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The High Cost of Energy in Rural America:

Household Energy Burdens and Opportunities for Energy Efficiency

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ENERGY EFFICIENCY FOR ALL

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American Council for an Energy-Efficient Economy

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Contents

Executive Summary

In this report we examine residential energy affordability in rural and small-town America. We analyze how rural household energy burdens—the percentage of household income spent on energy bills—vary across regions and among specific groups. Overall, Americans living in rural areas spend a disproportionally high share of their income on energy bills. Rural households have a median energy burden of 4.4%, compared to the national burden of 3.3%. Rural low-income households are even worse off, shouldering a median energy burden almost three times greater than the burden faced by their higher-income counterparts. Other rural residents hit particularly hard include the elderly, nonwhite, and renting households, and those living in multifamily or manufactured homes. The problem is most glaring in the East and Southeast.

In this report, we define rural households as those not located in a metropolitan census tract as specified by the US Department of Agriculture's rural-urban commuting area codes. These make up roughly 16% of all households and are spread across 72% of the nation's land area (USDA 2017a).

We calculate energy burdens for subsets of rural households according to:

- Housing type
  - Manufactured, also referred to as mobile homes (homes that are manufactured in a controlled environment or manufacturing plant and then transported to their final destination)
  - Single-family
  - Multifamily
- Tenure status
  - Renters
  - Owners

- Race
  - White
  - Nonwhite
- Age
  - Elderly
  - Non-elderly
- Income
  - Low-income (defined as less than 200% of the federal poverty level)
  - Non-low-income

Rural housing stock is more dispersed than in urban areas, and three-quarters of rural homes are single-family units. In some regions, more than 20% of rural households live in manufactured housing. About a quarter of all rural households are renters, the majority of them in single-family homes.

This study focuses on energy costs related to the physical housing structure. Energy costs in this analysis do not include transportation costs or water bills, although those costs do represent a large portion of household expenditures in rural areas. The report concludes with an overview of program options to address energy affordability, as well as challenges and opportunities related to serving rural households with energy efficiency.

Rural Energy Burden

Our analysis shows that while energy burdens vary greatly by region, rural households throughout the United States have a higher median energy burden (i.e., spend a higher percentage of household income on energy bills) than their overall region as well as a larger burden compared with metropolitan households. Other key findings include:

- East South Central, New England, and Mid-Atlantic regions have the highest median rural energy burdens at 5.1%.
- Low-income households have the highest energy burdens in the New England, Mid-Atlantic, South Atlantic, and East South Central regions, where the median energy burdens for these households are above 9.5%.
- Nationally, rural low-income households experience the highest median energy burden at 9%, which is almost three times greater than the non-low-income rural median of 3.1%. Some low-income households are even worse off: In several regions, one-quarter of the low-income rural households have a median energy burden greater than 15%.
- Residents of rural manufactured housing experience a median energy burden that is 42% higher than that of rural single-family homes. The median energy burden of residents of rural manufactured housing is also 32% higher than the overall rural energy burden. Residents of multifamily structures with 2–4 units have a median energy burden that is 20% higher than that of rural single-family households.
- The median energy burden of rural elderly households is 44% higher than that of non-elderly households.
- Rural renters experience a median energy burden 29% higher than that of owners.
- The median energy burden of nonwhite households in rural areas is 19% higher than that of their white counterparts.

Identifying high energy burdens in rural areas is an important step toward addressing rural energy affordability. Across the country, rural poverty and unemployment underscore the need for affordable energy.[1] Approximately 41% of households in rural areas have incomes below 200% of the federal poverty level, or $49,200 for a family of four in 2017.

A number of other factors besides income level may also contribute to higher energy burdens, including the physical condition of a home, a household's ability or inability to invest in energy-efficient equipment and upgrades, and the availability of efficiency programs and incentives that put energy-saving technologies within reach. (See table 2 for more details on the drivers of high energy burdens.) Elevated energy burdens have also been correlated with negative health outcomes, especially for children and the elderly, that may result from extreme temperatures in the home or dampness and mold. Energy-burdened households may improve their financial stability, comfort, and health by addressing these drivers.

We also found that energy efficiency upgrades can lower household energy burdens by as much as 25%. For some of the subgroups we studied, this translated into more than $400 savings annually. For example, the median low-income rural household would save about $420 a year, and the median manufactured housing resident, $408. Overall, every rural subgroup would benefit from improved housing efficiency.

While raising the efficiency of the housing stock in rural areas can help alleviate high energy burdens, comprehensive energy efficiency programs and services

have not taken hold in many of these communities. Further, many rural households lack the discretionary income—and therefore the upfront capital—to invest in energy efficiency upgrades such as a more efficient HVAC system or improved insulation, or they do not have the authority to undertake upgrades because they are renting their home. Additionally, energy efficiency programs that do serve rural communities could benefit from improved design and targeting in order to address long-term energy affordability needs.

To address high energy burdens, several types of program options exist to assist customers in rural and non-rural areas. These programs fall into three main categories: bill assistance, energy efficiency and weatherization, and on-bill financing options for efficiency upgrades. In this report, we focus on opportunities and challenges surrounding such efforts to make energy efficiency more accessible in rural areas.

Challenges and Ways Forward

LOW-INCOME HOUSEHOLDS

Rural communities have high concentrations of low-income households that experience high energy burdens and often cannot afford the upfront capital costs needed for energy efficiency improvements. To meet these needs, energy efficiency program administrators can partner with local community organizations to leverage funding and deliver resources. They can also encourage low-income families to invest in efficiency alongside other important issues related to household health, comfort, and safety. Programs that allow customers to make energy-saving investments and pay for some of these costs over time on their bills can help individuals whose credit history is a barrier to borrowing capital for efficiency upgrades.

RENTERS

Renters, who make up about a quarter of rural households, experience higher-than-average energy burdens. Split incentives may be a barrier to efficiency in rental properties. If the owner does not pay the energy bills, then he or she may not want to invest in efficiency upgrades to lower those bills. On the other hand, the renters who pay the bills may not have an incentive to invest in energy efficiency upgrades for a property that they do not own, even if such investments would lower their energy bills over time. To counteract these disincentives, utilities should make efficiency programs easy to enroll in, easy to understand, and cost effective for both property owners and their residents.

MANUFACTURED HOMES

Approximately 70% of all manufactured homes are located in rural areas. Even though manufactured homes consume 35% less energy than site-built homes due to their smaller size, residents spend 70% more per square foot on energy. The majority also rely on electricity and electric resistance furnaces as their main heating source.[2] In some cases, manufactured homes can be more challenging and expensive to weatherize or repair through efficiency programs due to air leakage or infiltration, crossover ducts, lack of insulation, poor thermostat placement, and inefficient heating systems.[3] To address these challenges, utilities must design innovative programs that facilitate repairs and efficiency upgrades for existing manufactured homes, as well as incentives that encourage greater efficiency in factory-built home construction.

BROADBAND

Broadband Internet expands economic opportunities in rural areas and allows energy efficiency technologies to be co-delivered through local utilities or energy and Internet service providers (ISPs). These providers have an opportunity to leverage broadband expansions by jointly promoting broadband and efficiency technologies (e.g., smart thermostats). Some co-ops also offer broadband services themselves and jointly promote efficiency and broadband to customers.

PROPANE AND FUEL OIL

Although many rural households rely on propane and fuel oil for heating, providers of these fuels typically do not fund weatherization and efficiency programs. Electric utilities are frequently the main providers of efficiency programs in rural areas but often are unable to offer efficiency incentives for nonelectric end uses, such as propane or fuel oil heating. To address this, fuel-blind programs can provide measures to address a variety of end uses through bundled funds from energy utilities and other weatherization funding sources.

PROGRAM RESOURCES

Many rural utilities are unable to allocate sufficient funding and capacity to meet the efficiency needs of their communities, leaving many rural households with little or no access to affordable efficiency upgrades. One solution is for small co-ops to partner with their wholesale generation and transmission (G&T) co-op to spread costs and leverage resources in order to better serve their customers with efficiency programs. By recognizing the mutual benefits of energy efficiency, such as providing a service to customers or efficiency

as a utility resource to meet customer energy needs, electricity distribution co-ops and G&T co-ops can work together to provide savings to their members.

ENERGY EFFICIENCY WORKFORCE

While the need for efficiency is high, energy efficiency investments in rural areas are hindered by numerous barriers, including limited utility program offerings, lack of information about programs to increase enrollment, and lack of trained contractor networks, to name a few. Contractors must have certifications and training in order to properly implement the US Department of Energy Weatherization Assistance Program and other, utility-led energy efficiency programs. Rural areas face barriers in terms of establishing certified energy efficiency contractor networks and maintaining the necessary volume of work to support them. Rural efficiency providers need to balance staff size and staff training with the demand for efficiency projects. To address this issue, contractors can be trained remotely taking advantage of distance learning opportunities through community colleges and education center programs or through rural utilities, to expand the efficiency workforce in rural communities.

PROGRAM MARKETING

All energy efficiency programs face challenges in effectively conveying program information, creating awareness of program options, ensuring language accessibility, and addressing customer or member skepticism regarding potential energy savings. Rural utilities can work to gain a better understanding of the households they serve, demographically and socially, which can facilitate improved marketing and targeting of programs. Program administrators can also improve marketing by jointly promoting efficiency programs with other offerings, such as broadband services or renewable energy options like solar, or by partnering with local agencies and service organizations to market and provide education to residents.

PROGRAM EVALUATIONS

Even if they are not required to evaluate programs, utilities can benefit from conducting evaluations to determine how to optimize their offerings. Evaluations can help identify ways to better serve customers; they can also address customer skepticism by verifying energy savings and other program goals. Due to the limited capacity of small rural utilities, federal and state governments can also consider providing assistance or standardization for evaluations of small rural co-ops and municipal utility programs. In addition, utilities can partner with local colleges or universities to help measure program outcomes and impact.

All of these ways forward can increase the reach, effectiveness, and energy savings from rural efficiency programs and investments. Energy efficiency not only can act as a strategy to reduce high energy burdens for rural communities but can also lead to other positive health, environmental, and economic development outcomes.

Conclusion

Our analysis reveals that rural households have higher energy costs, as a percentage of their income, than metropolitan households. Low-income, renting, nonwhite, and elderly households, as well as those occupying multifamily or manufactured homes, face even greater energy burdens than the rural median. Residential energy efficiency, an underutilized strategy in rural areas, can complement bill assistance and other social services to alleviate high household energy burdens. We recommend expanding current low-income program offerings, exploring no-risk or low-risk efficiency financing options, incorporating regional workforce development initiatives, and building relationships with other area service providers to strengthen program delivery. Energy utilities, in particular, are well positioned to work with community partners to design and deliver efficiency programs that meet the needs of their members or customers.

Programs that address high energy burdens can help alleviate poverty and provide other benefits to society beyond energy savings, including economic development, additional employment, education opportunities, and improved public health. Not only will rural households benefit from greater access to energy efficiency investments, but so will entire communities.

1 Department of Agriculture, "Rural Employment and Unemployment"(2017) www.ers.usda.gov/topics/rural-economy-population/employment-education/rural-employment-and-unemployment/

2 Department of Energy, Better Buildings Residential Network Peer Exchange Call Series: The Other 15%: Expanding Energy Efficiency to Rural Populations (Washington, DC: DOE, 2015) energy.gov/sites/prod/files/2015/10/f27/bbrn_Summary_RuralEE_091015.pdf.

3 E. Cody, Retrofitting Manufactured Homes for Improved Energy Efficiency (Arlington, VA: National Rural Electric Cooperative Association, 2011) www.cdf.coop/wp/wp-content/uploads/2012/02/RetrofittingManufacturedHomesforImprovedEnergyEfficiency.pdf. Crossover ducts take heated air from one side of a double-wide mobile home to the other. They frequently leak.

Introduction

Rural Household Characteristics

This report examines residential energy affordability in rural and small-town America. It is one of the first studies to analyze how rural household energy burdens—the percentage of household income spent on energy bills—vary across regions and among specific groups. Although energy costs are often overlooked, they can cause families to face challenging tradeoffs between energy and other basic necessities such as food and medical care, often compounding the negative impacts of low incomes. The first half of this report presents our rural energy burden analysis. The second half focuses on programs to increase energy affordability for rural communities and gives an overview of challenges and opportunities in the effort to ramp up investment in rural energy efficiency.

When rural energy issues are discussed, often the emphasis is on the implications of energy extraction and supply (Brown et al. 2013; Lobao et al. 2016; Brown et al. 2017). This report instead focuses on the economic and other hardships that result from energy demand in these communities, specifically the high share of income that rural households spend on energy. According to the 2015 Residential Energy Consumption Survey (EIA 2017), nearly one-third of rural households experience energy insecurity—for instance, having to reduce or forgo food or medicine to pay for energy, or to leave their home at an unhealthy temperature (EIA 2017).[4] While improved energy affordability could help alleviate these challenges, the up-front costs of energy efficiency upgrades can be prohibitive to rural households, especially those with low incomes.

Unlike households in more urban areas, rural households are more geographically dispersed, spread across 72% of the nation's land area (Department of Agriculture 2018). These households also have distinct patterns in terms of housing type, household tenure (renting versus owning), income characteristics, and heating fuel type. These characteristics can directly influence energy use and expenditures as well as the ability of comprehensive energy efficiency services to adequately serve these households; thus, these

WHY ENERGY EFFICIENCY FOR ALL AND ACEEE CARE ABOUT ENERGY BURDENS

The United States is in the midst of a severe housing crisis. For many low-income Americans, a safe and affordable home is becoming increasingly hard to find. There is currently a shortage of more than 7.2 million affordable housing units for the families who need them, and 8 million Americans pay more than half their income on rent each month (National Low Income Housing Coalition 2018). As the cost of housing increases and the availability of affordable options decreases, rising energy costs further burden families who can least bear it, forcing low-income households to spend up to 20% of their income on energy services after the rent is paid. Energy Efficiency for All and ACEEE want to ensure that all low-income people, particularly renters, are able to live in affordable, energy-efficient homes that promote health and well-being. Increasing the energy efficiency of homes and apartments can reduce average energy burden by 30%. We have an opportunity to provide effective services to families who need them most, enabling greater financial stability as energy burdens are eased.

TABLE 1. CHARACTERISTICS OF RURAL HOUSEHOLDS BY CENSUS REGION

	New England	Mid-Atlantic	East North Central	West North Central	South Atlantic	East South Central	West South Central	Mountain	Pacific	US total
Households										
Total households (in 1,000s)	5,780	15,679	18,016	8,379	22,982	7,199	13,781	8,511	17,963	118,290
Rural households (in 1,000s)	725	1,284	3,391	2,745	2,774	2,323	2,597	1,526	1,553	8,918
% rural (of all households)	12.6%	8.2%	18.8%	32.8%	12.1%	32.3%	18.8%	17.9%	8.6%	16.0%
Housing type (% of regional total)										
Single-family	73.9%	74.1%	79.3%	79.3%	67.4%	75.5%	72.4%	68.0%	75.7%	74.4%
Manufactured	6.8%	10.2%	7.9%	7.3%	21.2%	16.4%	15.9%	19.3%	14.1%	13.4%
Multifamily (2+ units)	19.3%	15.7%	12.8%	13.4%	11.4%	8.0%	11.7%	12.7%	10.2%	12.2%
Income (% of regional total)										
Low-income*	28.4%	34.5%	36.1%	38.5%	43.4%	51.5%	44.1%	40.6%	38.9%	40.7%
Heating fuel use (% of regional total)										
Piped natural gas	12.5%	34.0%	48.5%	47.1%	9.6%	23.1%	25.3%	40.8%	23.4%	31.2%
Propane	15.2%	11.5%	16.0%	14.1%	8.0%	6.5%	6.1%	16.5%	6.9%	11.0%
Housing age										
Median unit age	45	65	55	55	35	35	35	35	35	45

* Income below 200% of the federal poverty level (FPL). *Source:* US Census 2015.

characteristics provide useful context and areas of focus for our energy burden analysis. Table 1 presents rural household demographic and other housing information for each US Census Region (Census Bureau 2017). States included in each region can be found in figure 2 and table 3, and the parameters we used to define rural households can be found in the Methodology section, below.

Several characteristics of the rural housing stock differentiate it from its urban counterparts. On average, rural housing units tend to be larger than those in urban areas, and the median age of housing units is

45 years. The oldest rural housing is concentrated in the New England, Mid-Atlantic, and East and West North Central regions. The most prominent housing type in rural areas is single-family homes, making up three-quarters of all housing units. The remaining rural households are evenly split between manufactured housing and multifamily buildings, with most of the latter containing two to four units.[5] The three southern regions and the Mountain and Pacific regions have more manufactured housing than multifamily housing, while the other regions have the reverse. Roughly 30% of manufactured housing was built prior to issuance of the 1976 national building code for manufactured homes (i.e., before regulation of energy efficiency), and about 75% are occupied by low-income households. Additionally, on average, about a quarter of all rural households rent their homes. Unlike renters in urban areas, the majority of rural renters occupy single-family homes, not multifamily housing. Nevertheless, there is a significant supply of subsidized, affordable multifamily housing in rural communities, such as the 14,000 multifamily properties in rural America that are subsidized through the Section 515 program of the US Department of Agriculture (USDA).[6] Research also suggests that renters in rural areas are more likely to have affordability issues and are twice as likely to live in substandard housing, as compared with rural owners (HAC 2012).

There is a higher concentration of low-income households in rural communities than in urban areas. About 41% of households in rural areas have incomes below 200% of the federal poverty level (FPL), compared with roughly one-third of urban households (US Census 2015).

About 41% of households in rural areas have incomes below 200% of the federal poverty level (FPL), compared with roughly one-third of urban households (US Census 2015).

As indicated in table 1 and discussed later in our analysis, we define low-income households as those with an income below 200% of the FPL.[7] This is a common low-income definition among those studying families and poverty (Kobell and Jiang 2018). For context, in 2017 that figure stood at $49,200 for a family of four in the United States.[8] The three southern regions have the highest concentrations of low-income rural households. In general, millions of rural and small-town households face housing issues related to affordability, structural adequacy, and crowding (HAC 2012). These conditions illuminate the major impact of poverty and unemployment in rural America and underscore the need for affordable energy, along with other strategies to strengthen the resiliency of these communities (Department of Agriculture 2017a).

Heating fuel types can also be distinct to rural areas and often differ from those used in more urban areas. While there are notable characteristics of fuel types that span rural areas, much variance also exists among regions. For example, the use of fuel oil for heating is prevalent among rural households in the New England and Mid-Atlantic regions as well as Alaska but is less commonly used in other parts of the country. Throughout the Midwest and southern regions, propane use for heating is more common (EIA 2011). While natural gas is the dominant heating fuel in much of the country, it is less common for rural households in the New England, South Atlantic, and East South Central regions due in part to the cost of fuel switching and/or expanding pipeline infrastructure to remote, low-population-density regions. Reliance on fuel oil or propane for heating can have implications for energy costs, as their prices are more volatile and often more expensive than the prices of other fuels (Pirog 2017).

TABLE 2. DRIVERS OF HOUSEHOLD ENERGY BURDENS	
Drivers	**Examples of factors that increase energy burden**
Physical	Housing age and type (e.g., manufactured homes)
	Heating system, fuel type, and fuel cost
	Poor insulation, leaky roofs, inefficient and/or poorly maintained HVAC systems, and/or inadequate air sealing
	Inefficient large-scale appliances (e.g., refrigerators, dishwashers) and lighting sources
	Weather extremes that raise the need for heating and cooling
Economic	Chronic economic hardship due to persistent low income
	Sudden economic hardship (e.g., severe illness, unemployment, or disaster event)
	Inability to afford (or difficulty affording) up-front costs of energy efficiency investments
	Difficulty qualifying for credit or financing options to make efficiency investments
Behavioral	Lack of access to information about bill assistance or energy efficiency program options
	Lack of knowledge about energy conservation measures and impacts/cost savings
	Increased energy use due to age, number of people in the household, or disability
Policy	Insufficient or inaccessible policies and programs for bill assistance, weatherization, and energy efficiency for low-income households
	Certain utility rate design practices, such as high customer fixed charges, that limit customers' ability to respond to high bills through energy efficiency or conservation

Source: Updated from Drehobl and Ross 2016.

Drivers of High Energy Burdens

A household's energy burden is largely driven by household income, energy consumption, and energy prices. Higher-than-average energy consumption may be due to a number of factors, including the physical condition of a home, a household's ability (or lack thereof) to invest in energy-efficient equipment and upgrades, and the availability of energy efficiency programs and incentives that put energy-efficient technologies within reach.

In a previous ACEEE and Energy Efficiency for All report, Drehobl and Ross (2016) found that the drivers of high energy burdens fall into four categories: physical, economic, policy, and behavioral. Table 2 illustrates each of these drivers and provides examples of factors that influence household energy burdens. Households in rural areas are often more susceptible to the drivers of high energy burdens.

Rural low- to moderate-income families often live in poor-quality housing, with many homes in need of repairs or improvements in order to meet basic health and safety standards (NRHC 2018). Issues of housing affordability, structural adequacy, and crowding are a problem for millions of rural and small-town Americans (HAC 2012). Rural seniors—who often live on fixed incomes—especially experience challenges with

Households in rural areas are often more susceptible to the drivers of high energy burdens.

housing options, housing quality, and needed home repairs (Oberdorfer and Wiley 2014). In addition, households of color are even more likely to live in substandard housing. For example, African-American rural households are three times as likely to live in substandard housing as other rural residents (HAC 2012). The historical lack of affordable and adequate housing options in rural communities fuels many of these challenges.

Rural households often have limited options for and access to energy efficiency programs through their energy utilities or other means (National Academies of Sciences, Engineering, and Medicine 2016). A lack of consumer awareness, qualified energy assessors and contractors, and the right incentives make scaling up energy efficiency in rural communities challenging. These communities also have much higher poverty rates and limited employment opportunities, which hinder many residents' ability to invest in energy efficiency improvements (Wilson et al. 2008).

CONNECTION BETWEEN HEALTH AND ENERGY EFFICIENCY

Energy efficiency not only impacts energy affordability through lower bills but can also lead to improvements in household health. Energy efficiency upgrades in homes can reduce triggers of respiratory illnesses, such as mold, exposure to cold air or sudden temperature changes, air pollution, and pollen (Mayo Clinic 2018).

Communities are increasingly seeing partnerships between health care organizations and energy efficiency providers to reduce hospital readmissions and/or negative health impacts through efficiency upgrades. For example, Vermont's Rutland Regional Medical Center (RRMC) has a strong collaboration with NeighborWorks, a local nonprofit that does energy efficiency and healthy homes work. The two organizations came together in 2016 to create a program that leverages both organizations' skills and resources to help patients recover from illness and live in healthier homes (NeighborWorks of Western Vermont 2016).

Moving forward, health care providers and efficiency providers can continue to partner to leverage resources and funds to jointly increase household health and efficiency.

Impacts of High Energy Burdens

High energy costs can place a significant financial burden on families, especially when those families have low incomes and limited opportunities for upward economic mobility. Research suggests that these cost burdens can affect household and societal health and well-being through such negative impacts as extreme home temperatures, gas leaks, dampness, mold, and humidity (Hernández 2016, 2013). High energy burdens can make it difficult for a family to break out of the cycle of poverty and/or force difficult trade-offs between paying energy bills and meeting other basic needs, such as food and medicine.

The term *energy insecurity* is often used to describe the cumulative effect of these hardships and the disproportionate amount of household income that low-income families must devote to energy costs (Hernández and Phillips 2015).

Researchers have found a link between high energy burdens (and more broadly energy insecurity) and negative health outcomes. One study found that households with high energy burdens are correlated with under-heating and lower indoor temperatures (Healy and Clinch 2004). Another study found that households with lower temperatures tend to be more susceptible to dampness and mold, which can increase the risk of asthma (Fisk, Lei-Gomez, and Mendell 2007). Young children and elderly adults with preexisting health problems are particularly susceptible to negative impacts from under-heated homes. Among the elderly, research has found that colder homes may lead to increased risk of strokes, circulatory and respiratory issues, hospital admissions, and falls and injuries (Woodhouse, Khaw, and Plummer 1993; Rudge and Gilchrist 2005). Studies have also found correlations between high energy burdens and negative health impacts due to increased financial stress or less money available for other health-related expenditures (Kearns et al. 2008).

Addressing the causes of high energy burdens can help alleviate these negative financial, social, and health impacts, leading to healthier and more economically vibrant communities. While this is a critical issue for many rural households, it is not always simple to address. The up-front costs of energy efficiency upgrades are often beyond the reach of many. In the second half of this paper, we discuss strategies for enabling rural households to make their homes more energy efficient, thereby reducing their energy costs over the long term.

[4] As part of this referenced study, housing units are classified using criteria created by the US Census Bureau based on 2010 Census data. Urbanized areas are densely settled groupings of blocks or tracts with 50,000 or more people, while urban clusters have at least 2,500 but less than 50,000 people. All other areas are classified as rural.

[5] Manufactured homes (or mobile homes) are homes that are manufactured in a controlled environment or manufacturing plant and then transported in one or more sections to their final destination. These homes are built to the Manufactured Home Construction and Safety Standards code of the US Department of Housing and Urban Development. Manufactured homes, as defined here, do not include modular homes that, once built, cannot be moved.

[6] See www.rd.usda.gov/programs-services/all-programs/multi-family-housing-programs.

[7] Earnings vary by location. Therefore using a national indicator may place people into our definition of low-income that are above-average earners in their region.

[8] FPL amounts are higher in Alaska and Hawaii.

Methodology

We first analyze how rural household energy burdens vary across regions and particular household subsets.[9] We then describe energy affordability programs that currently serve rural communities and the challenges and opportunities for ramping up investment in rural residential efficiency. In many rural areas, energy efficiency is an underutilized strategy that can help improve long-term energy affordability.

Our analysis builds on a previous ACEEE and Energy Efficiency for All report, *Lifting the High Energy Burden in America's Largest Cities* (Drehobl and Ross 2016). That study examined energy burdens in 48 of the largest US metropolitan statistical areas and placed a needed spotlight on populations that are disproportionately impacted by high energy expenditures, including low-income, African-American, Latino, multifamily, and renter households. Due to data limitations, we were able to include only major metro areas in our previous analysis, even though evidence suggested that rural and small-town households also suffer from high energy burdens (McCormick 2015).

This new analysis uses household-level data from the *2015 American Housing Survey* (AHS) issued by the US Department of Housing and Urban Development (HUD). The AHS is a biennial, household-level survey conducted by the Census Bureau that collects a wide variety of housing and occupant demographics from a representational cross-section of households across the United States.[10] Essential to this report, the AHS includes household income data as well as energy cost data, which served as the basis for our energy burden calculation.[11]

In this report, we estimate energy burdens for rural households as well as subsets of rural households chosen on the basis of factors such as income, select demographic information, and housing type. While academics generally define high energy burdens as those consuming 6% or more of household income, there is no clear marker of energy affordability (Fisher, Sheehan, and Colton 2013). We do not set out to identify such a marker in this report. Instead we highlight energy burdens in relationship to US and regional medians.

We calculated energy burdens for each household in our dataset using the following equation, which yields an energy burden presented as a percentage. For our analysis, we used median energy burden values for each census region.

$$\text{Energy burden} = \frac{\text{Annual household energy spending}^{12}}{\text{Annual household income}^{13}}$$

While we recognize that the presence of children or the number of people residing in a home may affect energy use, we analyzed energy bills relative only to total household income to determine energy burdens. We also examined subset groups of households to explore energy burdens in greater detail. These subsets include:

- *Housing type*. Manufactured homes, single-family homes, small multifamily buildings (2–4 units), and large multifamily buildings (5+ units)
- *Tenure status*. Renters and owners
- *Race*. White householders and nonwhite householders[14,15]
- *Age*. Elderly (> 65) and non-elderly householders (≤ 65)
- *Income*. Low-income (≤ 200% FPL in 2015) and non-low-income (< 200% FPL in 2015)

In addition to energy bill and income data for each household, we also collected data on housing square footage in order to determine the median annual energy cost per square foot for each subgroup in our analysis. This calculation provides an estimate of household energy efficiency and helps illustrate the impact energy efficiency can have on reducing energy costs for these households.

Definitions of Rural and Metropolitan

Government agencies, researchers, and others use varying definitions of *rural*, often based on population size, proximity to major urban centers, local employment, and commuting flows (Department of Agriculture 2017c). For the purposes of this analysis, we define a rural household as one that lies outside a metropolitan census tract. Metropolitan census tracts are those where the primary (largest) commuting flow is to an urbanized area (i.e., an area with 50,000 or more residents**)**. To determine whether a census tract was non-metropolitan (i.e., rural), we used the USDA's Rural-Urban Commuting Area (RUCA) codes.[16] Using a 1–10 ranking system, RUCA codes designate 1–3 as *metropolitan*, 4–6 as *micropolitan*, 7–9 as *small town*, and 10 as *rural*. To make these assessments, RUCA codes take into account population density, urbanization, and commuting habits. The USDA updates these codes every 10 years alongside the census updates. Suburban areas are generally included in the metropolitan designation (Frey et al. 2004).

For this analysis, our definition of *rural* encompasses all households not in a metropolitan census tract (i.e., tracts labeled 4–10). For context, under this definition, roughly 2% of census tracts in New Jersey are identified as rural, 20% in Georgia, and nearly 56% in Mississippi. While we note that we could conceivably fail to count homes that appear to be in a rural setting but are located within a metropolitan tract, and vice versa, our analysis does not adjust for this. We acknowledge that this is an imperfect method for identifying and collecting data on rural homes, but it is superior to studies that identify rural households based on county-level definitions. Such studies, defining an

FIGURE 1. RURAL CENSUS TRACTS INCLUDED IN ANALYSIS

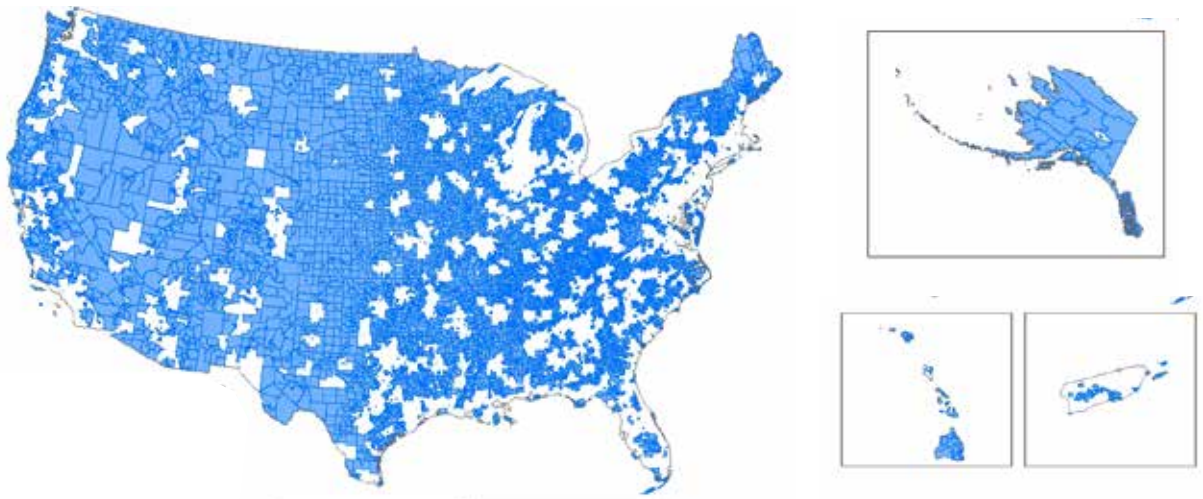

FIGURE 2. CENSUS REGIONS

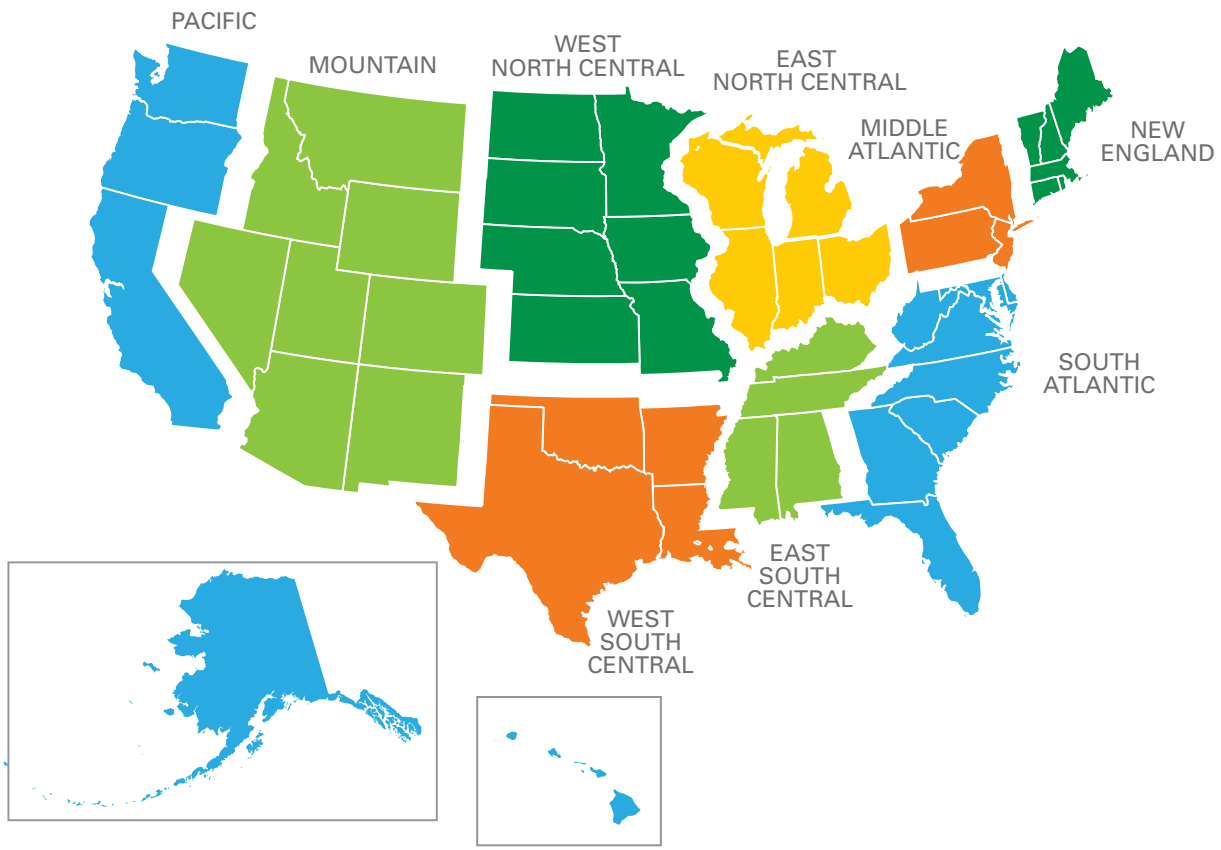

TABLE 3. STATES WITHIN EACH CENSUS REGION

Region	States
New England	Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont
Mid-Atlantic	New Jersey, New York, Pennsylvania
East North Central	Indiana, Illinois, Michigan, Ohio, Wisconsin
West North Central	Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota
South Atlantic	Delaware, DC, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia
East South Central	Alabama, Kentucky, Mississippi, Tennessee
West South Central	Arkansas, Louisiana, Oklahoma, Texas
Mountain	Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming
Pacific	Alaska, California, Hawaii, Oregon, Washington

entire county as either rural or urban, only exacerbates issues of precision. Figure 1 shows the footprint of the rural census tracts included in our analysis.

Census Regions

Due to our reliance on household-level data, census regions were the smallest geographical unit for which we could aggregate households.[17] Therefore the results of this methodology are representative of the entire region and cannot be attributed to particular towns, counties, or states within the region. Figure 2 and table 3 indicate the states within each census region in both map and list form.

Data Limitations

Although the AHS data are extensive, they come with limitations. The AHS dataset covers only the past 12 months, which means that it is susceptible to outliers

and provides only a moment-in-time snapshot of income and costs. For example, energy prices could be high in one year and/or one location due to a severe weather event. Additionally, although the modeling assumptions for household energy expenditures are based on actual billing data obtained directly from energy suppliers, the AHS dataset models household energy cost and is not based on actual billing information. This report does not attempt to adjust for these limitations.

Bill assistance and bill subsidies lower the overall amount of a household's energy bill and can greatly improve energy affordability for many households. An additional limitation of this study is that our analysis does not parse the impact of bill subsidies and bill assistance on energy burdens. The AHS dataset does not indicate if a household's energy bill includes a subsidy or other assistance. Without bill assistance and subsidies, household energy burdens could be even higher than reported in this study.

Additionally, we had to trim our sample size because of the data points necessary for our energy burden calculations. We included only those households from the AHS survey that reported a positive household income, paid their electric bill, and paid for their main heating fuel, as these are the variables needed to calculate energy burden. By excluding households that did not report income or pay their electric and heating costs, we eliminated certain subsets of households from the analysis, such as those living in multifamily buildings where heating and electricity costs are included in rent.

After controlling for these factors, the average sample size of rural households for each region was 627. Across all regions, our sample included 5,643 rural households. See appendix tables A1 and A2 for more information on sample sizes.

Our definition of low income (≤ 200% of FPL) also poses limitations. Due to variations in purchasing power and the cost of living across US regions, households with the same income in different locations may not be directly comparable. While other definitions of low income (e.g., percentage of area median income or of state median income) might have proved more appropriate, our dataset did not provide enough information to allow us to make these comparisons.

Interviews

In the second half of this report, we examine rural programs that address energy affordability and provide an overview of the challenges and ways forward for better serving rural communities with energy efficiency. To gain insight on this topic, we conducted interviews with 15 stakeholders who work in the rural energy or rural energy efficiency space, including utility program managers, statewide program administrators, consultants, and nonprofit organizations. These organizations represented many regions of the country, including the Northwest, Southeast, Midwest, and Northeast. Based on these conversations, we developed a list of challenges, opportunities, and program examples to help frame the current landscape of rural efficiency programs.

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[9] While we recognize that water bills and transportation costs are related to energy use and that these costs can exacerbate financial burdens for many households, this analysis includes only the burden of home energy bills. For this analysis, we focused on energy costs related to the physical housing structure.

[10] For more information, visit the AHS website: www.census.gov/programs-surveys/ahs.html.

[11] Beginning with the 2015 edition, the AHS stopped asking respondents to provide information about their energy costs. Previously, the majority of this data was self-reported. As part of the 2015 AHS redesign, researchers began to estimate energy costs through regression model–based imputation. They created the utility estimation system (UES) to estimate annual energy costs using regression models developed from the Residential Energy Consumption Survey (RECS), which collects administrative data from suppliers on actual billing amounts. This estimate was divided by 12 to calculate average monthly energy costs. The RECS also collects some housing characteristics similar to those the AHS collects, which allows the construction of models that can then be applied to the AHS. For more on energy cost estimation model development and decisions for the 2015 AHS, see www.huduser.gov/portal/sites/default/files/pdf/American-Housing-Survey.pdf.

[12] To determine annual energy spending for each household, we summed the values of electricity, natural gas, and other heating fuel types for each household. Households that did not report a positive value for income and did not indicate that they pay for their main heating fuel were excluded from the analysis.

[13] Annual household income includes wages, Social Security, public assistance, unemployment, and worker's compensation but excludes housing subsidies, food stamps, and the refundable earned income tax credit. For a complete list, please refer to the AHS definition of income found at www2.census.gov/programs-surveys/ahs/2015/2015%20AHS%20Definitions.pdf.

[14] Due to limited sample sizes leading to anonymity concerns, we were unable to break down race or ethnicity into specific groups beyond "nonwhite." We understand that a general "nonwhite" subgroup does not provide the specificity of data that is necessary to make strong claims about the burden experienced by specific communities of color.

[15] Householder refers to the person (or one of the people) in whose name the housing unit is owned or rented (maintained) or, if there is no such person, any adult member, excluding roomers, boarders, or paid employees. If the house is owned or rented jointly by a married couple, the householder may be either spouse. For more on the designation of householder see www.census.gov/programs-surveys/cps/technical-documentation/subject-definitions.html#householder.

[16] For more information on metro and non-metro designations, visit the RUCA website: www.ers.usda.gov/data-products/rural-urban-commuting-area-codes .

[17] Due to anonymity concerns, AHS is unable to report rural household-level data at local, county, or state levels. For this reason, we report our results by census region. For a more granular look at rural energy affordability, see the US Department of Energy's Low-Income Energy Affordability Data (LEAD) Tool. The tool features interactive state-, county-, and city-level worksheets that provide a breakdown of housing stock based on fuel type, building type, and construction year. The tool also provides average monthly energy expenditures and energy burden (percentage of income spent on energy). Visit the LEAD website at openei.org/doe-opendata/dataset/celica-data.

Energy Burden Results

In this section, we take a closer look at energy burdens for rural households and specific subsets of rural households. We pay particular attention to differences between rural and metropolitan household energy burdens regionally, as well as differences between subset household groups in each region. In this analysis, we do not explore or determine the drivers of these burdens. Rather, taken together, these statistics offer a snapshot of rural energy affordability and a better understanding of which households experience the greatest burdens.

Rural Versus Metropolitan Energy Burdens

The median energy burden is 3.3% for all US households, 3.1% for metropolitan households, and 4.4% for rural households.[18] Nationally, our analysis found that the median rural household energy burden is 42% greater than the median metropolitan household energy burden.

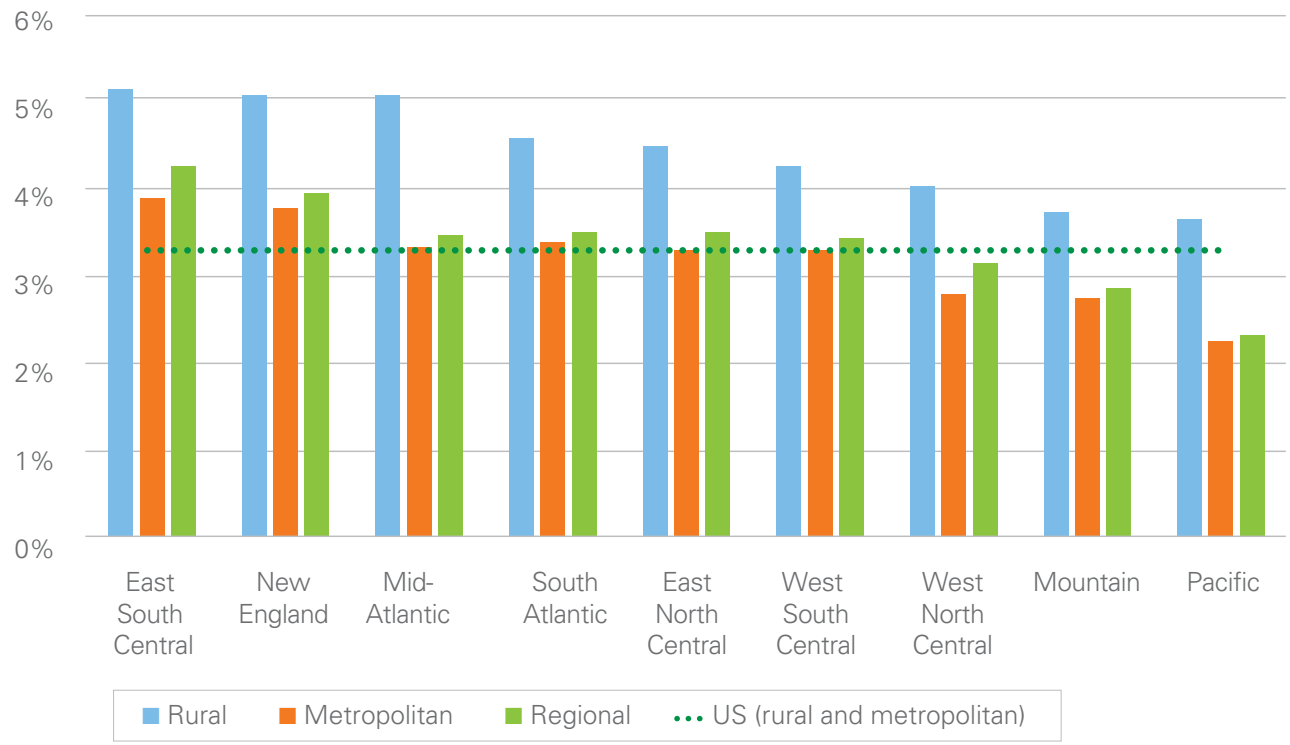
We found the most pronounced difference between rural and metropolitan households' energy burdens in the Mid-Atlantic region (5.1% for rural and 3.3% for metropolitan). Table 4 shows the median energy burdens by region for rural, metropolitan, and all US households.

The data in table 4 are represented graphically in figure 3, which lists regions by highest rural burden to lowest, with the total US median indicated as a reference line.

TABLE 4. MEDIAN ENERGY BURDENS FOR RURAL, METROPOLITAN, AND ALL HOUSEHOLDS

Household type	New England	Mid-Atlantic	East North Central	West North Central	South Atlantic	East South Central	West South Central	Mountain	Pacific	US total
Metropolitan	3.8%	3.3%	3.3%	2.8%	3.4%	3.9%	3.3%	2.8%	2.3%	3.1%
Rural	5.1%	5.1%	4.5%	4.0%	4.6%	5.1%	4.3%	3.7%	3.6%	4.4%
All households	4.0%	3.5%	3.5%	3.2%	3.5%	4.3%	3.4%	2.9%	2.3%	3.3%

FIGURE 3. RURAL, METROPOLITAN, AND REGIONAL MEDIAN ENERGY BURDENS FOR ALL HOUSEHOLDS

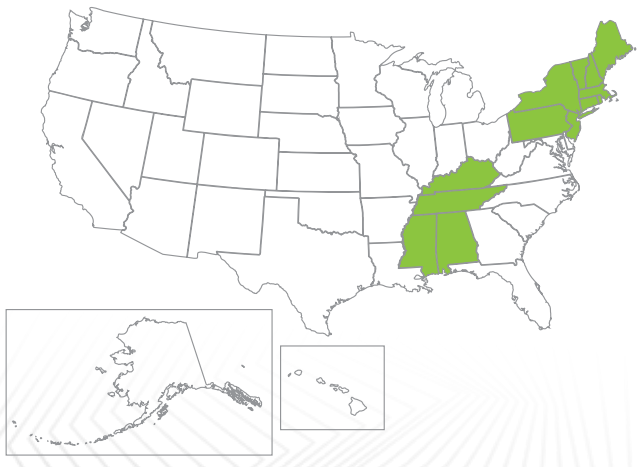


Rural Energy Burden by Region

The East South Central, New England, and Mid-Atlantic regions had the highest median rural energy burdens at 5.1%.

Households in the Pacific and Mountain regions had the lowest median rural energy burdens, at 3.6% and 3.7%, respectively. Figure 4 highlights the regions with the highest median rural energy burdens.

FIGURE 4. STATES WITHIN CENSUS REGIONS WITH HIGHEST MEDIAN ENERGY BURDENS



While using median values provides a useful way to understand the central tendency in a region, medians do not give us a sense of the severity of such burdens for those most impacted. In order to better illustrate the extreme burdens faced by those who are the worst off, we calculated the upper-quartile (i.e., 75th percentile) energy burden in each region. A quarter of households in the region experience an energy burden at or above this value.

East South Central had the greatest upper-quartile rural energy burden, with a quarter of rural households experiencing a burden greater than or equal to 9.4%.

The East South Central, New England, and Mid-Atlantic regions had the highest median rural energy burdens at 5.1%.

THE RELATIONSHIP BETWEEN ENERGY BURDENS AND ENERGY PRICES

Many people confuse their high energy bills with high electricity and gas prices. However lower prices may not result in a lower bill if a household uses more energy (DOE 2017a). For example, in 2016, electricity prices were highest in Hawaii, but energy bills were highest in South Carolina (EIA 2018a). Even though Hawaii's energy prices are more than twice the national average, residential customers in four states spent more per household for electricity in 2016: South Carolina, Alabama, Connecticut, and Maryland. Clearly energy prices do not tell the whole story in terms of energy affordability; other factors such as household income, household efficiency, and the amount of energy use also contribute to the energy affordability landscape.

TABLE 5. RURAL ENERGY BURDENS AT THE MEDIAN AND UPPER QUARTILE

	New England	Mid-Atlantic	East North Central	West North Central	South Atlantic	East South Central	West South Central	Mountain	Pacific	US rural total
Rural median	5.1%	5.1%	4.5%	4.0%	4.6%	5.1%	4.3%	3.7%	3.6%	4.4%
Rural upper quartile	9.2%	8.7%	7.7%	7.3%	8.8%	9.4%	7.1%	6.3%	6.2%	7.8%

TABLE 6. REGIONAL AVERAGE ELECTRICITY PRICE COMPARED TO ENERGY BURDEN RANKING

Region	2006 average retail price (cents/kWh)*	Energy burden ranking (1= highest)
New England	15.49	1
Pacific	14.71	7
Mid-Atlantic	12.68	1
South Atlantic	10.18	2
East North Central	10.03	3
West North Central	9.51	5
East South Central	8.97	1
Mountain	8.94	6
West South Central	7.96	4

* *Source:* EIA 2018b

New England had the second-highest value, at 9.2%. Table 5 shows rural energy burdens at the median and upper quartile for each region.

As mentioned, energy prices alone do not explain regional variation in energy burden. To demonstrate this, we examined the average retail price per kilowatt-hour (kWh) for each region. Table 6 lists the cost for each region alongside the region's energy burden ranking, with 1 representing the highest burden and 7 the lowest.

As table 6 indicates, there is not a direct relationship between energy prices and energy burdens, suggesting income and energy consumption are also at play.

Rural Energy Burden by Demographic

In this study, we examined different demographic groups that research shows experience high energy burdens (Drehobl and Ross 2016). Table 7 shows the median burden for each demographic group residing in rural areas.

As mentioned earlier, rural households overall experience higher energy burdens than metropolitan households (4.4% compared with 3.1%). Nationally, rural low-income households experience the highest median energy burdens. Their median was more than twice the overall rural median and nearly three times greater than the metropolitan median.

Overall, in rural areas, those residing in manufactured housing, the elderly, renters, and nonwhite households all faced median energy burdens higher than 5%. Figure 5 shows regional rural median energy burdens for households in a selection of subgroups.

In the following sections, we examine the subset groups by region to provide a richer investigation of how rural energy affordability varies regionally. In the rest of the analysis, we had to combine the New

FIGURE 5. RURAL MEDIAN ENERGY BURDEN BY DEMOGRAPHIC. GROUPS ARE NOT MUTUALLY EXCLUSIVE; HOUSEHOLDS MAY BE REPRESENTED IN MORE THAN ONE CATEGORY.

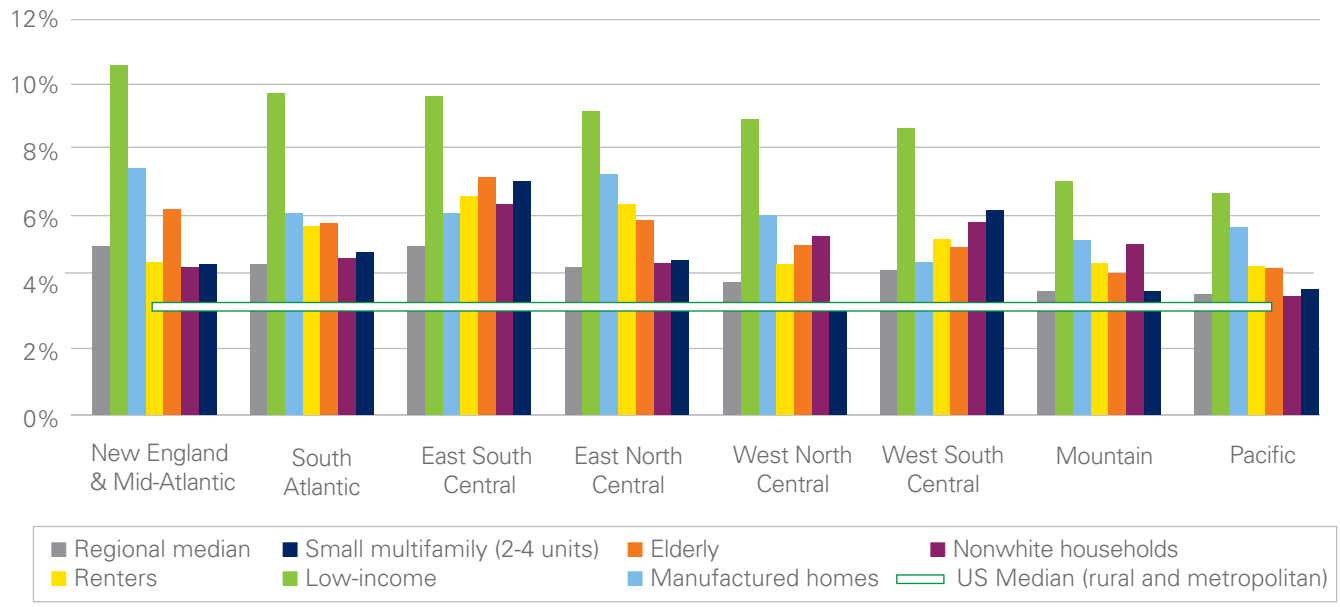


TABLE 7. NATIONAL MEDIAN RURAL ENERGY BURDEN BY DEMOGRAPHIC

Demographic		Rural
Total	Rural households	4.4%
	Metropolitan households	3.1%
Income	Low-income (<200% FPL)	9.0%
	Non-low-income	3.1%
Housing type	Manufactured	5.8%
	Small multifamily (2–4 units)	4.9
	Large multifamily (5+ units)	4.6%
	Single-family	4.1%
Age	Elderly	5.6%
	Non-elderly	3.9%
Housing tenure	Renters	5.3%
	Owners	4.1%
Race	Nonwhite	5.1%
	White non-Hispanic	4.3%

England and Mid-Atlantic regions for all demographic groups due to the same anonymity concerns discussed previously in this report (footnote 11). For additional information, appendix table A3 provides energy burden values for each rural demographic group by census region, and table A4 includes the upper-quartile energy burden for each group by census region.

LOW-INCOME HOUSEHOLDS

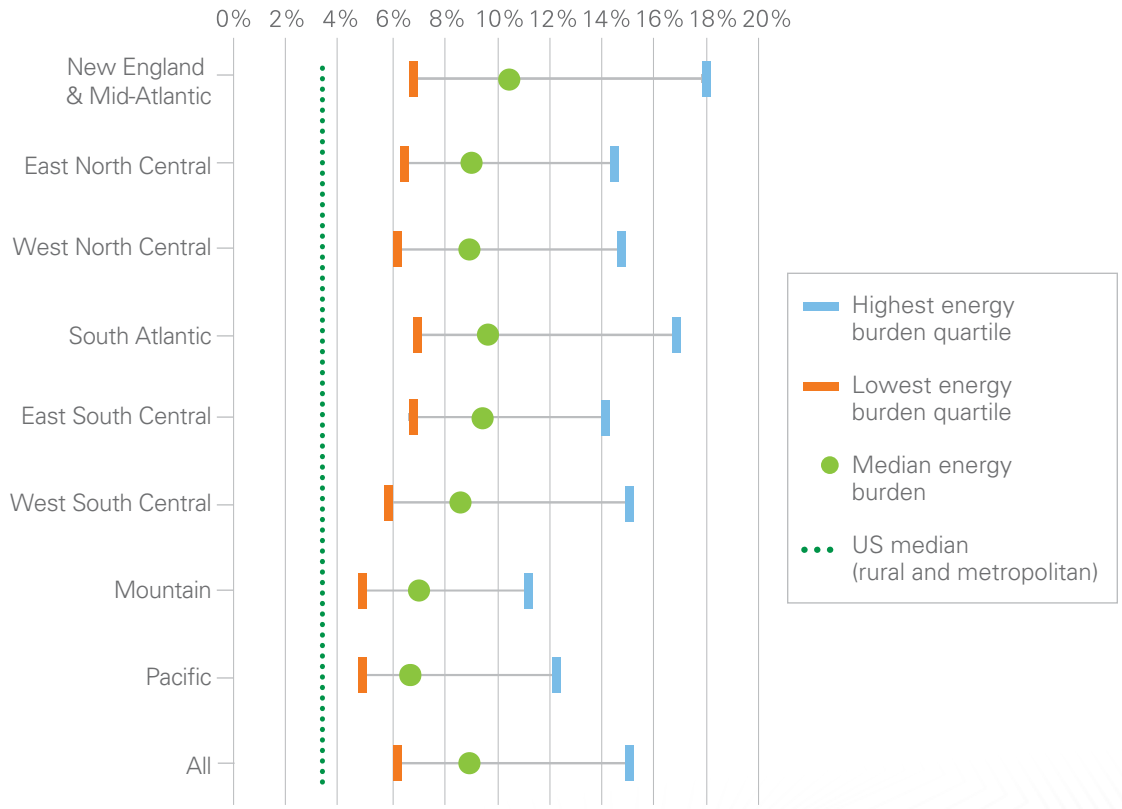
Nationally, rural low-income households experience the highest energy burdens across all regions in the study. These households have a median burden of 9.0%, more than twice that of the rural median and almost three times higher than their non-low-income counterparts (3.1%). The highest median burdens for rural low-income households are in the New England and Mid-Atlantic regions (10.6%). In addition, a quarter of rural low-income households in these regions experienced an energy burden of 18% or higher. We also found that over a quarter of rural low-income households devote more than 10% of their income to energy expenses. Table 8 lists the median and upper-

Nationally, rural low-income households experience the highest median energy burdens. Their median was more than twice the overall rural median and nearly three times greater than the metropolitan median.

TABLE 8. MEDIAN AND UPPER-QUARTILE RURAL ENERGY BURDENS FOR LOW-INCOME AND NON-LOW-INCOME HOUSEHOLDS

	New England & Mid-Atlantic	East North Central	West North Central	South Atlantic	East South Central	West South Central	Mountain	Pacific	US rural total
Low-income households (<200% FPL)	10.6%	9.1%	9.0%	9.8%	9.6%	8.6%	7.1%	6.7%	9.0%
Upper-quartile energy burdens for low-income households	18.0%	14.4%	14.8%	16.9%	14.3%	15.2%	11.3%	12.3%	15.0%
Non-low-income households	3.9%	3.3%	2.9%	3.3%	3.2%	2.8%	2.7%	2.5%	3.1%
Upper-quartile energy burdens for non-low-income households	6.0%	4.7%	4.0%	4.3%	4.1%	3.9%	3.9%	3.8%	4.3%

FIGURE 6. LOWEST-QUARTILE, MEDIAN, AND HIGHEST-QUARTILE ENERGY BURDENS OF RURAL LOW-INCOME (BELOW 200% FPL) HOUSEHOLDS



quartile energy burdens for low-income and non-low-income rural households across census regions. The upper quartile serves to classify the level of energy burden experienced by a quarter of households and does not represent income class.

Across all regions, the data illustrate that rural low-income households devote a much larger portion of their income to energy bills than do non-low-income households in rural areas. This is especially true for families who have upper-quartile energy burdens, which are nearly five times higher than the median energy burden of non-low-income households (15% versus 3.1%). Figure 6 shows the lowest-quartile, median, and highest-quartile energy burdens for rural low-income households.[19] This figure is useful for displaying the range of energy burdens faced by these households.

HOUSING TYPE

We found that those residing in manufactured housing in rural areas experience energy burdens higher than the national rural median (5.8% versus 4.4%). Their median energy burden is also 42% higher than that of their single-family counterparts. By region, as is the case with low-income households, the New England and Mid-Atlantic regions show the highest median burden for those residing in rural manufactured housing, at 7.4%. The upper-quartile burden, however, is largest in the East North Central region (12.8%), suggesting that there is a wide variance in energy burdens among those residing in manufactured housing across rural areas. Energy burdens for those residing in rural manufactured housing are much higher than those residing in multifamily and single-family housing in rural areas. Even so, households living in rural small and large multifamily buildings also experience an above-average burden of 4.9% and 4.6%, respectively, as compared with the national rural median of 4.4% and the rural single-family median of 4.1%. The highest burden for rural multifamily households (2–4 unit buildings) is in the

Almost a quarter of rural households living in manufactured housing in each region experienced an energy burden of nearly twice that of the national rural median.

TABLE 9. MEDIAN AND UPPER-QUARTILE RURAL ENERGY BURDENS BY HOUSING TYPE

	New England & Mid-Atlantic	East North Central	West North Central	South Atlantic	East South Central	West South Central	Mountain	Pacific	US rural total
Manufactured	7.4%	7.2%	6.0%	6.1%	6.1%	4.6%	5.3%	5.7%	5.8%
Upper-quartile manufactured	12.2%	12.8%	10.0%	11.4%	9.9%	7.1%	8.0%	8.8%	9.8%
Single-family	5.1%	4.2%	3.9%	4.3%	4.7%	4.1%	3.4%	3.2%	4.1%
Upper-quartile single-family	8.8%	7.1%	6.9%	8.0%	9.1%	6.9%	6.0%	5.6%	7.3%
Small multifamily (2–4 units)	4.6%	4.6%	3.3%	4.9%	7.1%	6.2%	3.7%	3.8%	4.9%
Upper-quartile small multifamily	8.2%	8.7%	6.8%	9.3%	10.9%	14.8%	7.8%	5.5%	9.1%
Large multifamily (5+ units)	4.3%	5.2%	3.5%	5.6%	6.1%	3.8%	3.9%	4.2%	4.6%
Upper-quartile large multifamily	5.9%	7.9%	6.0%	9.4%	8.2%	11.0%	5.9%	5.3%	7.4%

Rural elderly households (i.e., with a householder aged 65 or older) also see above-average energy burdens as compared with the national rural median (5.6% versus 4.4%).

East South Central region, at 7.1%. However the most extreme upper-quartile burdens for this group are found in the West South Central region, where a quarter of multifamily households (2–4 unit buildings) experience an energy burden of 14.8% or higher.

Table 9 lists rural energy burdens for households living in manufactured housing, single-family residences, and multifamily units in each region.

Nationally, about 13% of rural households reside in manufactured housing. Rural energy burdens for manufactured housing in every region are higher than single-family housing burdens. In addition, almost a quarter of rural households living in manufactured housing in each region experienced an energy burden of nearly twice that of the national rural median.

AGE

Rural elderly households (i.e., with a householder aged 65 or older) also see above-average energy burdens as compared with the national rural median (5.6% versus 4.4%). Elderly households, many of which are on fixed incomes, also have median burdens 44% greater than their non-elderly counterparts. Rural elderly households faced the highest energy burden in the East South Central region, at 7.2%, and in that same region, one-quarter of rural elderly households have burdens greater than 11.3%. Table 10 shows the median and upper-quartile energy burdens for rural elderly households in each region.

The upper-quartile burdens for rural elderly households are especially high in the South Atlantic and East South Central regions, where a quarter of elderly households experience a burden of at least 11.2%, and in the New England and Mid-Atlantic regions, with a quarter of rural elderly households experiencing a burden greater than 10.6%. In general, a quarter of rural elderly households in each region (except the Mountain, West South Central, and Pacific regions) devote almost 10% of their annual household income to energy costs.

TENURE TYPE

Overall, rural renters face higher energy burdens than rural homeowners, though this varies by region.[20] Overall, the rural renter median energy burden is 29% higher than the burden for those who own their homes. Table 11 lists the energy burdens for rural renters and owners, including median and upper-quartile energy burden values.

Our analysis found that rural renters in the East South Central region have the highest median energy burden (6.6%) and that a quarter of these renting households experience a burden greater than 10.7%. While the

TABLE 10. MEDIAN AND UPPER-QUARTILE RURAL ENERGY BURDENS FOR ELDERLY AND NON-ELDERLY HOUSEHOLDS

	New England & Mid-Atlantic	East North Central	West North Central	South Atlantic	East South Central	West South Central	Mountain	Pacific	US rural total
Elderly	6.2%	5.9%	5.1%	5.7%	7.2%	5.1%	4.2%	4.5%	5.6%
Upper-quartile elderly	10.6%	9.7%	9.6%	11.2%	11.3%	9.2%	7.1%	6.8%	9.7%
Non-elderly	4.5%	4.0%	3.6%	4.0%	4.4%	3.8%	3.4%	3.2%	3.9%
Upper-quartile non-elderly	7.8%	6.9%	6.2%	7.8%	7.9%	6.5%	6.1%	5.9%	6.9%

TABLE 11. MEDIAN AND UPPER-QUARTILE RURAL ENERGY BURDENS FOR RENTERS AND OWNERS									
	New England & Mid-Atlantic	East North Central	West North Central	South Atlantic	East South Central	West South Central	Mountain	Pacific	US rural total
Owners	5.2%	4.1%	3.9%	4.4%	4.6%	3.9%	3.7%	3.2%	4.1%
Upper-quartile owners	8.9%	6.8%	7.0%	8.2%	8.2%	6.7%	6.3%	5.7%	7.3%
Renters	4.6%	6.3%	4.5%	5.7%	6.6%	5.3%	4.6%	4.5%	5.3%
Upper-quartile renters	8.2%	10.1%	7.5%	10.8%	10.7%	9.4%	6.6%	7.6%	9.3%

majority of renters experience higher energy burdens than owners, the opposite is true in the New England and Mid-Atlantic regions.

RACE

Due to sample size restrictions, our analysis could break down rural energy burdens into only two broad racial groups for each region: white non-Hispanic and nonwhite. Table 12 includes median and upper-quartile rural energy burdens for these two groups, by region.

Overall, rural nonwhite households face energy burdens higher than the rural median (5.1% versus 4.4%). These households also have a median energy burden almost 19% higher than that of their rural white counterparts. In all regions excluding the New England, Mid-Atlantic, and Pacific regions, rural nonwhite households devote more of their income to energy costs than their white counterparts do. As with rural elderly households and rural renters, the East South Central region has the highest median burden for rural nonwhite households, at 6.4%. The upper-quartile burden for rural nonwhite households is highest in the West North Central region, at 12.1%, nearly twice that of the upper-quartile energy burden for rural white households in that region.

TABLE 12. MEDIAN AND UPPER-QUARTILE RURAL ENERGY BURDENS FOR WHITE AND NONWHITE HOUSEHOLDS									
	New England & Mid-Atlantic	East North Central	West North Central	South Atlantic	East South Central	West South Central	Mountain	Pacific	US rural total
White (non-Hispanic)	5.1%	4.5%	3.9%	4.6%	4.6%	3.8%	3.7%	3.8%	4.3%
Upper-quartile white (non-Hispanic)	9.0%	7.6%	6.9%	8.8%	8.6%	6.2%	6.0%	5.9%	7.5%
Nonwhite	4.5%	4.6%	5.4%	4.7%	6.4%	5.8%	5.1%	3.6%	5.1%
Upper quartile nonwhite	7.1%	8.3%	12.1%	9.3%	10.6%	10.2%	8.2%	6.7%	9.2%

Reducing Energy Bills through Energy Efficiency

Energy efficiency is an effective tool for reducing high household energy burdens. For example, the US Department of Energy Weatherization Assistance Program (DOE-WAP), which retrofits the homes of families living at or below 200% of the federal poverty level, saves an average single-family home $283 per year (DOE 2017b). As part of this analysis, we examined the extent to which the inefficiency of the housing stock contributes to high energy burdens and specifically, the reduction in energy burden that could be achieved if energy efficiency upgrades were implemented.

To estimate the efficiency of housing stock, we used the metric of energy cost per square foot as a proxy. This is a limited approach as housing type, climate, and heating/cooling systems will affect energy usage per square foot. To create an "adjusted median annual

TABLE 13. ADJUSTED RURAL ENERGY BURDEN SPENDING, SAVINGS, AND EFFICIENCY GAP						
Demographic		**Estimated median annual energy spending[1]**	**Adjusted median annual energy spending[2]**	**Annual median savings**	**Adjusted energy burden[3]**	**Reduction in energy burden**
	Total	$1,910	$1,432	$477	3.3%	25.0%
Ownership	Owners	$2,040	$1,547	$493	3.1%	24.2%
	Renters	$1,400	$1,070	$330	4.0%	23.6%
Race	White (non-Hispanic)	$1,968	$1,488	$480	3.3%	24.4%
	Nonwhite	$1,567	$1,191	$377	3.7%	24.0%
Age	Non-elderly	$1,890	$1,440	$450	2.9%	23.8%
	Elderly	$1,872	$1,408	$464	4.3%	24.8%
Housing type	Manufactured	$1,848	$1,440	$408	4.7%	22.1%
	Single-family	$2,083	$1,575	$508	3.2%	24.4%
	Small multifamily (2–4 units)	$1,074	$842	$233	4.0%	21.7%
	Large multifamily (5+ units)	$998	$760	$238	3.6%	23.9%
Income	Low-income (<200% FPL)	$1,584	$1,164	$420	6.5%	26.5%
	Non-low-income	$2,101	$1,611	$490	2.5%	23.3%

[1] Calculated by multiplying median square footage for the subgroup by median energy cost per square foot for that subgroup.
[2] Calculated by multiplying median square footage for the subgroup by first quartile energy cost per sq. ft. for that subgroup.
[3] Calculated by dividing adjusted median annual energy spending by the median income of that subgroup.

energy spending" value for each rural subgroup, we multiplied the median square footage for each subgroup by the first quartile energy cost per square foot for that subgroup.

Adjusted median annual energy spending = (Subgroup median sq. footage) * (First quartile energy cost per sq. ft. of each respective subgroup)

As table 13 shows, raising the efficiency of the median household for each subgroup to the first quartile energy cost per square foot for each respective subgroup can result in substantial savings for some of the rural subgroups we analyzed in the preceding section. This table compares the estimated annual energy spending (the median energy spending per square foot of the subgroup multiplied by the median household square footage of the group) to the adjusted annual energy spending and displays the annual savings and reduction in household energy burden that could result. See appendix table A5 for a breakdown of energy spending per square foot for each of the subgroups below and for more on how we arrived at potential savings and energy burden reduction for the median household in each group.

Retrofitting the median rural household to be as efficient per square foot as its more efficient counterpart would result in a 25% reduction in overall rural energy burdens. For some subgroups, this translates into more than $400 savings annually. The median low-income rural household would experience an annual savings of about $420, while the median manufactured housing resident would see an annual savings of $408. Overall, every rural subgroup would benefit from improvements in housing efficiency.

According to the 2009 Residential Energy Consumption Survey (RECS), rural households make up roughly 23% of all households nationally and account for about 24% of US residential energy consumption (EIA 2013).[21] At the same time, our analysis shows that while rural households consume a proportionate amount of

Retrofitting the median rural household to be as efficient per square foot as its more efficient counterpart would result in a 25% reduction in overall rural energy burdens. For some subgroups, this translates into more than $400 savings annually.

physical energy relative to the nation as a whole, the economic consequences of their consumption are significantly different. Specifically, the share of income rural households spend on energy is significantly higher than their non-rural counterparts' expenditures. There are a number of factors that can account for this difference, including income levels and energy prices. Our analysis shows that price differences do not account for high energy burdens, and that while income levels play an important role, they alone do not account for this observed difference in energy burdens.

We find that rural households tend to be less efficient than their non-urban counterparts, so that while urban and rural households tend to consume similar amounts of energy *per household*, rural households tend to pay much more than their non-rural counterparts per square foot of living space. To the extent that living space and income are correlated, this means that at any given income level, rural households tend to pay a larger share of their income on energy. We also find that energy burden tends to be higher for lower-income households, which means that as income declines, energy consumption falls less quickly. This in turn implies that living space tends to fall less quickly than income, reflecting the fact that there is some minimum level of living space required for households at any income level, so that the systematically higher levels of inefficiency in rural housing stock impact rural households at an increasing rate as their income falls. There are thus qualitative differences in rural housing stock that explain the higher level of energy burdens we find.

Summary of Findings

The goal of this analysis was to describe the landscape of energy affordability in rural areas and highlight certain groups that face disproportionately high energy costs relative to their income. Overall, we found that median energy burdens are higher for rural households than for metropolitan households. Demographically, those with the highest burdens are low-income households and those living in manufactured housing. Other rural households with above-average median burdens are elderly, nonwhite, and rental households. All of these groups experience a median energy burden above 5%. Geographically, the households with the highest median rural energy burdens are located in the East South Central, New England, Mid-Atlantic, and South Atlantic regions. A quarter of all rural households in each of these regions devote more than 8.5% of their income to energy costs.

Our results also indicate that high energy burdens are not simply a result of low incomes and/or high energy prices. If households became more energy efficient, thereby reducing energy costs per square foot, their energy burdens would be reduced. These findings are counter to the myth that high energy burdens are directly related to high energy prices, which was not the case in our analysis. While we did not fully analyze the factors responsible for high energy burdens, we were able to examine the effect of improving household efficiency levels on energy burdens.

It is important to remember that energy burdens are not just a number. The US Energy Information Agency (EIA) has estimated that roughly one in five households has to forgo or reduce food and medicine spending to pay energy bills at least one month a year, and that more than 10% of households cannot use heating and/or cooling equipment at least one month a year due to cost concerns (EIA 2017). Similarly, about 15% of American households have reported receiving a disconnection notice for energy service (EIA 2017). This is worrisome given the fact that once a customer is in arrears, utility service costs often increase due to fees associated with avoiding disconnection or restoring services once they have been shut off. These statistics underscore the real-world impacts of high energy burdens.

[18] The median occupies the middle position in an ordered set of values; it is not influenced by extreme values or skewed data.

[19] Twenty-five percent of these households have an energy burden less than the lowest-quartile value; 25% of them have an energy burden greater than the highest-quartile value.

[20] We included only those households that pay for their own electricity and other heating fuel costs. Renters who do not pay their energy bills were not included in the analysis.

[21] As part of this referenced study, housing units are classified using criteria created by the US Census Bureau based on 2010 Census data. Urbanized areas are densely settled groupings of blocks or tracts with 50,000 or more people, while urban clusters have at least 2,500 but less than 50,000 people. All other areas are rural.

Benefits of Investing in Energy Efficiency in Rural Areas

Rural communities can experience many benefits from energy efficiency investments. Efficiency can especially help low-income and highly burdened rural households reduce energy burdens and increase disposable income for other necessities. By improving housing conditions, efficiency investments can also increase property values, household health, and quality of life (Russell et al. 2015). Efficiency investments can also stimulate the local economy through job creation, which can lead to higher employment, wages, and spending power (ACEEE 2017). A retrospective evaluation of DOE-WAP found that the program supports 8,500 jobs annually and that participating households save on average $283 or more per year (DOE 2017b). Additionally, energy efficiency can help rural utilities address their aging infrastructure by reducing energy demand and avoiding costs of increased generation, transmission, and distribution investments (Baatz 2015).

Table 14 summarizes how energy efficiency investments provide benefits for low-income households beyond direct energy savings. These benefits affect program participants, utilities and ratepayers (i.e., customers), and communities.

TABLE 14. ENERGY EFFICIENCY BENEFITS FOR LOW-INCOME HOUSEHOLDS, UTILITIES, AND COMMUNITIES

Benefit recipient	Energy efficiency outcome	Resulting benefit
Low-income program participants	Lower monthly utility bills	Lower household energy burden and greater disposable income
		Reduced stress and fewer tradeoffs between energy and other necessities
		Reduced exposure to risk from utility rate increases
		Lower risk of delinquency and disconnection due to nonpayment
	Improvements in the efficiency of the housing stock	Improved health and safety and greater household comfort
		Increased property value, more reliable equipment, and lower maintenance costs
		Preservation of affordable housing
		Greater satisfaction with the building/unit and improved household and neighborhood stability
Utilities and ratepayers	Demand-side management (both gas and electric)	Avoided excess costs of increased generation, capacity, and transmission investments
		Contribution toward compliance with energy efficiency portfolio standards and other environmental legislation
	Cost savings to utilities and ratepayers	Reduced arrearages and cost of shut-offs, which lowers utility operating costs
		Reduced maintenance costs due to less stress on the system
		Improved customer service and satisfaction
Communities	Lower electricity and gas demand	Reduced environmental pollutants and improved public health
	Lower monthly utility bills due to avoided utility costs	More money spent in the local economy due to greater household disposable income, with higher local multiplier effect
		Poverty alleviation and improved standard of living
	Improvements in the efficiency of the housing stock	Local job creation through weatherization programs and energy efficiency providers and trade allies
		Improved quality of life
		Increased property values and preservation of housing stock

Source: Updated from Drehobl and Ross 2016

Programs for Improving Energy Affordability in Rural Communities

Several program approaches exist to help address rural energy affordability. These programs fall into three main categories: bill assistance, energy efficiency and weatherization, and on-bill financing options (Cluett, Amann, and Ou 2016).[22]

TABLE 15. PROGRAMS FOR ADDRESSING HIGH ENERGY BURDENS IN RURAL AREAS

Program type	Program	Provider	Funding source
Bill assistance	Low-Income Home Energy Assistance Program (LIHEAP)	State health and human services agencies and their sub-grantees (CAAs, state agencies, nonprofit service providers, utilities, and municipalities)	Federal and state taxpayers
	Other low-income bill assistance programs	IOUs, munis, co-ops	Utility ratepayers, private contributions
	Modified rate design, rate discounts or waivers, and modified billing methods	IOUs, munis, co-ops	Utility ratepayers
Energy efficiency and weatherization	DOE-WAP	State weatherization offices and their sub-grantees (CAAs, municipalities, and weatherization contractors)	Federal and state taxpayers
	Other federally funded programs that support energy efficiency in residential housing	Variety of state, local, and federal implementers	Federal taxpayers
	Utility-led and ratepayer-funded efficiency programs	IOUs, munis, distribution co-ops, G&T co-ops, and statewide program administrators, often in collaboration with weatherization networks (CAAs), and municipal and nonprofit housing and energy providers	Utility ratepayers or other utility funds
	On-bill tariffs (e.g., Pay As You Save® model programs)	IOUs, munis, co-ops, or other financial lenders or institutions	Internal funds, low-cost federal government loans (e.g., USDA), and/or private capital obtained by the utility or through partnership with a lender
On-bill financing options for efficiency upgrades	Loans for efficiency investments that are paid back through the customer's utility bill	IOUs, munis, co-ops, or other financial lenders or institutions	Internal funds, low-cost federal government loans (e.g., USDA), and/or private capital obtained by the utility or through partnership with a lender

Nationally, these program options vary in terms of offerings, design, funding sources, and delivery methods. Often, utility-led efficiency programs and funds are offered jointly with DOE-WAP through local nonprofit and community action organizations. Providers of these three program types include community action agencies (CAAs), investor-owned utilities (IOUs), municipal utilities (munis), rural electric distribution cooperatives (co-ops), rural generation and transmission cooperatives (G&Ts), local governments, and nonprofit organizations. Table 15 gives an overview and short summary of each program type, program description, program provider, and funding source.

Bill Assistance Programs

Bill assistance programs provide a direct subsidy to help lower a household's energy bill, which can provide immediate relief from high energy burdens. Bill assistance can include direct subsidies to bills through federal, utility, nonprofit, or charity funds and can also include additional ways to lower bills, such as modified rate design. Energy efficiency programs can complement bill assistance programs to provide more long-term relief to rural customers experiencing high energy burdens.

The US Department of Health and Human Services (HHS) Low-Income Home Energy Assistance Program (LIHEAP) provides funding for home energy bill assistance, energy crises, weatherization, and energy-related minor home repairs. In 2017, the U.S. Department of Health and Human Services provided $3.39 billion in funding (US Congress 2018). Even with this budget, there are many more households that qualify for assistance than are able to receive LIHEAP funds. In 2014, 38.5 million households qualified for LIHEAP, with these funds reaching fewer than 20% of qualified households (DHHS 2016).

The federal government allocates LIHEAP funds to states, which then distribute the funds to bill assistance and weatherization program implementers. While the majority of LIHEAP funds are allocated to bill assistance, states can earmark up to 15% (or up to 25% with a waiver from HHS) to bolster their DOE-WAP funding, which is used to weatherize low-income homes (LIHEAP Clearinghouse 2018).

DOE-WAP implementers face challenges when serving rural communities, such as a lack of skilled labor and opportunities for training, older and poorly maintained housing stock, and additional travel time between weatherization jobs.

In order to address high energy burdens, energy utilities too can offer bill assistance programs similar to LIHEAP, but funded through ratepayer or other utility dollars or private contributions. Some rural co-ops fund bill payment assistance through bill round-up programs, in which members opt to have their bill rounded up to the nearest dollar, with the extra proceeds going into a bill assistance fund. In addition, utilities can create modified rate designs to make energy bills more affordable for low- to moderate-income households. These can include rate discounts, affordable rate plans such as percentage income payment plans, waivers, or modified billing methods for income-qualified households (Brockway, Kallay, and Malone 2014).

Energy Efficiency and Weatherization Programs

This section provides an overview of the types of energy efficiency and weatherization programs that can serve rural households. These programs can be federally funded or utility led and ratepayer funded, or they can be on-bill tariff programs. The latter are discussed in the subsequent on-bill section.

DEPARTMENT OF ENERGY WEATHERIZATION ASSISTANCE PROGRAM

DOE-WAP provides funding to weatherize households across the country. These funds are allocated to all 50 states, the District of Columbia, and the five US territories. The state and territory grantees then divide funds among local agencies that implement DOE-WAP throughout the entire state, serving every county. In 2017, the DOE-WAP budget was $225 million, with $3 million of the total allocated to DOE headquarters for training and technical assistance (US Congress 2018). DOE-WAP has reached 7 million households over a period of 40 years and currently weatherizes about 35,000 homes a year, out of roughly 39,560,000 income-eligible households (DOE 2017b; Carroll, Kim, and Driscoll 2014). This amounts to weatherizing less than 0.1% of income-eligible households annually through DOE-WAP. In addition, many income-eligible households are not eligible for DOE-WAP participation due to program deferrals for a wide range of reasons, including health and safety issues and other disqualifications.

DOE-WAP implementers face challenges when serving rural communities, such as a lack of skilled labor and opportunities for training, older and poorly maintained housing stock, and additional travel time between weatherization jobs (NACAA 2014; NeighborWorks America 2015). Limited funding, resources, and local knowledge of WAP may also hinder enrollment and participation. Numerous states have households in rural, urban, and suburban areas waiting many years to participate, and for some states, the wait list effectively spans decades. For example, Madison County, North Carolina, has about 1,200 energy-burdened households with a high likelihood of need for weatherization, yet only about 6 homes are weatherized in the county annually (T. Logan, economic development director, Community Action Opportunities, pers. comm. to Rory McIlmoil, Appalachian Voices, April 4, 2018). At this rate, without other funding and program resources, it would take 200 years to weatherize all the homes in need in Madison County. This example indicates the need for more funding, program options, and program enrollment and uptake for energy-burdened homes.

Other efficiency program options complement efforts funded by DOE-WAP. Many utility-led energy efficiency programs partner with DOE-WAP implementers to share administrative costs and combine measures for more impactful weatherization projects. By doing so, households can receive upgrades from multiple funding streams, which may cover a wider variety of efficiency measures and provide a more comprehensive home retrofit. In 2016, the DOE-WAP network leveraged $358,600,733 in nonfederal funds, including utility funds and state or local funds (NASCSP and WAP 2016).

OTHER FEDERALLY FUNDED PROGRAMS THAT SUPPORT RESIDENTIAL ENERGY EFFICIENCY

In addition to the DOE, other federal agencies provide funding that can be used for home weatherization and efficiency upgrades.[23] For example, the US Department of Housing and Urban Development (HUD) provides multiple programs that can fund energy efficiency, such as its Energy Performance Contracting, Rehabilitation Mortgage Assistance, FHA Energy Efficient Mortgages, Community Development Block Grants, and HOME Investment Partnership Program. These programs all provide funding that can facilitate residential energy efficiency upgrades. Additionally, the US Department of Veterans Affairs has Energy-Efficient Mortgages available for new construction and retrofits, and the Internal Revenue Service offers the Low-Income Housing Tax Credit (LIHTC) and Residential Energy Efficiency Tax Credit to fund new construction and retrofit projects. The US Department of Agriculture runs

programs such as Section 504 Home Repair, which targets low-income elderly households in rural areas for health, safety, and efficiency upgrades. Similar to DOE-WAP, these programs face barriers in terms of funding, access, and implementation.

UTILITY-LED AND RATEPAYER-FUNDED ENERGY EFFICIENCY PROGRAMS

Many energy utilities provide energy efficiency programs for their customers. Funded by ratepayers through a systems benefits charge, these programs aim to deliver cost-effective energy savings. Utilities often design, fund, and implement them, but they can also be implemented through statewide or third-party program administrators, DOE-WAP providers such as CAAs, or other entities. In addition, many rural utility programs are funded and implemented in conjunction with DOE-WAP. Energy-efficient measures provided through these programs vary by program, ranging from replacing a refrigerator with a more efficient model to installing insulation and sealing air leaks to reduce heating and cooling costs. In addition, some states, such as Arkansas, Colorado, and Minnesota, have recognized the need to specifically serve low-income customers with energy efficiency and require that their regulated utilities do so (Berg et al. 2017).

In the remainder of this section, we discuss the current program landscape for reducing high energy burdens in rural communities and small towns, focusing on utility-led rural energy efficiency programs. Local energy providers often design, fund, and implement energy efficiency programs in rural communities. Table 16 describes rural utility types, offering information on utility ownership, service territory size, and regulatory structures.

Overall, distribution co-ops and munis serve the majority of households in rural areas. These small utilities may face efficiency program implementation challenges. Co-ops tend to have fewer customers, more low- to moderate-income households within their service territories, and generally less-dense populations. Co-ops average about eight customers per mile of line and collect annual revenue of approximately $16,000 per mile. This compares starkly with IOUs, which average 34 customers and collect $75,500 per mile, and with munis, which average 48 customers and collect $113,000 per mile (NRECA 2017b). Small munis tend to be the most densely populated, with the average muni serving a small community comprising 2,000 electric meters (APPA 2018). In addition, many co-ops and munis are not regulated by a state body and therefore are not subject

to state energy policy requirements. This means that policy approaches for advancing IOU efficiency programs and regulated utility programs may differ from policy approaches for advancing programs in rural areas for non-regulated utilities.

IOUs and larger munis can deliver savings at a lower cost per kWh by spreading fixed program administration costs across a larger base of customers who reside in closer proximity to one another (Wheeless, Grant, and Keegan 2016). Smaller utilities,

Ratepayer-funded efficiency programs are typically available to both urban and rural households. However in practice these programs are often more accessible to urban than to rural customers, due to barriers such as the high cost of serving households in low-population-density areas.

TABLE 16. RURAL UTILITY TYPES, OWNERSHIP STRUCTURES, SERVICE TERRITORY SIZE, AND REGULATORY STRUCTURES				
Utility type	**Description**	**Ownership**	**Rural service territory size**	**Regulatory structure**
Rural electric distribution cooperatives (co-ops)	Nonprofit electricity providers; often do not own generation and therefore buy power from IOUs or G&T co-ops (which are often created by distribution cooperatives)	Locally owned by "consumer-members" (all customers and businesses served by co-op)	Serve the majority of rural households	Regulated by members in most states, sometimes by commissions
Rural generation and transmission cooperatives (G&T co-ops)	Provide electricity to rural electric co-ops and other utilities; some also provide energy efficiency offerings to member cooperatives	Owned by their member distribution cooperatives	Serve the majority of rural households	Regulated by member co-ops in most states, sometimes by commissions
Municipal utilities (munis)	Managed by municipal governments; provide services such as electricity, natural gas, sewage treatment, waste collection/management, wholesale telecommunications, and/or water to municipal residents	Publicly owned by a municipal government	Majority of munis serve small communities	Regulated by municipal government or sometimes by commissions
Investor-owned utilities (IOUs)	For-profit business organizations that provide utility services, such as electricity or natural gas; report profits to shareholders	Privately owned by investors	Serve majority of customers in the US, but not in rural areas	Regulated by public utility commissions at the state level
Statewide program administrators	Provide efficiency services on behalf of one or more energy utilities in a state (e.g., Bonneville Power Administration, Efficiency Vermont, Focus on Energy)	For-profit or nonprofit organizations	Serve all or most of certain states (e.g., Washington, Vermont, Wisconsin)	Regulated by public utility commissions at the state level

on the other hand, must manage higher levels of grid infrastructure and program overhead per customer over a vast area, leading to stretched resources. In addition, co-op and muni efficiency programs do not typically address whole-building energy savings opportunities, such as building envelope and system efficiency upgrades, and instead focus on behavior change and particular technologies that can be readily installed. According to a survey by the National Rural Electric Cooperative Association, the majority of rural co-ops offer energy efficiency education programs and energy audits for their members, but far fewer directly offer whole building weatherization services (NRECA 2017a).[24]

Ratepayer-funded efficiency programs are typically available to both urban and rural households. However in practice these programs are often more accessible to urban than to rural customers, due to barriers such as the high cost of serving households in low-population-density areas (Wheeless, Grant, and Keegan 2016).

Ratepayer-funded efficiency programs typically provide funding for nonprofit and weatherization providers to cover the cost of efficiency upgrades (especially for low-income programs) such as energy audits, direct installation of low-cost efficiency measures, and/or weatherization measures.

Many rural electric distribution cooperatives have banded together to form generation and transmission cooperatives (G&Ts). This allows them to share costs by aggregating power purchases, with the goal of delivering cost-effective power and other services to their members (Bickford and Geller 2016). Energy efficiency investments can benefit G&Ts by lowering customer demand and reducing the need for additional baseload or peak-serving power plants. While not all G&Ts have energy efficiency programs, some provide programs to complement those provided by their electric co-op members, either voluntarily or through regulation requirements (Bickford and Geller 2016).

For example, Great River Energy in Minnesota offers a variety of programs through its member co-ops as part of the Energy Wise Minnesota program, with measures including lighting, water heating, and air heating and cooling upgrades (Great River Energy 2018). Elsewhere, Cooperative Energy in Mississippi offers a variety of programs for its members, including rebates for energy efficiency measures, energy audits, and ENERGY STAR® purchasing information. By recognizing the mutual benefits of energy efficiency—such as providing a member service for generation co-ops or energy efficiency as a utility resource for G&Ts—distribution co-ops and G&Ts can work together to provide efficiency for their members.

On-Bill Efficiency Programs

Many low- to moderate-income households in rural communities may face barriers, such as credit eligibility issues, that prevent them from participating in an energy efficiency financing program. On-bill programs provide an avenue to alleviate some of these barriers. On-bill lending is a method of financing energy efficiency improvements that uses the utility bill as the repayment mechanism. These programs allow households to access the up-front capital they need to make energy-efficient investments in their homes and then pay back the cost of the investments through charges on their energy bills.

On-bill lending may take the form of loans or tariffs. Utilities may finance efficiency upgrades through loans that can be paid back through the bill; these create consumer debt tied to the borrower. Tariffed programs, on the other hand, are tied to the meter, so the costs, in theory, can be transferred to subsequent renters of the property. This method helps address split incentive barriers that renters may face, as the investment stays with the property and not the tenant. The Pay As You Save® (PAYS®) model is the most prominent on-bill tariff model.

Importantly, on-bill programs must be designed carefully to ensure bill neutrality—that is, to make sure the energy savings cover the cost of the repayment. For more information on the different types of on-bill programs, see ACEEE's On-Bill Energy Efficiency Toolkit at aceee.org/sector/state-policy/toolkit/on-bill-financing.

On-bill programs rely on different funding sources and repayment structures. These programs can utilize internal utility reserves, public funding (such as federal loans), ratepayer funds, private lending institutions, community development finance institutions (CDFIs), foundations and charitable organizations, bond issuances, and property taxes (for munis) (Michigan Saves et al. 2017). The USDA offers a few options for financing on-bill repayment programs, such as the Rural Economic Development Loan & Grant

USDA RURAL GRANT PROGRAMS

The US Department of Agriculture offers two grant programs for rural electric co-ops and munis to help finance on-bill programs for residential energy efficiency upgrades: the Energy Efficiency Conservation Loan Program (EECLP) and the Rural Energy Savings Program (RESP).

EECLP is a provision of the 2008 Farm Bill, finalized in 2013, that provides money to eligible electric co-ops and munis serving rural areas. The rural utilities can apply to borrow money at low interest from the USDA's Rural Utilities Service, created for the purpose of helping utilities reduce consumption and manage load in the areas they serve. This allows the utilities to provide energy efficiency and renewable energy upgrades to their own facilities and the properties of their customers or members. The loans can be repaid through on-bill tariffs on customer bills. The EECLP has roughly $6.5 billion available annually, though not all of these funds are allocated (EESI 2016).

RESP, a provision of the Agriculture Act of 2014, makes $52 million in zero-interest loans available to fund cost-effective energy efficiency upgrades in homes and small businesses. RESP specifically funds on-bill-financing energy efficiency loans. These loans can be billed to customers or members through on-bill tariffs, PACE programs, or traditional loan programs. Public power districts, public utility districts, or electric co-ops can receive RESP loans to serve their customers or members with energy efficiency upgrades, though non-utility entities also qualify to receive RESP loans.

Program (REDLGP), the Efficiency and Conservation Loan Program (EECLP), and the Rural Energy Savings Program (RESP). For more information on these programs, see the "USDA Rural Grant Programs" text box, above.

EXAMPLES OF ON-BILL TARIFF AND LOAN PROGRAMS

Roanoke Electric Cooperative, based in North Carolina, was one of the first recipients of financing through EECLP. In September 2015, Roanoke Electric received $6 million from EECLP for its PAYS energy efficiency on-bill tariff program (REC 2017). This bill-positive program, called Upgrade to $ave, provides cost-effective energy efficiency upgrades for residential households and commercial customers, and annual cost recovery charges are limited to 80% of the estimated savings of each upgrade without assumption of energy inflation. The program also allows for premium upgrades beyond what is cost effective if the participating member pays the incremental up-front cost for these improvements, such as energy-efficient windows. Renters can also participate in the program with the property owner's permission at no cost to the owner (Wynn 2015). Roanoke estimates that members use about 75% of their energy savings to pay back the on-bill tariff, with 25% estimated savings kept by the member (Leventis et al. 2017).

In 2011, rural co-ops in South Carolina launched a pilot of the Help My House on-bill efficiency loan program and achieved about 30% energy savings for the 125 participating households through a whole-house approach (EESI 2013). Homes were evaluated for all potential energy efficiency measures. The program relied on federal loans, supplemented by some co-op funds. More than 95% of participants reported they were "more than satisfied" with their co-op after

On-bill lending is a method of financing energy efficiency improvements that uses the utility bill as the repayment mechanism. These programs allow households to access the up-front capital they need to make energy-efficient investments in their homes and then pay back the cost of the investments through charges on their energy bills.

participating in the pilot program (EESI 2013). Today KW Savings Co., a statewide nonprofit organization created by the state's co-ops, coordinates the Help My House program among seven rural co-ops. In 2017, KW Savings received an additional $13 million from the USDA RESP to provide capital to continue the program (Department of Agriculture 2017b).

CONSUMER PROTECTIONS AND BILL NEUTRALITY/POSITIVITY

A growing number of rural munis and co-ops offer on-bill programs for their customers or members. These programs, like most types of debt, should include strong consumer protections. Utilities can also design these programs to be bill neutral or bill positive. As mentioned above, bill neutral means that cost recovery cannot exceed the estimated savings, including estimated rate increases, over 100% of the estimated life of the upgrades. Bill positive means that the expected average energy savings from the efficiency investments exceed the on-bill payments on an annualized basis. Achieving net savings is especially important for rural on-bill programs in order to reduce high energy burdens. On-bill tariff programs can only use bill-positive terms, while on-bill loan programs can use either bill-neutral or bill-positive terms. Evaluation, measurement, and verification of energy savings is critical to ensure bill-positive results.

Utilities calculate the cost effectiveness of on-bill program loans or tariff investments using current utility rates and fixed charges. If a utility increases its fixed charges or changes its rate structure after the tariff or loan is deemed cost effective, this can invalidate the original payback and cost-effectiveness estimates and, in turn, negate the bill-positive or bill-neutral terms of the bill tariff or loan. Utilities should consider how changes in their rates could potentially impact their on-bill tariffs or loans when they are considering new rate structures.

[22] For more information about on-bill energy efficiency programs, see ACEEE's On-Bill Energy Efficiency Toolkit: aceee.org/sector/state-policy/toolkit/on-bill-financing.

[23] For more information on federal funding sources for energy efficiency, see the DOE Clean Energy for Low-Income Communities Accelerator's program funding catalog at www.energy.gov/eere/slsc/low-income-community-energy-solutions.

[24] For more information on which distribution and G&T cooperatives offer efficiency programs and what measures they offer, see the "NRECA Cooperatives Promote Efficiency" map at www.cooperative.com/content/public/maps/energyefficiency/index.html.

Challenges, Ways Forward, and Program Examples

In the remainder of this report, we highlight the main challenges that rural energy providers face in making energy efficiency upgrades available to their customers or members. We then offer recommendations for addressing these challenges with the goal of achieving long-term energy affordability in rural communities.

To gain a better understanding of the challenges and opportunities surrounding the improvement and expansion of rural efficiency, we spoke with a variety of experts including individuals from the federal government, consultants, nonprofit organization officials, and IOU and co-op utility program managers. Based on our discussions and research, the following sections present a series of challenges and opportunities for rural program design and delivery related to these areas:

- Low-income customers
- Renters
- Manufactured homes
- Broadband access
- Propane and fuel oil
- Program resources
- Energy efficiency workforce development
- Program marketing
- Program evaluation

Table 17 provides an overview of challenges, ways forward, and promising program examples for each of these topic areas.

TABLE 17. CHALLENGES, WAYS FORWARD, AND PROMISING PROGRAM EXAMPLES

Topic area	Challenges	Ways forward	Promising program examples
Low-income customers	Low-income households often cannot afford the up-front investment needed for efficiency improvements; may also lack information about programs and their benefits that would encourage participation	Partner with local community, nonprofit, and religious organizations to address certain necessary expenses for efficiency upgrades; utilize on-bill tariff programs to help customers/members with credit as a barrier to access efficiency programs; share program resources among multiple organizations serving low-income households	• Mountain Association for Community Economic Development (MACED) How $martKY Program • Colorado Delta Montrose • South Carolina Home Works • Appalachia Service Project
Renters	Split incentives hinder property owners from investing in efficiency if the tenant pays the energy bill; about a quarter of rural households are renters and may face this barrier	Design programs that appeal to property owners by making the program easy to enroll in, easy to understand, and cost effective for a building owner and tenants to participate; on-bill tariffs that are tied to the meter may also facilitate renter participation	• Ouachita Electric Cooperative
Manufactured homes	Manufactured homes can be more costly to operate and more challenging and expensive to weatherize and repair through efficiency programs; the majority of manufactured home residents live in rural areas	Target existing manufactured homes through innovative program offerings; address new manufactured homes through incentives for high-efficiency designs. Also consider innovative design options, such as super-efficient or zero-energy modular housing; work with nonprofit housing agencies to incorporate high-efficiency factory-built housing into their development plans	• PPL Electric Utilities • East Kentucky Power Cooperative • Northwest Energy Efficient Manufactured Housing program • VEIC's Zero Energy Modular℠ (ZEM℠) program • Next Step
Broadband access	Rural areas often lack access to broadband Internet, which hinders economic opportunities; broadband also is necessary for some efficiency technologies and can facilitate communication about efficiency program offerings	Leverage broadband expansions by jointly promoting broadband and efficiency offerings with the local Internet service providers (ISPs); pair efficiency with broadband expansions to counteract increased energy use through the broadband installation	• Focus on Energy
Propane and fuel oil	Many rural households rely on these fuels for heat, and electric utilities cannot always provide efficiency measures for homes that use these fuels	Bundle funds through fuel-blind programs so a single energy efficiency program can address all end uses together (e.g., one-stop-shop model)	• Arkansas Oklahoma Gas (AOG) and Oklahoma Gas and Electric (OGE)
Program resources	Small utilities may be unable to allocate the necessary resources to meet the efficiency needs of their communities	Share program administration costs and resources by partnering small co-ops and G&T utilities	• Mountain Association for Community Economic Development (MACED)

(CONTINUED)

TABLE 17. CHALLENGES, WAYS FORWARD, AND PROMISING PROGRAM EXAMPLES			
Topic area	**Challenges**	**Ways forward**	**Promising program examples**
Energy efficiency workforce development	Limited volume of work and lack of training resources act as barriers to establishing a robust efficiency workforce in rural areas; the need to balance demand for projects with job creation and training also proves challenging	CAAs can share in-house contractor crews to maintain a trained workforce with enough job demand; provide remote training as well as programs at community colleges and education centers to facilitate growth in the rural energy efficiency workforce; build on existing trade programs (e.g., HVAC, electric, building trades) and existing curricula to incorporate new technologies in the energy efficiency field; expand training partnerships with private sector and industry associations; use mobile cadre method to serve remote households	• Southern Virginia Higher Education Center • Redwood Community Action • Alfred State College
Program marketing	Challenge to convey information about programs, offer transparency about program options, and address customer/member skepticism about program savings/outcomes	Collect demographic data to better target and reach customers; pair efficiency with other technologies, such as broadband or solar, to reach more customers; partner with local agencies and service organizations; change marketing strategy and outreach vehicles; utilize program evaluation results to address customer skepticism	• Focus on Energy • Co-Mo in Missouri • Pedernales Electric Cooperative
Program evaluation	Utilities that are not regulated by a state public utility commission are not always required to conduct evaluations for their efficiency programs, which leads to lack of knowledge about program effectiveness	Nonregulated utilities can consider designing and implementing rigorous evaluations to help determine the most effective efficiency program designs and offerings to meet customer needs and increase customer satisfaction	• Help My House Program • Roanoke Electric Cooperative • Ouachita Electric Cooperative • AOG & OGE

An additional way to address efficiency program participation barriers for low-income households is for energy utilities to partner with local community organizations, such as nonprofits or religious institutions, to deliver programs to low-income residents.

Low-Income Households

As stated previously, 43% of households in rural areas have incomes below 200% FPL. Although many of these households are subject to inordinate energy burdens, these residents generally do not have the up-front capital needed to invest in efficiency improvements. Further, poor credit scores will exclude some people from traditional financing options. To address this barrier, utilities can support on-bill programs utilizing alternative underwriting standards that do not rely on credit scores to assess the likelihood of repayment.

For example, Fleming-Mason Energy in Kentucky partnered with the Mountain Association for Community Economic Development (MACED) on How$mart™KY, a tariffed on-bill program through the utility based on the Pay As You Save (PAYS) system. MACED, whose mission is to stimulate the eastern Kentucky and central Appalachia economy, provides capital for the How$martKY program and operates it. More than half of the retrofits from the program have been undertaken by low- and moderate-income households, and almost a quarter by manufactured housing residents. How$martKY does not require credit checks for participation and instead relies on utility payment history. Since the program began in 2010, How$mart has completed $2.2 million in home retrofits, creating local jobs and contributing to local economic development (Rocha 2017).

Pooling program resources can also prove effective for serving low-income households. In Colorado, Delta Montrose Electric Association (DMEA), the Colorado Energy Office, and Housing Resources of Western Colorado partnered to provide low-income DEMA members with free weatherization services. Eligible members receive a comprehensive energy audit on their home to determine their efficiency needs.

An additional way to address efficiency program participation barriers for low-income households is for energy utilities to partner with local community organizations, such as nonprofits or religious institutions, to deliver programs to low-income residents. In South Carolina, rural electric co-ops collaborate with the nonprofit Home Works of America to address issues of health, safety, and sanitation during home weatherization under the Help My House program. Home Works and the co-ops combine funds to include health and safety repairs for those participating. The funds provided by Home Works allow many households to take part in the Help My House program who would otherwise be unable to because of the additional health and safety repair costs (Electric Cooperatives of South Carolina 2018).

Programs offered by nonprofit or religious organizations can also help improve efficiency in low-income communities. The Appalachia Service Project is a service ministry that aims to bring volunteers to rural central Appalachia to repair homes for low-income families. The project's goal is to make both new and existing homes "warmer, safer, and drier" through health and efficiency upgrades. The group's New Build Appalachia program aims to create energy-efficient homes with an energy rating score of HERS 75, meaning the home uses only 75% of the energy of a typical new 2006 home (ASP 2018).

Renters

As of 2013, there were approximately 7.1 million renter-occupied homes in rural communities, making up 28.4% of the total rural housing stock (HAC 2013). Even though the rural rental housing rate is lower than national levels, there is still a great need for rural renters to access energy efficiency measures for their

Rural utilities can work to ensure that their efficiency program offerings address the split-incentive problem by designing a program that appeals to both property owners and residents.

homes to improve energy affordability. Rural renters are disproportionately represented among households facing issues around housing affordability, with nearly 50% spending more than 50% of their incomes on housing costs (HAC 2013).

Perceived split incentives between property owners and renters often hinder the participation of rental households in efficiency programs. If the property owners include utilities in the monthly rent, the owner may be monetarily incentivized to participate in energy efficiency programs, but the residents may be unwilling to improve a property they may not inhabit in a few years. On the other hand, if the residents pay for their own utilities, then the property owner is not motivated to make efficiency upgrades to the building, but the tenants may be motivated to save energy to lower their bill. On-bill loan programs create consumer debt tied to the borrower. However tariffed programs are tied to the meter, so the costs, in theory, can be transferred to subsequent renters of the property.

Rural utilities can work to ensure that their efficiency program offerings address the split-incentive problem by designing a program that appeals to both property owners and residents. They can design efficiency programs and tariffed on-bill programs that allow renters to participate, as well as provide information and incentives to encourage buy-in from building owners. Additionally, programs should avoid creating disincentives to owner participation, such as requiring owner co-payments or using time-consuming and complex application processes. These voluntary programs can offer landlord and tenant incentives for participation, guarantee savings, cover costs through savings, and provide transparency and durability of program outcomes (Bird and Hernández 2012). DOE-WAP provides guidance on addressing the split-incentive problem by providing information on how utilities can offer no-cost upgrades while guaranteeing savings to ensure benefit to tenants (DOE 2016).

Ouachita Electric Cooperative is an example of a rural utility reaching renters through its energy efficiency program. Ouachita designed its tariffed on-bill program HELP PAYS® to target and meet the needs of renters, who were ineligible to participate in the co-op's HELP program. The utility pays the up-front costs of all cost-effective upgrades when the renter opts into the program and the property owner agrees to maintain the upgrades. The utility recovers its costs with a fixed charge on the member's bill that is capped at 80% of the estimated savings, and the cost recovery period is capped at 80% of the useful life of the upgrades. For renters in multifamily housing, property owners agree to make co-payments, where required. More than one-third of HELP PAYS® participants in 2016 were renters (Harvell 2017).

Manufactured Homes

Approximately 14 million of the 20 million manufactured homes in the United States are served by electricity co-ops (DOE 2015). The majority of households living in manufactured housing qualify as low-income. Although these homes consume 35% less energy than site-built homes, due to their smaller size, their residents spend 70% more per square foot on energy (DOE 2015). Manufactured homes have a useful life of about 50 years, and about 66% of manufactured housing units were produced before the 1994 HUD Code update, which featured significant energy efficiency improvements. In addition, 22% were built prior to the HUD Code's enactment in 1976 (Grant and Keegan 2015).

Owners of manufactured housing units have particular difficulty accessing capital for efficiency investments, repairs, or improvements (Stewart 2017). This is due to lower incomes, lack of ownership of the property on which their home is sited, and other barriers to obtaining efficiency loans. In addition, manufactured housing is often classified as personal property instead of real estate, which makes it difficult for manufactured homeowners to obtain mortgages or other loans with reasonable interest rates comparable to mortgages for home financing (Brennan et al. 2017).

In terms of weatherization and repairs, manufactured homes often have issues with air leakage or infiltration, crossover ducts, lack of insulation, poor thermostat placement, and inefficient heating systems (Cody 2011).[25] A 2012 ACEEE analysis estimated that cost-effective energy efficiency investments in new and existing manufactured housing could save 40% of electricity consumption and 33% of natural gas consumption over two decades (Talbot 2012). While this is a sizable potential for energy savings, efficiency programs serving manufactured homes continue to face technical challenges and market barriers in delivering comprehensive, whole-home retrofits to this housing stock. Additionally, manufactured homes are more vulnerable to damage from weather, potentially increasing their long-term maintenance and rehabilitation costs and reducing the likelihood that they will receive the needed investments to improve efficiency (Ross 2013).

In order to increase manufactured home efficiency, programs and policies can target either existing manufactured homes through targeted weatherization programs or new homes by encouraging stricter energy codes and efficiency incentives for manufactured home producers. Both options can lead to energy savings. We acknowledge that while these improvements lead to decreased energy costs, they may also lead to higher purchase or resale costs. Efficiency programs may want to consider addressing this issue by assisting prospective buyers with the additional up-front cost due to efficiency improvements.

A few utilities have piloted innovative and effective efficiency options for weatherizing existing manufactured home. For example, PPL Electric Utilities, a large electricity distribution company in Pennsylvania, offers a weatherization program called Wise Homes for income-eligible customers living in manufactured homes. This program provides no-cost air and duct sealing. A third-party evaluation found that in 2015, the program weatherized 110 manufactured homes, cut electricity consumption by an average of 11% per household, and proved cost effective overall. The program targeted manufactured home communities, which yielded large program uptake, and focused on high-impact but low-cost energy efficiency measures (Stewart 2017).

Utilities and other stakeholders can also encourage more efficient manufactured homes by incentivizing efficient new manufactured home construction or existing home upgrades. Certified ENERGY STAR manufactured homes use about 30% less energy than manufactured homes built to the 1994 HUD Code standards (DOE 2015). Utilities can incentivize their customers to purchase or upgrade to ENERGY STAR–certified manufactured homes. For example, East Kentucky Power Cooperative (EKPC), a G&T co-op serving 16 electric distribution co-ops in Kentucky, launched its ENERGY STAR Manufactured Home program in 2014. More than a quarter of the 1.1 million people served by EKPC's distribution members live in manufactured housing. As of 2016, the co-op had

enrolled 40 manufactured homes in the program, spending up to $1,250 toward insulation and $500 for heat pump upgrades for each home (Cash 2016).

Utilities can also create incentive programs for manufacturers to encourage stronger manufactured housing efficiency in new construction. For example, the Bonneville Power Administration and many Pacific Northwest utilities and co-ops partnered to encourage regional manufactured home factories to build to a more efficient standard. This led to the creation of the Northwest Energy Efficient Manufactured (NEEM) Housing program, in which 74 utilities and co-ops throughout the Pacific Northwest participate. The program promotes ENERGY STAR manufactured homes via rebates, ranging from $800 to $1,400 for homebuyers and $100 to $150 for manufactured home dealers (Grant and Keegan 2015).

Nonprofits and other stakeholders can also encourage efficient new manufactured home design. Next Step, a nonprofit dedicated to advancing affordable manufactured housing, works with partners to ensure that homes placed through their nonprofit partners are designed to balance quality and affordability. This means that the homes meet or exceed ENERGY STAR standards and are designed to be installed on permanent foundations. Next Step also provides comprehensive homebuyer education and support, as well as access to fair, fixed-rate home financing to promote the building of wealth through homeownership (Next Step 2018).

Modular homes, an alternative to traditional manufactured housing, offer efficiency and affordability benefits. Modular homes are prefabricated houses that consist of multiple sections called modules. Modules are constructed off-site and then transferred and installed at the final site location. Vermont Energy Investment Corporation's (VEIC) zero energy modular (ZEM) home program provides an example of an innovative approach to efficiency in the factory-built home sector. ZEM homes emerged as a solution to housing needs in Vermont after Tropical Storm Irene in 2011. VEIC assisted in developing a high-efficiency modular home that could be a durable replacement for a manufactured home. The program currently operates in Vermont and Delaware, and as of 2018 it has provided more than 85 homes, created 25 full-time jobs, and avoided the emission of 900 metric tons of carbon dioxide (Schneider 2016). VEIC also works with local lenders to incorporate low-interest mortgage financing into the program. Together, the low-interest financing, negligible energy costs, and minimal maintenance help keep monthly bills manageable, reduce overall costs of ownership, and increase housing and energy affordability.

Broadband Access

Many rural communities still lack access to broadband infrastructure, which is necessary for economic growth and development. Broadband also proves necessary for certain energy efficiency technologies that offer monitoring and control capabilities, such as automated thermostats and appliances, autonomous circuit breakers, and connected LED lighting. In 2016 the Federal Communications Commission (FCC) reported that 39% of rural Americans (23 million people) lacked access to 25 Mbps/3 Mbps[26] or faster Internet, which is the minimum speed required by the FCC's broadband benchmark goal (FCC 2016). This is the necessary speed to enable these energy efficiency technologies. Without broadband access, rural households can miss out on economic opportunities that rely on high-speed Internet access.

Energy providers can leverage broadband marketing to advance energy efficiency measures, particularly smart technology such as thermostats. Additionally, pairing energy efficiency with broadband can mitigate the increase in energy use due to broadband expansion. Some electric distribution co-ops (e.g., Co-Mo Electric in Missouri, North Alabama Electric Cooperative, Northeast Rural Services in Oklahoma) also provide broadband services to their customers. These co-ops have the opportunity to jointly promote efficiency alongside their broadband offerings to their members.

Internet service providers (ISPs) are often the entities reaching out to rural customers to expand broadband service. Rural utilities can work with them to market energy efficiency programs and technologies along with broadband opportunities. For example, Wisconsin's Focus on Energy (FOE) partners with ISPs to offer energy efficiency kits to customers who sign up for new broadband service. The kits allow customers to choose among a number of connected energy efficiency devices such as connected lighting and smart power strips, programmable thermostats, and discounted smart thermostats (Sheil and Grimyser 2017).

Propane and Fuel Oil

According to the 2009 Residential Energy Consumption Survey, more than 10% of households in the United States rely on propane or fuel oil for home heating or cooking (EIA 2011). Fuel oil use is particularly prevalent in northeastern states, while propane is more scattered throughout rural areas, with the highest concentration in the Midwest and South (EIA 2011). Reducing use of these heating fuels can help lower bills, reduce air pollution, and lead to more comfortable and healthier buildings and residents (Nowak, Kushler, and Witte 2014).

Electric utilities tend to be the main providers of rural energy efficiency programs, and if they are regulated by the state, they may be unable to offer efficiency measures for nonelectric end uses. This is the case in states where electric utilities are not able to achieve cost recovery for non-electric measures installed as part of an electric efficiency program. Many states do not require or facilitate the development of fuel-blind energy efficiency programs, which allow electric and natural gas IOUs and other regulated utilities to jointly achieve and count savings from a variety of fuel types. Statewide energy efficiency program administrators are well positioned to administer fuel-blind programs since they already coordinate funds from electric and natural gas utilities as well as other sources.

Fuel-blind programs are an effective way to reduce all energy use and increase energy affordability in rural communities.

Fuel-blind programs are an effective way to reduce all energy use and increase energy affordability in rural communities. For example, in Arkansas, all IOUs that provide energy services to customers living in severely energy-inefficient homes across the state can claim water, gas, propane, and electric savings. This allows Arkansas IOUs to provide fuel-blind efficiency programs that can address all fuel uses simultaneously. For instance, Arkansas Oklahoma Gas (AOG) can claim the electric savings among rural electric customers resulting from the installation of energy efficiency measures such as insulation. This allows rural customers to access efficiency program offerings beyond those offered by their electric distribution co-op.

Program Resources

Many rural utilities are unable to allocate sufficient funding and capacity to meet the efficiency needs of their communities. Rural areas have limited weatherization contractor networks for program implementation yet face high need. Many stakeholders cite extremely long waits for participation in efficiency and weatherization programs in rural areas. In particular, the waiting list for the DOE-WAP program can be years long for some rural households due to limited funding. Long waits pose a challenge for households looking to receive efficiency benefits in the near term. Even with high need, often only a fraction of those who qualify for program participation are able to access services due to lack of program availability, lack of information about available programs, and other barriers.

Rural utilities tend to be smaller and therefore may have a hard time reaching efficiencies of scale. Small rural electric co-ops can save time and money and streamline efficiency program management by partnering with their G&T utility. By combining resources, they can also lower the cost of energy savings by spreading the fixed costs of program administration, design, training, marketing, and evaluation over more members. Centralized program management with a statewide program administrator or G&T can also help. For example, the G&T co-op EKPC has a history of working with its distribution co-ops on energy efficiency programs and acts as a hub for administration, training, and developing program materials (Wheeless, Grant, and Keegan 2016).

To best serve their rural households, energy efficiency program managers must determine who those households are, what their needs are, and how best to reach and serve them.

Energy Efficiency Workforce

Urban areas have higher demand for weatherization jobs and therefore tend to have more robust and sophisticated energy efficiency contractor networks. Rural areas face barriers in terms of establishing such networks and maintaining the necessary volume of work to support them. In order to create a robust energy efficiency workforce in rural areas, contractors and program implementers need to balance the costs of training and maintaining a weatherization workforce with the demand for weatherization jobs. Lack of training resources, limited workforce availability, and limited access to efficiency jobs can make it difficult for rural communities to train and maintain contractors with specific knowledge of efficiency practices.

CAAs, which often implement WAP, often rely on in-house crews for their weatherization. Because WAP provides guaranteed funds and job volume, these community agencies can often justify maintaining a certified in-house crew to complete jobs. Even so, certification costs can prove to be a barrier, especially in areas where there are not enough jobs to make the necessary certifications for WAP implementation cost effective. In some cases, contractor crews are shared among agencies in order to lower costs and increase available job volume for the crews. While not common, some DOE-WAP providers have also begun offering market-rate efficiency services in rural areas in order to maximize the available volume of jobs.

Our conversations with rural energy providers indicated that contractors in rural areas tend to be older, as few young people have been joining the industry in recent years. This will prove a barrier in future years as the workforce ages out and there are few younger replacements to step in.

While the volume of work in rural area remains a large barrier, access to training can also limit the ability of rural areas to maintain contractor networks. A way to address this is to make efficiency training more accessible. Many training centers that utilize DOE-WAP funds provide distance learning options across state lines and in states with fewer training options. This allows contractors to gain expertise in weatherization without having to attend classes at a learning center. To make these centers financially viable, they also tend to offer numerous types of training, such as for efficiency, lead abatement, and other construction issues (Hawkins et al. 2014). Many also provide a mobile cadre of trainers for the hands-on experience needed for weatherization certification. This allows contractors without access to a physical training location to learn how to implement a weatherization program.

Some community colleges and education centers in rural areas offer training in energy efficiency and housing construction, which can help expand the workforce. For example, the Southern Virginia Higher Education Center houses the R&D Center for Advanced Manufacturing and Energy Efficiency. Established in 2006, this center provides training for the energy efficiency workforce through hands-on learning and applied research, such as projects exploring the production of affordable energy-efficient housing (SVHEC 2018). States can support their community colleges and education centers that provide training for the next generation of the efficiency workforce. Program implementers, such as CAAs, provide another opportunity for worker training and program implementation. Because CAAs tend to rely on in-house crews, they train their own staff to implement their programs. EEtility, the program manager of the Pay As You Save (PAYS) on-bill program, has the

capacity to train contractors to implement the PAYS program (EEtility 2016a).

Another solution to workforce shortages is a mobile cadre of weatherization providers. While this allows weatherization providers to expand their reach, it does come with downsides, such as less accountability for upgrades and difficulty returning to a job site to make fixes if needed. Even so, in some regions, CAAs implementing weatherization programs have the capacity to travel to remote rural communities and stay for extended periods of time to provide weatherization services. Some states, such as Alaska, Texas, and Utah, use this approach to reach rural and remote households. In Utah, CAAs travel once a year to Indian reservations and stay for a few weeks to serve these households. This method helps contractor networks maintain needed job volume without needing a permanent location in areas with less demand for weatherization.

Program Marketing

According to a report by SEEAction, energy efficiency barriers commonly arise from program marketing difficulties, such as lack of public awareness of programs as well as lack of confidence and trust that a program will result in the energy savings advertised (Leventis, Kramer, and Schwartz 2017). All energy efficiency programs face challenges related to conveying program information, transparency about program options, and customer or member skepticism with regard to energy savings (IBE 2013). This challenge is even more acute for rural households due to low population density and, in some areas, communication barriers stemming from lack of broadband access.

In a survey conducted for the National Rural Electric Cooperative Association, some electric co-ops pointed to member skepticism about savings as a key barrier to investment in energy efficiency improvements (Cody 2011). Some utilities have attempted to address this skepticism by using mailers to reach customers or members with program information, while others have offered information through community events and community organizations.

To best serve their rural households, energy efficiency program managers must determine who those households are, what their needs are, and how best to reach and serve them. Demographic data—such as income level, race, home type, and education level—can help them better understand their customers' needs and ultimately improve the effectiveness of the programs they offer. Language can also be a persistent barrier, especially for immigrant communities that provide low-cost labor in rural industries, such as agriculture and livestock management (California Energy Commission 2016). However few rural energy providers have collected data on their customer demographics. This is an important step for strengthening communication with members or customers.

Another effective marketing strategy is to pair efficiency upgrades with other technology offerings. We have already mentioned co-ops like Co-Mo in Missouri that offer broadband to their customers. Solar is another potential offering that utilities serving small towns and rural communities can pair with energy efficiency. Efficiency reduces the up-front costs for households purchasing solar power and makes the installations more cost effective. Utilities can require efficiency before solar installation or offer solar and efficiency measures simultaneously. For example, Pedernales Electric Cooperative (PEC) in Texas provides PEC Empower Loans to members to install solar panels on their homes. In order to participate in the program, members must first conduct an energy audit and site assessment and pursue energy-efficient upgrades (PEC 2018). In addition, California and Colorado have integrated solar into energy assistance programs such as LIHEAP and DOE-WAP, and other states such as Minnesota and Oregon are in the process of doing so as well (Vote Solar 2017). As more states adopt

Even without being required, program evaluations can help co-ops and munis determine how to optimize their programs. They can help utilities identify ways to better serve their customers or members and increase program satisfaction by improving their design and delivery methods.

this model, more solar energy will become available to low-income and rural communities. States and utilities should ensure that solar and energy efficiency are offered together for the most cost-effective and beneficial result to the household and utility.

Program Evaluation

State utility regulators often require that IOUs conduct evaluation, measurement, and verification (EM&V) of their efficiency programs to determine if they have achieved required program goals. Munis and co-ops are often self-regulated and therefore do not necessarily have to achieve specific cost-effectiveness outcomes for their programs. Therefore some munis and co-ops do not evaluate their program impacts.

Even without being required, program evaluations can help co-ops and munis determine how to optimize their programs. They can help utilities identify ways to better serve their customers or members and increase program satisfaction by improving their design and delivery methods. Program evaluations can also help address customer skepticism by verifying that participants achieve energy savings and other program goals. While many utilities hire external consultants for program evaluations, some also work with local colleges and universities. Due to the limited capacity of small rural utilities and municipal utility programs, federal and state governments can also consider providing assistance or standardization for evaluations.

Some utilities or statewide program administrators serving rural areas are required to undergo program evaluations. For example, the Vermont Public Service Board, which serves a predominantly rural state, requires independent evaluations of programs delivered by the state's energy utilities (Vermont DPS 2018). Similarly, Focus on Energy, the statewide program administrator for Wisconsin, conducts evaluations of its efficiency programs (Cadmus 2017).

Many rural co-ops have worked with partners to evaluate their programs. For example, EEtility's EM&V of the PAYS on-bill tariff programs offered by Ouachita Electric and Roanoke Electric provides data on the effectiveness of these programs (EEtility 2016b). Similarly, Delta Montrose Electric Association (DMEA), Midwest Energy, and the city of Springfield, Missouri, all hired evaluators to review their programs (Johnson et al. 2016). Additionally, in 2016, Cooperative Energy, a G&T co-op in Mississippi, collaborated with Advanced Energy (AE) to develop a two-year Residential Retrofit Pilot Study examining the impact of three types of retrofit measures. The goal of the program was to ensure high levels of customer service, good communication, and customer satisfaction with the program (Susser 2016).

[25] Crossover ducts take heated air from one side of a double-wide mobile home to the other. They frequently leak.

[26] Mbps stands for megabits per second, which is a measure of data transfer speed. In the above case, 25 Mbps indicates the required upload speed, and 3 Mbps indicates the required download speed.

Conclusion

Our research revealed that rural households pay disproportionately more for their energy costs as a percentage of their income compared with urban households. We also determined that certain households—namely low-income, renting, nonwhite, and elderly households and those residing in multifamily and manufactured housing—face even greater energy burdens. In fact, rural low-income households have an energy burden that is nearly double the rural median and almost three times greater than rural non-low-income households. Overall, rural energy burdens are greatest in the New England, Mid-Atlantic, South Atlantic, and East South Central regions. A quarter of all households in these regions devote more than 8.5% of their income to their energy bills. These results indicate that there is a strong need for affordable energy and efficiency program options in rural communities.

Our analysis highlighted the cumulative impact of geography, class, and race on energy affordability and access to household energy services. This is not a story about high energy prices, but rather one that highlights how historic inequities in the deployment of energy infrastructure and services manifests itself in disproportionate household energy costs and intersects with other inequalities in such areas as housing and income. The interplay of geography, race, and class influence who has access to affordable energy and at what cost. Because of this, rural households often find themselves paying disproportionately more for residential energy services.

Our research found that energy efficiency is an important strategy for addressing high rural energy burdens, especially for low-income households. In rural areas, residential energy efficiency is an underutilized strategy that could complement bill assistance and other social services to alleviate high household energy burdens. However many rural households lack the discretionary income—and therefore the up-front capital—to invest in energy efficiency upgrades. Energy efficiency programs that serve rural communities could benefit from improved design, expanded offerings, and targeting in order to address long-term energy affordability needs. Program examples presented in this paper,

The interplay of geography, race, and class influence who has access to affordable energy and at what cost. Because of this, rural households often find themselves paying disproportionately more for residential energy services.

such as the use of inclusive financing and community engagement strategies, highlight some of the innovative strategies and improvements that could help scale residential energy efficiency in rural communities.

We identified several innovative mechanisms and programs that overcome barriers to making energy efficiency more accessible to rural households. These include expanding current low-income programs, exploring no- to low-risk financing options, incorporating regional workforce development initiatives, and building relationships with other service providers throughout the community to improve program delivery. Energy providers, in particular, are well positioned to work with community partners to design and deliver efficiency programs that meet the distinct needs of their communities. There is certainly room for programs to adapt to the varying and predominant rural fuel uses and housing types as well as to make use of the established communication channels that typically reach rural households.

Scaling up rural energy efficiency programs not only can save households and utilities money but also has the potential to create local, skilled, and stable jobs. In this way, efficiency programs that address high energy burdens can also help alleviate poverty and provide other benefits to society beyond energy savings, such as economic development, additional employment, education opportunities, and improved public health. While providing these benefits, energy efficiency will not break cycles of poverty or completely eradicate high energy costs for all households. Energy efficiency is a big part of the solution, but we still have a long way to go to ensure an equitable distribution of energy costs for all American families.

Next Steps and Future Research

We hope that this report's findings and recommendations will spark action among rural energy providers, policymakers, and other stakeholders who want to consider new energy efficiency strategies and determine how best to help their residents obtain affordable and equitable access to energy. We know that high energy bills, low household income, inefficient housing stock, and lack of access to efficiency programs contribute to energy burden. Rural households face all these challenges, making these communities ripe for the long-term benefits that energy efficiency can offer.

We encourage rural communities and policymakers to use this report's energy burden data and recommendations in their efforts to design and deliver energy efficiency policies and programs addressing rural energy affordability. These stakeholders can compare their regional rural energy burden to the national and metropolitan median as well as examine the outcomes for specific groups within their region (appendix table A3). The energy burden data in this report provide a snapshot of the current rural energy burden landscape, and stakeholders should use the data as guidance for shaping their energy efficiency strategy and as a baseline for measuring outcomes of such approaches.

ACEEE plans to release a report in late 2018 that will highlight the best practices of rural efficiency programs. Subsequent research should look deeper into the drivers of high energy burdens in rural communities so that solutions, including local, state, and federal collaboration, can be tailored to address them. Additional evaluation of existing rural energy efficiency programs and services is also needed. Unique barriers impede the delivery of effective energy efficiency solutions in rural communities, and there is still much to learn about the best strategies to overcome these barriers and deliver energy savings.

In rural areas, residential energy efficiency is an underutilized strategy that could complement bill assistance and other social services to alleviate high household energy burdens.

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Appendix A. Detailed Data

TABLE A1. SAMPLE SIZE OF RURAL AND METROPOLITAN HOUSEHOLDS INCLUDED IN THIS STUDY			
Census division	**Metropolitan**	**Rural**	**All**
New England	2,749	229	2,978
Mid-Atlantic	5,006	363	5,369
East North Central	6,918	1,098	8,016
West North Central	1,590	937	2,527
South Atlantic	10,416	811	11,227
East South Central	1,679	616	2,295
West South Central	6,465	786	7,251
Mountain	3,538	357	3,895
Pacific	10,777	446	11,223
All rural households	**49,138**	**5,643**	**54,781**

TABLE A2. SAMPLE COUNTS OF DEMOGRAPHIC GROUPS OF RURAL HOUSEHOLDS INCLUDED IN THIS STUDY									
	New England & Mid-Atlantic	**East North Central**	**West North Central**	**South Atlantic**	**East South Central**	**West South Central**	**Mountain**	**Pacific**	**All**
Total	**592**	**1,098**	**937**	**811**	**616**	**786**	**357**	**446**	**5,643**
Ownership									
Owners	432	774	658	554	401	501	267	287	3,874
Renters	160	324	279	257	215	285	90	159	1,769
Race									
White non-Hispanic	542	1,047	845	589	457	529	283	300	4,592
Nonwhite	50	51	92	222	159	257	74	146	1,051
Age									
Non-elderly	384	731	651	516	426	522	223	313	3,766
Elderly	208	367	286	295	190	264	134	133	1,877
Housing type									
Manufactured home	56	83	66	160	95	120	71	65	716
Single-family home	427	844	743	544	446	534	240	335	4,113
Multifamily unit	109	171	128	107	75	132	46	46	814
Income									
Low-income	202	434	368	361	328	351	145	186	2,375
Non-low-income	390	664	569	450	288	435	212	260	3,268

TABLE A3. MEDIAN ENERGY BURDEN BY RURAL DEMOGRAPHIC GROUP									
	New England & Mid- Atlantic	East North Central	West North Central	South Atlantic	East South Central	West South Central	Mountain	Pacific	Rural total
Ownership									
Owners	5.2%	4.1%	3.9%	4.4%	4.6%	3.9%	3.7%	3.2%	4.1%
Renters	4.6%	6.3%	4.5%	5.7%	6.6%	5.3%	4.6%	4.5%	5.3%
Race									
White non-Hispanic	5.1%	4.5%	3.9%	4.6%	4.6%	3.8%	3.7%	3.8%	4.3%
Nonwhite	4.5%	4.6%	5.4%	4.7%	6.4%	5.8%	5.1%	3.6%	5.1%
Age									
Non-elderly	4.5%	4.0%	3.6%	4.0%	4.4%	3.8%	3.4%	3.2%	3.9%
Elderly	6.2%	5.9%	5.1%	5.7%	7.2%	5.1%	4.2%	4.5%	5.6%
Housing Type									
Manufactured	7.4%	7.2%	6.0%	6.1%	6.1%	4.6%	5.3%	5.7%	5.8%
Single-family	5.1%	4.2%	3.9%	4.3%	4.7%	4.1%	3.4%	3.2%	4.1%
Small multifamily (2–4 units)	4.6%	4.6%	3.3%	4.9%	7.1%	6.2%	3.7%	3.8%	4.9%
Large multifamily (5+ units)	4.3%	5.2%	3.5%	5.6%	6.1%	3.8%	3.9%	4.2%	4.6%
Income									
Low-income (<200% FPL)	10.6%	9.1%	9.0%	9.8%	9.6%	8.6%	7.1%	6.7%	9.0%
Non-low-income	3.9%	3.3%	2.9%	3.3%	3.2%	2.8%	2.7%	2.5%	3.1%
Regional total	**5.1%**	**4.5%**	**4.0%**	**4.6%**	**5.1%**	**4.3%**	**3.7%**	**3.6%**	**4.4%**

TABLE A4. UPPER-QUARTILE ENERGY BURDEN FOR EACH RURAL DEMOGRAPHIC GROUP									
	New England & Mid- Atlantic	**East North Central**	**West North Central**	**South Atlantic**	**East South Central**	**West South Central**	**Mountain**	**Pacific**	**All**
Total	**8.80%**	**7.70%**	**7.30%**	**8.80%**	**9.40%**	**7.10%**	**6.30%**	**6.20%**	**7.80%**
Ownership									
Owners	8.90%	6.80%	7.00%	8.20%	8.20%	6.70%	6.30%	5.70%	7.30%
Renters	8.20%	10.10%	7.50%	10.80%	10.70%	9.40%	6.60%	7.60%	9.30%
Race									
White non-Hispanic	9.00%	7.60%	6.90%	8.80%	8.60%	6.20%	6.00%	5.90%	7.50%
Nonwhite	7.10%	8.30%	12.10%	9.30%	10.60%	10.20%	8.20%	6.70%	9.20%
Age									
Non-elderly	7.80%	6.90%	6.20%	7.80%	7.90%	6.50%	6.10%	5.90%	6.90%
Elderly	10.60%	9.70%	9.60%	11.20%	11.30%	9.20%	7.10%	6.80%	9.70%
Housing type									
Manufactured	12.20%	12.80%	10.00%	11.40%	9.90%	7.10%	8.00%	8.80%	9.80%
Single-family	8.80%	7.10%	6.90%	8.00%	9.10%	6.90%	6.00%	5.60%	7.30%
Small multifamily (2–4 units)	8.2%	8.7%	6.8%	9.3%	10.9%	14.8%	7.8%	5.5%	9.1%
Large multifamily (5+ units)	5.9%	7.9%	6.0%	9.4%	8.2%	11.0%	5.9%	5.3%	7.4%
Income									
Low-income (<200% FPL)	18.00%	14.40%	14.80%	16.90%	14.30%	15.20%	11.30%	12.30%	15.00%
Non-low-income	6.00%	4.70%	4.00%	4.30%	4.10%	3.90%	3.90%	3.80%	4.30%

TABLE A5. INCOME, SIZE OF UNIT, AND UTILITY SPENDING BY DEMOGRAPHIC GROUP								
	Annual income		Size of unit (sq. ft.)		Estimated median annual energy spending*		Annual utility costs per sq. ft.	
	Metropolitan	Rural	Metropolitan	Rural	Metropolitan	Rural	Metropolitan	Rural
Total	**$57,800**	**$43,000**	**1,586**	**1,540**	**$1,812**	**$1,905**	**$1.16**	**$1.24**
Owners	$70,246	$50,000	1,800	1,700	$2,028	$2,040	$1.11	$1.20
Renters	$38,000	$27,050	1,000	1,000	$1,284	$1,400	$1.27	$1.40
White non-Hispanic	$65,000	$45,300	1,700	1,600	$1,884	$1,963	$1.13	$1.23
Nonwhite	$45,000	$32,000	1,300	1,215	$1,656	$1,563	$1.22	$1.29
Non-elderly	$64,000	$49,200	1,500	1,500	$1,824	$1,890	$1.19	$1.26
Elderly	$40,000	$32,800	1,656	1,600	$1,764	$1,873	$1.07	$1.17
Manufactured	$31,200	$30,513	1,166	1,200	$1,740	$1,850	$1.47	$1.54
Single-family	$68,000	$50,000	1,800	1,750	$2,016	$2,078	$1.13	$1.19
Small multifamily (2-4 units)	$37,800	$20,960	934	850	$1,188	$1,056	$1.27	$1.26
Large multifamily (5+ units)	$38,330	$21,140	860	800	$1,032	$948	$1.19	$1.25
Low-income (<200% FPL)	$18,899	$17,952	1,200	1,200	$1,524	$1,580	$1.24	$1.32
Non-low-income	$80,000	$65,481	1,700	1,751	$1,920	$2,101	$1.14	$1.20

*Calculated by multiplying median square footage for the subgroup by median energy cost per square foot for all metropolitan households

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