



Economic Research Service
U.S. DEPARTMENT OF AGRICULTURE

Economic
Information
Bulletin
Number 300

October 2026

Contributing Factors to Rural Energy Use, Costs, and Affordability in the Early 2020s

Justin B. Winikoff, Hannah Kamen, and Richelle L. Winkler





Economic Research Service www.ers.usda.gov

Recommended citation format for this publication:

Winikoff, J. B., Kamen, H., & Winkler, R. L. (2026). *Contributing factors to rural energy use, costs, and affordability in the early 2020s* (Report No. EIB-300). U.S. Department of Agriculture, Economic Research Service.



Cover photo image from Adobe Stock.

Use of commercial and trade names does not imply approval or constitute endorsement by USDA.

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audio-tape, American Sign Language, etc.) should contact the State or local Agency that administers the program or contact USDA through the Telecommunications Relay Service at 711 (voice and TTY). Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at [How to File a Program Discrimination Complaint](https://www.usda.gov/program-discrimination-complaint-form) and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by: (1) mail: U.S. Department of Agriculture, Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Mail Stop 9410, Washington, D.C. 20250-9410; (2) fax: (202) 690-7442; or (3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.



Contributing Factors to Rural Energy Use, Costs, and Affordability in the Early 2020s

Justin B. Winikoff, Hannah Kamen, and Richelle L. Winkler

Abstract

Affordable access to energy is critical for economic and physical welfare. This report draws largely on data from the U.S. Department of Energy's 2020 Residential Energy Consumption Survey to study energy affordability in the rural United States, focusing on household costs and factors contributing to energy affordability. Rural households spend more of their income on home energy use than their urban counterparts. This disparity is driven primarily by differences in heating costs. Several factors explain the higher costs (including heating fuel type, the prevalence of mobile homes, and exposure to cold temperatures). Low-income rural households tend to live in less energy efficient homes and spend more money per square foot on both heating and cooling.

Keywords: energy costs, rural welfare, mobile homes, rural housing

Acknowledgments

The authors thank participants in seminars at the USDA, Economic Research Service (USDA, ERS), Federal Housing Finance Agency, and Midwest Economics Association annual meeting. They would also like to thank Becka Brolinson, Bob Dinterman (USDA, Rural Development), and the Housing Assistance Council for early feedback on the project. Finally, they would like to express gratitude to USDA, ERS staff Jonathan McFadden, Grant Wall, Christopher Whitney, and Jeremy Bell for shepherding this report through the publication process.

About the Authors

Justin Winikoff is a research agricultural economist at the USDA, Economic Research Service. Hannah Kamen is a graduate student at the Colorado School of Mines and a former intern with ERS. Richelle Winkler is a Professor of Sociology and Demography at Michigan Technological University and a former research social scientist at ERS.

Contents

Summary	iii
Introduction	1
Data and Methodology.....	3
Rural/urban Differences in Energy Use and Burden	4
Factors Contributing to Higher Rural Energy-Cost Burdens	9
Rural Households Less Frequently Heat Their Homes With Natural Gas	10
Mobile Homes Are More Common in Rural Areas.....	12
Households in Rural Areas Experience More Cold Days, Fewer Hot Days Than Those in Urban Areas	14
Other Rural/urban Differences.....	16
Energy Insecurity Among Rural Households.....	18
Rural Households With Children, Renters, and Lower Income Households Face More Energy Insecurity.....	19
Lower-income Rural Households Spend More and Have Less Efficient Homes	20
Conclusion.....	24
References.....	25
Appendix: Supplementary Figures and Tables.....	28



A report summary from the Economic Research Service

Contributing Factors to Rural Energy Use, Costs, and Affordability in the Early 2020s

Justin B. Winikoff, Hannah Kamen, and Richelle L. Winkler



Key Points

- Rural households spend a higher percentage of their income on at-home energy expenditures than urban households. Approximately 26 percent of rural households were “energy-cost burdened,” meaning they spent more than 6 percent of their income on energy, compared to just 17 percent of urban households. Higher rural expenditures were driven primarily by increased heating costs.
- Fewer rural households heated their homes with natural gas, which is generally less expensive than alternatives that are more common in rural areas, such as electricity, fuel oil, and propane.
- Mobile homes are more common in rural communities. Mobile homes cost more to heat because they are less likely to be heated with natural gas and are generally less energy efficient.
- Low-income rural households were more likely to be energy insecure because they lived in less efficient homes and had higher heating and cooling costs per square foot. Rural renters and homes with children also experienced energy insecurity at above-average rates.

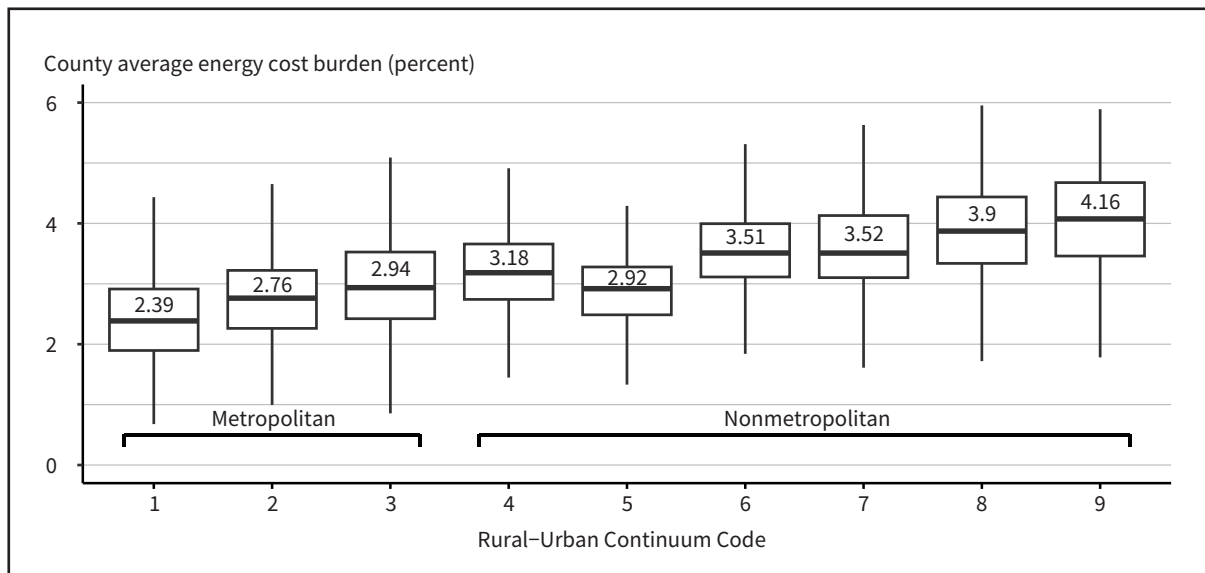
Why Does This Matter?

Energy is an essential good, necessary for both heating and cooling. Energy insecure households may forgo other necessities such as food or medicine to pay their energy bills. These homes are generally less healthy and face other financial hardships. This challenge is particularly important for rural households, who already experience poverty at a higher-than-average rate. To address

higher energy costs in rural areas, the U.S. Department of Agriculture, through the Rural Utilities Service (RUS), facilitates several electric programs that intend to secure low-cost energy for rural Americans. Findings from this report provide insights into the factors that explain higher energy costs for rural households. This report will allow policymakers to consider ways to improve program facilitation to lower energy costs and enhance rural prosperity.

A Few More Details

County energy cost burden by Rural-Urban Continuum Codes



Note: Energy-cost burden is defined as the percentage of income a household spends on at-home energy. The Rural-Urban Continuum Code (RUCC) measures rurality along a continuum ranging from counties within the largest metropolitan areas (RUCC = 1) to remote counties with urban populations of less than 5,000 (RUCC = 9). For each RUCC, the bolded line in the middle of each box represents the median measure of average energy-cost burden for counties with each code. The lower and upper limits of each box represent the 25th and 75th percentile average burden. The lines extend to 1.5 times the distance of the difference between the 75th and 25th percentiles.

Source: USDA, Economic Research Service using data from the U.S. Department of Energy's Low-Income Energy Affordability Database (LEAD) and USDA, ERS Rural-Urban Continuum Codes.

Rural households spend a higher percentage of their income on energy than urban households. Energy-cost burdens (the share of income spent on at-home energy use) are higher among rural households than urban households. The most urban counties with a Rural-Urban Continuum Code (RUCC) of 1 (metropolitan-area counties with a population of 1 million or more) spent 2.4 percent of income on energy, on average. By contrast, counties with a RUCC of 9 (counties that were not adjacent to metropolitan areas with an urban population of fewer than 5,000) spent an average of 4.16 percent of their income on energy. Rural households were more likely to be energy-cost burdened, meaning they spent more than 6 percent of their income on energy expenditures.

Several factors explain higher energy cost burdens for rural households, which were primarily driven by higher heating costs. More than 60 percent of urban households are heated with natural gas, compared to about a quarter of rural homes. Electricity is the most common heating fuel for rural households, which is generally more expensive, as are other alternatives such as fuel oil or propane. Furthermore, mobile homes accounted for approximately 17 percent of rural housing units and just 3 percent of urban units. The average heating and cooling cost for mobile homes was \$0.61 per square foot, compared to \$0.45 and \$0.42 for single family homes and apartments. Finally, rural households experienced more very cold days than urban households, requiring more heating fuel to warm their homes and raising rural energy expenditures.

Low-income rural households were particularly energy insecure. Approximately 45 percent of rural households below 200 percent of the Federal poverty line experienced some form of energy insecurity, such as forgoing necessities to pay energy bills, receiving a disconnection notice, the inability to use heating or cooling equipment, or leaving their home at an unhealthy temperature.

ERS is a primary source of economic research and analysis from the U.S. Department of Agriculture, providing timely information on economic and policy issues related to agriculture, food, the environment, and rural America.

Contributing Factors to Rural Energy Use, Costs, and Affordability in the Early 2020s

Introduction

Rural households consistently have lower incomes than those in urban areas. In 2023, 23 percent of rural households had incomes of less than \$35,000¹ and 13.6 percent of the nonmetropolitan population (about 6 million people) lived below the official Federal poverty line, compared to 10.7 percent of the metropolitan population (Farrigan et al., 2024). Furthermore, 85 percent of persistent poverty counties were in nonmetropolitan counties (USDA, Economic Research Service (ERS), 2025).

For low-income households, affording essential goods can be a challenge. This report studies one critical commodity families often struggle to afford—energy. Home energy use, particularly for heating in the winter and cooling in the summer, is necessary for health and well-being. In July of 2024, nearly 28.3 percent of U.S. residents reported forgoing other household necessities such as medicine or food to pay an energy bill, and 18.5 percent reported keeping their home at a temperature that felt unsafe or unhealthy (U.S. Department of Commerce, Bureau of the Census, 2024b).

Energy insecurity broadly refers to a household’s inability to reliably meet its energy needs (see box, “Defining Energy Insecurity and Energy-Cost Burden” and table 1). An energy insecure household may keep their home at an unsafe temperature, forego other essential expenses, or risk and experience service disconnections. Energy-insecure households have also faced other serious consequences, including health impacts resulting from exposure to hazardous heat and cold, asthma, and mental health challenges (Liddell & Morris, 2010; Hernández, 2016; Hernández & Siegel, 2019). Energy insecure households often took out high-interest, short term loans to keep the power on (Tonn et al., 2015) and were more likely to transition into or remain in poverty (Bohr & McCreery, 2020). Furthermore, Doremus et al. (2022) indicated that although high-income families increased energy expenditures during extreme temperatures, low-income households did so less and cut back on food expenditures.

¹ American Community Survey 2023, 1-year estimates (table S1901).

Defining Energy Insecurity and Energy-Cost Burden

Energy insecurity and energy-cost burden are two closely related concepts that, although they often occur simultaneously, have different meanings. Energy insecurity refers broadly to a household’s inability to meet its daily energy needs.¹ Hernández (2016) explained three different components of energy insecurity. Economic energy insecurity accounts for financial hardship associated with paying for energy. Physical energy insecurity is the result of infrastructural deficiencies that can cause discomfort or increase costs. Finally, behavioral energy insecurity results from coping strategies used to mitigate economic or physical insecurity. In its 2020 survey, the U.S. Department of Energy defined an energy insecure household as one reporting reducing or forgoing food or medicine

¹ Energy security may also reference a more national perspective, including a reduced reliance on foreign energy sources, and general security and reliability of energy infrastructure, as it was used in the Energy Independence and Security Act of 2007. This report focuses solely on energy security of individual households.

to pay for energy, leaving their home at an unhealthy temperature, receiving a disconnect or fuel delivery stop notice, or being unable to use heating or cooling equipment (U.S. Department of Energy, Energy Information Administration, 2023a). Other researchers, such as Lin (2018) and Harker Steele and Bergstrom (2021), create indices to mathematically define energy insecurity.

Energy-cost burden (often referred to as energy burden) refers to a specific calculation, energy expenditures divided by income, representing the percentage of household income spent on energy at home. Energy expenditures (and consequently, energy-cost burdens) are measured using money spent on all expenditures, whether from electricity, natural gas, or other fuel types. Due to data availability, energy-cost burden is a commonly used metric that can proxy for economic energy insecurity. Although there is no formal definition of what makes a household energy-cost burdened, a frequently used threshold is spending more than 6 percent of income on energy (Colton, 2011; Colton, 2013).² A cost-burdened household may not necessarily be insecure, and an insecure household may not be cost-burdened. However, because reduced energy costs (or higher income) reduce both energy-cost burden and components of energy insecurity, the two are highly correlated.

The table below provides more details on different aspects of energy insecurity and their use in this report.

Table 1

Categories of energy insecurity

Category	Definition	Report examples
Economic	“Financial hardship associated with the cost of energy relative to income and other expenses.”	- Energy-cost burden: spending more than 6 percent of income on energy (Colton, 2013) - Receiving an energy disconnection notice
Physical	“Deficiencies in the physical infrastructure of the home environment that impact thermal comfort, induce harmful indoor exposures and increase energy costs.”	- Heating fuel type - Home type (i.e., single family, multifamily, mobile) - Housing insulation - Housing design and exterior building inefficiencies - Inability to use home heating and cooling equipment
Behavioral	“Behavioral strategies used to cope, improve and counteract the impacts of economic and structural energy insecurity.”	- Leaving home at unhealthy temperature - Forgoing necessities to pay energy bills

Source: USDA, Economic Research Service using definitions provided in Hernández (2016).

² “Energy poverty” is another term that refers to having enough energy to meet everyday necessities (Brown et al., 2020). This definition can be the result of a variety of socio-economic, environmental, and technological factors (Bednar & Reames, 2020). This report does not use this term, although it is closely related.

Previous studies have found that income, weather, demographics, age, and housing type (Drebohl & Ross, 2016; Lyubich, 2020; Graff et al., 2021; Memmott et al., 2021; Konisky et al., 2022; Kear et al., 2023) contribute to households’ energy insecurity.² Fewer studies, however, have examined the effects of rurality and its implications for energy expenditures and insecurity. One notable exception is Ross et al. (2018). Using 2015 data from the American Community Survey (ACS), they found rural households had an energy-cost burden of 4.4 percent, compared to 3.1 percent for their urban counterparts and that rural homes are less energy efficient. They also found higher energy-cost burdens among house-

² For a summary of the earlier literature on this topic, see Brown et al. (2020).

holds living in manufactured homes and among different demographic groups of rural residents and highlight some geographic differences.³ Adua and Beaird (2018) similarly found higher energy costs among rural households in the 1990s and 2000s. Furthermore, MacDonald et al. (2020) reported rural Alaskan and New England homes were less energy efficient than urban homes.

This report examines rural households' energy use at home. First, this study identifies differences in energy expenditures and cost burdens between rural and urban areas and explores factors that contribute to these differences. These include heating fuels, home type, and relative differences in temperatures. Next, this study identifies differences in energy-cost burdens and energy insecurity across different rural groups, including by age, income, and housing type. This report highlights subsets of rural households that are particularly vulnerable to energy insecurity and identifies contributing factors including home type, fuel use, weather. The findings inform implementation of USDA programs intending to reduce rural energy costs, including Rural Electrification Act lending, Denali Commission High Energy Cost Grants, Energy Efficiency and Conservation Loan Program, High Energy Cost Grants, and Rural Energy Savings Program obligations. Much of this funding goes to the approximately 900 rural electric cooperatives (co-ops) which provide energy to about 42 million people.

Data and Methodology

This report uses several datasets to analyze energy costs, burdens, and insecurity in rural areas. Doing so relies on detailed energy use, expenditures data, and clear definitions of rurality. However, due to the different geographies used across data sources, varied definitions of rurality are used depending on the dataset.

The first data set is the Residential Energy Consumption Survey (RECS), administered by the U.S. Department of Energy, Energy Information Administration (EIA), with the most recently released version conducted in 2020 (EIA, 2023). RECS consists of a nationally representative sample of approximately 18,500 households, sampled to represent a variety of geographies, housing types, and incomes, among other factors. The data provide indicators of energy use, including energy expenditures, fuel type, and appliances. The survey also asked about home temperature, self-reported measures of energy comfort, and a variety of measures of energy insecurity.

RECS provides regional variables and a measure of rurality, breaking homes into three categories (urban, urban cluster, and rural) based on definitions from the 2010 U.S. Census. Households in urban areas or urban clusters are both classified as urban to distinguish from rural households. Thus, the unit of analysis is the household, with differences in means evaluated between rural and urban households. Although rural communities are less common in the survey, RECS provides survey weights and error corrections so that estimates are representative of the rural population as well as different regions, States, fuel uses, climates, or other household characteristics. RECS uses a within-State sampling selection to ensure rural/urban differences are not due to under-sampling rural areas within certain states.

One disadvantage of RECS is the lack of precise geographic information. To supplement this resource, we also use the U.S. Department of Energy's Low-Income Energy Affordability Data (LEAD) Tool (U.S. Department of Energy, 2024). LEAD, which is derived from the 2022 American Community Survey, provides average county and census-tract measures of energy expenditures, income and energy-cost burden, allowing for more focused geographic analysis.

³ Additional studies that, in part, discuss rural/urban differences in energy costs and use include Shoemaker et al. (2018) and Gawrys and Carswell (2020).

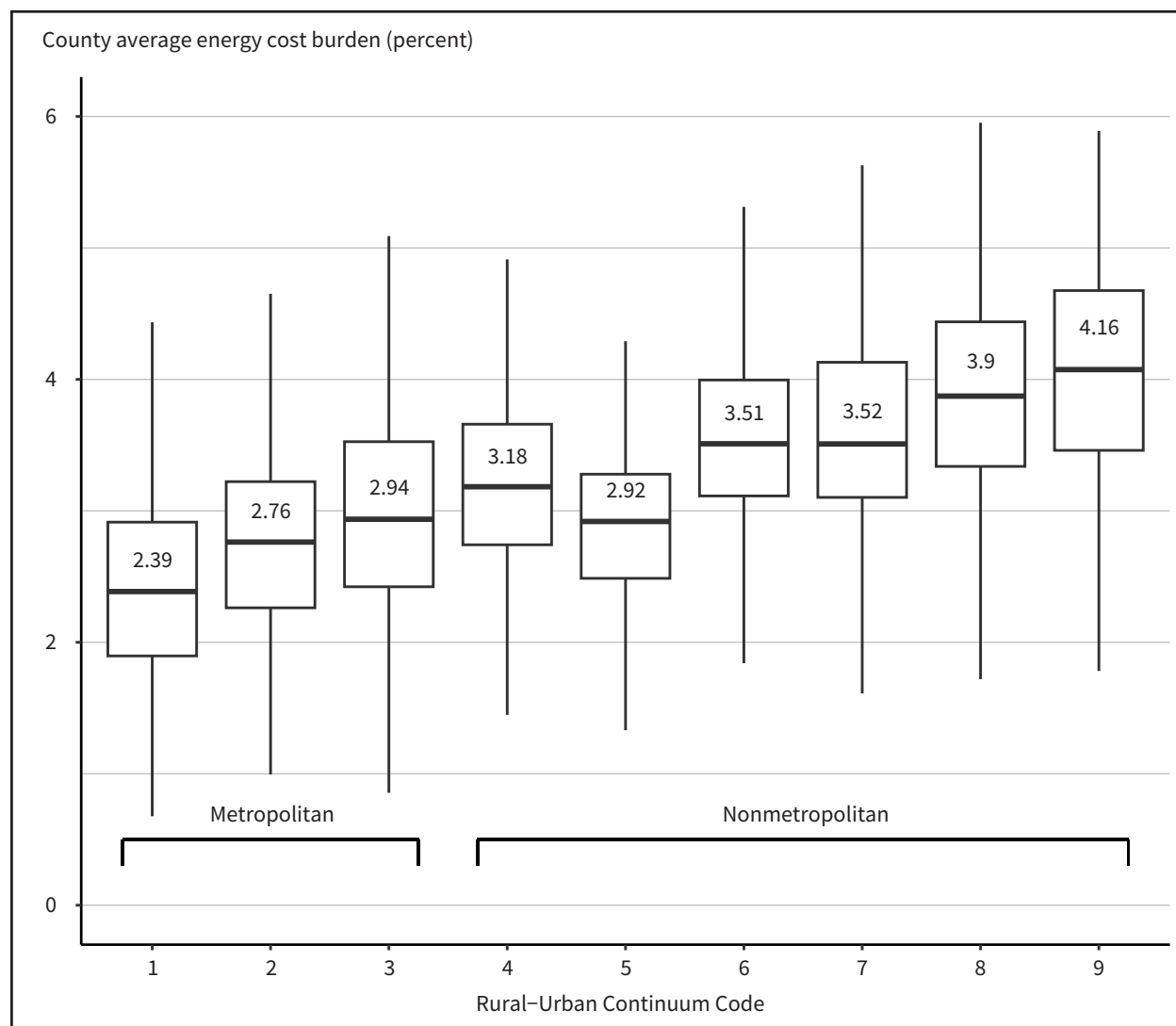
This study compares LEAD data along a rural-urban gradient using two measures of rurality as defined by USDA, Economic Research Service (ERS). The first measure is the Rural-Urban Continuum Code (RUCC), which distinguishes the degree of urbanization in both metropolitan and nonmetropolitan counties (USDA, Economic Research Service (ERS), 2024). The second measure of rurality comes from the Rural-Urban Commuting Area (RUCA) Codes, which provide census tract-level categorizations of rurality based on population density and commuting patterns (USDA, ERS, 2019). Thus, the unit of analysis is the county or tract, averaged over each level of the RUCC or RUCA codes. Each of these datasets are used in the subsequent sections to understand rural/urban differences in energy burdens, factors that explain those differences, and differences among subgroups of the rural population.

Rural/Urban Differences in Energy Use and Burden

Using LEAD data, figures 1 and 2 demonstrate how a household's average energy-cost burden (percent of income spent on energy) generally increased with rurality. In figure 1, the box plots of the average energy-cost burden by county are presented, organized by RUCC. The bar in the middle of each box represents the median measure of average county-cost burden for counties within each code. Metropolitan counties (represented by RUCC 1–3) had generally lower energy cost burdens than nonmetropolitan counties (RUCC 4–9). For example, among the most urban counties with a RUCC of 1 (metropolitan counties with a population greater than 1 million), the median energy-cost burden was 2.4 percent. In counties with a RUCC of 9, (an urban population of less than 5,000 and not adjacent to a metropolitan area), the median burden measure was about 4.2 percent.

Figure 1

Energy cost burdens by county across the Rural-Urban Continuum

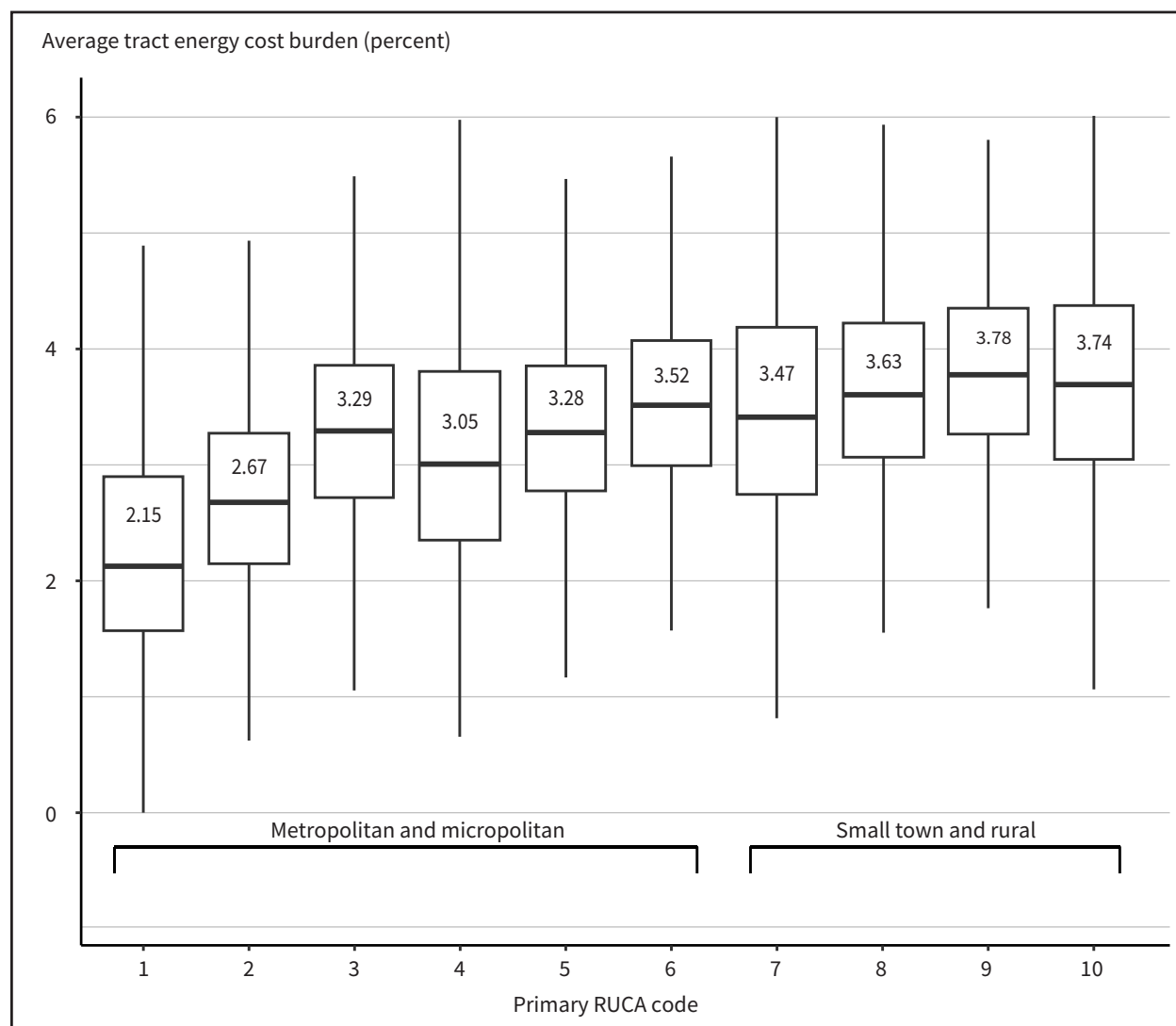


Note: Energy-cost burden is defined as the percentage of income a household spends on at-home energy. The Rural-Urban Continuum Code (RUCC) measures rurality along a continuum ranging from counties within the largest metropolitan areas (RUCC = 1) to remote counties with urban populations of less than 5,000 (RUCC = 9). For each RUCC, the bolded line in the middle of each box represents the median measure of average energy-cost burden for counties with each code. The lower and upper limits of each box represent the 25th and 75th percentile average burden. The lines extend to 1.5 times the distance of the difference between the 75th and 25th percentiles.

Source: USDA, Economic Research Service using data from the U.S. Department of Energy's Low-Income Energy Affordability Database (LEAD) and USDA, ERS Rural-Urban Continuum Codes.

Census tracts in figure 2 reveal a similar pattern: Energy-cost burdens were generally higher in more rural tracts. For example, the median energy-cost burden among tracts with a RUCA code of 1 (metropolitan core, primary flow in an urbanized area) was 2.15 percent, compared to 3.74 percent in tracts with a RUCA code of 10 (rural areas with a primary flow to tracts outside of urban areas or clusters).

Figure 2

Energy-cost burdens by census tracts across Rural-Urban Commuting Area Codes

Note: Energy-cost burden is defined as the percentage of income that a household spends on at-home energy. For each Rural-Urban Commuting Area (RUCA) code, the bold line in the middle of each box represents the median measure of average energy-cost burden for census tracts with each code. The lower and upper limits of each box represent the 25th and 75th percentile average burden. The lines extend to 1.5 times the distance of the difference between the 75th and 25th percentiles. RUCA codes range from the most urban (1) to the most rural (10).

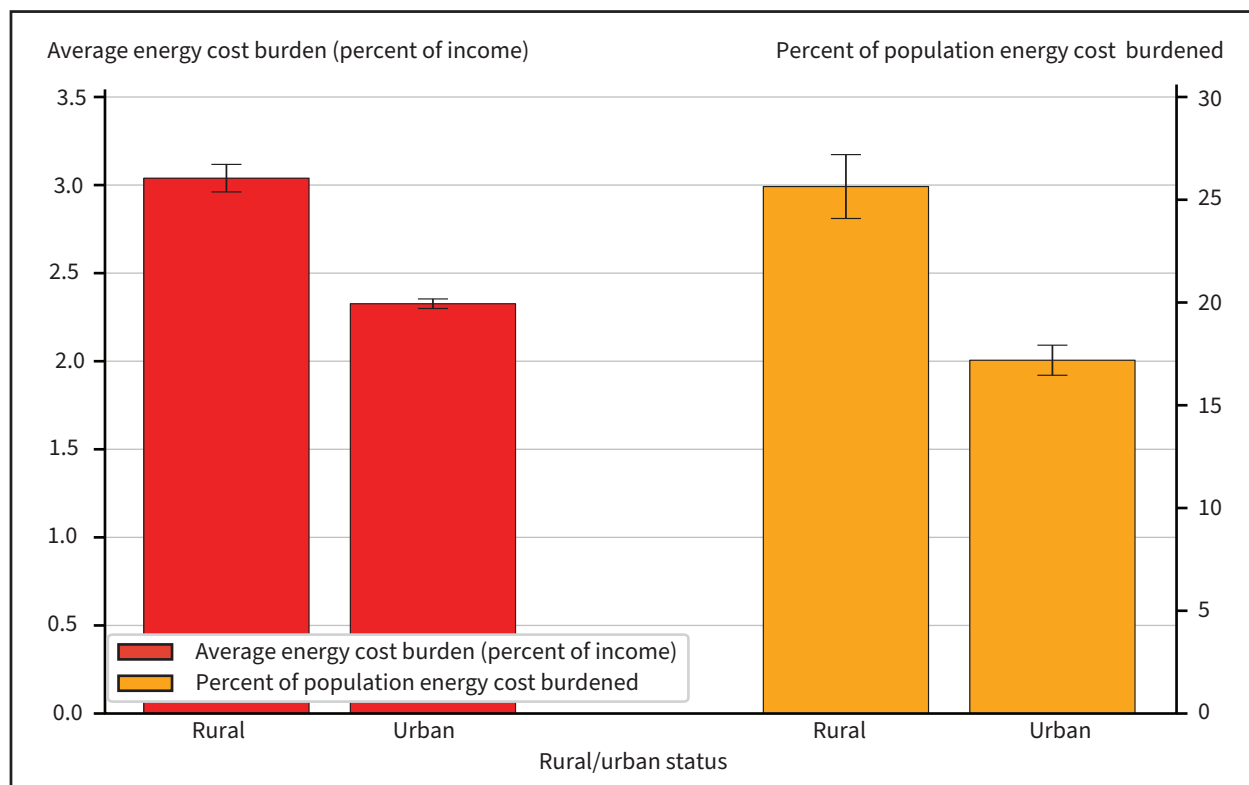
Source: USDA, Economic Research Service (ERS) using data from the U.S. Department of Energy's Low-Income Energy Affordability Database (LEAD) and the USDA, ERS Rural-Urban Commuting Area Codes.

Like the results using LEAD, data from the 2020 RECS survey also show that the energy-cost burden increases with rurality (figure 3). Two metrics reveal higher energy-cost burdens in rural areas. On the left side, the average rural household spent an estimated 3.12 percent of income on energy, compared to 2.35 percent for urban households. On the right side, approximately 25.6 percent of rural households were energy-cost burdened in 2020. The number is lower for urban areas, where only 17.2

percent of households spent more than 6 percent of their income on energy. Overall, the evidence suggests that rural households generally spend a higher share of their income on energy.^{4 5}

Figure 3

Energy-cost burdens in rural and urban areas, 2020



Note: Energy-cost burden is defined as the percentage of income a household spends on at-home energy. Households are considered “energy-cost burdened” if the households spent more than 6 percent of income on energy (Colton, 2011; Colton, 2013). Incomes are estimated as the midpoint for the household’s reported income bracket. Rural/urban status is determined by whether a household lived in an urban area. The error bars represent the 95 percent confidence interval.

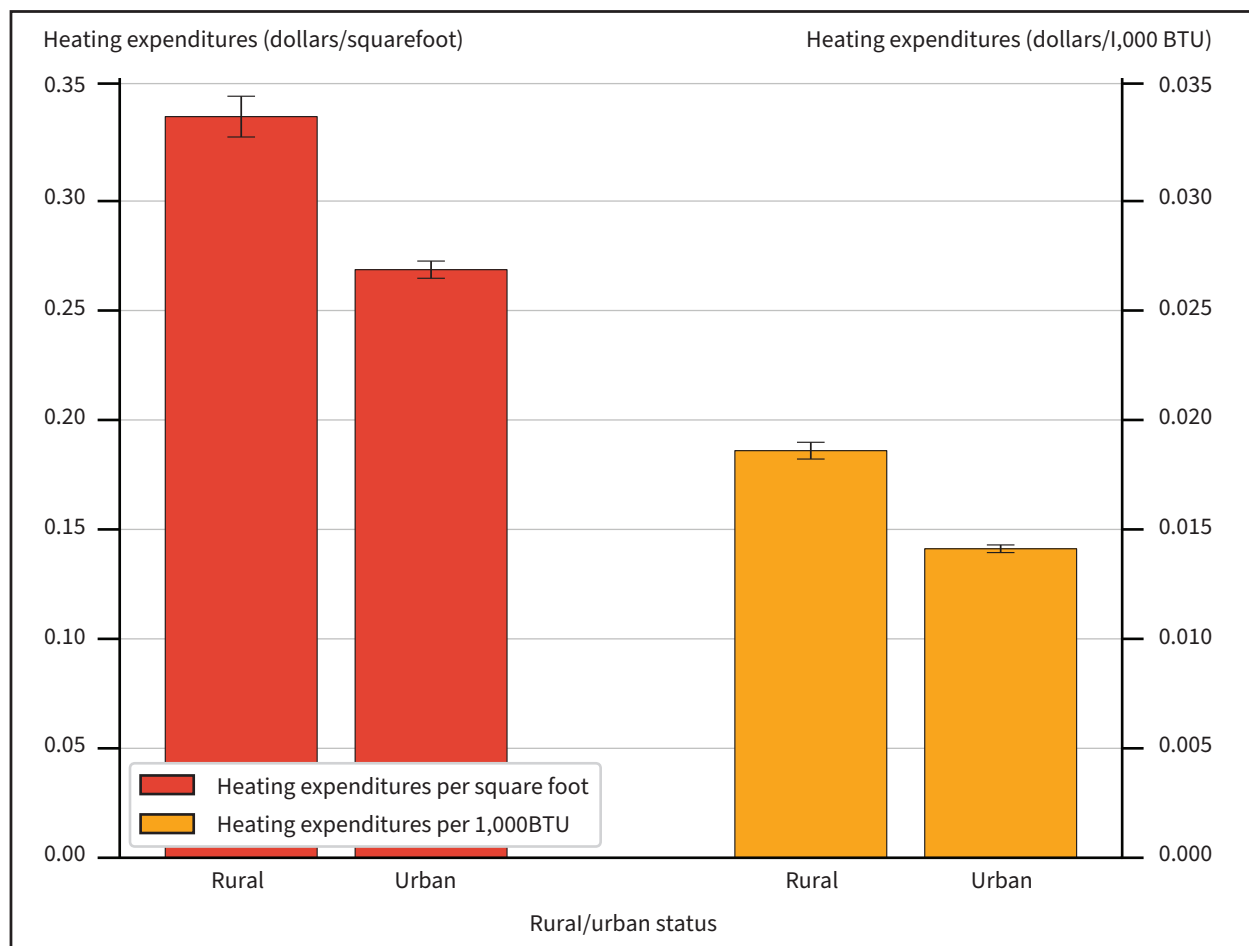
Source: USDA, Economic Research Service using data from the 2020 Residential Energy Consumption Survey by the U.S. Department of Energy, U.S. Energy Information Administration.

Figure 4 demonstrates the contribution of heating costs to higher energy-cost burdens in rural households. Heating expenditures were higher among rural households than their urban counterparts. Rural households spent approximately \$0.34 per square foot to heat their homes, about 26 percent more than the \$0.27 per square foot spent by urban households. Differences in expenditures per square foot could reflect differences in efficiency, fuel costs, or preferences such as keeping the home warmer in winter. Per 1,000 BTU (British Thermal Units, a standardized measure of energy that would be independent of efficiency and preferences), rural homes still had higher expenditures. Rural households spent \$0.19 per 1,000 BTU on heating, compared to \$0.14 per 1,000 BTU among urban households. This suggests there were differences in fuel costs between rural and urban areas. The differences across both measures are statistically different at the 95 percent level.

⁴ One concern may be that energy burdens are driven by differential participation in energy assistance programs. In fact, urban households participated in energy assistance programs (5.6 percent) at a slightly higher rate than rural households (4.0 percent). Still, among both households that did and did not receive assistance, rural households had a significantly higher energy burden (appendix figure A.1).

⁵ Additional differences in energy costs could be driven by participation in energy efficiency programs or local building codes. Rural households may be less likely to participate in these programs due to geographic and financial barriers, as well as limited program awareness (MacDonald et al., 2020). Furthermore, building codes may vary across States, and those and more stringent standards can reduce electricity consumption (Kellogg & La Cumbre-Gibbs, 2023).

Figure 4

Heating expenditures by rural/urban status, 2020

Note: BTU stands for British Thermal Unit, a standardized measure of energy that would be independent of efficiency and preferences. Heating and consumption expenditures exclude those from wood and other heating sources, for which RECS does not provide costs. Rural/urban status is determined by whether a household lived in an urban area. The error bars represent the 95 percent confidence interval.

Source: USDA, Economic Research Service using data from the U.S. Department of Energy, U.S. Energy Information Administration 2020 Residential Energy Consumption Survey.

However, cooling expenditures were lower in rural households (figure 5). In rural households, the average expenditure per square foot was \$0.11, compared to \$0.15 in urban households. Similarly, rural households spent less on cooling on a per-1,000 BTU basis (\$0.35) than their urban counterparts (\$0.38). Despite these lower cooling expenditures, overall energy-cost burdens remained higher for rural households than urban households (figure 3). This is because space heating comprises a significantly larger portion of most households' energy bills; in 2015, space heating accounted for 43 percent of U.S. end-use energy consumption, while air conditioning accounted for just 8 percent (EIA, 2023b).⁶

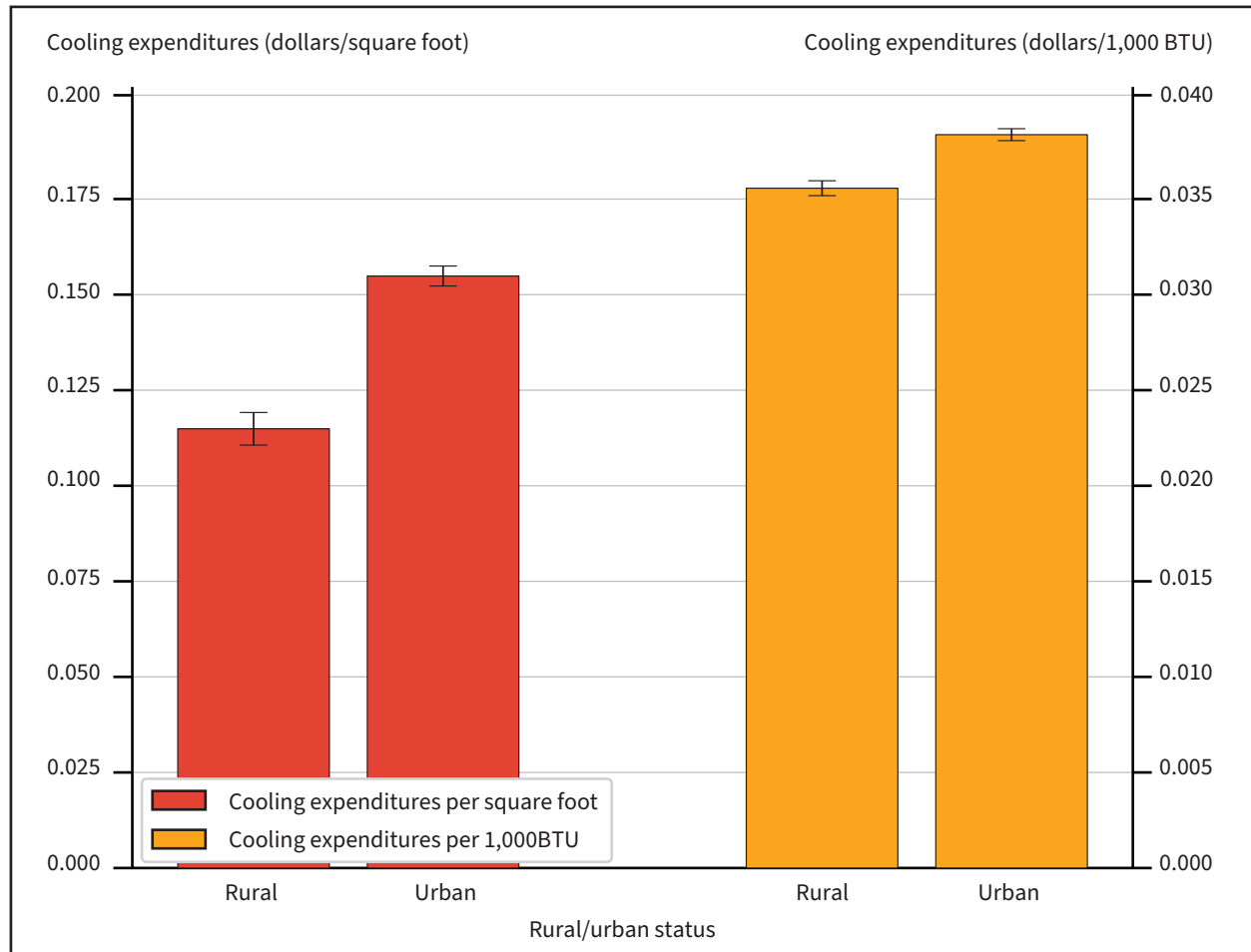
While the remainder of this paper demonstrates higher energy costs for rural households, we briefly discuss why rural households spend a lower share of their income on cooling. First, as discussed in more detail below, rural areas are generally located in less hot areas, reducing cooling demand. Second, electricity prices are slightly less expensive in rural areas, although the difference is small.

⁶ The second largest share of home energy use is water heating, not cooling. Appendix figure A.2 shows differences in home expenditures for water heating. There was no statistical difference in expenditures per square foot, although rural households did spend more per BTU, suggesting higher energy costs.

It is also worth noting that rural homes spend about 8 percent less per BTU to cool their homes, while spending 26 percent more per BTU to heat their homes, suggesting the decreased per-unit expenditures on cooling are much smaller than the increase for heating.

Figure 5

Cooling expenditures by rural/urban status, 2020



Note: BTU stands for British Thermal Unit, a standardized measure of energy that would be independent of efficiency and preferences. Rural/urban status is determined by whether a household lived in an urban area. The error bars represent the 95 percent confidence interval.

Source: USDA, Economic Research Service using data from the U.S. Department of Energy, U.S. Energy Information Administration 2020 Residential Energy Consumption Survey.

Factors Contributing to Higher Rural Energy-Cost Burdens

The previously discussed results show energy-cost burdens were higher in rural areas, meaning rural households spent more of their income on energy than urban households. Heating is the predominant energy use driving this finding.⁷ Rural households on average have higher expenditures due to their heating fuel, the prevalence of mobile homes, and weather.

⁷ Higher energy-cost burdens could also be due to less income, thereby decreasing the denominator. Although this is the case in this context (rural households in this sample earn about \$3,000 less), it holds true that rural energy expenditures are higher.

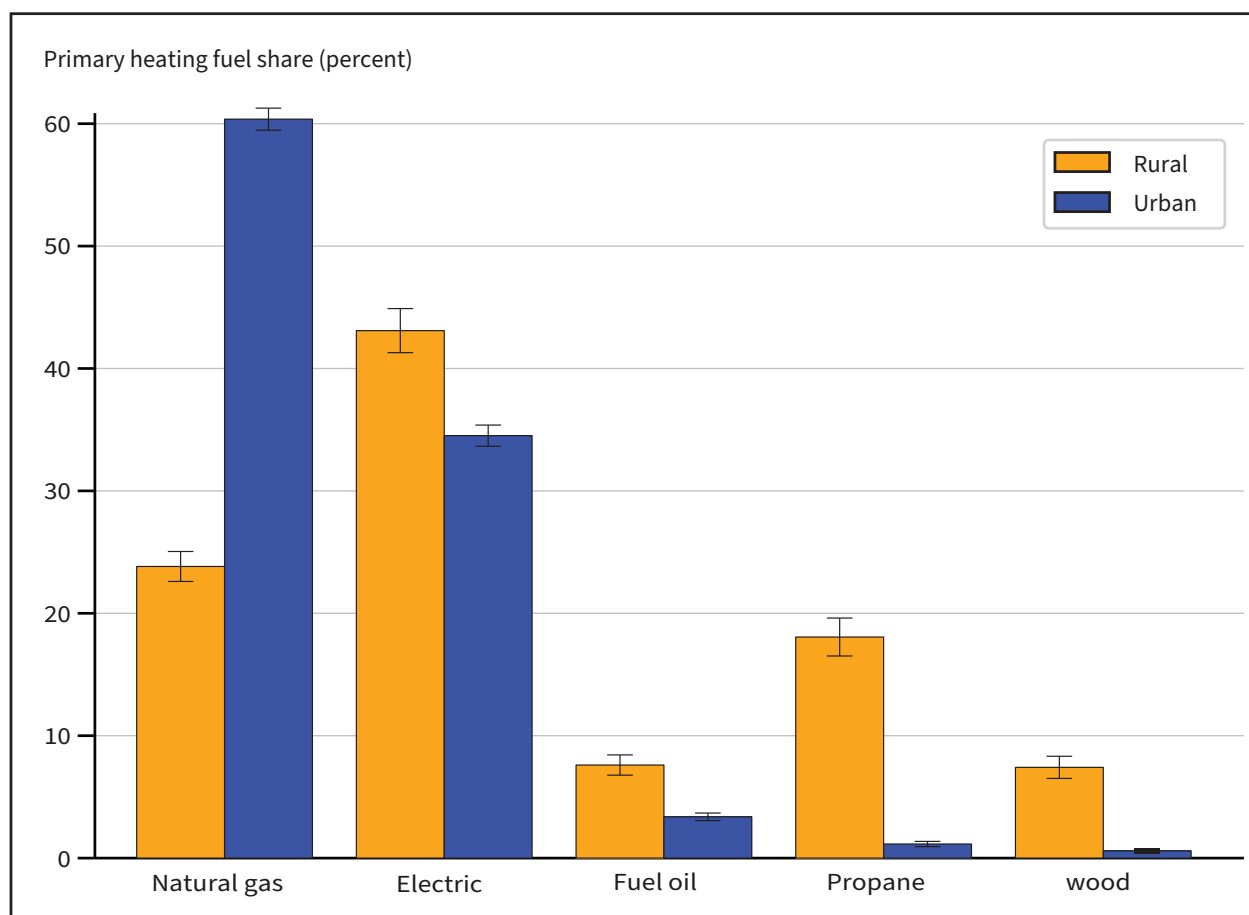
Rural Households Less Frequently Heat Their Homes With Natural Gas

Households have a variety of options for heating their homes during cold weather, dictated often by local infrastructure, housing type, and the age of home construction. Because these fuels are not priced the same, expenditures and energy-cost burdens vary, depending on what fuel is used for heat.

Figure 6 shows how primary heating fuel type differed depending on whether a household was in a rural or urban area. Most urban households (60 percent) used natural gas as their primary heating source, compared to only 24 percent of rural households. The most common heating source among rural homes was electricity, accounting for 43 percent of rural and 35 percent of urban households. These two sources comprised an overwhelming majority of urban homes' primary heating source, accounting for 95 percent of homes. This means just 5 percent of urban homes were heated primarily using alternative sources such as fuel oil, propane, and wood. By contrast, alternative sources (including fuel oil, propane, and wood) accounted for about one third of rural households' primary heating source.

Figure 6

Primary heating fuel shares by rural/urban status, 2020



Note: The error bars represent the 95 percent confidence interval. Percentages calculated exclude those homes heated by other heating sources.

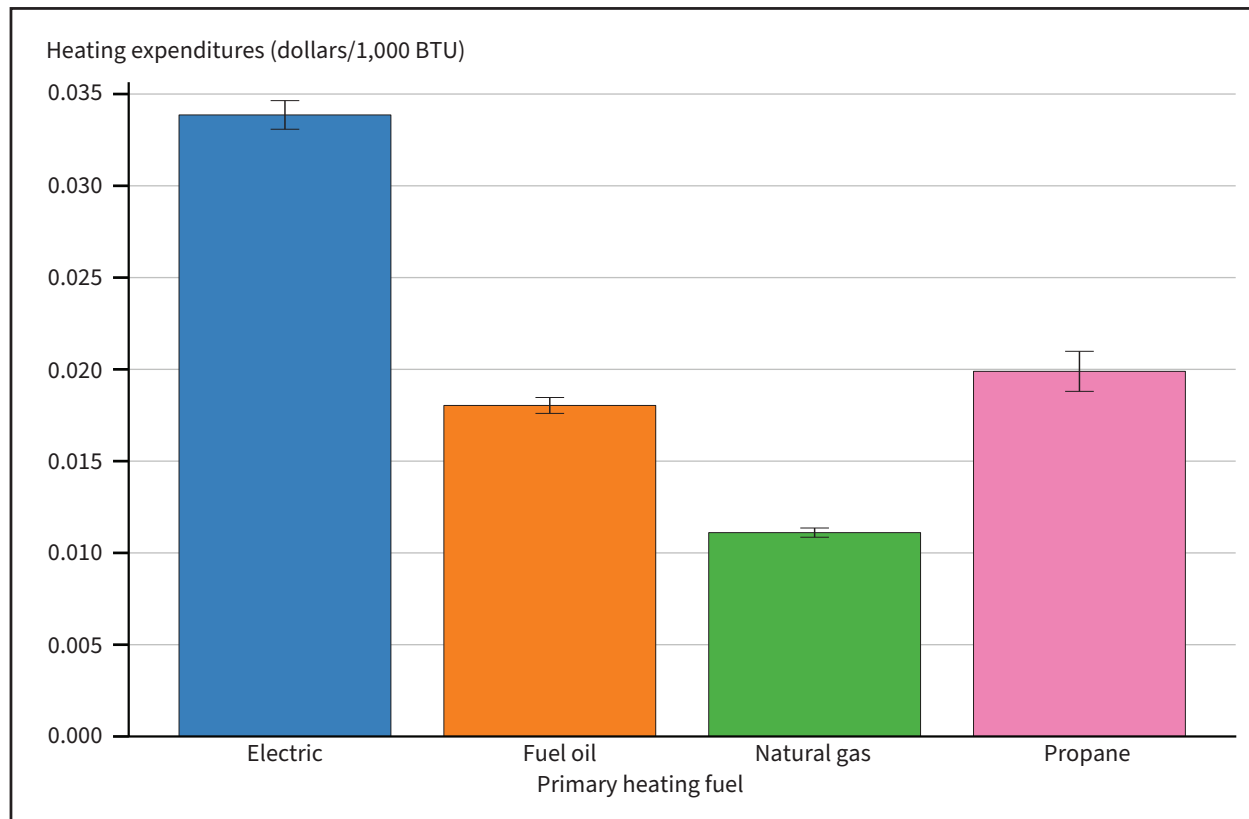
Source: USDA, Economic Research Service using data from the U.S. Department of Energy, Energy Information Administration 2020 Residential Energy Consumption Survey.

These differences in primary heating fuel use would only affect relative heating expenditures if their costs were different. Figure 7 confirms this is the case. On a per-unit of energy basis, homes heated primarily with natural gas had the lowest expenditures at about \$0.011 per 1,000 BTU. Fuel oil and

propane were next lowest at \$0.018 and \$0.020 per 1,000 BTU respectively, more than 60 percent more expensive. Homes heated primarily with electricity, the most common heating fuel in rural communities, had the highest heating expenditures at approximately \$0.034 per 1,000 BTU, a 209-percent increase relative to natural gas. The evidence suggests that fuel type is a primary factor contributing to higher energy-cost burdens and expenditures among rural households even though electricity prices were lower and natural gas prices were nearly identical in rural areas.^{8 9} Indeed, a lower share of households (rural or urban) were energy-cost burdened if they heated with natural gas (16 percent of households) compared to electricity (20 percent), fuel oil (27 percent), or propane (30 percent), as can be seen in appendix figure A.3.

Figure 7

Heating expenditures by primary heating fuel, 2020



Note: BTU stands for British Thermal Unit, a standardized measure of energy that would be independent of efficiency and preferences. Heating expenditures and consumption exclude those from wood and other heating sources, for which RECS does not provide costs. The error bars represent the 95 percent confidence interval.

Source: USDA, Economic Research Service using data from the U.S. Department of Energy, Energy Information Administration 2020 Residential Energy Consumption Survey.

Only about 60 percent of households (rural or urban) used natural gas in their homes in some capacity (heating or otherwise), suggesting further adoption in rural areas is likely limited by pipeline infrastructure. Certain regions were particularly limited, with just 22 and 23 percent of rural homes in the

⁸ Average electricity prices were less than one cent lower per kilowatt hour and natural gas prices were less than two tenths of a cent per thousand BTU lower in rural homes.

⁹ Alternative heating fuels that are more common in rural areas may cause additional challenges for these households. For example, heating rural homes with wood stoves or kerosene can worsen health outcomes (Semmens et al., 2015; Fleishman et al., 2024).

Northeast and South using natural gas, respectively (figure A.4).¹⁰ On the other hand, virtually all households used electricity in some capacity. This suggests that improving the efficiency of electric heating could be done without pipeline infrastructure. Space heating with heat pumps is generally more efficient at heating homes (Martinopoulos et al., 2018). RECS households with heat pumps used 29 percent less energy per square foot to heat their homes than those using other electric heating systems. However, as of 2020, adoption was still relatively limited. Just 13 percent of households had installed heat pumps, representing about a third of homes heated with electricity.

Mobile Homes Are More Common in Rural Areas

Rural and urban areas have a different housing stock composition, another factor that may contribute to disparate energy-cost burdens and expenditures. Two notable differences are the relative abundance of manufactured and mobile homes and the relative lack of apartments in rural areas. Rural areas hosted about 20 percent of all housing units but about 53 percent of manufactured/mobile homes or trailers in 2023 (U.S. Department of Commerce, Bureau of the Census, 2024a). Mobile homes comprised about 17 percent of all rural units and 3 percent of all urban units. By contrast, housing units in multi-unit buildings (apartments) accounted for 4 percent of rural units and about 30 percent of urban units. Most units in both rural and urban areas are single family homes, but they are more common in rural areas (79 percent of units) than in urban areas (67 percent).¹¹

Figure 8 demonstrates how housing type contributed to energy expenditures. Mobile housing units had the highest average heating and cooling expenditures per square foot at \$0.61. Average heating and cooling expenditures in single family homes and apartments were significantly lower than in mobile homes, at \$0.45 and \$0.42 per square foot.^{12 13} Figure 9 explains how this effect is driven in part by heating fuels. Natural gas is less common in mobile homes (24 percent) than in apartments (41 percent). On the other hand, more expensive fuel types such as electricity, propane, and wood are all most common in mobile homes.

¹⁰ Although rural homes in the Northeast and South use natural gas at similar rates, the regions are otherwise different. Nearly two thirds of rural homes in the South use electricity to heat their homes, while two thirds in the Northeast use fuel oil, propane, or wood. Furthermore, heating accounts for less of Southern energy costs, where winters are warmer.

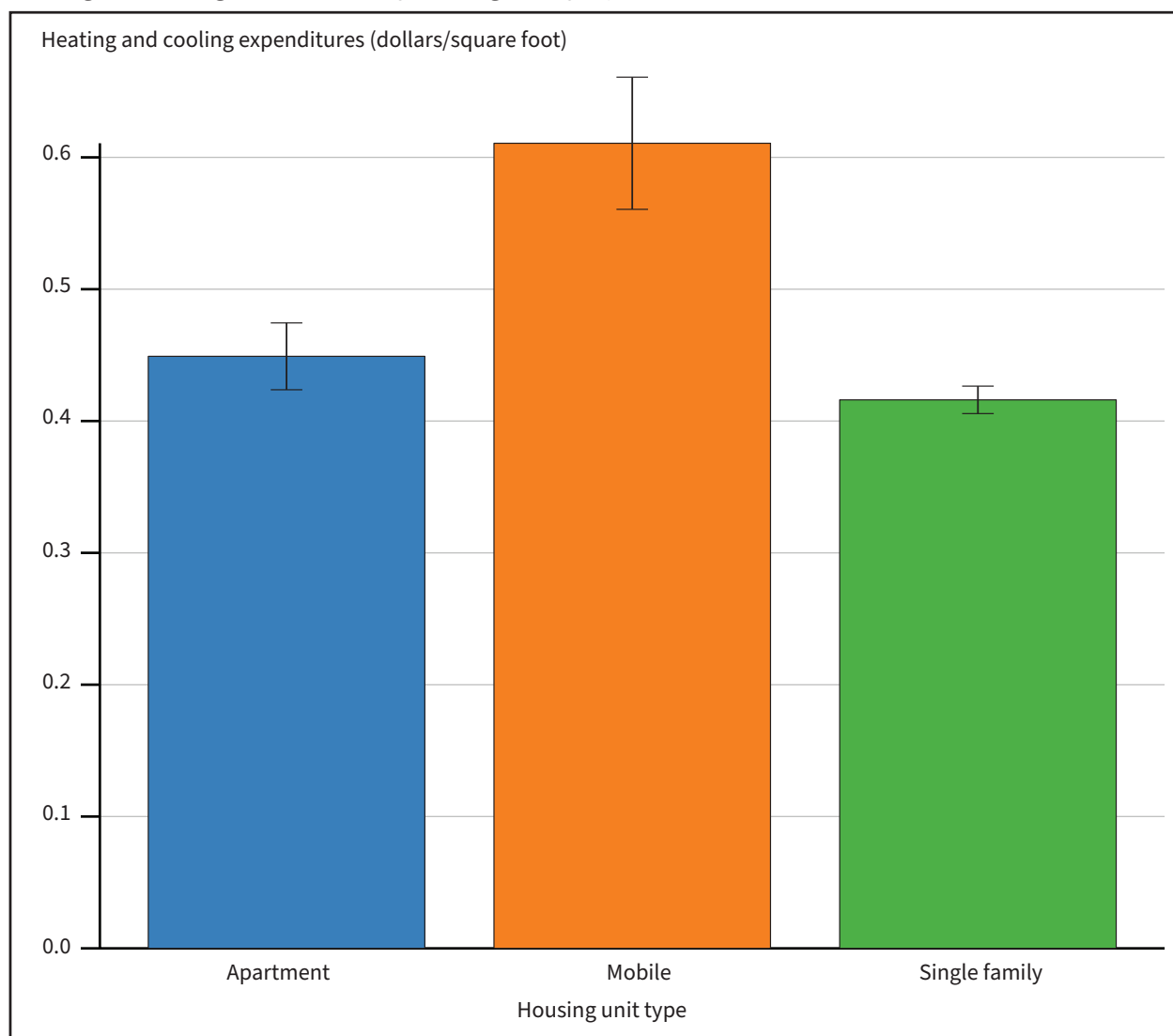
¹¹ As subsequent figures suggest, detached single-family homes and mobile homes, which are freestanding and do not share walls like multi-family apartments, have structural disadvantages for retaining energy. A detailed discussion of the relative energy use intensities of building types can be found in Reyna et al. (2022).

¹² Manufactured homes are not separated in the RECS data.

¹³ Among those living in mobile homes, 45 percent were cost burdened, compared to 21 percent for those in apartments and 16 percent in single-family homes.

Figure 8

Heating and cooling expenditures by housing unit type, 2020

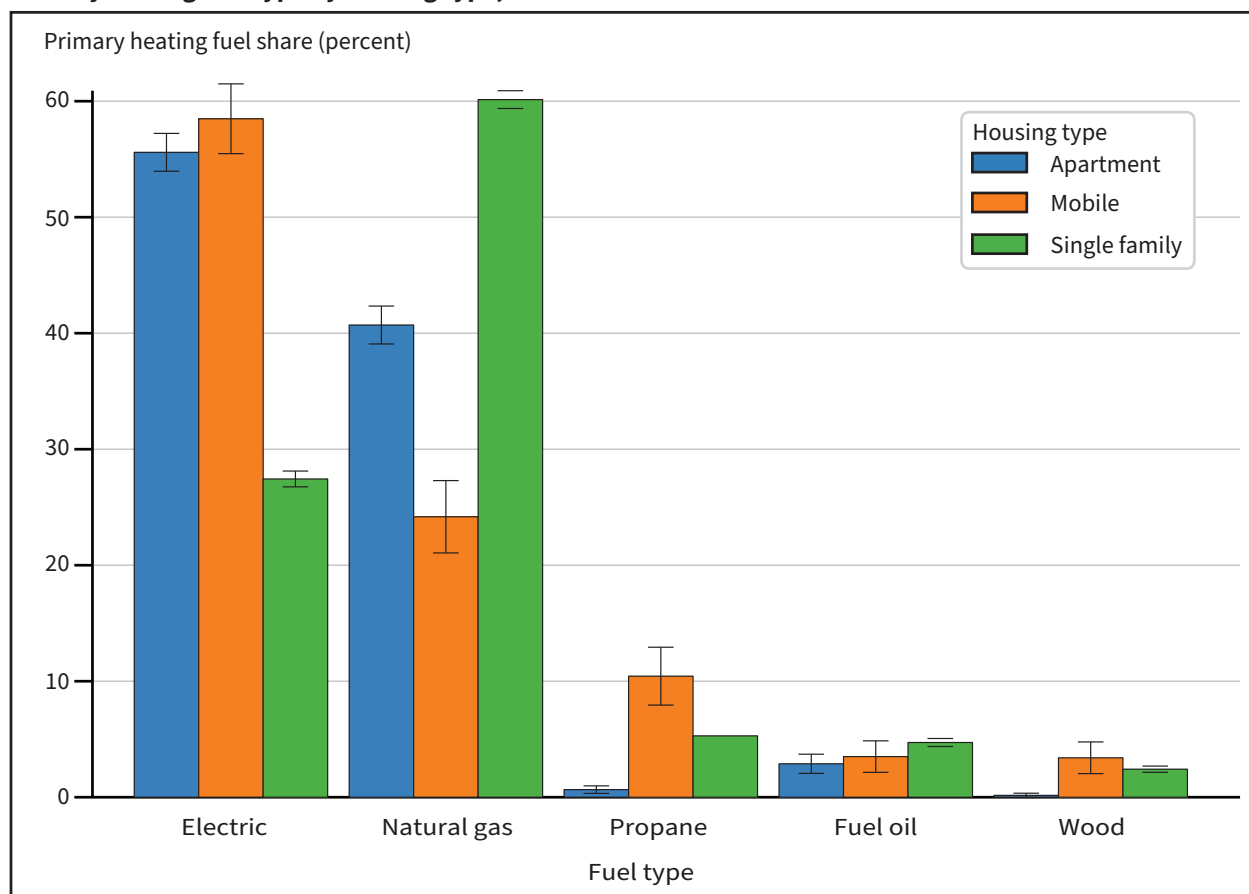


Note: Heating expenditures and consumption exclude those from wood and other heating sources, for which the Residential Energy Consumption Survey (RECS) does not provide costs. The error bars represent the 95 percent confidence interval.

Source: USDA, Economic Research Service using data from the U.S. Department of Energy, Energy Information Administration 2020 Residential Energy Consumption Survey.

Even after accounting for heating fuel type, mobile homes still cost more to heat and cool, suggesting energy efficiency contributes to heating expenses. Appendix figure A.5 demonstrates that when limited to households whose primary heating fuel was electricity, mobile home households spent about \$0.58 per square foot to heat and cool their homes. By comparison households in apartments and single-family homes spent \$0.39 and \$0.43, respectively. For homes heated by natural gas, households in mobile homes similarly spent more, although the difference is not statistically different from zero. This highlights how mobile homes, which are more common in rural areas, tend to heat less efficiently than their counterparts.

Figure 9

Primary heating fuel type by housing type, 2020

Note: The error bars represent the 95 percent confidence interval. Percentages are calculated excluded those homes who report being heated by “other” heating sources.

Source: USDA, Economic Research Service using data from the U.S. Department of Energy, Energy Information Administration 2020 Residential Energy Consumption Survey.

Households in Rural Areas Experience More Cold Days, Fewer Hot Days Than Those in Urban Areas

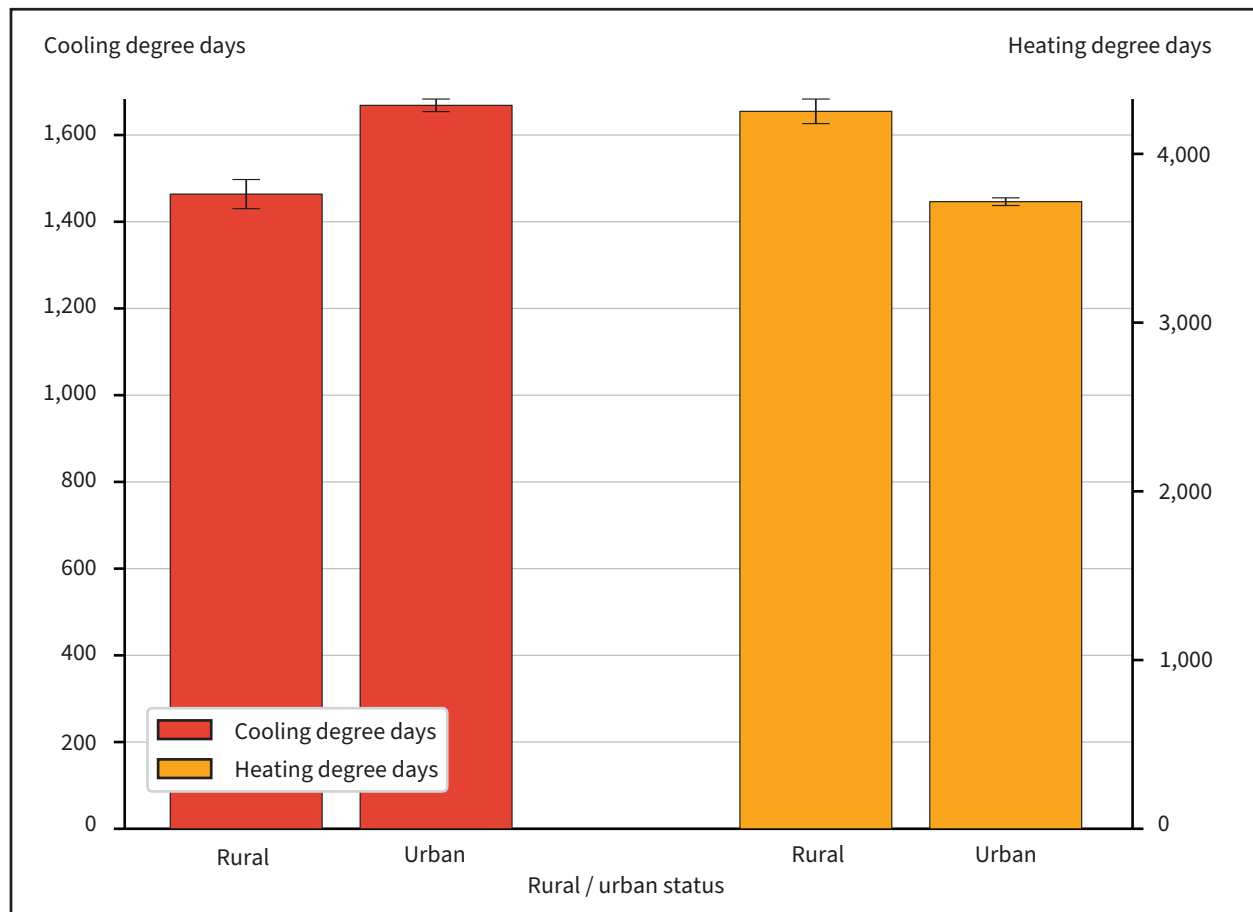
Rural and urban homes are located in different geographic areas with different built and natural environments, which may influence exposure to extreme heat or cold. Because extreme weather requires more energy to heat and cool a home to a specific temperature, it can lead to higher energy bills. One measure of the effect extreme temperatures is the use of heating and cooling degree days (HDD and CDD). A heating degree day accounts for the number of degrees below 65 for a given day, potentially requiring a household to heat its home. For example, a day with an average temperature of 30 degrees would have 35 HDD. Cooling degree days work similarly, but for temperatures above 65 degrees.

Figure 10 shows HDD and CDD in 2020 by rural/urban status and shows a consistent pattern: Rural areas are generally colder than urban areas.¹⁴ The average rural household faced 1,430 cooling degree days in 2020, compared to 1,654 for urban households, indicating they would need less cooling and air conditioning. On the other hand, rural households also may demand more winter heat, as they

¹⁴ Heating and cooling degree days in 2020 were calculated in RECS using a weighted average of temperatures from weather stations near each home.

experienced an average of 4,276 heating degree days in 2020 compared to 3,737 for urban households. Rural homes may experience fewer cooling degree-days than urban areas due to the urban heat island effect, a well-documented phenomenon in which an increase in the built environment in urban areas results in higher temperatures than outlying rural regions (Oke, 1982; Klaiber et al., 2017; Yang et al., 2024). To some extent these differences may offset in aggregate expenditures. However, the difference in HDD likely contributes to differences in overall costs, given heating makes up a larger portion of energy expenditures. Appendix figure A.6 demonstrates that these differences are not driven by the regional composition of rural and urban households, as rural homes experienced more HDD in each of the four Census regions.

Figure 10
Cooling and heating degree days by rural/urban status, 2020



Note: The error bar surrounding the top of each bar represents the 95 percent confidence interval of each measure. Heating degree days are the number of degrees the average daily temperature was below 65 degrees Fahrenheit, aggregated over the course of the year in 2020. Cooling degree days are the number of degrees the average daily temperature was above 65 degrees Fahrenheit, aggregated over the course of the year in 2020.

Source: USDA, Economic Research Service using data from the U.S. Department of Energy, Energy Information Administration 2020 Residential Energy Consumption Survey.

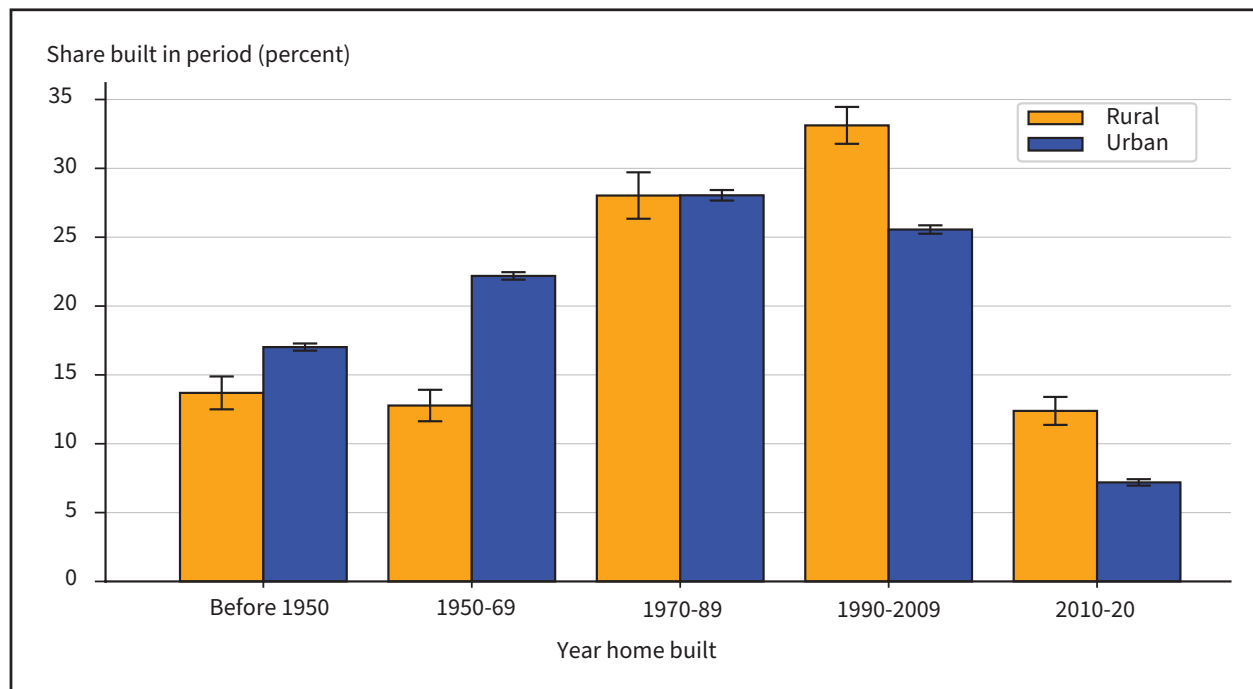
Other Rural/Urban Differences

Higher rural energy-cost burdens were primarily explained by fuel type, home type, and differences in weather.¹⁵ We next highlight several other rural/urban differences (or lack thereof) in various dimensions that can contribute to energy insecurity.

Generally, homes have become more energy efficient over time due to technological improvements and stricter standards. As such, if rural households were older than the urban housing stock, it would help explain differences in energy-cost burdens. However, figure 11 demonstrates that as of 2020, rural homes in the RECS sample were on average built more recently than urban homes. About 12 percent of rural homes were built from 2010 onwards, compared to just 7 percent of urban homes. Furthermore, about 39 percent of urban units were built prior to 1970, compared to just 26 percent of rural units. That rural energy-cost burdens are higher despite generally living in newer homes suggests the discrepancies persist despite home construction age, not because of it.

Figure 11

Home age by rural/urban status, 2020



Note: The error bar surrounding the top of each bar represents the 95 percent confidence interval of each measure.

Source: USDA, Economic Research Service using data from the U.S. Department of Energy, Energy Information Administration 2020 Residential Energy Consumption Survey.

¹⁵ As an additional test, a regression analysis appears in appendix table A.1. The first column correlates these factors with an indicator for whether the household is rural. The second column correlates the factors with the household's energy cost burden. The first column indicates that natural gas is less common in rural areas, while fuels like propane and wood are more common. Mobile and single family homes are more common in rural areas and rural households are exposed to more heating degree days and fewer cooling degree days. Column two indicates that households heating with propane and fuel oil spend 1.5 and 2.2 percent more on their income than those heating with electricity, respectively. Houses heating with natural gas spend slightly more of their income on energy than those with electricity, though this is in part explained by geography. Both those living in mobile and single-family homes spend more of their income on energy. Heating and cooling degree days are similarly correlated.

Because of the various ways to define rural and urban areas, alternative datasets suggest caution in interpreting these findings. RECS uses Census Bureau definitions of urban and rural areas, rather than RUCA codes, which are not reported in the survey. RECS and the American Housing Survey (AHS) suggest rural homes are newer. However, defining rurality using RUCA codes leads to the opposite conclusion in both the AHS and American Community Survey, suggesting that rural homes are older, not newer. Homes appearing as newer in rural areas in the AHS and RECS is likely driven by the fact that exurban areas are classified as rural. These areas are likely to see significant construction of new homes as cities expand, increasing RECS's share of rural areas with newer homes. Had RECS used RUCA codes for their definition of rurality, rural homes would appear older, and the rural/urban energy expenditures gap would be larger.

Home age may also vary by home type in such a way that, although rural homes are generally newer, they may be a less efficient type. Appendix figure A.7 plots mobile homes as a share of total rural homes constructed during each time period. For homes constructed before 1970, which were more common in rural areas, relatively fewer were mobile. Of homes built between 1990 and 2009, when a plurality of rural homes were built, about 23 percent of rural homes were mobile. This suggests that although rural homes are broadly newer, they are disproportionately mobile homes, which are less energy efficient than single family homes or apartments. This trend broadly reversed, however, in the 2010s, when a lower share of rural homes was mobile.¹⁶

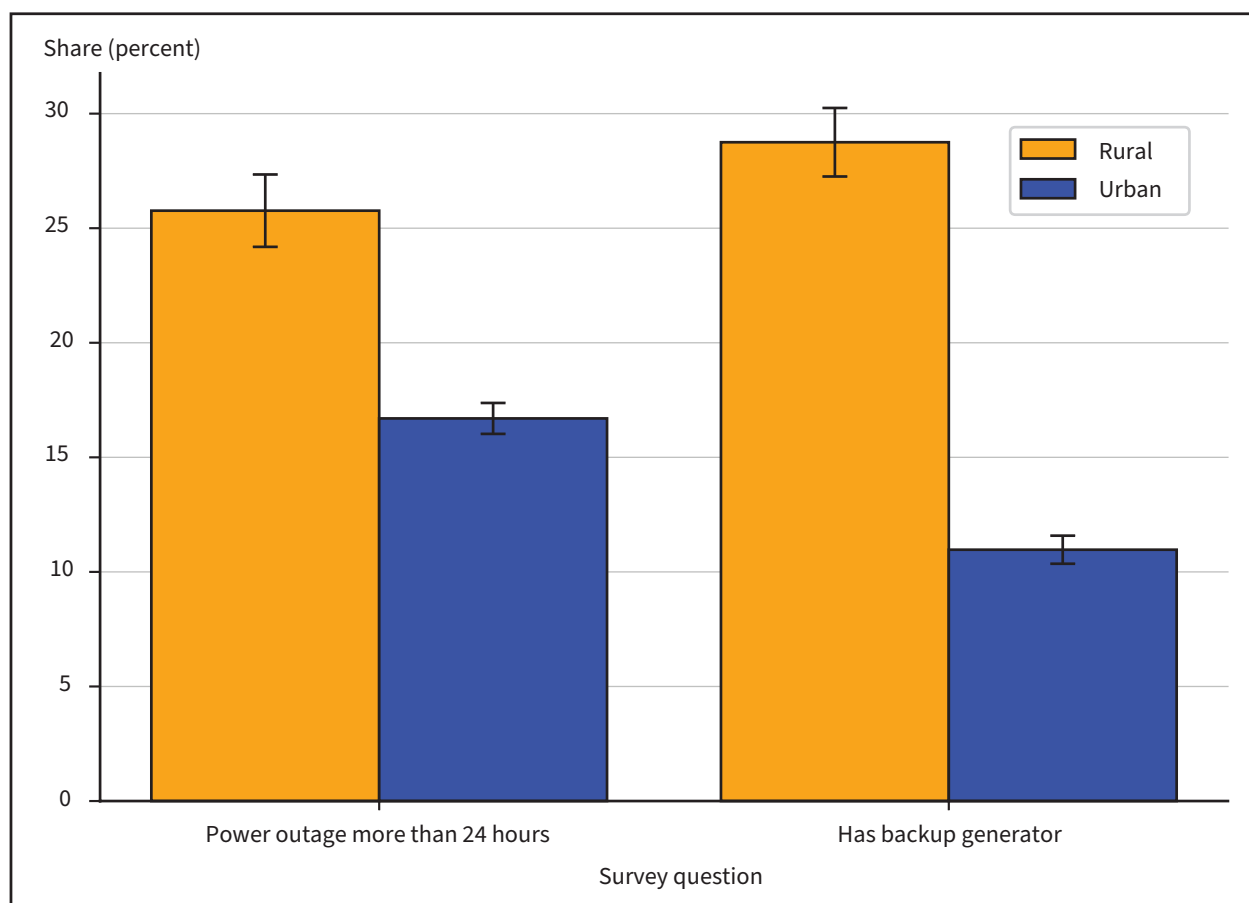
Although most older homes are not mobile, more than 200,000 rural households lived in mobile homes in 2020 that were built prior to 1990. Like for apartments and single-family homes, energy efficiency upgrades and retrofits are possible in mobile homes. However, they may not be feasible or cost effective in particularly old homes, thus increasing the rural-urban energy burden gap for those older mobile homes that remain (American Council for an Energy-Efficient Economy (ACEEE), 2023). This suggests older mobile homes uniquely contribute to higher rural energy burdens.

Another aspect of energy security is reliable energy. An energy insecure home could lose power due to a weather outage, a failure to pay bills, or a planned disruption. The lefthand columns of figure 12 show power outages exceeding 24 hours were significantly more common in rural areas. Just over a quarter of rural households experienced a power outage lasting longer than 1 day in 2020, compared to just 17 percent of urban households. The difference was driven almost entirely by outages due to weather events. Although it is not clear whether these outages were caused by less resilient, aging infrastructure, more exposure to disasters, or slower recovery, it demonstrates how rural areas were particularly vulnerable. One contributing factor may be the less dense distribution of consumers in rural areas. Electric cooperatives served about 7 customers per mile of transmission line compared to 35 for investor-owned utilities and 47 for municipal utilities (Deller et al., 2009), meaning transmission repairs after power outages would take longer to restore service to all customers. However, rural households also tended to be better prepared for outages; approximately 29 percent of rural homes had backup generators compared to 11 percent of urban homes. Although generators can help overcome power outages, they also provide rural homes with additional costs to purchase, fuel, and maintain, and so may be more accessible to higher-income households.

¹⁶ Notably, however, the urban share of new homes that were mobile also grew. Mobile homes represented about 4.4 percent of urban homes built since 1990, compared to about 2.7 percent prior.

Figure 12

Power outages and backup generator by rural/urban status, 2020



Note: The error bar surrounding the top of each bar represents the 95 percent confidence interval of each measure.

Source: USDA, Economic Research Service using data from the U.S. Department of Energy, Energy Information Administration 2020 Residential Energy Consumption Survey.

Energy Insecurity Among Rural Households

Lower income households and households with children or older people may be particularly vulnerable to high energy costs, which are determined by a combination of fuel costs, efficiency, and home type.

Rural Households With Children, Renters, and Lower Income Households Face More Energy Insecurity

Figure 13 shows the prevalence of higher energy-cost burdens, energy expenditures divided by income, and certain measures of economic, physical, and behavioral energy insecurity among all rural households, rural households with incomes less than 200 percent of the Federal poverty line, rural households with children, rural households with people aged 65 years or older, and renters. About 25 percent of rural homes are labeled as energy-cost burdened, meaning they spend more than 6 percent of their income on energy. This number was substantially higher for households with income less than 200 percent of the Federal poverty line, with 70 percent labeled as energy-cost burdened, and for renters with 41 percent cost burdened. This is not surprising given that energy-cost burden's calculation is based directly on income. Furthermore, 31 percent of households with members older than

65 were energy-cost burdened. Just 21 percent of rural households with children were energy-cost burdened and the number is not statistically different from the rural average.

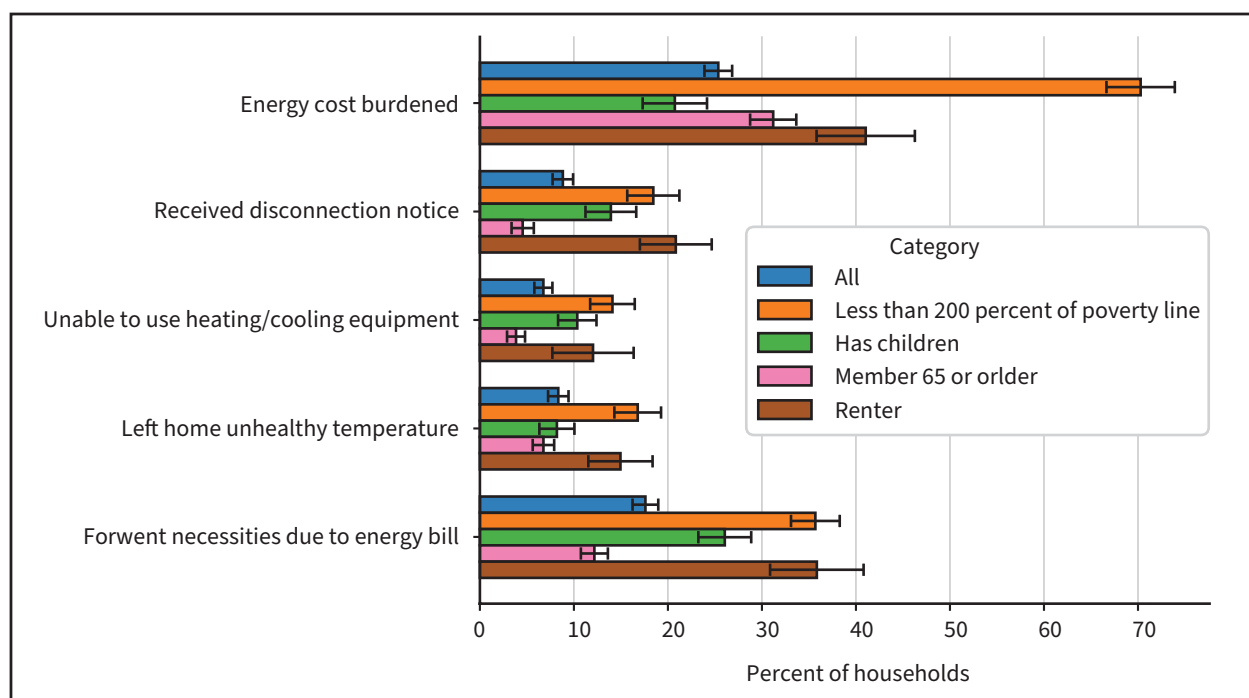
The remaining bars measure various measures of insecurity that households responded to experiencing almost every month, some months, or 1 or 2 months in the prior year. The measures include receiving a disconnection notice, being unable to use heating or cooling equipment, leaving their home at an unhealthy temperature, or forgoing other necessities to pay energy bills. The measures of insecurity show a consistent pattern: Lower-income households, households with children, and renters experienced energy insecurity at above-average rates. Furthermore, despite being more frequently cost burdened, rural homes with members aged 65 years or older recorded indicators of energy insecurity at below-average rates. This highlights the differences between energy-cost burden and insecurity: Homes with older residents who may be retired may have less income but may also have more wealth, savings, or access to programs to pay energy bills. This aligns with the lower poverty rates among rural individuals aged 65 and older and higher poverty rates among rural households with young children, according to Farrigan et al. (2024).

Across these groups and measures, figure 13 shows how common energy insecurity is among rural households. For example, almost 18 percent of rural households did without other necessities, such as food or medicine to pay energy bills.¹⁷ Almost 36 percent of lower income rural households and renters did without necessities, as did more than a quarter of households with children.

Fewer than 9 percent of rural households received an energy disconnection notice. However, these notices were received by 14 percent of households with children, 18 percent of lower-income households, and 21 percent of renters. It was less common that households were unable to use their heating or cooling equipment (7 percent) or they left their home at an unhealthy temperature (8 percent), but these factors were also more common among lower-income rural households (14 and 17 percent, respectively) and renters (12 and 15 percent, respectively). Overall, about a quarter of all rural households experienced one of these four measures of energy insecurity at some point during the year.

¹⁷ As noted in the introduction, energy insecurity can be associated with various negative health outcomes (Liddell & Morris, 2010; Hernández, 2016; Hernández & Siegel, 2019).

Figure 13

Energy-cost burden and insecurity in rural households, 2020

Note: The error bar represents the 95 percent confidence interval of each measure. Energy-cost burdened households are those that spent more than 6 percent of their income on energy. For the other energy insecurity measures (disconnection notices, being unable to use heating/cooling equipment, leaving the home at an unhealthy temperature, or forgoing necessities due to an energy bill), a household is included if the household experienced the measure for any number of months during the year.

Source: USDA, Economic Research Service using data from the U.S. Department of Energy, Energy Information Administration 2020 Residential Energy Consumption Survey.

On all measures, rural renters had an above average energy-cost burden or insecurity. Overall, just under 14 percent of rural households rent, compared to about 23 percent of all U.S. households.¹⁸ Generally, however, these households are poorer, with approximately 58 percent of rural renters below 200 percent of the Federal poverty line, compared to 27 percent of rural homeowners. Given this, it is unsurprising that rural renters are generally more energy insecure. Furthermore, economic incentives can lead renters to have less efficient appliances (Davis, 2010), poor insulation (Gillingham et al., 2012), and incomplete information regarding energy efficiency within their rental unit (Myers, 2020).

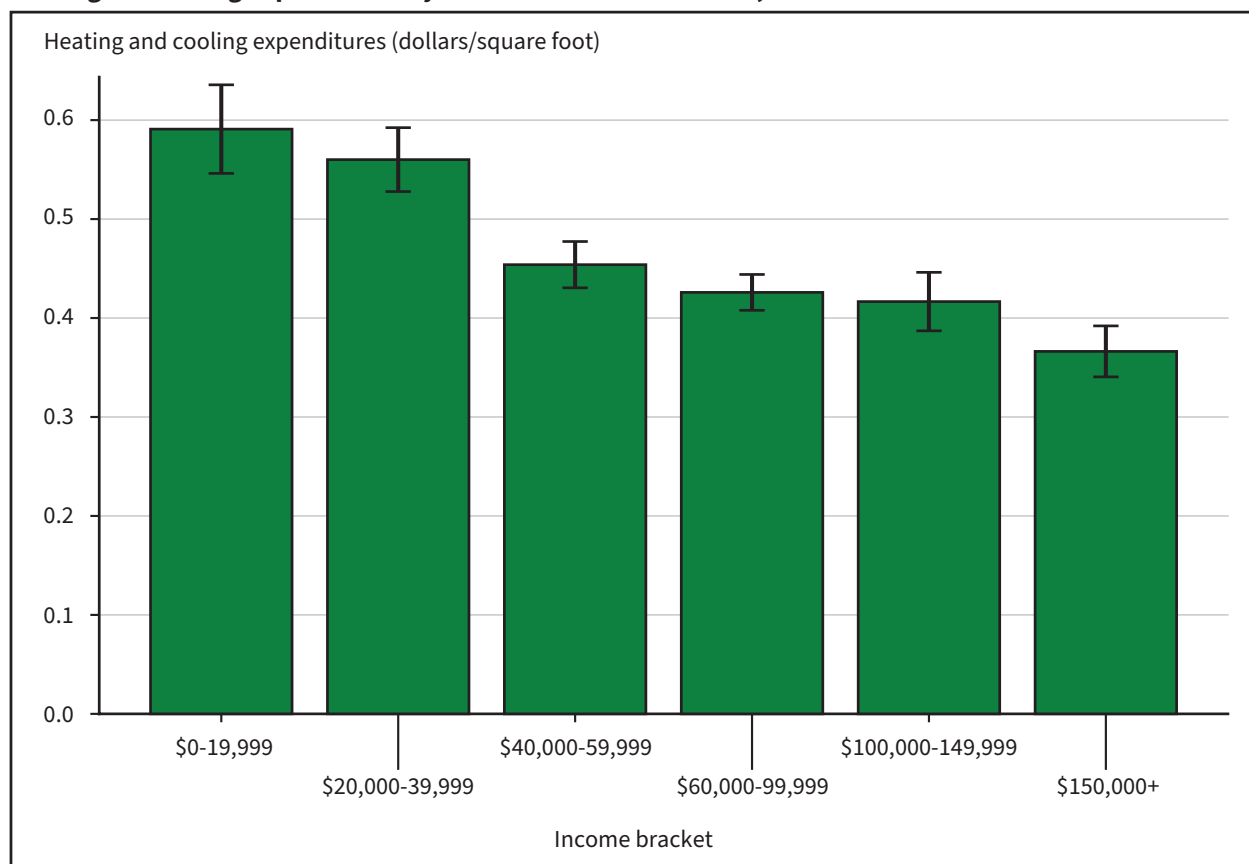
In total, about 45 percent of rural lower-income households (making less than 200 percent of the Federal poverty line) experienced one of the four measures of insecurity. This suggests that energy challenges constitute an impactful hardship for nearly half of rural lower-income households.

Lower-income Rural Households Spend More and Have Less Efficient Homes

Figure 14 shows how income is related to rural households' energy expenditures. Households with lower incomes had higher heating and cooling expenditures per square foot than higher-income households. The average rural household with an income of under \$20,000 spent about \$0.59 per square foot heating and cooling its home, more than 50 percent higher than households with incomes greater than \$150,000.

¹⁸ Given home ownership rates are higher among rural households than urban households, the higher energy-cost burdens among renters works to reduce, rather than increase, the rural-urban gap.

Figure 14

Heating and cooling expenditures by income in rural households, 2020

Note: The error bar represents the 95 percent confidence interval of each measure.

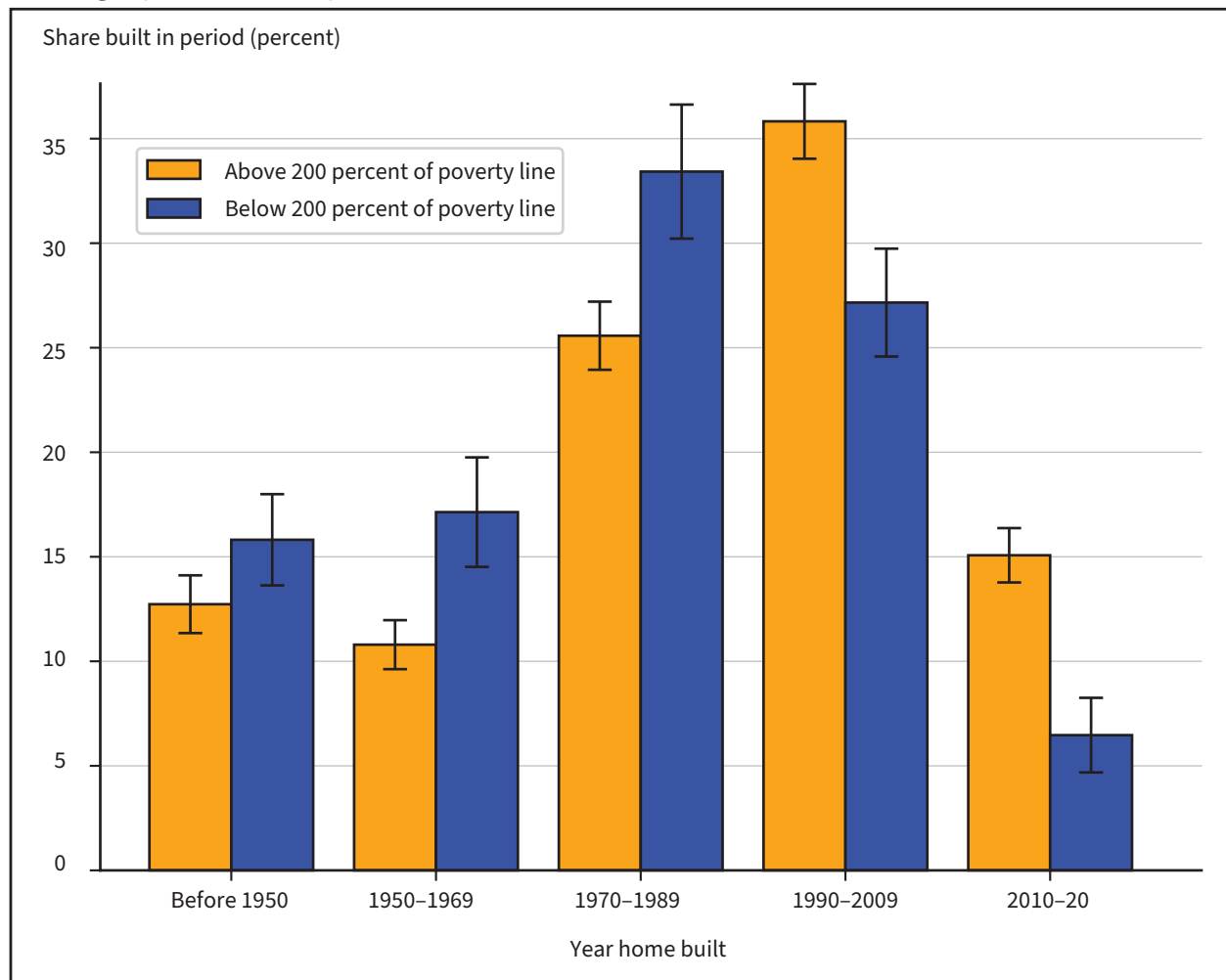
Source: USDA, Economic Research Service using data from the U.S. Department of Energy, Energy Information Administration 2020 Residential Energy Consumption Survey.

This finding may be driven, in part, by different heating fuel types; but it is also driven by differences in home efficiency. The pattern holds not only for heating but also for cooling, which is done with electricity regardless of the heating fuel (see appendix figures A.8 and A.9).¹⁹ Lower-income households self-report less efficient homes than high-income households. Approximately 20 percent of households with income less than \$60,000 reported their home had poor to no insulation, compared to just 8 percent for those with incomes greater than \$60,000. Another contributing factor was home age. Figure 15 demonstrates how households below 200 percent of the Federal poverty line were more likely to live in homes built prior to 1990, and less likely to live in homes built after 1990.

¹⁹ However, higher-income rural households are more likely to heat their home with natural gas, although the pattern is not uniform, as can be seen in appendix figure A.10.

Figure 15

Home age by Federal poverty status in rural households, 2020

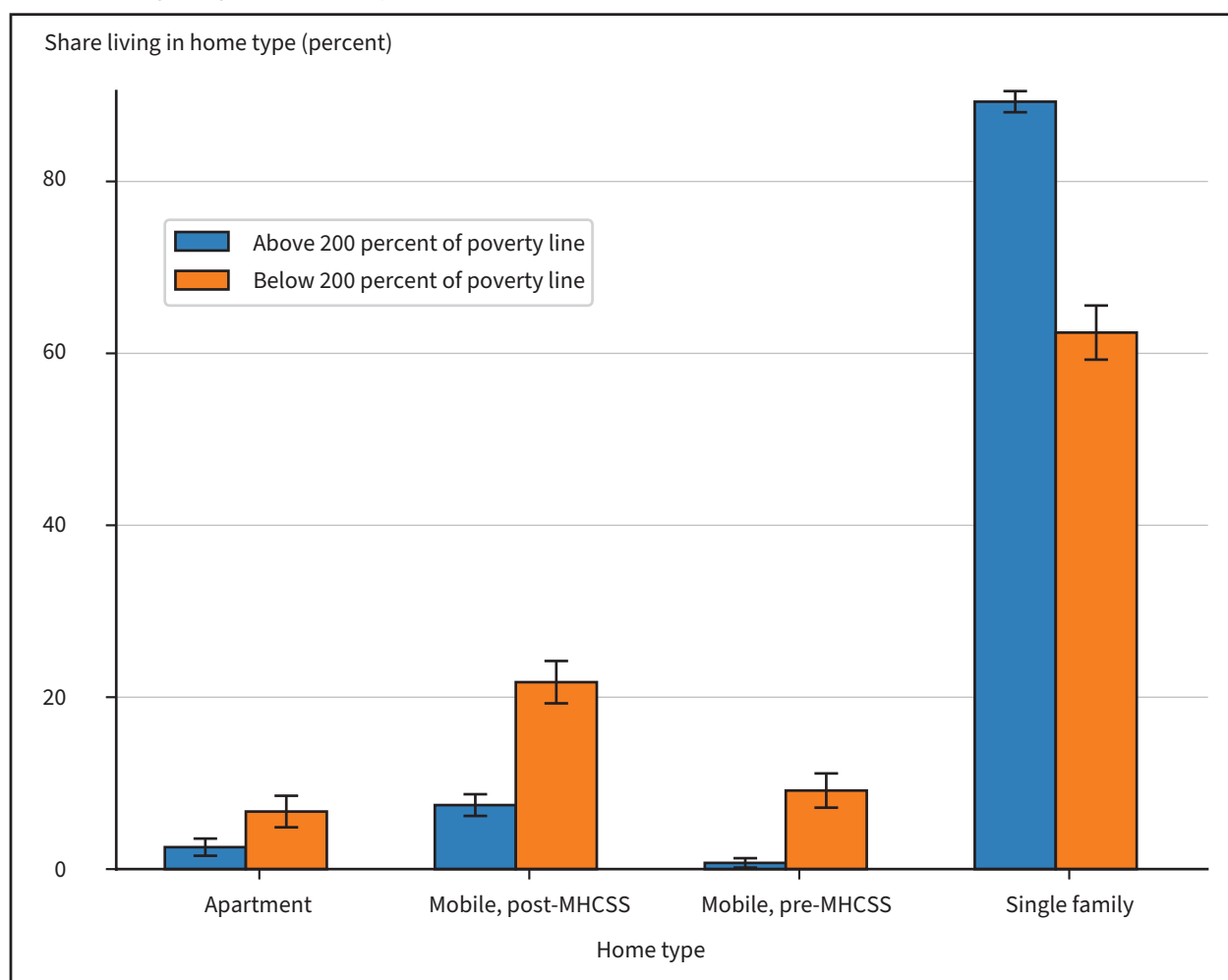


Note: The error bar represents the 95 percent confidence interval of each measure.

Source: USDA, Economic Research Service using data from the U.S. Department of Energy, Energy Information Administration 2020 Residential Energy Consumption Survey.

Figure 16 demonstrates how low-income rural households (income less than 200 percent of the Federal poverty line) lived in different types of homes than households with more income. Nearly 90 percent of high-income households lived in single-family homes, while just 62 percent of low-income households did. Most of the remaining low-income households (31 percent) lived in mobile homes, which figure 8 shows were the least efficient homes.

Figure 16

Rural home type by income level, 2020

Note: The error bar represents a 95 percent confidence interval of each measure. MHCSS is the U.S. Department of Housing and Urban Development's Manufacturing Home Construction and Safety Standards of 1976.

Source: USDA, Economic Research Service using data from the U.S. Department of Energy, Energy Information Administration 2020 Residential Energy Consumption Survey.

The Manufactured Home Construction Safety Standards (MHCSS), implemented in 1976, were intended to improve the durability, safety, and efficiency of manufactured homes (U.S. Department of Housing and Urban Development, 2025). Although mobile homes broadly are less efficient, those built prior to the implementation of these standards were particularly inefficient. The average rural household living in a mobile home built prior to the regulations spent about \$0.91 per square foot on heating and cooling, while those after spent \$0.54, a 41 percent reduction.²⁰ These older mobile homes were virtually non-existent in higher-income rural families; fewer than 1 percent lived in older mobile homes. However, nearly 9 percent of low-income families lived in rural homes constructed prior to MHCSS, suggesting these homes are particularly critical in explaining higher energy expenditures in these households.²¹

²⁰ RECS provides only 10-year windows for the construction period of a home. Those homes built between 1970 and 1979 are considered pre-MHCSS, as the standards were implemented in 1976, the second half of the time period.

²¹ Older mobile homes that have been relocated may also become structurally weaker in the process of relocation.

In sum, about 70 percent of rural lower-income households were energy-cost burdened and about 45 percent faced energy insecurity. Data suggest that the prevalence of these problems was associated with the fact that rural lower-income households tended to live in less efficient homes. Lower-income rural households spent more per square foot on heating and cooling costs, were more likely to live in older homes, and were more likely to live in mobile homes (especially older mobile homes built prior to safety standards) than higher-income rural households.

Conclusion

This report investigated the prevalence of both energy insecurity and energy-cost burden in the rural United States, explaining differences between rural and urban communities and paying particular attention to energy costs among lower-income rural households. Descriptive results show that rural households experienced higher energy-cost burdens and had higher energy expenditures, relative to their urban counterparts. Rural-urban differences were primarily driven by home heating costs and were the result of the type of fuel used for heating, housing stock, and weather exposure. Limited access to infrastructure, such as natural gas and the high prevalence of mobile homes in rural areas, contribute to higher energy expenditures. Furthermore, low-income rural households tended to have less efficient homes and high rates of energy insecurity, and energy insecurity was also higher among rural households with children.

The findings show that certain communities may be burdened by high energy costs. These burdens can cause adverse health effects and cause households to cut back on other necessities. The results highlight how structural home characteristics place households at risk of energy insecurity and higher home energy costs, particularly among lower-income households who can least afford those energy costs. Although some explanatory factors, including differential temperatures between rural and urban areas are difficult to adjust, others suggest energy insecurity can be reduced. Improvements to home efficiency, reductions in reliance on expensive fuels, and changes in the types of houses built may benefit the lower income rural households most at risk of energy insecurity.

References

- Adua, L., & Beaird, A. (2018). Place-based inequality in “Energetic” pain: The price of residence in rural America. *Socius: Sociological Research for a Dynamic World*, 4, 1–18
- American Council for an Energy-Efficient Economy (ACEEE). (2023). *Topic briefs: Upgrading manufactured homes*.
- Bednar, D. J., & Reames, T. G. (2020). Recognition and response to energy poverty in the United States. *Nature Energy*, 5, 432–439.
- Bednar, D. J., Reames, T. G., & Keoleian, G. A. (2017). The intersection of energy and justice: Modeling the spatial, racial/ethnic and socioeconomic patterns of urban residential heating consumption and efficiency in Detroit, Michigan. *Energy and Building*, 143, 25–34.
- Bohr, J., & McCreery A. C. (2020). Do energy burdens contribute to economic poverty in the United States? A panel analysis. *Social Forces*, 99(1): 155–177.
- Brown, M. A., Soni, A., Lapsa, M. V., Southworth, K., & Cox, M. (2020). High energy burden and low-income energy affordability: Conclusions from a literature review. *Progress in Energy*, 2(4).
- Colton, R. D. (2011). *Home energy affordability in New York: The affordability gap (2008–10)*. Prepared for the New York State Energy Research Development Authority.
- Colton, R. D. (2013). *Home energy affordability gap: 2010 (Connecticut Legislative Districts)*. Fisher, Sheehan, & Colton Public Finance & General Economics.
- Davis, L. (2010). *Evaluating the slow adoption of energy efficient investments: Are renters less likely to have energy efficient appliances?* (NBER Working Paper 16114). National Bureau of Economic Research.
- Deller, S., Hoyt, A., Hueth, B., & Sundaram-Stukel, R. (2009). *Research on the economic impact of cooperatives*. University of Wisconsin Center for Cooperatives.
- Doremus, J. M., Jacqz, I., & Johnston, S. (2022). Sweating the energy bill: Extreme weather, poor households, and the energy spending gap. *Journal of Environmental Economics and Management*, 112, 102609.
- Drehobl, A., & Ross, L. (2016). *Lifting the high energy burden in America’s largest cities: How energy efficiency can improve low income and underserved communities*. American Council for an Energy Efficient Economy.
- Farrigan, T., Genetin, B., Sanders, A., Pender, J., Thomas, K. L., Winkler, R., & Cromartie, J. (2024). *Rural America at a glance, 2024 edition* (Report No. EIB-282). U.S. Department of Agriculture, Economic Research Service.
- Fleishman, R., Hand, E., Perrow, M., & Hernández, D. (2024). Energy insecurity—What is it and why does it matter? *Energy Law Journal*, 45(1), 67–65.
- Gawrys M. R., & Carswell, A. T. (2020). Exploring the cost burden of rural rental housing. *Journal of Rural Studies*, 80, 372–379.

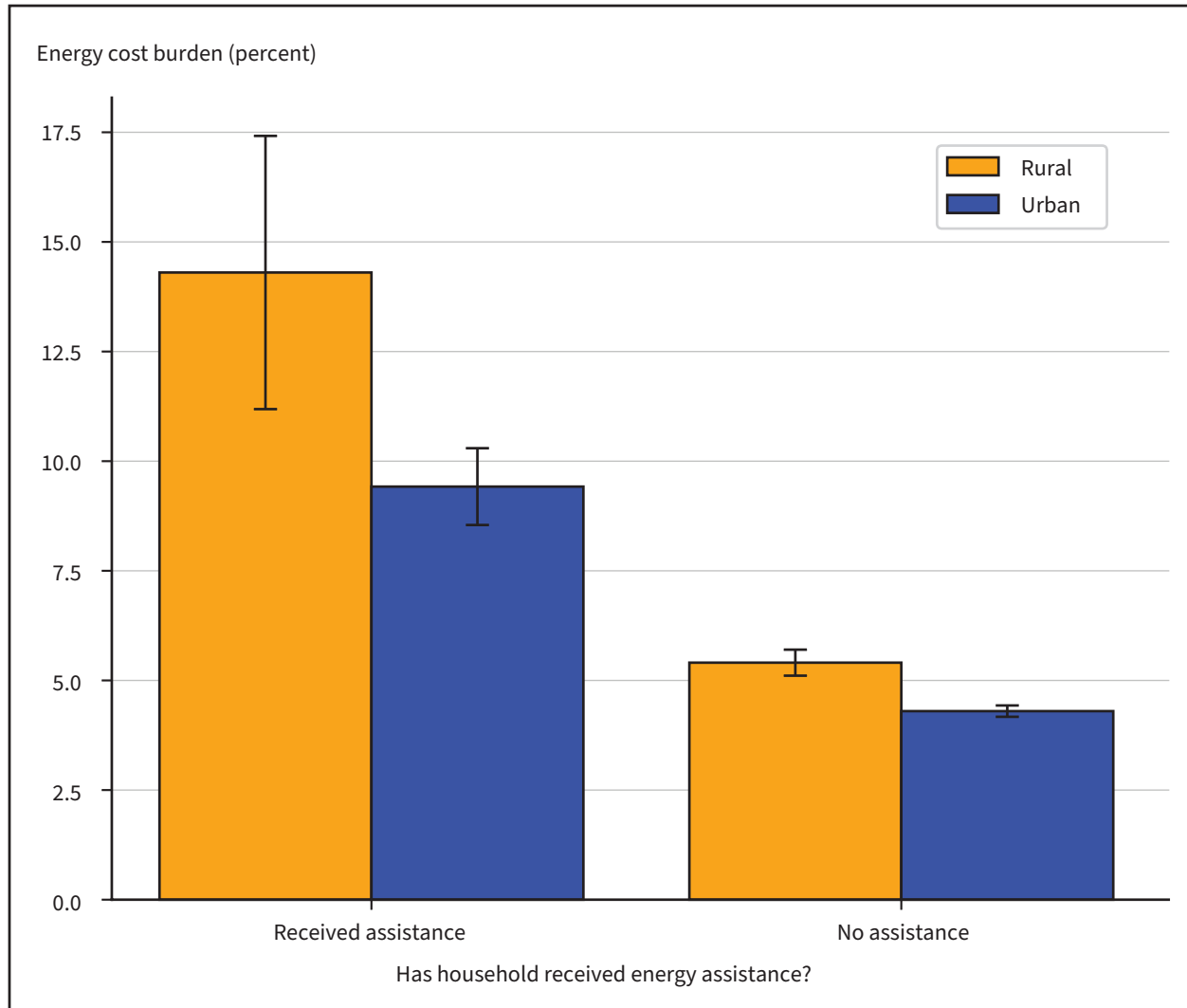
- Gillingham, K., Harding, M., & Rapson, D. (2012). Split incentives in residential energy consumption. *Energy Journal*, 33(2), 37:62.
- Graff, M., Carley, S., Konisky, D.M., & Memmott, T. (2021). Which households are energy insecure? An empirical analysis of race, housing conditions, and energy burdens in the United States. *Energy Research & Social Science*, 79, 102144.
- Harker Steele, A.J. & Bergstrom, J.C. (2021). “Brr! It’s cold in here” Measures of household energy insecurity for the United States. *Energy Research & Social Science*, 72: 101863.
- Hernández, D., (2016). Understanding energy insecurity and why it matters to health. *Social Science & Medicine*, 167, 1–10.
- Hernández, D. & Siegel, A. (2019). Energy insecurity and its ill health effects: A community perspective on the energy-health nexus in New York City. *Energy Research & Social Science*, 47, 78–83.
- Kear, M., Wilder, M. O., Martinez-Molina, K. G., McCann, L., & Meyer, D. (2023). Home thermal security, energy equity and the social production of heat in manufactured housing. *Energy Research & Social Science*, 106, 103318.
- Kellogg, K. A., & La Cumbre-Gibbs, N. (2023). The impact of State level residential building code stringency on energy consumption in the United States. *Energy and Buildings*, 278, 112607.
- Klaiber, D. M., Abbott, J. K., & Smith, V. K. (2017). Some like it (less) hot: Extracting trade-off measures for physically coupled amenities. *Journal of the Association of Environmental and Resource Economists*, 4, 1053–1079.
- Konisky, D. M., Carley, S. Graff, M., & Memmott T. (2022). The persistence of household energy insecurity during the COVID-19 pandemic. *Environmental Research Letters*, 17, 104017.
- Liddell, C., & Morris, C. (2010). Fuel poverty and human health: A review of recent evidence. *Energy Policy*, 38(6), 2987–2997.
- Lin, J. (2018). Affordability and access in focus: Metrics and tools of relative energy vulnerability. *The Electricity Journal*, 31(6): 23–32.
- Lyubich, E. (2020). *The race gap in residential energy expenditures* (Energy Institute WP 306). Energy Institute at Haas.
- MacDonald, S., Winner, B., Smith, L., Juillerat, J., & Belknap, S. (2020). Bridging the rural efficiency gap: Expanding access to energy efficiency upgrades in remote and high energy cost communities. *Energy Efficiency*, 13, 503–521.
- Martinopoulos, G., Papakostas, K.T., & Papadopoulos, A. M. (2018). A comparative review of heating systems in EU countries, based on efficiency and fuel cost. *Renewable and Sustainable Energy Reviews*, 90, 687–699.
- Memmott, T., Carley, S., Graff, M., & Konisky, D. M. (2021). Sociodemographic disparities in energy insecurity among low-income households before and during the COVID-19 pandemic. *Nature Energy*, 6, 186–193.
- Myers, E. (2020). Asymmetric information in residential rental markets: Implications for the energy efficiency gap. *Journal of Public Economics*, 190, 104251.

- Oke, T. R. (1982). The energetic basis of the urban heat island. *Quarterly Journal of the Royal Meteorological Society*, 108, 1–24.
- Reyna, J., Wilson, E., Parker, A., Satre-Meloy, A., Egerter, A., Bianchi, C., Praprost, M., Speake, A., Liu, L., Horsey, R., Dahlhausen, M., CaraDonna, C., & Rothgeb, S. (2022). *U.S. building stock characterization study; A national typology for decarbonizing U.S. buildings* (NREL/TP-5500-83063). U.S. Department of Energy, National Renewable Energy Laboratory.
- Ross, L., Drehtobl, A., & Stickles, B. (2018). *The high cost of energy in rural America: Household energy burdens and opportunities for energy efficiency*. American Council for an Energy-Efficient Economy.
- Semmens, E. O., Noonan, C. W., Allen, R. W., Weiler, E. C., & Ward, T. J. (2015). Indoor particulate matter in rural, wood stove heated homes. *Environmental Research*, 138, 93–100.
- Shoemaker, M., Gilleo, A., & Ferguson, J. (2018). *Reaching rural communities with energy efficiency programs* (Report U1807). American Council for an Energy-Efficient Economy.
- Tonn, B., Rose, B., & Hawkins, B. (2015). *Survey of weatherization assistance program services: Assessment of household budget and energy behavior pre- to post- weatherization* (Report No. ORNL/TM-2015/64). U.S. Department of Energy, Oak Ridge National Laboratory.
- U.S. Department of Agriculture, Economic Research Service (ERS). (2019). *Rural-Urban Commuting Area Codes*.
- U.S. Department of Agriculture, Economic Research Service (ERS). (2023). *Rural poverty and well-being*.
- U.S. Department of Agriculture, Economic Research Service (ERS). (2024). *Rural-Urban Continuum Codes*.
- U.S. Department of Agriculture, Economic Research Service (ERS). (2025). *Rural poverty and well-being*.
- U.S. Department of Commerce, Bureau of the Census. (2024a). *2023 American Housing Survey*.
- U.S. Department of Commerce, Bureau of the Census. (2024b, August 20). *Phase 4.1 cycle 07 Household Census Pulse Survey: June 25–July 22*.
- U.S. Department of Energy, Energy Information Administration. (2023a). *Form EIA-457A of the 2020 Residential Consumption Survey*.
- U.S. Department of Energy, Energy Information Administration. (2023b). *Use of energy explained: Energy use in homes*.
- U.S. Department of Energy, Energy Information Administration. (2024). *Form-861 of the annual Electric Power Industry Report*.
- U.S. Department of Energy, Office of State and Community Energy Programs. (2024). *Low-Income Energy Affordability Data (LEAD) tool and community energy solutions*.
- U.S. Department of Housing and Urban Development. (2025). *Manufactured home construction and safety program*.
- Yang, Q., Xu, Y., Chakraborty, T. C., Meng, D., Hu, T., Zhang, L., Liu, Y., Yao, R., Yang, J., Chen, S., Changjiang, X., Liu, R., Zhang, M., & Chen, R. (2024). A global urban heat island intensity dataset: Generation, comparison, and analysis. *Remote Sensing of Environment*, 312, 114343.

Appendix: Supplementary Figures and Tables

Figure A.1

Energy-cost burden by rural/urban status among recipients of energy assistance, 2020

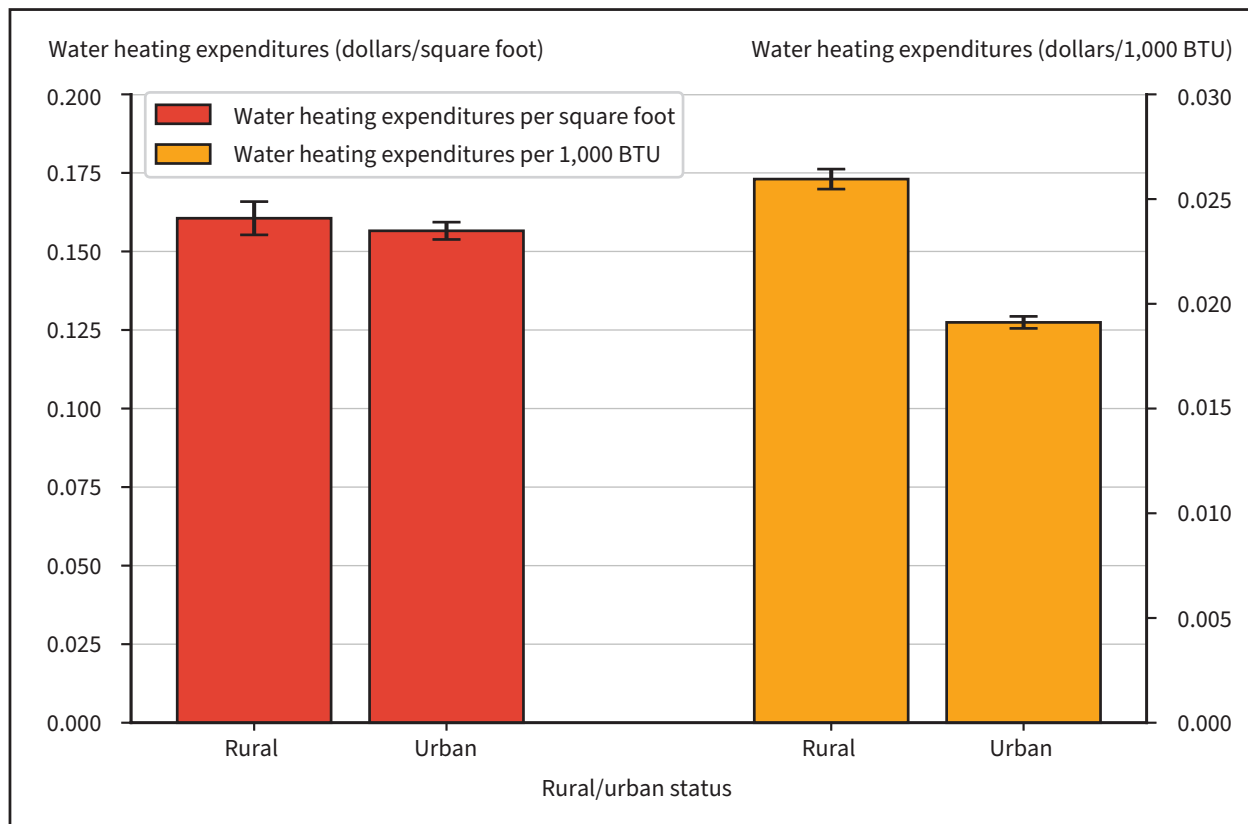


Note: Energy-cost burden is defined as the percent of income a household spends on at-home energy. Incomes are estimated as the midpoint for the household's reported income bracket. Rural/urban status is determined by whether a household lived in an urban area. The error bars represent the 95 percent confidence interval.

Source: USDA, Economic Research Service using data from the U.S. Department of Energy, Energy Information Administration 2020 Residential Energy Consumption Survey.

Figure A.2

Water heating expenditures by rural/urban status, 2020

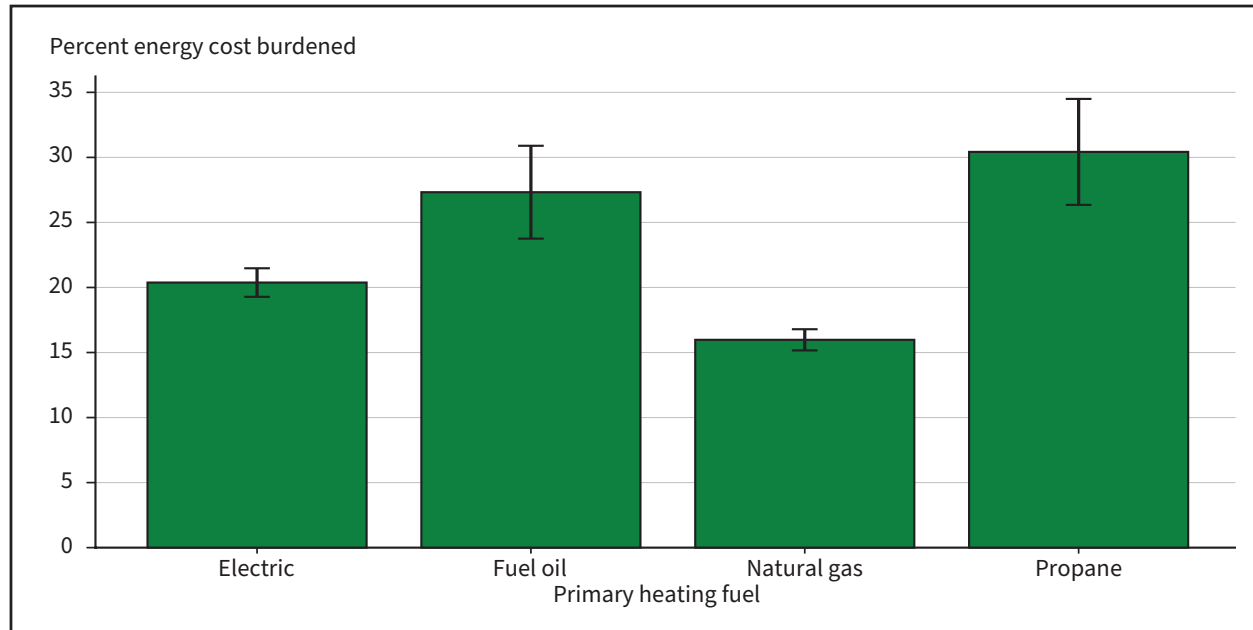


Note: BTU stands for British Thermal Unit, a standardized measure of energy that would be independent of efficiency and preferences. Water heating expenditures and consumption exclude those from wood and other water heating sources, for which the Residential Energy Consumption Survey (RECS) does not provide costs. Rural/urban status is determined by whether a household lived in an urban area. The error bar represents the 95 percent confidence interval of each measure.

Source: USDA, Economic Research Service using data from the U.S. Department of Energy, Energy Information Administration 2020 Residential Energy Consumption Survey.

Figure A.3

Energy-cost burden by primary heating fuel, 2020

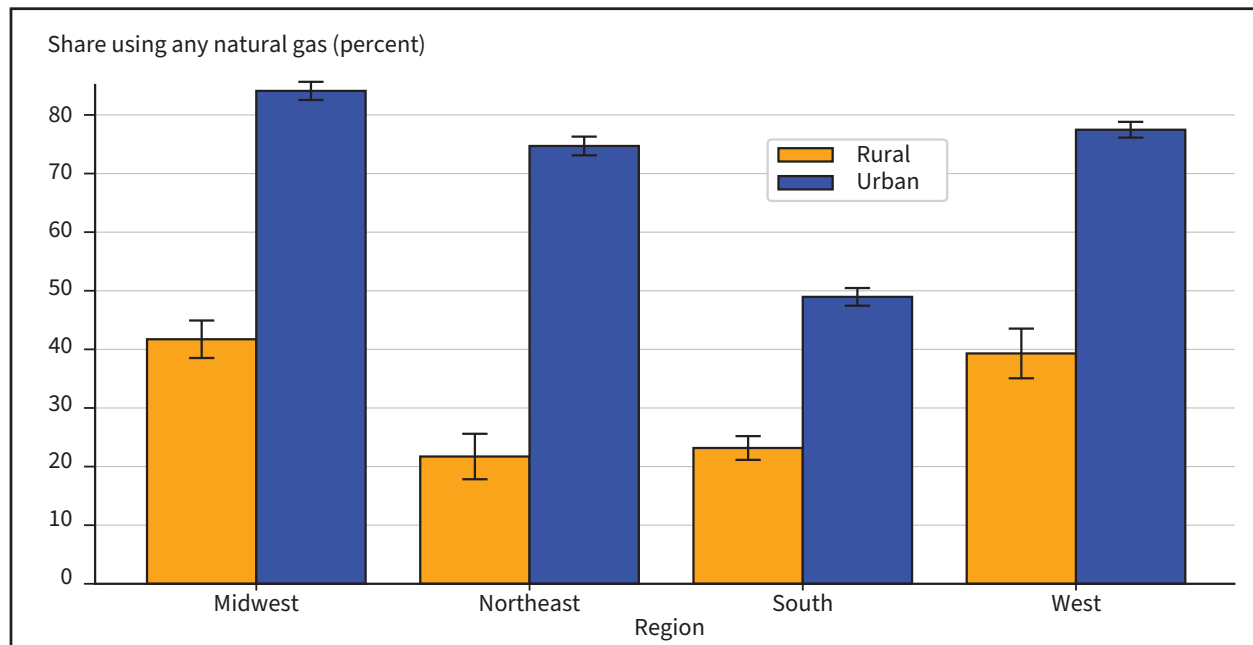


Note: The error bars represent the 95 percent confidence interval. Energy-cost burdened houses spend more than 6 percent of their income on energy.

Source: USDA, Economic Research Service using data from the U.S. Department of Energy, Energy Information Administration 2020 Residential Energy Consumption Survey.

Figure A.4

Natural gas use by rural/urban status and Census region, 2020

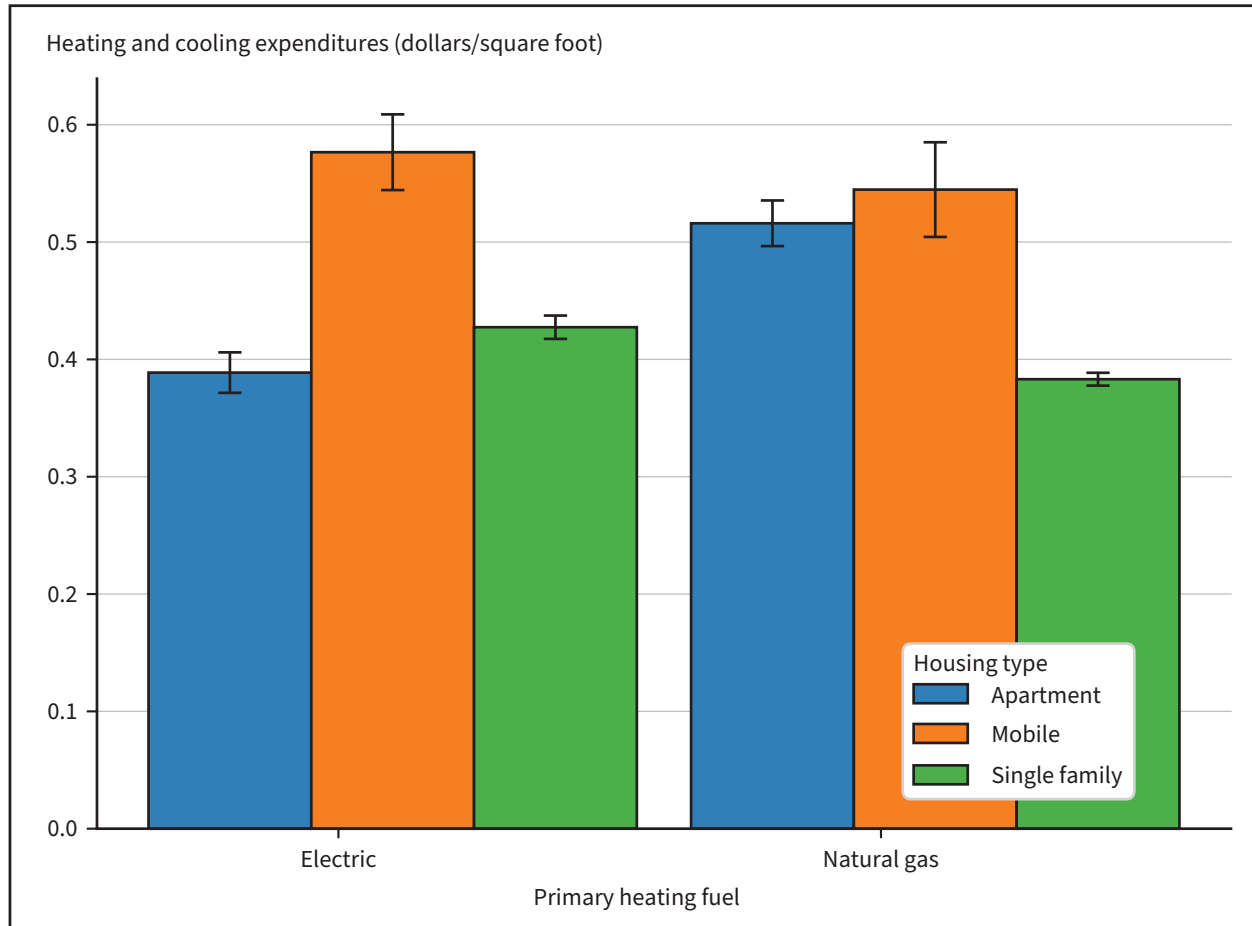


Note: The error bar represents the 95 percent confidence interval of each measure. Census regions are Midwest: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin. Northeast: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont. South: Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, Washington, D.C., and West Virginia. West: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Wyoming, and Washington.

Source: USDA, Economic Research Service using data from the U.S. Department of Energy, Energy Information Administration 2020 Residential Energy Consumption Survey.

Figure A.5

Heating and cooling costs by fuel and housing type, 2020

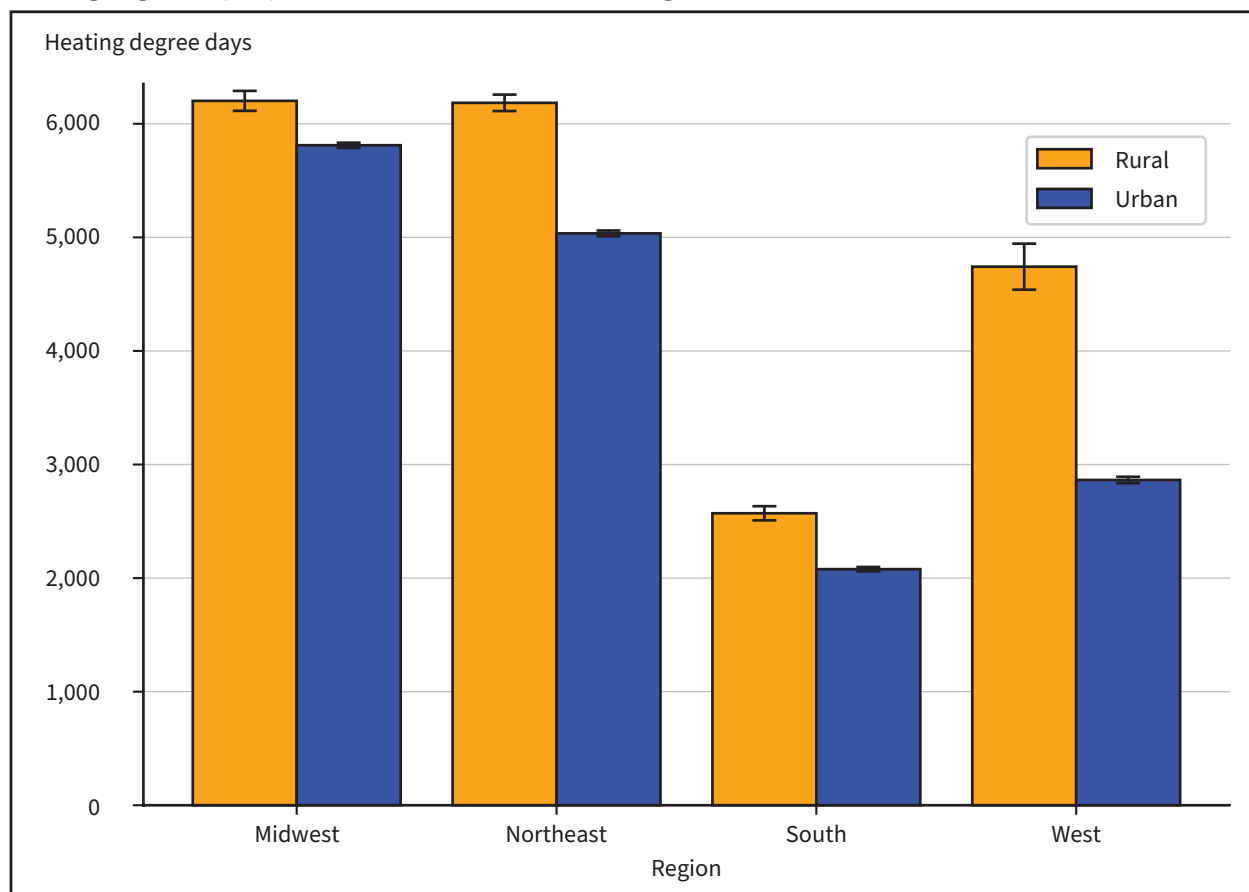


Note: The error bar represents the 95 percent confidence interval of each measure.

Source: USDA, Economic Research Service using data from the U.S. Department of Energy, Energy Information Administration 2020 Residential Energy Consumption Survey.

Figure A.6

Heating degree days by rural/urban status and Census region, 2020

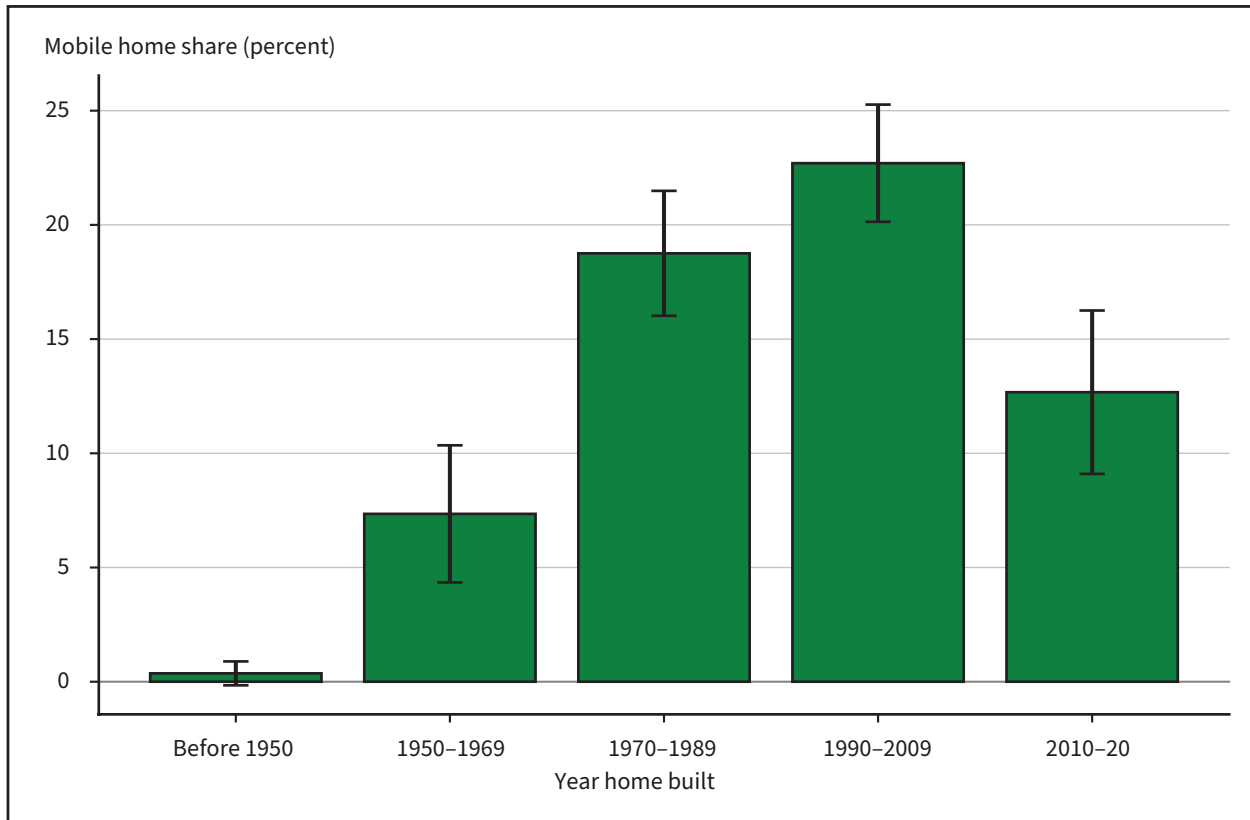


Note: The error bar represents the 95 percent confidence interval of each measure. Heating degree days are the number of degrees the average daily temperature was below 65 degrees Fahrenheit, aggregated over the course of the year in 2020. Census regions are Midwest: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin. Northeast: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont. South: Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, Washington, D.C., and West Virginia. West: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Wyoming, and Washington.

Source: USDA, Economic Research Service using data from the U.S. Department of Energy, Energy Information Administration 2020 Residential Energy Consumption Survey.

Figure A.7

Percent of rural homes that were mobile by year built, 2020

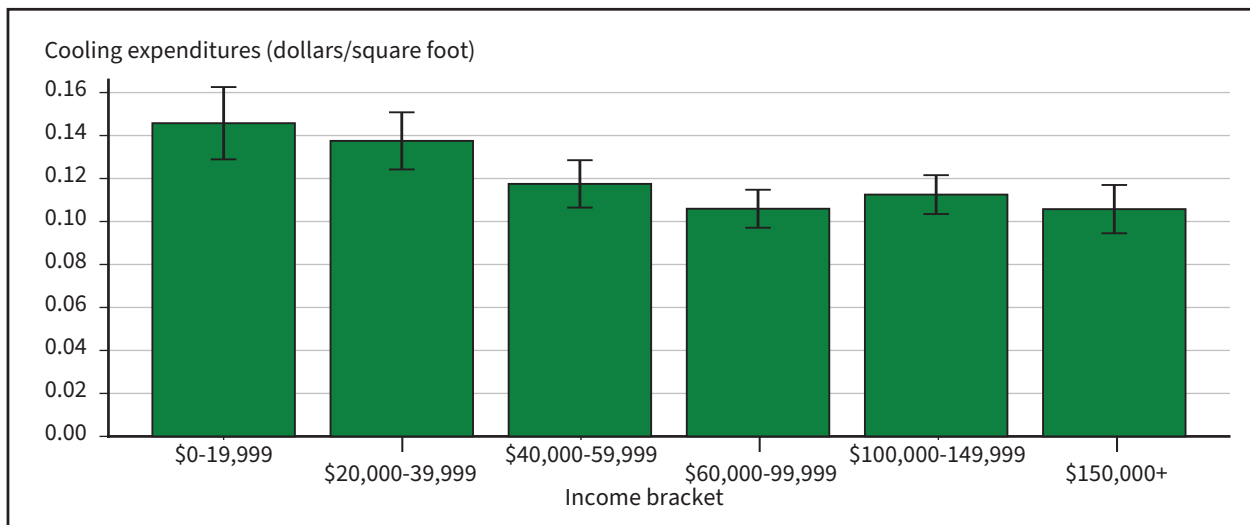


Note: The error bar represents the 95 percent confidence interval of each measure.

Source: USDA, Economic Research Service using data from the U.S. Department of Energy, Energy Information Administration 2020 Residential Energy Consumption Survey.

Figure A.8

Cooling expenditures by income in rural households, 2020

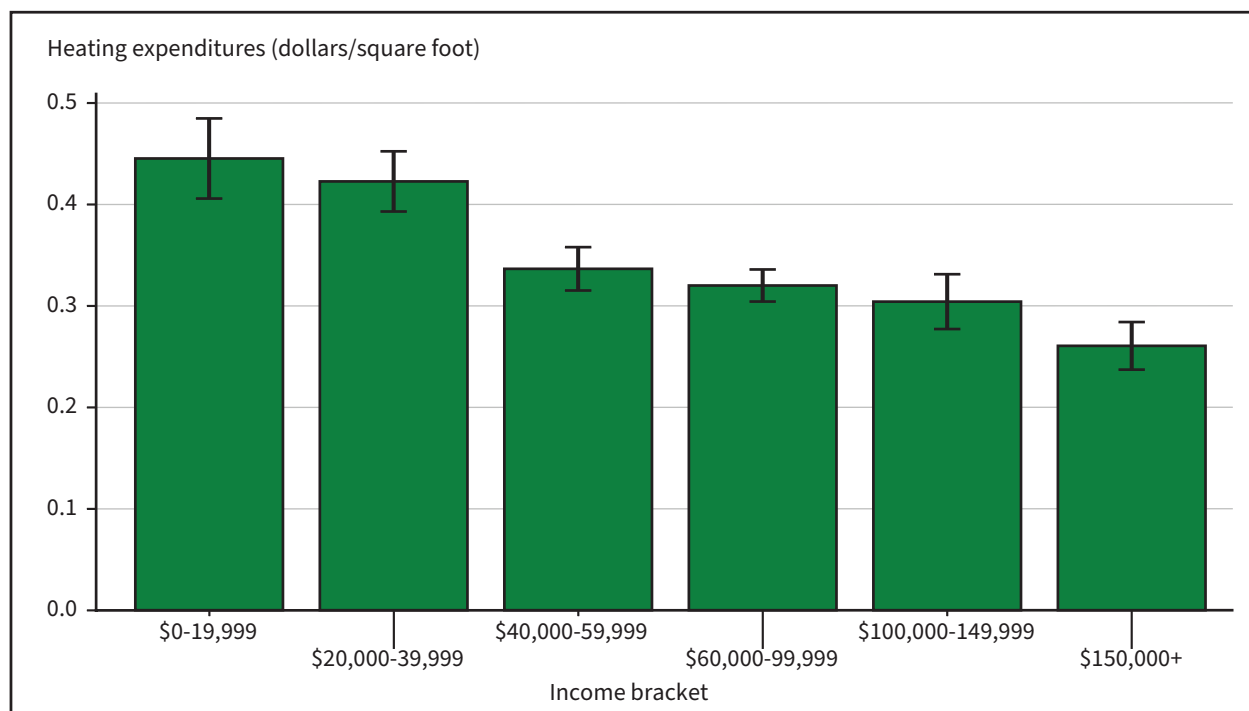


Note: The error bar represents the 95 percent confidence interval of each measure.

Source: USDA, Economic Research Service using data from the U.S. Department of Energy, Energy Information Administration 2020 Residential Energy Consumption Survey.

Figure A.9

Heating expenditures by income in rural households, 2020

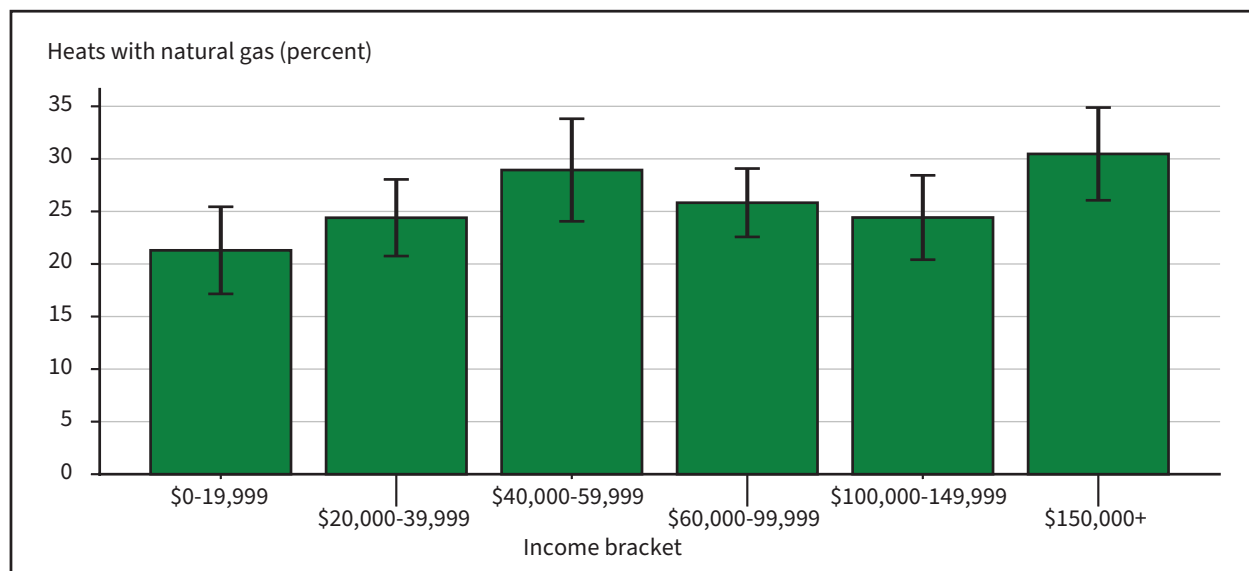


Note: The error bar represents the 95 percent confidence interval of each measure.

Source: USDA, Economic Research Service using data from the U.S. Department of Energy, Energy Information Administration 2020 Residential Energy Consumption Survey.

Figure A.10

Natural gas prevalence among rural households by income, 2020



Note: The error bar surrounding the top of each bar represents the 95 percent confidence interval of each measure.

Source: USDA, Economic Research Service using data from the U.S. Department of Energy, Energy Information Administration 2020 Residential Energy Consumption Survey.

Table A.1

Multivariate regression analysis

	Dependent variable:	
	Rural	Energy-cost burden
Heats with:		
Fuel oil	0.022	0.022***
	(0.014)	(0.004)
Natural gas	-0.200***	0.003**
	(0.006)	(0.001)
Other	-0.094***	-0.011***
	(0.011)	(0.002)
Propane	0.423***	0.015***
	(0.018)	(0.003)
Wood	0.393***	-0.009***
	(0.023)	(0.003)
Home type:		
Mobile	0.394***	0.025***
	(0.018)	(0.003)
Single family	0.159***	0.015***
	(0.005)	(0.001)
Heating degree days	0.000***	0.000***
	(0.000)	(0.000)
Cooling degree days	-0.000***	0.000***
	(0.000)	(0.000)
Number of observations	18,496	18,496

Note: Regression is survey-weighted with standard errors estimated using the jackknife method. Asterisks denote statistical significance with *** denoting $p < .01$, ** denoting $p < .05$, and * denoting $p < .1$. Rural is an indicator variable equal to 1 if the household was located in a rural area. Energy-cost burden is the share of income a household spends on energy. Heats with is relative to the omitted category, Electricity. Home type is relative to the omitted category, Apartment. Additional controls for income and house size are included.

Source: USDA, Economic Research Service using data from the U.S. Department of Energy, Energy Information Administration 2020 Residential Energy Consumption Survey.