR	NR	NR
Compliance Rate	NA	NA	NA

There is no SHGC requirement in CZs 5 and 6. Idaho is a heating dominated climate, so in general a higher SHGC is helpful to reduce heating demand. This is especially true in CZ6, which is colder than CZ5 on average.

The permit values ranged from 0.24 to 0.48 with a statewide average of 0.33. The on-site data ranged from 0.19 to 0.36, with a statewide average of 0.29. Both CZs had higher average SHGC values in the permit data as compared to the on-site data. It is unclear whether this difference stems from sampling differences or a notable difference in permit documentation and as-built conditions.

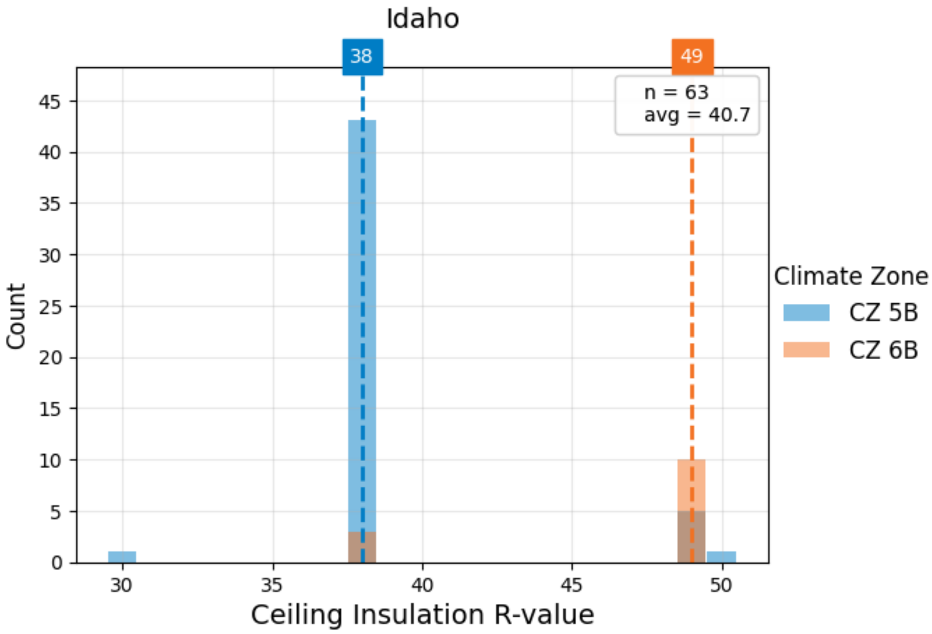

Figure 21. Ceiling R-value (from site data)

Table 36. Ceiling R-value (from site data)

Climate Zone	CZ5	CZ6	Statewide
Number	50	13	63
Range	30 to 50	38 to 49	30 to 50
Average	39.2	46.5	40.7
Requirement	38	49	Varies
Compliance Rate	49 of 50 (98%)	10 of 13 (77%)	59 of 63 (94%)

For ceiling insulation, the statewide compliance was 99% for the permit data and 94% for the on-site data. This discrepancy is driven by lower compliance rates in CZ6 in the on-site data (77% vs 100%). All 11 permit observations complied with CZ6 ceiling insulation requirements, while only 10 of the 13 on-site observations did. Is it unclear what causes this difference, but it could be that users are unlikely to enter a non-compliant value on permitting paperwork.

Appendix C – Modeling Methodology

EnergyPlus and OpenStudio

For the energy modeling tasks, the study used the PNNL Single Family Residential Prototype building models based on the 2018 version of the IECC for climate zones 5B and 6B.

Note that since the previous field study, updates were made to the single family EnergyPlus prototype model files to directly use the airflow network for duct leakage modeling rather than relying on post processing.

The following modifications to the models were made to comply with IECC 2018 with Idaho amendments:

- Window U-factor
  - Climate zone: 5B
    - 0.3 --> 0.32 Btu/h-ft^2-F
- Ceiling R-value
  - Climate zone: 5B
    - 49 --> 38 h-ft^2-F/Btu
- Wood-framed Wall R-value
  - Climate zone: 6B
    - 20+5 or 13+10 (0.045) --> 22 or 13+5 (0.057)
- Envelope tightness
  - Climate zones: 5B and 6B
    - 3 ACH50 --> 5 ACH50
- High Efficiency lighting:
  - Climate zones: 5B and 6B
    - 90% --> 75%

Additionally, a model was created for an unvented crawlspace foundation. The existing PNNL crawlspace foundation assumes a vented crawlspace with foundation insulation placed in the floor. The newly created model for an unvented crawlspace assumes:

- Insulation is placed along the exterior crawlspace wall
  - R-19 cavity insulation
- Crawlspace ventilation matches the indoor ventilation:
  - 5 ACH50

Idaho Fuel Prices and Emission Factors

The fuel prices used for calculating potential energy cost savings from improved compliance are derived from the U.S. Energy Information Administration's (EIA) Idaho State Energy Profile, which shows a state average residential electricity price of $0.1155/kWh and residential gas price of $8.69/Mcf, which is equal to $0.849/therm assuming a natural gas heat content of 1,023 Btu/cf.[19,20]

The emissions rates used to calculate potential greenhouse gas (GHG) emissions savings for electricity available from improved compliance are derived from the National Renewable Energy Laboratory's (NREL) Cambium database for forecasted grid carbon intensity. Using the Cambium 2023 Mid-Case scenario's average CO_2e emissions (which include CO_2, CH_4, and N_2O) rate for electric

[19] "Idaho State Energy Profile." US EIA. 2024. https://www.eia.gov/state/print.php?sid=ID
[20] "Heat Content of Natural Gas Consumed.: US EIA. 2024. https://www.eia.gov/dnav/ng/ng_cons_heat_a_EPG0_VGTH_btucf_a.htm

load in the NorthernGrid East region (ID, MT, and part of WY), the 2025 rate is projected to be 0.2597 kg CO_2e/kWh. In 2050, the average emissions rate is projected to be 0.0169 kg CO_2e/kWh due to more low-carbon generation in the grid region.[21,22]

The emissions rate used to calculate GHG emissions savings for natural gas is derived from the EPA's emission factors for combustion fuels, which shows an emissions rate of 5.33 kg CO_2e/therm of natural gas.[23]

[21] "Cambium 2023 Scenario Descriptions and Documentation." NREL. 2024. https://www.nrel.gov/docs/fy24osti/88507.pdf

[22] "Cambium 2023". NREL. 2024. https://scenarioviewer.nrel.gov/?project=0f92fe57-3365-428a-8fe8-0afc326b3b43&mode=download&layout=Default

[23] Natural Gas Combustion. AP 42, 5thEdition, Vol. 1, Chapter 1. EPA. 1998. https://www3.epa.gov/ttn/chief/ap42/ch01/final/c01s04.pdf

Appendix D – Interview Guide

Builders

NEEA Residential Energy Code Compliance Study

Draft Interview Guide – Builders

[POPULATE THE FOLLOWING FIELDS PRIOR TO CONDUCTING THE INTERVIEW.]

Date of Interview: _______________

Interviewer Name: ______________

Interviewer Email: _______________

Respondent Name: _______________

Respondent Organization Name: ______________________________

Respondent Phone: __________________________

Respondent Email: ________________

Introduction

[INTERVIEWER READ] Thank you for your participation in the Northwest Energy Efficiency Alliance (NEEA) Residential Code Evaluations Study. Interviews with homebuilders like you are an important part of the study. I will be asking you some questions about your experience with new single-family home construction projects in Idaho. When you answer these questions, please consider homes that you are building now and homes that you built within the last two years. All responses will remain confidential, and no personal information will be shared. May I begin?

1. Please briefly describe your background and your company. How many years have you been building homes Idaho? What part(s) of the State do you mostly work in and what types of homes (i.e., custom versus prescriptive) do you typically build?
2. In a typical year, how single-family new construction homes does your company build in Idaho?

2A. Has the number of single-family new construction homes that your company builds in a typical year changed over the past decade? If so, please describe how this has changed.

3. I am now going to read a list of six building components. For each, please rate the level of difficulty to comply with the *current* Idaho Code (i.e., IECC 2018 with Idaho amendments) using a scale of 1 (least difficult to comply with) to 5 (most difficult to comply with). Difficulty in complying may be driven by a number of factors including, but not limited to, costs of obtaining materials, installation costs, availability of skilled labor, rigor of enforcement of the building energy code, clarity of code requirements, pressure from homeowners, etc. For each component, please provide the reason why you provided this rating. [INTERVIEWER READ LIST AND POPULATE RESPONSES FOR EACH]

Building/Code Component	Rating (1-5)	Reason for rating
3A. Windows (U-factor & solar heat gain coefficient)		
3B. Wall Installation (assembly U-factor)		
3C. Ceiling Insulation (R-value)		
3D. Lighting (percent high efficiency)		
3E. Foundation Insulation (includes floor insulation, basement wall insulation, crawlspace wall insulation, and slab insulation; R-value)		
3F. Duct tightness (cfm per 100 ft^2 of conditioned floor area at 25 Pascals)		

4A. Has the difficulty in complying with any of the above components changed substantially with the shift from the previous code (2018 IECC w/ Idaho amendments) to the current (2021 IECC w/ Idaho amendments)? If yes, what elements have been the most challenging and why?

4B. Are there any elements of the previous or current Idaho code that were not listed above where compliance is a challenge? If so, please explain why compliance is a challenge for this component. How difficult is compliance using the 1-5 scale that you used previously?

4C. How do you think your challenges with code compare with other new, single-family homebuilders in Idaho?

5A. Have you built homes in multiple permit-issuing jurisdictions (i.e., have you had to apply for permits with multiple cities, towns, and/or counties) within the State? If yes, please briefly describe how permitting/compliance differs across these jurisdictions.

5B. [READ IF NOT ADDRESSED in 4A] Have you built homes in both areas of the State where permits are issued by the State of Idaho, and in areas where the local jurisdiction provides the permits? If yes, please briefly describe how permitting/compliance differs between the Statewide process and local jurisdictions.

6. Are there any other thoughts you would like to share on the permitting/compliance process within the State of Idaho?

Code Officials

NEEA Residential Energy Code Compliance Study

Draft Interview Guide – Code Officials

[POPULATE THE FOLLOWING FIELDS PRIOR TO CONDUCTING THE SURVEY.]

Date of Survey: ________________

Interviewer Name: _______________

Interviewer Email: ________________

Respondent Name: ________________

Respondent Jurisdiction: ________________________________

Respondent Phone: ____________________________

Respondent Email: _________________

Intro

[INTERVIEWER READ] Thank you for your participation in the Northwest Energy Efficiency Alliance (NEEA) Residential Energy Code Compliance Study. Interviews with code compliance officials like you are an important part of the study. I will be asking you some questions about your experience with overseeing new single-family home construction projects within your jurisdiction [IF STATEWIDE OFFICIAL READ, "WITHIN IDAHO"]. When you answer these questions, please consider homes that you have reviewed that have been built within the last two years. All responses will remain confidential, and no personal information will be shared. May I begin?

Background

4. Please briefly describe your background, including your current position, the number of years you have served in this role, and any previous experience you have in the Idaho residential new construction space.
5. In a typical year, how many single-family new construction homes are built in your jurisdiction (i.e., how many permit review processes do you typically oversee)?

2A. Has the number of single-family new construction homes that have built in a typical year in your jurisdiction changed substantially over the past decade? If so, please describe how this has changed.

Code Compliance

6. I am now going to read a list of six building components. For each, please rate the level of difficulty that you have observed from builders in complying with the *current* Idaho Code (i.e., IECC 2021 with Idaho amendments) using a scale of 1 (rarely or almost never compliant) to 5 (almost always compliant). Observed difficulty with compliance may be driven by a number of factors, including frequent questions from builders, low-initial/overall compliance rates, frequent pushback, etc. For each component, please provide the reason why you provided this rating. [INTERVIEWER READ LIST AND POPULATE RESPONSES FOR EACH]

Building/Code Component	Rating (1-5)	Reason for rating
3A. Windows (U-factor & solar hear gain coefficient)		
3B. Wall Installation (assembly U-factor)		
3C. Ceiling Insulation (R-value)		
3D. Lighting (percent high efficiency)		
3E. Foundation Insulation (includes floor insulation, basement wall insulation, crawlspace wall insulation, and slab insulation; R-value)		
3F. Duct tightness (cfm per 100 ft^2 of conditioned floor area at 25 Pascals)		

4A. Have you received any feedback from builders that their difficulty in complying with any of the above components changed substantially with the shift from the previous code (2018 IECC w/ Idaho amendments) to the current (2021 IECC w/ Idaho amendments), and/or have you observed any changes in compliance rates?

4B. Are there any elements of the current Idaho code that were not listed in the previous questions where compliance is a challenge, or you have observed low compliance rates? If so, please explain why compliance is a challenge for this component. If so, please explain why compliance is a challenge for this component. How difficult is compliance using the 1-5 scale that you used previously?

5. If you have hosted any trainings/workshops with builders/contractors in your jurisdiction, or solicited their feedback, are there any areas where you frequently receive questions about compliance or feedback that it is difficult to comply? If so, what are the typical reasons that compliance is difficult with these components?

6. How does the permitting process work in your jurisdiction? For example, do builders self-certify? What percent of homes receive an inspection? Is this announced or surprise?

6A. What happens if you find that a home is not compliant?

6B. Is a minimum level of compliance with building energy codes required to receive a permit?

7. What is the typical level of effort to check code compliance per new home being built? Specifically; [INTERVIEWER READ EACH FOLLOW UP QUESTION SEPARATELY AND RECORD RESPONSE]

7A. What is the number of FTEs in your department?

7B. How many staff are typically involved in reviewing compliance/issuing a permit for a single (residential new construction) site?

7C. What are the typical hours spent per staff member at each site?

8. Are there any other thoughts you would like to share on the permitting/compliance process within the State of Idaho?

Appendix E – Interview & Permit Data Request Outreach Email

Below is the template for the outreach email the IEc team sent to builders to request their participation in interviews for the study, and the template the team sent to code officials to request permit data. While the outreach to code officials for interviews was similar, the team did not use a set template as most of these emails were follow ups to the request for permit information and varied based on the conversations to date.

Builders – Interview Outreach

Hi XXXX,

My name is XXXX, and I am reaching out on behalf of the Northwest Energy Efficiency Alliance (NEEA). My company, Industrial Economics, Inc. (IEc), is currently working with NEEA to conduct a Residential Energy Code Evaluation in the State of Idaho. As part of this study, we are collecting and analyzing building permit data, conducting some targeted on-site visits with builder approval, and interviewing several Idaho homebuilders such as yourself.

We are interested in asking you some questions about your experience building new single-family homes in Idaho. There are no right or wrong answers, and your candor will help ensure that our study results are accurate and useful. All responses will remain confidential, and no personal information will be shared with NEEA. After we complete the interview, we will send you a $175 Visa gift card for participating.

Please let me know if you are interested in participating and provide a few dates and times when you would be available for a 20 - 30-minute virtual meeting over the next couple of weeks. Then, I will follow up by sending a meeting invitation.

Feel free to let me know if you have any questions about this study or the interview itself before deciding whether to participate. Thank you for your consideration!

Best,
XXXX

Code Officials – Permit Data Requests

Hi XXXX,

My name is XXXX, reaching out on behalf of the Northwest Energy Efficiency Alliance (NEEA). My company, Industrial Economics inc. (IEc), is currently working with NEEA to conduct a Residential Energy Code Evaluation in the State of Idaho. As part of this study, we are collecting and analyzing data from a random selection of jurisdictions across the State to better understand how energy codes are being implemented in Idaho, and through this methodology, we have selected XXXX for part of our review.

We are specifically hoping to review permit data to extract energy code data including wall/ceiling/foundation insulation values, blower door tests, etc. I am wondering:

1) Do you track this type of information in your permits?

2) Would you be able to share this data from recently issued permits at newly constructed single family homes, and/or is there a public requests process I could go through to request this information?

Study results will not contain any personally identifiable information about homeowners, builders, or compliance department staff. For more information about the study, please contact Meghan Bean at mbean@neea.org or 503-688-5413, or I would be happy to answer any additional questions via email or a brief phone call. For more information about NEEA, please visit: neea.org.

Thank you!

Best,
XXXX

Appendix F – Outreach Letter for Site Visits

Notification:

Residential Energy Code Compliance Study

The Northwest Energy Efficiency Alliance, Inc. (an alliance of Northwest utilities) and its contractors (collectively, "NEEA") are conducting a Residential Energy Code Compliance Study by collecting and analyzing data to better understand how energy codes are being implemented in Montana and Idaho (the "Study"). Using protocols established by the Department of Energy, NEEA is collecting the following data points from a group of randomly selected residences: envelope tightness, window heat gain, window U-factor, wall insulation, ceiling insulation, floor and foundation insulation, lighting efficacy, and duct leakage. Not all data points will be collected from each residence.

This residence has been randomly selected to contribute to this Study. By allowing the collection of data, you agree to participate in the Study and to the following terms:

- NEEA takes your privacy seriously and will not disclose any information in a manner that could identify you or the location of the residence.
- NEEA is not providing advice, recommendations, or certification related to residential energy code compliance. Any advice, guidance, or services provided by NEEA is provided "as is". **NEEA disclaims all representations, endorsements, guarantees, advice and warranties, express or implied, regarding the study including without limitation, the implied warranties of merchantability and fitness for a particular purpose. NEEA makes no representation or warranty, and assumes no liability with respect to quality, safety, performance, or any other aspect of any design, of equipment or structures inspected pursuant to the study, and expressly disclaims any such representation, warranty or liability.**

For more information about the Study, please contact **XXXX** at NEEA (**XXXX@neea.org** or **XXX-XXX-XXXX**) or **XXXX** at Industrial Economics (IEc) (**XXXX@indecon.com** or **XXX-XXX-XXXX**). For more information about NEEA, please visit our website: **neea.org**.