

Falling Short: Does Energy Code Compliance and Enforcement Vary by Income?

*Chitra Nambiar, Ian Blanding, Carmen Cejudo, Pacific Northwest National Laboratory
Michael Reiner, Chris Perry, Department of Energy*

Abstract

Energy code compliance ensures that owners of newly constructed homes realize the savings associated with updated energy codes. While energy code adoption typically occurs at the state level, local jurisdictions are tasked with code implementation. The resources available for implementation may vary by jurisdiction and as a result, the benefits of energy codes may not be the same, particularly in under-funded or rural jurisdictions. This study seeks to answer whether energy codes are implemented equitably across jurisdictions.

Using data collected from residential code compliance field studies in 19 states, the study analyzes how compliance rates vary by income and socioeconomic characteristics between counties. The study's goal is to help prioritize utility, federal, and state funding, as well as code support programs at the local level to ensure that the benefits of energy codes are realized equitably across all communities.

Introduction

In the U.S., building energy codes are developed at the national level through a standards development process and are updated every three years to incorporate energy efficient technologies and approaches in construction practices. The International Energy Conservation Code (IECC), developed by the International Code Council (ICC), is the national model residential energy code as defined and confirmed by the U.S. Department of Energy (DOE) (ECPA 2005). Although the IECC is developed at the national level, it is adopted and enforced, at the state and local level. States and adopting jurisdictions often amend the model energy code to suit local construction practices and considerations. This ability to introduce differences in the locally adopted version of the IECC can provide important flexibility but may result in lower levels of efficiency. Additionally, differences in enforcement, and the availability of customized compliance education and training programs, may result in differences in rates of compliance at local levels. This in turn impacts the long-term operational energy costs to residents and poses challenges to achieving decarbonization and net-zero-energy goals in new construction.

Understanding why differences in energy code implementation exist between jurisdictions within the same state and under the same energy code edition is a key but difficult question to answer. Anecdotally, we know that jurisdictions with fewer resources also tend to have less capacity to ensure compliance with all applicable building codes. Under this scenario, the energy code typically becomes a lower priority than structural, fire, electrical, mechanical, and plumbing codes which are perceived to have a larger impact on occupant health and safety.

One of the many questions of interest in understanding the differences in energy code compliance is whether jurisdictional code compliance varies by socioeconomic characteristics. In other words, do homes constructed in lower income communities experience higher rates of non-

compliance than homes constructed outside those communities? To answer this question, we analyzed data collected from previous residential code compliance field studies to examine the existence of differences in energy code compliance rates between regions based on their socioeconomic characteristics. This paper presents: i) our assumptions to determine county-level socioeconomic characteristics ii) methodology to assess the impact of county-level socioeconomic characteristics on energy code compliance rates based on the residential field-study data iii) limitations of the approach iv) results of the analysis and v) discussion of findings and recommendations for future work.

Background

The White House established the Justice40 Initiative (J40), a multi-agency effort within DOE to ensure disadvantaged communities receive 40% of the benefits from federal investment (U.S. President. Executive Order 14008). Through this initiative and other efforts, the federal government aims for equitable distribution of energy savings and improved access to energy efficient technologies to all. Studies to assess household energy disparities historically focus on the existing housing stock. Such work typically relies on energy burden as the primary metric to assess energy consumption against household income. Studies show that socioeconomic characteristics play a major role in energy burdens; with higher energy burdens reported in low- and middle-income communities (Brow 2020). Factors that contribute to high energy burdens include energy prices, appliances, and inefficient building envelopes.

In recent years, greater attention has focused on promoting equity within the energy code development process. Efforts primarily call for increased participation and representation from disadvantaged communities within the code development process and greater consideration of non-energy benefits (e.g., indoor air quality, resilience, health) (Blankenship 2020). Energy justice advocates in California supported energy code changes to facilitate a transition away from fossil fuels within new buildings (Saadat et al. 2020). California's 2022 Title 24 Building Energy Efficiency Standards now establish a more robust pathway to promote all-electric new construction to improve indoor air quality, resilience, and energy cost savings (CEC 2022). Despite these recent efforts to address energy equity within model code development, limited work examines equity in the implementation of the energy code. One likely reason could be limited data on energy code implementation in the U.S.

Improvement in energy code compliance through robust education and training efforts is critical to preparing the workforce for future code updates. In 2013, DOE established a robust methodology to assess statewide residential energy code construction practices and compliance rates and began a series of energy code field studies to better understand trends and support targeted education and training programs (Bartlett et al. 2016). Since then, residential energy code field studies based on this established methodology have been conducted 27 times in 20 states, representing a comprehensive set of building construction and energy code compliance data at the state and county level. Data from these studies provide a consistent code compliance and energy performance assessment of key energy code measures (key items) – a subset of code requirements identified as having the largest direct impact on residential energy efficiency within single family homes.

The seven key items in the sample include: 1) foundation R-value and insulation installation quality (IIQ), 2) wall R-value and IIQ, 3) ceiling R-value and IIQ, 4) window U-factor and solar heat gain coefficient (SHGC), 5) envelope air tightness (ACH50), 6) duct

tightness (CFM25/100 ft²), and 7) percentage of high-efficacy lighting.¹ Homes were only visited one time to minimize bias and ensure participant confidentiality, which means that in order to collect observations for all seven measures two or more homes had to be visited within the same jurisdiction. Field teams collected data at two different times during the construction process; once before drywall was installed and right before the certificate of occupancy was issued. The observations across the seven key items were geotagged based on the county in which the data was collected.

An analysis of the data was conducted for each state to determine statistical compliance trends, projected energy and cost savings resulting from improved measure level compliance, and a comparison of average statewide energy use relative to a scenario where all homes met minimum energy code compliance. This methodology was initially developed to assess whether an energy codes training program could result in a statistically significant reduction in overall energy use across an entire state. This paper explores whether this existing data can be utilized to assess compliance differences between higher income and lower income counties in states across the U.S. that have conducted at least one baseline field study since 2014. Figure 1 highlights the spread of the counties where the over 87,000 observations were collected. The pie charts indicate the statewide compliance rate based on all key item observations.

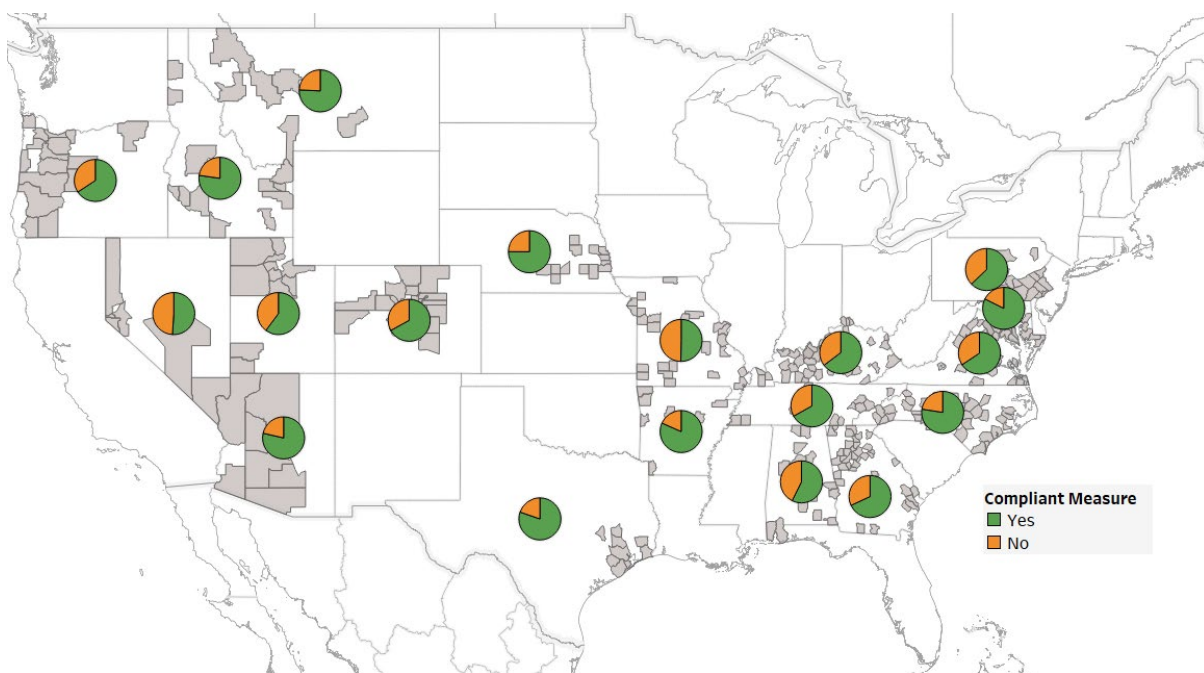


Figure 1: Energy Code Compliance by State

¹ Insulation Installation Quality is based on a grading scale in the RESNET 301 standard for cavity insulation measures. Envelope tightness is measured in air changes per hour at 50 pascals (ACH50) and duct tightness in cubic feet per minute at 25 pascals per 100 Sq. Ft.

Methodology

Though the field study was not explicitly designed to support a comparative analysis of socioeconomic characteristics on compliance rates, it is the largest dataset currently available on energy code implementation in the U.S. In this paper, we present an initial approach to assess differences in compliance levels by socioeconomic characteristics and identify opportunities to modify the field study methodology to better address disparities in code compliance, particularly in disadvantaged communities.

For the purposes of this study, we utilize county-level income data to investigate how compliance trends vary across the aggregated field study data. The field study sampling plan was structured to avoid collecting precise construction locations in the interest of participant confidentiality, thereby limiting the granularity of this study's analysis. As such, we rely on the county code included with the compliance data from each site visit. The collected data is grouped into two categories to differentiate single-family homes constructed in lower income counties from the those constructed in higher income counties. The two categories are set based on the percent of population within each county at or below 80% of the area median income (AMI). 80% AMI is a common indicator to determine housing affordability and eligibility for certain low- and moderate-income (LMI) housing programs, notably the Community Development Block Grants (CDBG) administered through The Department of Housing and Urban Development (HUD).²

Across all counties within the field study data, the median percent of LMI population below 80% AMI was 38%. Based on the median, counties with an LMI population that fall above the median are classified as a "lower income" county, while counties with an LMI population that falls below the median are classified as a "higher income" county. Figure 2 demonstrates how counties in the field study sample compare to all counties in the U.S across this same economic indicator. As discussed in more detail in this paper, the field study sample skews toward higher income counties given these areas have a higher prevalence of market rate single family home construction.

² The Community Development Block Grant (CDBG) defines moderate income as between 50 and 80% of AMI. <https://www.hudexchange.info/programs/acs-low-mod-summary-data/>

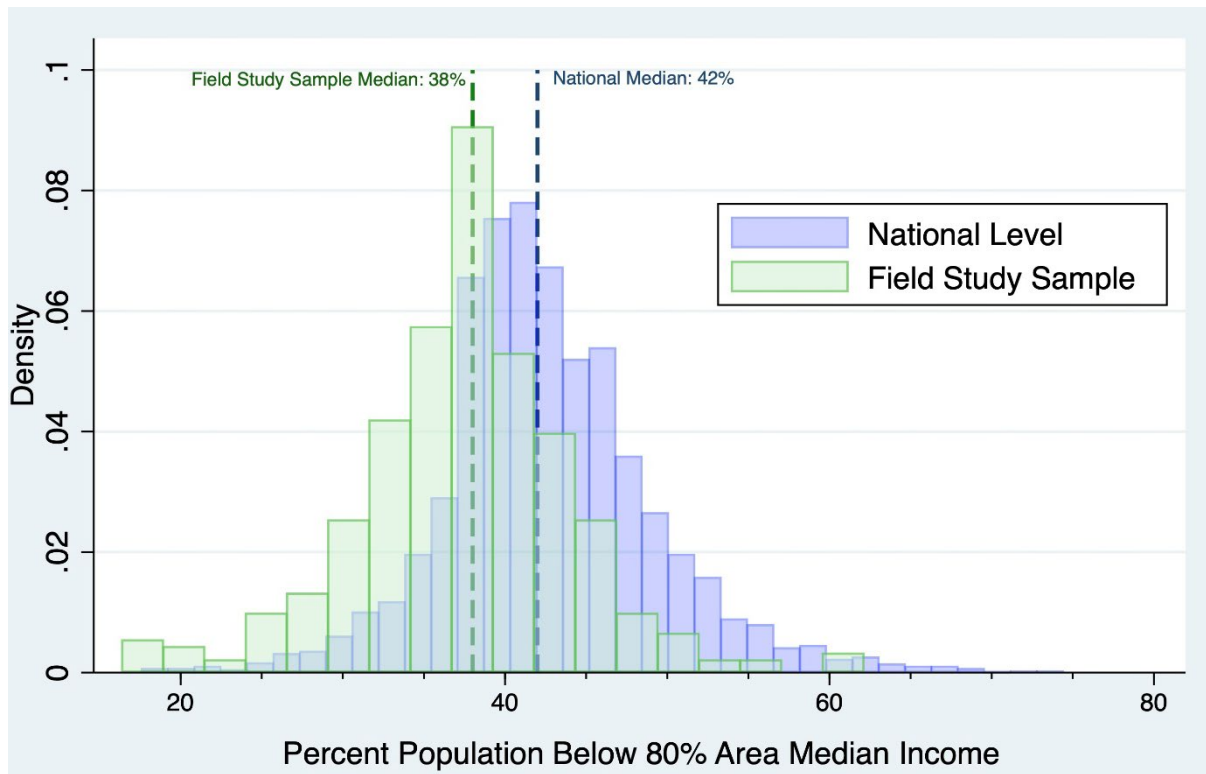


Figure 2: Comparison of 80% AMI in Field Study Counties vs. all U.S. Counties

Next, key item data collected in the field is compared directly against the code requirement for each measure to determine whether the measure is compliant and is labeled as “compliant” or “not compliant.” For envelope measures, assembly U-factors are calculated based on insulation levels and the IIQ and compared against prescriptive code U-factors. Observations with insufficient information are dropped.

Finally, to check if the data collected from the residential filed study is representative of actual construction activity, we compared the number of permits awarded in higher and lower income labeled counties to the number of observations in the field study data from lower income and higher income labeled counties as shown in Table 1.

Table 1: Comparison of Lower Income and Higher Income counties: Field Study Observations vs Permit Data

County	Data Source	Lower Income % of Total	Higher Income % of Total
Lower Income	Number of Permits ³	50%	50%
Higher Income	Field Study Observations	47%	53%

The comparison in Table 1 shows that the data from the field study are a reasonably representative of lower income and higher income counties at aggregate scale. However, the data may still have biases as each state's sampling plan was developed using a proportional random

³ Average number of permits for each County from 2014 to 2022.

sample approach based on the total number of building permits in each jurisdiction. Jurisdictions with more building permits per year were more likely to be sampled than places with fewer permits. As the sampling plan development did not consider lower income representation, this data may not be applicable for micro-scale analysis of code compliance based on socioeconomic characteristics. Another limitation is that the data in this analysis represents code compliance of new single-family homes which is inherently biased toward a set of residents who can afford to purchase a new home. As the predominant share of housing units in lower income communities is existing, not new construction, so the data may be skewed toward higher income households. Additional limitations of this study include:

- **Data Granularity** – To keep field study data anonymized and prevent any perception that individual building departments were being graded on energy code implementation, location data was only provided at the county level. Understanding that counties are not homogenous, J40, among other organizations developing policies to support more affordable housing, typically categorizes lower income communities at the zip code or city level. By using county data, it is impossible to determine whether a home constructed within a lower income county is constructed in a town or city that also meets LMI criteria. Collecting field study data at a more granular level would enable a more refined assessment of community socioeconomic characteristics and result in a more robust analysis.
- **Price of Home** – The field study methodology did not require the final or expected home sale price data to be collected. Therefore, we cannot determine whether the homes constructed in lower income counties are affordable, market rate, or high-end homes. A question to collect this data could be easily added to the field data collection form for future studies.
- **Local Building Department Resources** – Data on building departments was not collected as part of this study. This was done partly to keep it anonymous and to avoid any perceptions that studies would be used to grade an individual builder or building department. As a result, there is no way to know whether building departments had adequate resources and staff to enforce the energy code.

Analysis

In this section, we present the analysis and major findings of the study. Figure 2 shows the number of observations in the final dataset categorized by their socioeconomic level: lower income or higher income and energy code compliance: compliant or non-compliant



Data Source: Bartlett et.al (2018), doi:10.2172/1441138

Figure 3: Energy code compliance observation in Lower income vs Higher income counties

The seven key items in the field study data are mapped to the following measure categories: Infiltration, Duct, Roof Insulation, Wall Insulation, Below Grade Wall (BGWall) Insulation, Floor Insulation, Lighting and Window. The infiltration category refers to envelope tightness (ACH50) and duct refers to the HVAC duct distribution system tightness (CFM25/100 ft²). The insulation in various opaque envelope assemblies (walls, roof, below grade and floor) are categorized separately. The lighting category includes high-efficiency lighting (%) and window includes window U-factor and SHGC observations. Figure 3 and Figure 4 show the number of observations for each of these measure categories for compliant and non-compliant observations respectively. These figures also show the distribution of efficiency by measure category for lower income and higher income counties.

Efficiency in these boxplots represent the improvement over minimum code requirement calculated as:

$$Efficiency = \frac{Observed\ value - Code\ value}{Code\ value} \quad \text{Equation 1}$$

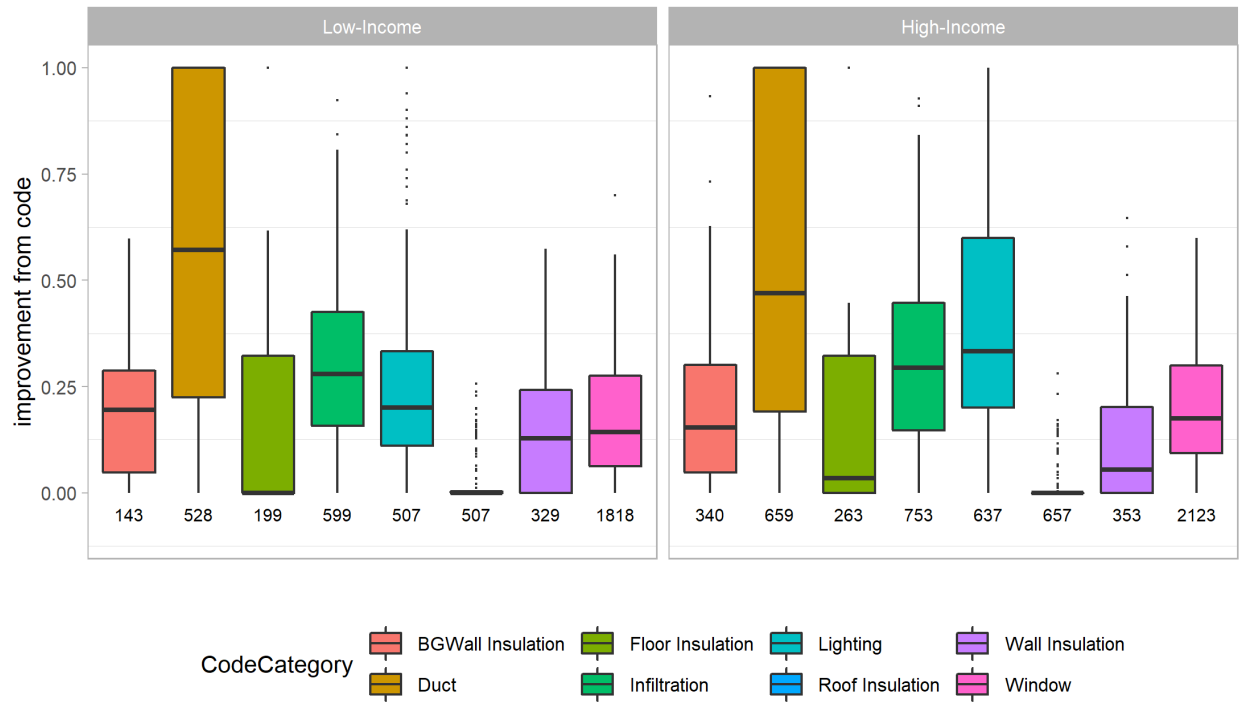


Figure 4: Efficiency distribution of compliant observations by measure category

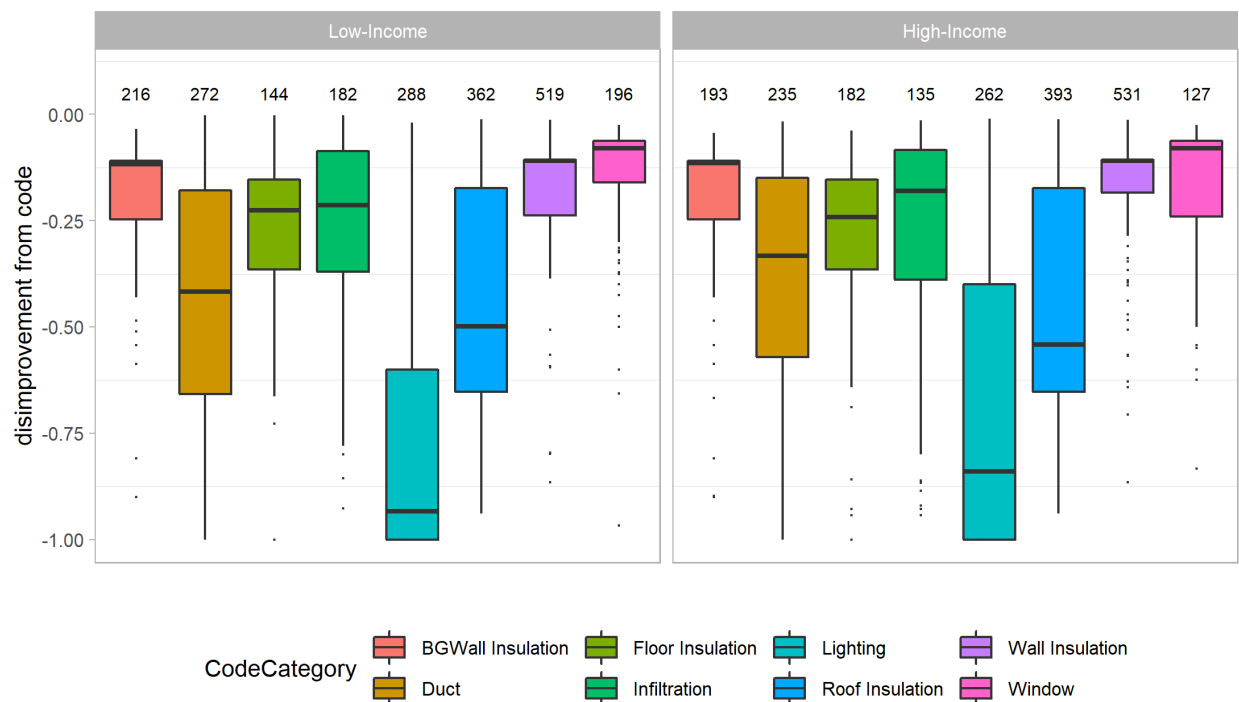


Figure 5: Efficiency distribution of non-compliant observations by measure category

The plots show that the distribution of efficiency is highly variable among measure categories for both compliant and non-compliant measures. The Duct measure category has very high variability in the compliant and non-compliant measures for both lower income and higher

income. The variability in the Lighting category is also high particularly for the higher income category for both compliant and non-compliant observations. In addition to the key item categories described above, the field study data includes HVAC and Domestic Hot Water efficiency observations comprising of gas furnace and heat pumps. This equipment is subject to federal equipment efficiency standards. As a result, they are sold in the marketplace per mandated federal efficiency requirements. Hence, we excluded these observations from energy code compliance comparison and analyzed if there are any differences in fuel sources (gas vs electric) for space and water heating between lower income and higher income categories. Figure 6 illustrates that gas-based space heating and water equipment dominate over their electric counterparts in both lower income and higher income categories.

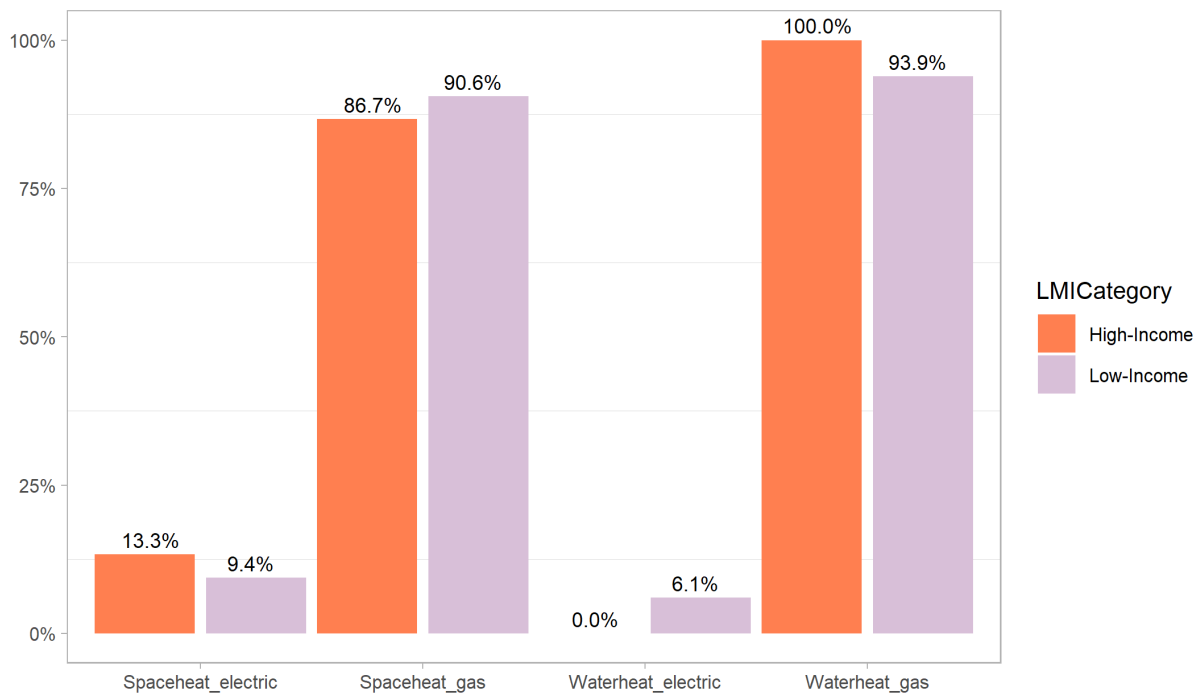


Figure 6: Comparison of fuel type for space and water heating

The field study data identifies the edition of the IECC in effect at the time of the data collection. The IECC editions across the 19 states at the time of data collection include the 2009, 2012, 2015 and 2018 editions. Some of the states had amended versions of the IECC; however, for simplicity we labeled the code version of the observations based on the four major code editions listed above. Figure 7 and Figure 8 show the number of observations and distribution of efficiency values calculated per Equation (1) by compliant and non-compliant observations, respectively, for lower income and higher income categories. Compared to the other editions of IECC, the number of observations and efficiency variability in the dataset is largest for observations that have IECC 2009 as the baseline code. The variability is also larger for non-compliant measures compared to compliant measures for both lower income and higher income categories.



Figure 7: Efficiency distribution of compliant observations by baseline code

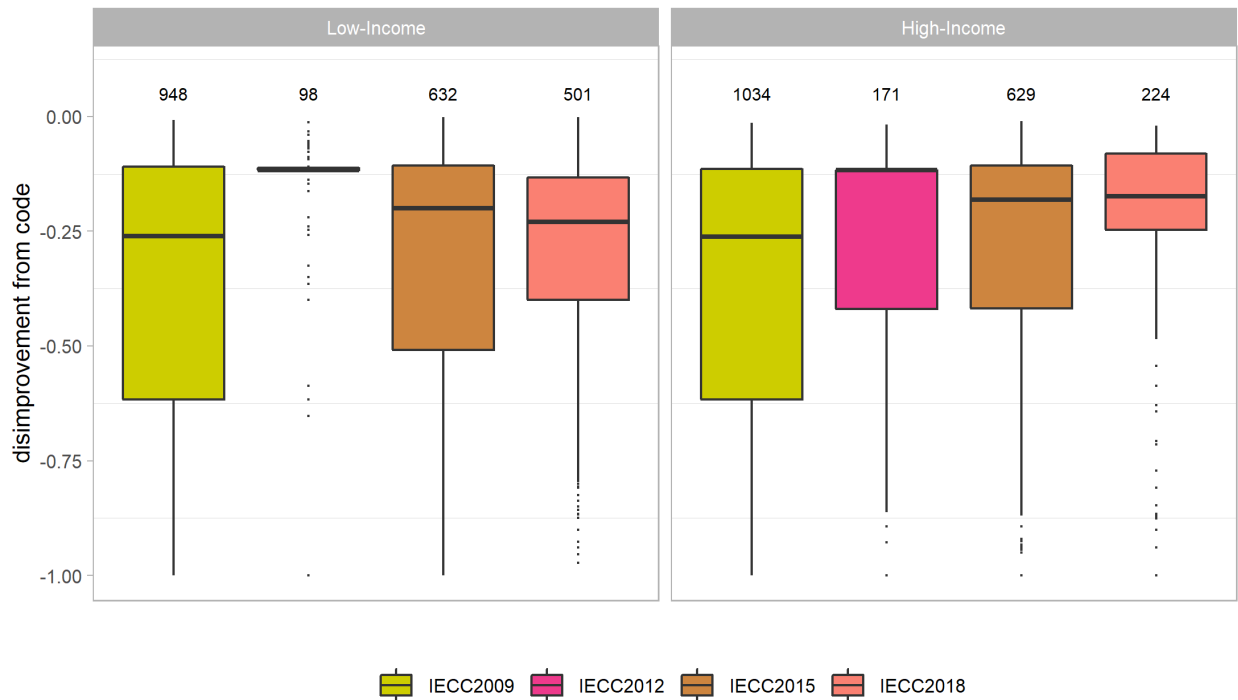


Figure 8: Efficiency distribution of non-compliant observations by baseline code

Finally the exploratory data analysis—specifically Figure 4, Figure 5, Figure 7 and Figure 8—show that median efficiency for both compliant and non-compliant measures are not the same for lower income and higher income categories. To test this a-priori theory, we conducted a statistical hypothesis test to determine if a difference between the lower income

compliance rate and higher income compliance rate is due to chance or due to a relationship between the socioeconomic characteristics and energy code compliance. We chose a Pearson's chi-squared test (χ^2 test) of independence with Yate's correction for continuity to test the hypothesis because: i) the observations in each category are mutually exclusive ii) the observations are independent and iii) the probability of outcome (compliant or non-compliant) is the same for each observation. χ^2 test is conducted to test the impact of socioeconomic characteristics on compliance rate for the following parameters:

- i) Aggregate compliance rate: lower income vs higher income
- ii) Compliance rate for Duct measure category: lower income vs higher income
- iii) Compliance rate for Infiltration: lower income vs higher income
- iv) Compliance rate for Below grade wall insulation: lower income vs higher income
- v) Compliance rate for Floor insulation: lower income vs higher income
- vi) Compliance rate for Wall insulation: lower income vs higher income
- vii) Compliance rate for Lighting: lower income vs higher income
- viii) Compliance rate for Lighting: lower income vs higher income
- ix) Compliance rate for Window: lower income vs higher income
- x) Lower income Compliance rate for old edition of IECC (2009) vs newer edition (2018)
- xi) Higher income Compliance rate for old edition of IECC (2009) vs newer edition (2018)

These tests are aimed to answer the following key research questions:

1. Do socioeconomic characteristics have an impact on energy code compliance rate in the U.S.? Specifically, is the compliance rate in lower income counties same as that in higher income counties?
2. Are there differences in energy code compliance rates between lower income and higher income counties by measure categories?
3. Are there differences in energy code compliance rate in lower income and higher income counties based on baseline energy code? Stated otherwise, is the compliance rate lower in regions that have adopted newer editions of IECC baseline energy code?

The compliance rate is for each parameter is calculated as:

$$\text{Compliance rate}_i = \frac{n_{\text{compliant}_i}}{n_{\text{total}_i}}$$

Equation 2

where $n_{\text{compliant}_i}$ = number of complaint observations for parameter i
 n_{total_i} = total number of observations for parameter i

Non-compliance rate for category i is calculated as:

$$\text{Noncompliance rate}_i = 1 - \text{Compliance rate}_i$$

Equation 3

For each of the test scenarios, the null hypothesis expressed as $H_0: p_1 = p_2$, is that there is no difference in compliance rates between lower income and the higher income observations. The alternate hypothesis expressed as $H_a = p_1 \neq p_2$ for research question i) is that the compliance rate of lower income counties and higher income counties are not the same; for ii)

the alternate hypothesis is that the compliance rates for lower income and higher income counties are different by measure categories; and for iii) the alternate hypothesis is that compliance rates in lower income and higher income counties are different for older vs newer edition of IECC editions. For this case we use observations from regions that have IECC 2009 as a proxy for old code edition and those with IECC 2018 as new code edition. The critical value α is 0.05. The test statistics, result, and estimate compliance rates for the χ^2 test are in Table 2.

Table 2: Summary of Pearson's chi-squared test for independence

Test No.	Test Parameter	Group 1	Group 2	χ^2	p-value	Rate estimate: Group 1 (95% CI)		Rate estimate: Group 2 (95% CI)		Result
						lower	upper	lower	upper	
i	Compliance	Higher Income	Lower Income	67.5	0.00000	0.78	0.80	0.72	0.74	Different
ii	Duct Tightness	Higher Income	Lower Income	11.2	0.00080	0.70	0.79	0.62	0.71	Different
iii	Infiltration	Higher Income	Lower Income	17.3	0.00003	0.88	0.96	0.80	0.88	Different
iv	Below Grade Insulation	Higher Income	Lower Income	49.4	0.00000	0.76	0.89	0.53	0.66	Different
v	Floor Insulation	Higher Income	Lower Income	0.49	0.48270	0.67	0.77	0.69	0.78	Not Different
vi	Roof Insulation	Higher Income	Lower Income	13.3	0.00027	0.64	0.73	0.56	0.64	Different
vii	Wall Insulation	Higher Income	Lower Income	0.19	0.66420	0.36	0.46	0.35	0.45	Not Different
viii	Lighting	Higher Income	Lower Income	8.7	0.00318	0.74	0.83	0.67	0.76	Different
ix	Window	Higher Income	Lower Income	28.3	0.00000	0.97	1.00	0.93	0.96	Different
x	Compliance rate: Lower Income	IECC 2009	IECC2018	16.0	0.00006	0.71	0.77	0.66	0.71	Different
xi	Compliance rate: Higher Income	IECC 2009	IECC 2018	12.7	0.00036	0.75	0.83	0.68	0.76	Different

Results

Based on the hypothesis testing results (χ^2 and p-values) in Table 2, we draw the following conclusions to the three research questions identified in the previous section:

1. **Overall Compliance Rate:** We reject the null in favor of the alternate hypothesis that the compliance rate in lower income and higher income counties are different. The sample estimate of compliance rate in higher income counties is 73%, which is 6 percentage points higher than that of lower income counties.
2. **Measure Level Compliance Rates:** We reject the null in favor of the alternate hypothesis that the compliance rate in lower income and higher income counties are different for the duct tightness, infiltration, below grade wall insulation, roof

- insulation, lighting and window measure categories. The estimated compliance rate in higher income counties is 23 percentage points higher for below grade wall insulation, 8 percentage points higher for duct tightness, infiltration and roof insulation, and 4 percentage points higher for windows when compared to lower income counties.
3. **IECC Version Compliance Rates:** We reject the null in favor of the alternate hypothesis that compliance rates differ between older (IECC 2009) and newer (IECC 2018) edition of energy code for both lower income and higher income. The estimated compliance rate is higher in counties with an older edition of (IECC 2009) as state adopted code. This is true for both lower income and higher income counties. In the sample, the estimated compliance rate in counties with IECC 2009 compared to IECC 2018 is 6 percentage points higher in lower income counties and 7 percentage points higher in higher income counties.

Conclusions

Using data from 19 statewide single-family residential energy code field studies from 2014 to 2021, we assessed differences in compliance rates between lower income and higher income communities at the county level. Although the field study methodology was not designed to assess whether jurisdictional income levels impact energy code compliance, this paper describes a methodological approach to determine whether a relationship exists. Based on this set of data, a relationship between income levels and energy code compliance at the county level does exist when considering energy code compliance across all measures. Our analysis shows that lower income counties have higher rates of non-compliance than higher income counties. On the individual measure level, we found that lower income counties have a higher rate of non-compliance for all but two measures (floor and wall insulation), and the biggest compliance disparities were present in below grade wall insulation, roof insulation, duct tightness and envelope tightness. Reduced compliance in these measures have important implications on energy costs, occupant comfort, and building resiliency. However, as discussed throughout the paper, there are many limitations to assess this relationship using field study data. Therefore, results from this research cannot be extrapolated to other lower income communities; findings are only relevant to the field study data.

This analysis should be viewed as an initial approach to assess the impact of community socioeconomic characteristics on energy code compliance and construction trends. This type of research should be significantly refined and expanded to address some of the limitations of this analysis and better represent LMI communities. As DOE considers updates to the field study methodology, incorporating modifications to better represent disadvantaged communities and assess energy code compliance is critical. Community level data is needed to generalize findings to the general population. The infrastructure to collect and analyze energy code field study data is already well established based on experience over the last seven years, so developing and implementing a new methodology focused solely on energy code compliance in LMI communities will likely be successful.

Future Research

There are a number of modifications that can be made to the DOE methodology – from minor to more significant changes – to enable a more representative analysis of LMI communities. Changes that could be considered are as follows:

- **Location Data:** Field study data is collected at the county level, where most assessment of LMI communities occurs at the block, city or zip code level. Although the sampling plan may ultimately be developed at the county level in cases where it is necessary based on the breakdown of residential permits in a state, the location data collected during the study could easily be at the city or zip code level. This is a simple change to the data collection form and would not impact the methodology or approach to analysis.
- **Sampling Plan Development:** In order to collect more data from LMI communities, a modification to the sampling plan development process would be needed. The current approach is to collect 3 years of residential permit data at the municipal level and weight the number and location of samples based on number of permits and then randomize the locations. This approach does not account for any socioeconomic characteristics of jurisdictions in the state, although this could easily be implemented during the process. One possible approach is to understand the percentage of new permits in LMI communities compared to the rest of the state and ensure the sampling plan appropriately reflects that ratio of LMI to Non-LMI communities. However, data can only be collected where construction is occurring. Given the limited single-family construction occurring in LMI communities, the sampling plan may need to overweight LMI communities in order to collect enough data.
- **Representativeness:** Even with the modifications to the sampling plan to consider LMI communities, there still may not be enough data at the individual state level to compare LMI to Non-LMI communities with the same level of statistical significance under the current methodology. As described in the current methodology, 63 complete data samples are required to determine if there is a statistically significant change in statewide average single-family building EUI between Phase I and Phase III. Using this same approach, to determine differences between an LMI and Non-LMI cohort, each cohort would need 63 complete sets of data. However, given the fact that construction is more limited in LMI communities, a new statistical analysis could be conducted to determine the amount of data needed in each cohort to generate a reasonable confidence interval of the results.
- **Multifamily Housing:** The data assessed in this paper was from new single-family homes, which is not typically representative of LMI communities in most states. There may be more multifamily housing being constructed in LMI communities than single-family homes, so conducting field studies of multifamily building types may provide a more fruitful set of data and be more representative as a building type than single-family. A low-rise multifamily energy code field study pilot study was conducted across four states in 2018 so a methodology already exists.⁴ This current methodology could easily be adapted to ensure representativeness of LMI communities, and these types of studies could be employed at the state level with the same success as the single-family studies.

⁴ https://www.energycodes.gov/sites/default/files/2021-07/LRMF_Studies_final_report_2020-06-24.pdf

References

- Bartlett, R., Halverson, M., Mendon, V., Hathaway, J., and Xie, Y. *Residential Building Energy Code Field Study*. United States: N. p., 2018. Web. doi:10.2172/1441138.
- Xie, Y., V. Mendon, M. Halverson, R. Bartlett, J. Hathaway, Y. Chen, Michael Rosenberg, Todd Taylor, and Bing Liu. "Assessing Overall Building Energy Performance of a Large Population of Residential Single-Family Homes Using Limited Field Data." *Journal of Building Performance Simulation* 12, no. 4 (2019): 480-93.
<https://doi.org/10.1080/19401493.2018.1477833>.
- Blankenship, B., J. R., H. Werner, M. Lerner, K. Cunningham. *Hand-in-Hand: Environmental and Social Justice Communities and California Energy Code*. Proceedings of the 2020 ACEEE Summer Study of Energy Efficiency in Buildings. Washington, D.C.: American Council for an Energy-Efficient Economy.
- Brow, M. A., A. Soni, M. V. Lapsa, K. Southworth (2020). *Low-Income Energy Affordability: Conclusions from A Literature Review*. ORNL/TM-2019/1150. Oak Ridge National Laboratory.
- CEC (California Energy Commission) 2022. *Warren-Alquist State Energy Resources Conservation and Development Act Public Resources Code Section 25000 et seq.* 2022 Edition. CEC-140- 2022- 001.
- U.S. President. Executive Order. "*Tackling the Climate Crisis at Home and Abroad*", Executive order 14008 of January 27, 2021." Federal Register Vol. 86, no. 19 (February 1, 2021): 7619-7633. <https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/27/executive-order-on-tackling-the-climate-crisis-at-home-and-abroad/>.
- Saadat, S., M. Vespa, C. Garoupa White, T. Frantz, Andrea Vidaurre, S. Azamian, N. Ghio, M. Krogh, C. K. Miller, J. Torres. 2020. S. Saadat, et al. to California Energy Commission. <https://earthjustice.org/sites/default/files/files/cec-title-24-ej-comment-letter-8-10.pdf>.
- The Energy Conservation and Production Act (ECPA) of 2005. 42 U.S. Code § 6833.
<https://www.energycodes.gov/statutory-requirements>
- Weatherization Program Notice. "2021 Federal Poverty Guidelines and Definition of Income" (February 10, 2021). <https://www.energy.gov/sites/default/files/2021/02/f82/wpn-21-3.pdf>
- White House Climate and Economic Justice Screening Tool. 2022.
<https://screeningtool.geoplatform.gov/en/methodology#3/33.47/-97.5>