Maine Low-Income Home Energy Burden Study

Final report

Prepared for Maine Office of the Public Advocate

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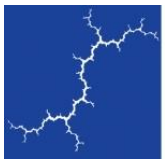

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EXECUTIVE SUMMARY

Maine's low-income residents, like those throughout the United States, face higher energy burdens than other residents. That is, they spend proportionally more of their budgets on electricity and heating fuels than higher income residents. While the state of Maine has addressed this disparity through various measures for decades, the state and other relevant entities can act more effectively by gaining a better understanding of how and where this disparity tends to strike. With this in mind, the Maine Office of the Public Advocate commissioned a study by Synapse Energy Economics (Synapse) to shed light on the energy burdens faced by Maine's residents. Our research complements an earlier study by GDS Associates that established an energy efficiency baseline for low-income households in Maine.[1]

The resulting report describes Synapse's findings on energy use in homes. We relied on various publicly available federal data sources such as the U.S. Department of Energy's Low-Income Energy Affordability Data (LEAD) tool. We assessed differences in home energy expenditures by income bracket, by home ownership status, by type of heating fuel, and by county.

This analysis reveals that Maine's low-income households have a high energy burden: The average (mean) home energy burden for low-income households is 19 percent. On average, low-income households in the state far exceed the thresholds for the various definitions of energy poverty (generally starting with a minimum energy burden in the range of 6 to 10 percent of household income).[2] In comparison, we find in our analysis that the average home energy burden for all Maine households is 6 percent.

Our findings generally align with those of similar studies done nationally and in other regions. For comparison, ACEEE's 2018 national study of home energy burden found that New England and Mid-Atlantic rural households with income less than 200 percent of the federal poverty limit (higher than the income threshold used in our analysis to define low income) experience a median home energy burden of 10.6 percent, and an upper quartile home energy burden of 18 percent.[3] Non-low-income households in the same region (New England and the Mid-Atlantic) experience an average energy burden of 3.9 percent.[4]

Despite the similarities, several findings stood out:

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[1] GDS Associates, 2018. *Maine Low-Income Household Energy Efficiency Baseline Study Final Report*, prepared for the Maine Office of the Public Advocate.

[2] Vermont Energy Investment Corporation, 2016. *Mapping Total Energy Burden in Vermont: Geographic Patterns in Vermonters' Thermal, Electric, and Transportation Energy Use*.

[3] Ross, Lauren, Ariel Drehobl, and Brian Stickles, 2018. *The High Cost of Energy in Rural America: Household Energy Burdens and Opportunities for Energy Efficiency*. ACEEE. https://aceee.org/.

[4] Ross, Lauren, Ariel Drehobl, and Brian Stickles, 2018. *The High Cost of Energy in Rural America: Household Energy Burdens and Opportunities for Energy Efficiency*. ACEEE. https://aceee.org/.

- Low-income homeowners tend to face higher home energy burdens than renters (22 and 16 percent respectively).
- Bottled propane gas as a heat source drives up energy burdens. Those heating their homes primarily with propane experience an average home energy burden (41 percent) more than twice as high as the heating fuel associated with the second highest home energy burden (wood).

With this in mind, our recommendations include focusing on policies that target the most expensive and least efficient heating systems and support homeowners' efforts to weatherize and increase energy efficiency. With regards to energy efficiency programs, homeowners face fewer barriers to participation than renters. However, efficiency programs targeting remote, northern Maine households may be difficult to implement cost-effectively and thus might require special attention. Other potential barriers could include systemic constraints on fuel switching (such as from oil or natural gas heating to electric heat pumps).

Effective policies to alleviate energy burden, such as energy efficiency programs targeted at low-income households, will help low-income residents manage energy costs and promote customer equity. Such policies will benefit the overall system as well: They can include efforts to reduce ratepayer costs, including programs that help manage low-income accounts. They can also reduce the environmental impacts of energy use.

1. INTRODUCTION AND BACKGROUND

Energy burden is the percentage of household income devoted to energy expenditures. Households with high energy burdens may face difficult choices, such as between necessities like home heating, food, and healthcare.[5] Because of the associated long-term bill savings, energy efficiency is particularly important for low-income customers and other customers with high energy burdens. Low-income energy efficiency programs can also reduce energy assistance program costs over time.

Maine has a longstanding priority of reducing the home energy burden for low-income consumers. After the start of the Organization of the Petroleum Exporting Countries (OPEC) oil embargo in 1973, the state of Maine applied to the federal government for funding to start an energy assistance and winterization program to offset the effects of growing home energy costs to residents. Maine's program prompted the first federal program to assist low-income households during the energy crisis, the Emergency Energy Conservation Program—a predecessor of the federal Low-Income Home Energy Assistance Program (LIHEAP).[6]

Maine's commitment to those with high home energy burdens continues to this day. By law, at least 10 percent of the funds for the statewide programs administered by Efficiency Maine Trust (EMT), the state's independent energy efficiency program administrator, must support energy programs for low-income residents.[7] However, lack of information about energy use characteristics of low-income households can make implementation and targeting of low-income energy efficiency difficult.[8]

To provide insights on home energy use and energy burden to enable improvements in the effectiveness and targeting of low-income energy efficiency programs, Maine's Office of the Public Advocate commissioned GDS Associates, Inc. (GDS) and Synapse Energy Economics (Synapse) to study low-income energy consumption, energy efficiency, and energy burdens in Maine. In 2018, GDS completed an energy efficiency baseline study for low-income households in Maine. The GDS study analyzed the energy consumption and energy efficiency characteristics of low-income homes, based on a sample of 68 households dispersed throughout the state. These households were drawn from participants in the income-qualified LIHEAP program. The study found significant opportunities for energy savings in

[5] Drehobl, Ariel, and Lauren Ross. 2016. *Lifting the High Energy Burden in America's Largest Cities: How Energy Efficiency Can Improve Low Income and Underserved Communities*. ACEEE. https://aceee.org/.

[6] Perl, Libby. 2018. LIHEAP: Program and Funding. Congressional Research Service.

[7] ACEEE State and Local Policy Database. https://database.aceee.org/state/maine.

[8] Kallay, Jennifer, Alice Napoleon, and Max Chang. 2016. *Opportunities to Ramp Up Low-Income Energy Efficiency to Meet State and National Climate Policy Goals*. Paper presented at the 2016 ACEEE Summer Study on Energy Efficiency in Buildings conference.

surveyed households, notably with air and duct sealing, wall insulation, furnaces and boilers, and lighting.[9]

The purpose of Synapse's report is to provide the results of our research on low-income home energy burdens. Section 2 summarizes our literature review that supports our analysis documented in Section 3.0. In Section 3.1, we discuss our analysis of energy expenditures in the home. Section 3.2 describes our energy burden findings. Section 4 includes a discussion of the study findings, and Section 5 offers preliminary conclusions. Appendix A provides a detailed methodology for calculating energy burden.

2. LITERATURE REVIEW

Studies of energy burden are becoming increasingly common. In a joint study released in 2016, the American Council for an Energy Efficient Economy (ACEEE) and Energy Efficiency for All reported the results of their analysis of energy burden values for 48 of the largest U.S. cities and specific demographic segments within each city using U.S. Census data. The authors found that the majority of single-family and multifamily low-income households, defined as those with income at or below 80 percent of area median income, experienced significantly higher energy burdens related to home energy use than the average household in the same city. Across all cities in the sample, the median home energy burden was 3.5 percent, while the median energy burden for low-income households was 7.2 percent.[10]

On a more localized scale, a 2016 study examined the geographic distribution of thermal, electric, and transportation energy use and energy burden in nearby Vermont. Using U.S. Census and other data, this study found that thermal energy spending ranged from a low of 1 percent to a high of 10 percent of median household income by Census block group; high thermal energy burdens were found in block groups in which fuel oil is prevalent for home heating. Electricity spending as a percent of median household income ranged from 1 percent for higher-income block groups to about 7 percent for lower-income block groups.[11]

ACEEE's 2018 national study considered differences in energy burden related to home energy use by region and for rural and non-rural populations. It found that rural energy burdens are highest in New England, East South Central, and Mid-Atlantic regions. [12] The analysis found that low-income households

[9] GDS Associates, 2018. *Maine Low-Income Household Energy Efficiency Baseline Study Final Report*, prepared for the Maine Office of the Public Advocate.

[10] Drehobl, Ariel, and Lauren Ross, 2016. *Lifting the High Energy Burden in America's Largest Cities: How Energy Efficiency Can Improve Low Income and Underserved Communities*. ACEEE. https://aceee.org/.

[11] Vermont Energy Investment Corporation, 2016. *Mapping Total Energy Burden in Vermont: Geographic Patterns in Vermonters' Thermal, Electric, and Transportation Energy Use*.

[12] Ross, Lauren, Ariel Drehobl, and Brian Stickles, 2018. *The High Cost of Energy in Rural America: Household Energy Burdens and Opportunities for Energy Efficiency*. ACEEE. https://aceee.org/.

(defined as less than 200 percent of the federal poverty limit) have the highest median and upper quartile rural energy burdens in New England and the Mid-Atlantic, at 10.6 percent and 18 percent, respectively.[13] It also found that median energy burdens are higher in rural tracts (4.4 percent) than in metropolitan ones (3.1 percent).

3. SYNAPSE ANALYSIS

3.1. Energy Expenditures in the Home

Synapse's analysis of home energy expenditures in Maine relies primarily on data contained within the U.S. Department of Energy's Low-Income Energy Affordability Data (LEAD) tool.[14] We used the 2015 New England LEAD file for county-level data on housing counts, household energy expenditures, household income, primary home heating fuel, and residence status (whether the home is owned or rented).[15] We also relied on federal Area Median Income (AMI) and Federal Poverty Guidelines (FPG) data, which we used to identify over 130,000 households that fit within LIHEAP eligibility criteria.[16] Our methodology for converting households within AMI ranges to FPG ranges is discussed in Appendix A. Energy expenditure values were converted into 2018 dollars using the federal Consumer Price Index (CPI) for fuels and utilities.[17]

We calculated average energy expenditures within Maine across the following household characteristics:

- **Income:** We assessed differences in average energy expenditures across different income brackets.
- **Residential status:** We analyzed differences in average home energy expenditures between households that own their homes and those that rent.

[13] *Ross, L. et al*., 2018.

[14] U.S. Department of Energy. Low-Income Energy Affordability Data (LEAD) Tool. https://openei.org/doe-opendata/dataset/celica-data.

[15] The 2015 version of the LEAD tool was the most recent version available at the time of this analysis. The 2015 LEAD files aggregate 2015 vintage data from the American Community Survey (ACS) and U.S. Energy Information Administration Forms 861 and 176.

[16] U.S. Department of Housing and Urban Development (HUD). Income Limits: 2015. https://www.huduser.gov/portal/datasets/il.html#2015_data; U.S. Department of Health and Human Services (HHS), Office of Assistant Secretary for Planning and Evaluation. Prior HHS Poverty Guidelines and Federal Register References. https://aspe.hhs.gov/prior-hhs-poverty-guidelines-and-federal-register-references.

[17] Federal Reserve Economic Data: Chained Consumer Price Index for all Urban Consumers: Fuels and utilities. https://fred.stlouisfed.org/series/SUUR0000SAH2.

- **Home heating fuel:** We evaluated how average home energy expenditures differ based on primary heating fuel.
- **County:** We evaluated differences in expenditures across the 16 Maine counties.

Findings

We present the results of our analysis of home energy expenditures below.

Results by income

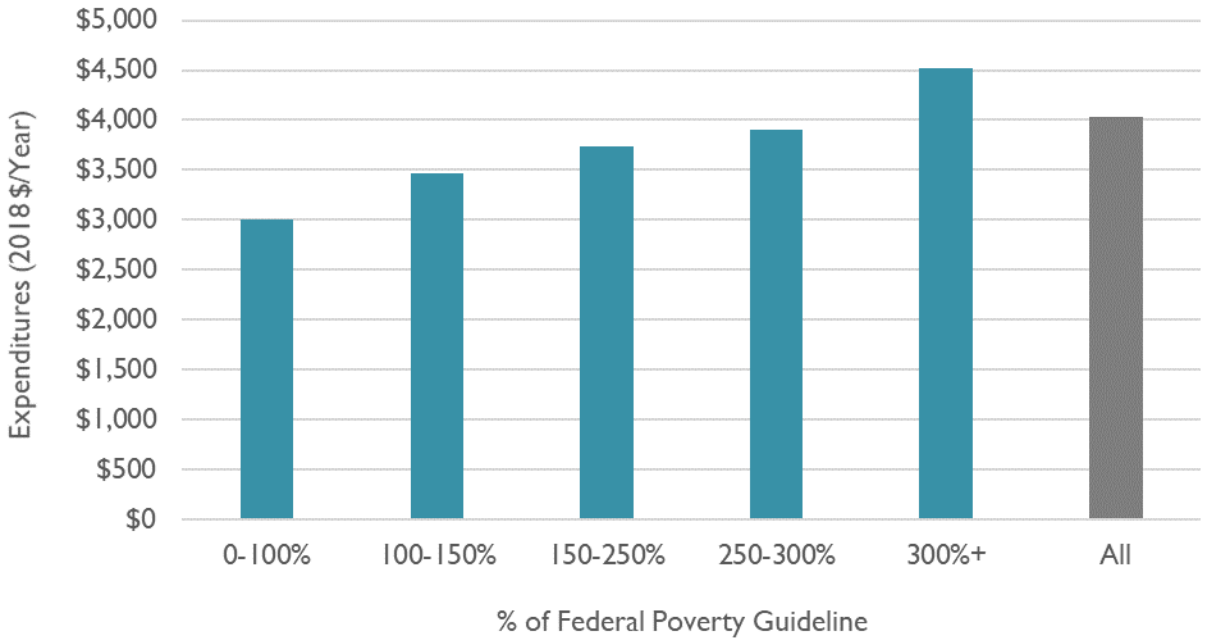
Our analysis considers five income bins, defined relative to the FPG. Table 1 shows the income thresholds for 100, 150, 250, and 300 percent of the FPG. These income thresholds were used to create the five income bins of 0-100 percent, 100-150 percent, 150-250 percent, 250-300 percent, and greater than 300 percent of the FPG.

Table 1. 2018 FPG, dollars per household, 2-person household

100% FPG	150% FPG	250% FPG	300% FPG
$16,460	$24,690	$41,150	$49,380

As expected, higher-income households tend to spend more on in-home energy. Figure 1 indicates that an average Maine household below the FPG spends about $3,000 per year on in-home energy, whereas a household earning more than three times the FPG spends about $4,500 annually on household energy. We find that average energy expenditures increase monotonically with each higher income bracket. Within our LIHEAP-eligible low-income sample of households with average income less than 150 percent of the FPG we estimate average annual home energy expenditures of approximately $3,200.

Figure 1. Maine average home energy expenditures by household income level



Results by residence status

Our low-income sample is roughly evenly split between households that own their homes and those that rent. Statewide, LEAD indicates that 45 percent of Maine households own their homes while 55 percent rent. However, the low-income homeownership percentage varies substantially by county (see Figure 2). Unsurprisingly, the lowest homeownership percentages for low-income households are found in more urban counties, such as Androscoggin County (Lewiston-Auburn) and Cumberland County (Portland), whereas higher homeownership rates are found in more suburban and rural counties.

Figure 2. Maine low-income household homeownership percentage by county

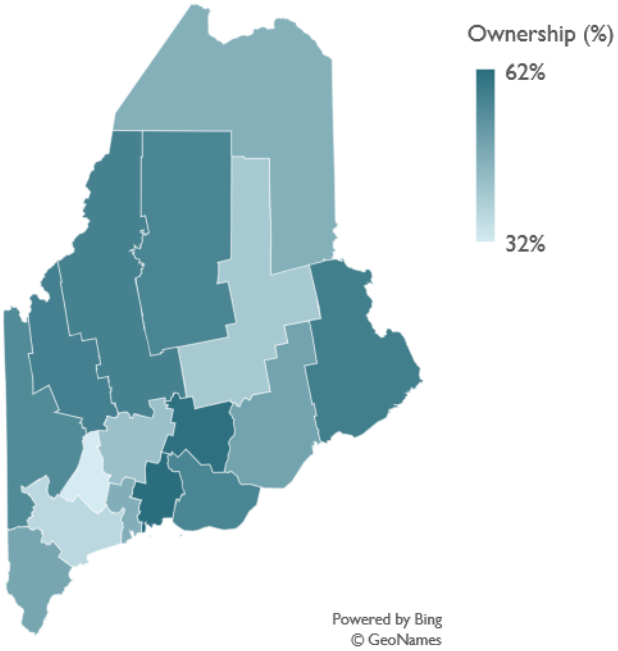
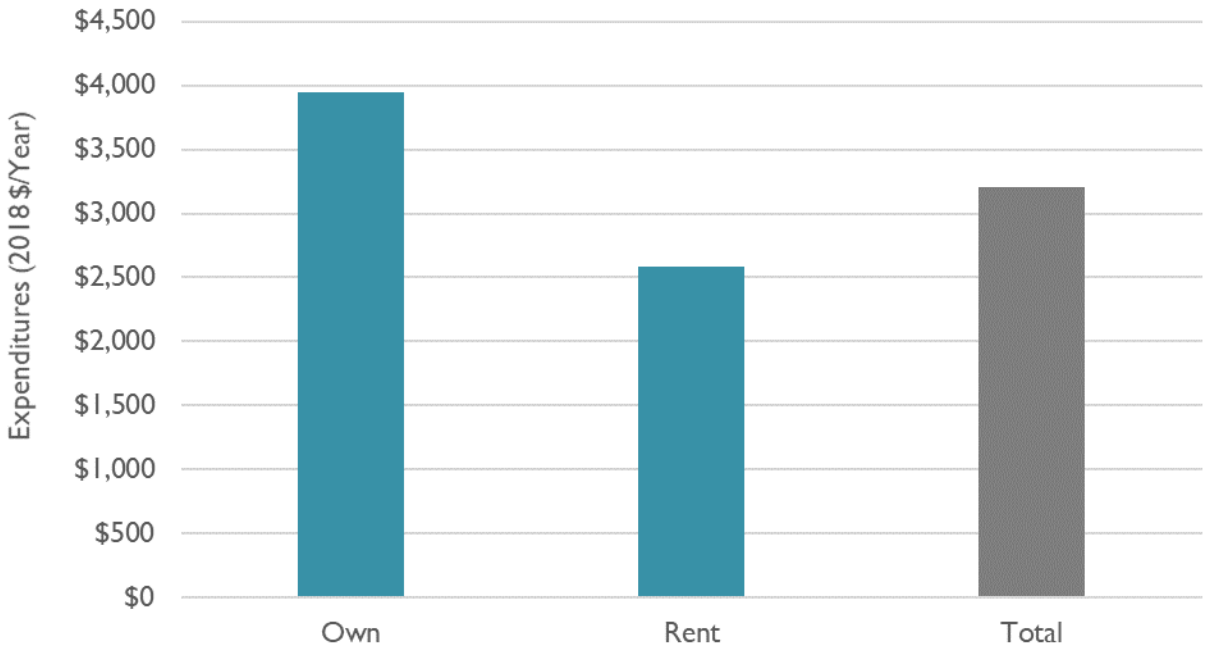


Figure 3 indicates that low-income homeowners in our sample pay far more in energy costs than their renter counterparts. Average home energy expenditures for homeowners are nearly $4,000 per year, more than 50 percent greater than for renters. This marked difference may in part reflect the tendency for homeowners to have larger homes to heat than renters and the fact that apartments in multifamily units (which are mostly rented) have fewer exterior-facing surfaces.

Figure 3. Maine low-income household average home energy expenditures by residence status



Results by heating fuel

The LEAD tool, drawing from American Community Survey (ACS) data, indicates that most low-income Maine households primarily rely on fuel oil to heat their homes. Smaller fractions heat their homes primarily with utility natural gas, bottled propane gas (liquid propane gas stored in bottles or tanks that are refilled or exchanged when empty), electricity, or wood. Less than 2 percent of households heat their homes with other fuels such as solar or coal, and less than 1 percent are listed as not having any home heating fuel source at all.

Table 2. Primary heating fuel prevalence in Maine low-income households

Heating Fuel	% of Households
Natural Gas	8%
Propane	8%
Electricity	10%
Fuel Oil	62%
Wood	10%
Other	2%
None	1%

Table 3 presents the prevalence of various low-income household primary heating fuels by county. Natural gas heating is most common in the southern, urban counties of Cumberland and Androscoggin. Propane heating is relatively consistent across the state but is least common in the northern counties of Aroostook and Penobscot. Electric heating is most common in Hancock and Knox counties. At least half of low-income households primarily heat their homes with fuel oil in all 16 counties, but fuel oil usage is higher in the more northern and rural counties than in the more southern and urban counties.

Table 3. Primary heating fuel prevalence in Maine low-income households by county

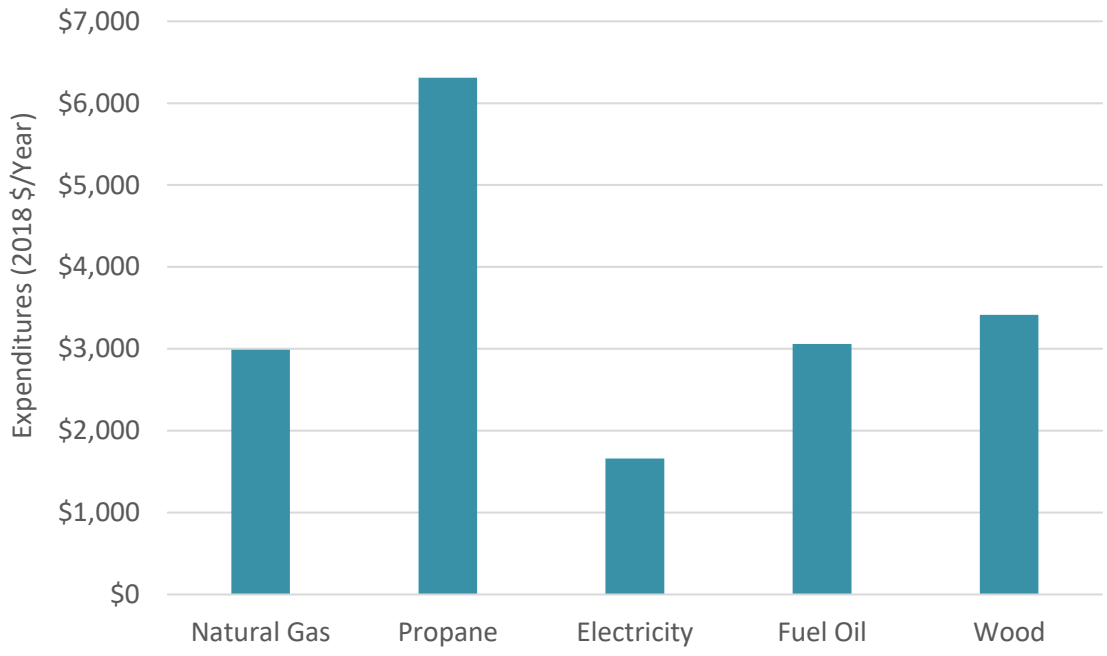
County	Natural Gas	Propane	Electricity	Fuel Oil	Wood	Other	None
Androscoggin	19%	4%	8%	62%	5%	1%	1%
Aroostook	1%	2%	12%	67%	13%	5%	1%
Cumberland	26%	8%	11%	50%	4%	2%	1%
Franklin	1%	11%	8%	56%	23%	1%	1%
Hancock	1%	12%	16%	58%	11%	2%	0%
Kennebec	1%	6%	5%	78%	8%	1%	0%
Knox	1%	11%	17%	59%	11%	1%	1%
Lincoln	0%	10%	9%	65%	13%	1%	2%
Oxford	1%	10%	12%	57%	18%	1%	0%
Penobscot	7%	5%	13%	62%	10%	2%	0%
Piscataquis	1%	7%	10%	58%	22%	2%	1%
Sagadahoc	2%	11%	10%	62%	11%	1%	2%
Somerset	1%	12%	6%	61%	19%	1%	0%
Waldo	1%	10%	8%	61%	19%	1%	1%
Washington	1%	11%	9%	65%	13%	1%	0%
York	4%	12%	8%	67%	6%	1%	0%

Note: Data may be sparse for some combinations of primary heating fuel and county. Small differences (e.g., one or two percent) between primary heating fuel type by county may reflect the methodology rather than actual differences.

Figure 4 suggests that there are substantial differences in average low-income household energy expenditures based on primary home heating fuel type. Households that primarily use propane to heat their homes spend more than twice as much on all in-home energy (including energy consumption

associated with appliances, cooking, and water heating as well as space heating) as those that primarily heat their homes with electricity, natural gas, or fuel oil. Low-income households with wood heating systems as the primary source of heat spend the second most on in-home energy, followed by those with fuel oil heating systems. These relative rankings make some sense, since propane and fuel oil systems tend to rely on more expensive fuel and be less efficient than natural gas heating systems, though the degree of the differences is surprising.

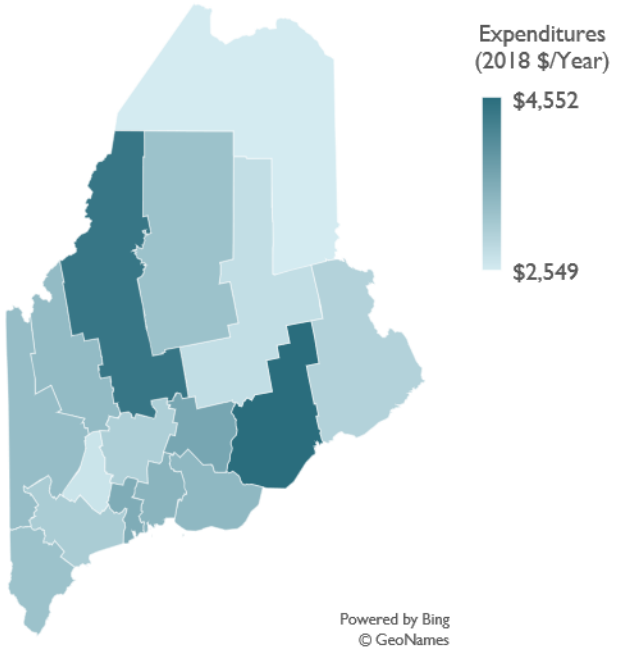
Figure 4. Maine low-income household average home energy expenditures by primary heating fuel



Results by county

Figure 5 indicates that there is substantial variation in energy expenditures by county. Interestingly, the two counties with the highest average energy expenditure levels are Hancock and Somerset counties, both located in Central Maine. Meanwhile, Aroostook County, covering the northernmost section of the state, had the lowest average energy expenditures. This indicates that cold winters and associated differences in heating requirements are not driving regional differences in home energy expenditures among low-income Mainers. Other factors that could be driving the geographic differences include heating fuel type prevalence, home ownership, and home size.

Figure 5. Maine low-income household average home energy expenditures by county



Source: Visual representation of data in Table 4.

3.2. Energy Burden

Since energy burden is defined as energy expenditures divided by income, the inputs that form one half of our energy burden equation were derived directly from outputs from our analysis of home energy expenditures described above. For the bottom half of the equation, we used income values provided by the LEAD tool based on the ACS data. As with home energy expenditures, we evaluated energy burden by income level, by residence status, by home heating fuel type, and by county.

A detailed description of our methodology for calculating energy burden is provided in Appendix A.

Findings

Results by income

Figure 6 displays our finding that, on average, lower-income households spend a higher portion of their income on home energy than higher-income households. This is unsurprising. It is generally well understood that higher income households spend more on energy in aggregate, but that those expenditures represent a smaller fraction of their income. We find substantial differences in energy burden even among those households that qualify as low-income under LIHEAP eligibility standards. Those with incomes below the FPG have an average home energy burden of 24 percent, while those

with incomes between 100 and 150 percent of the FPG face an average home energy burden of 14 percent.

Figure 6. Maine average household home energy burden by income level

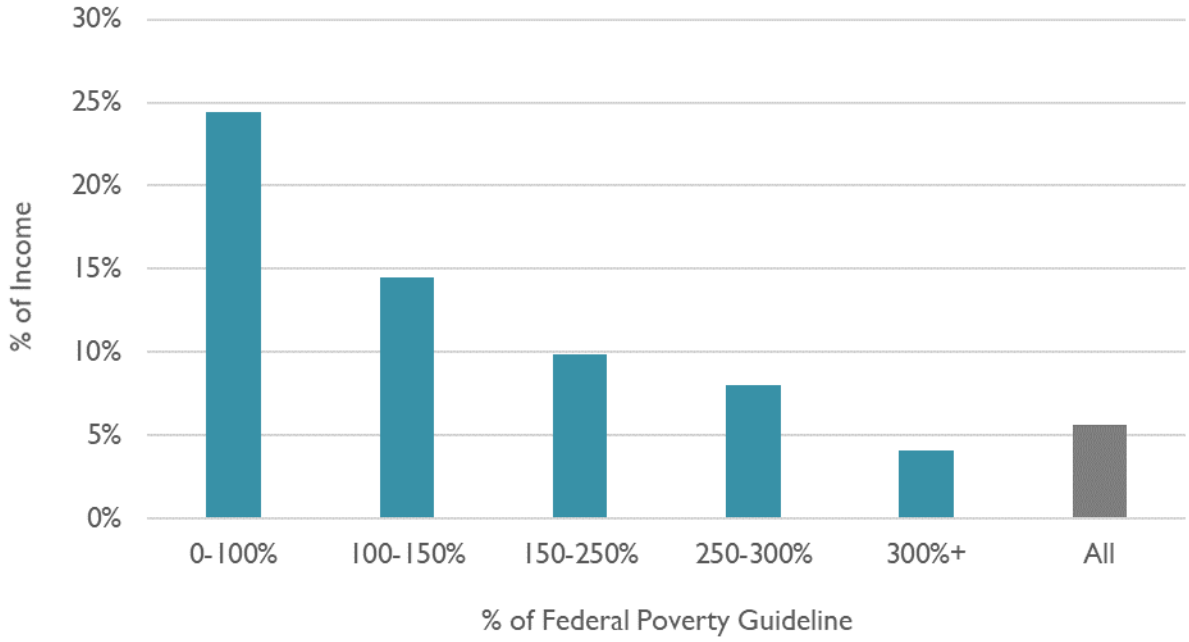
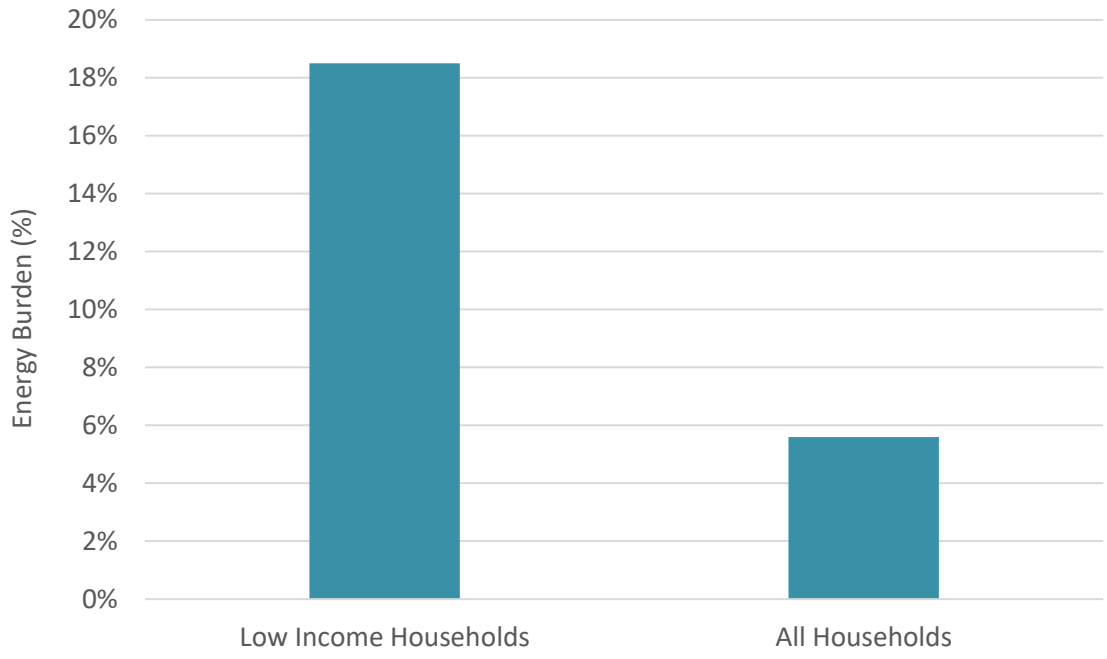


Figure 7 presents our findings regarding average home energy burden among low-income households relative to average energy burden for all households in Maine. We find that Maine households with incomes below 150 percent of the FPG have an average in-home energy burden of 19 percent. In comparison, the average energy burden for all households in the state is 6 percent.

Figure 7. Maine low-income and average household home energy burden



Results by residence status

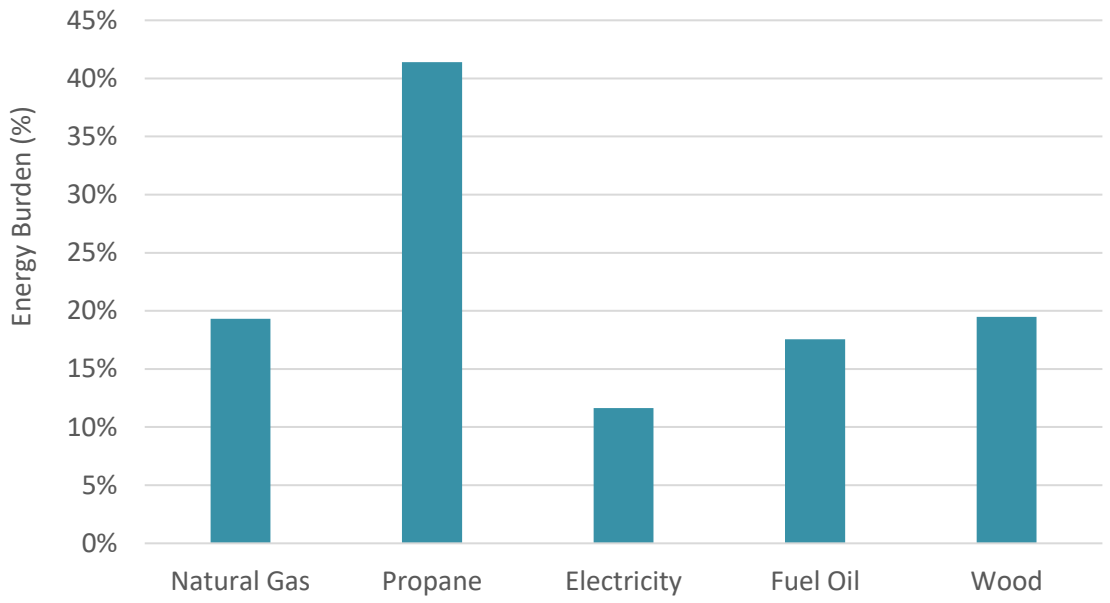
Figure 8 shows our estimate of average home energy burden based on residency status. Consistent with our analysis of home energy expenditures, we find that low-income homeowners face higher home energy burdens than renters, with home energy burdens of 22 and 16 percent respectively. This finding is relatively consistent across the state, as homeowners face a higher energy burden than renters in 14 of the 16 counties and have very similar burdens to renters in the other two counties.

Figure 8. Maine low-income household average home energy burden by residence status

Results by heating fuel

Figure 9 displays our estimate of average low-income household home energy burdens based on primary home heating fuel type. Consistent with our energy expenditure results, we find that homes heated mainly with propane face much greater home energy burdens (on average over 40 percent statewide) than those heated with fuel oil, natural gas, electricity, and wood (less than 20 percent on average statewide). This finding again appears to be consistent across the state rather than driven by an outlier region. The average home energy burden among low-income households that are primarily heated with propane is greater than 30 percent in 14 of Maine's 16 counties, and greater than 40 percent in seven counties.

Figure 9. Maine low-income household average home energy burden by primary heating fuel



Results by county

Figure 10 displays our estimate of average low-income home energy burdens by county. These results mirror our county-level energy expenditure results, as among a sample of low-income households differences in energy burden are driven more by variation in expenditures than by differences in income.

Figure 10. Maine low-income household average home energy burden by county

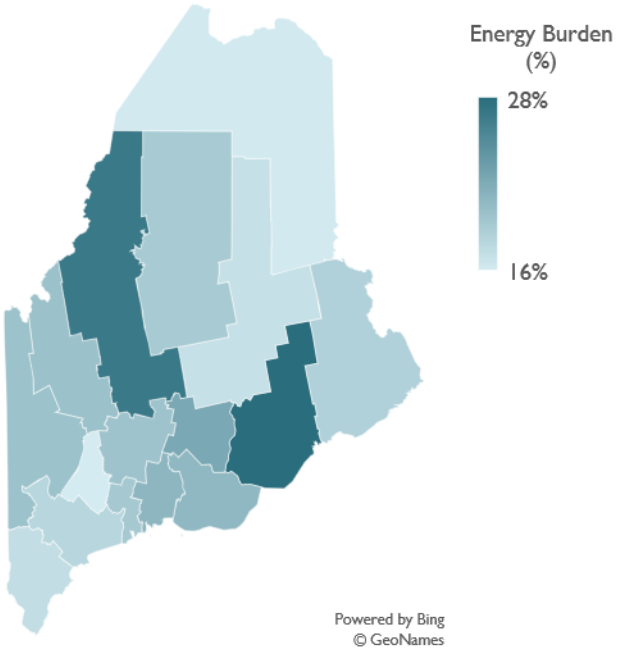


Table 4 provides greater detail on our county-level estimates of home energy burden for each county in Maine. Calculated average low-income home burdens range from 16 percent in Androscoggin County to 28 percent in Hancock County.

Table 4. Maine low-income household average home energy burden by county

County	Home Energy Burden (%)	Home Energy Expenditures (2018 $/Year)
Hancock	28%	$4,552
Somerset	27%	$4,402
Waldo	22%	$3,645
Lincoln	21%	$3,422
Knox	21%	$3,359
Franklin	20%	$3,311
Oxford	20%	$3,279
Kennebec	20%	$3,002
Sagadahoc	19%	$3,555
Piscataquis	19%	$3,204
Washington	18%	$2,941
Cumberland	18%	$3,043
York	17%	$3,205
Penobscot	17%	$2,762
Aroostook	16%	$2,549
Androscoggin	16%	$2,664

4. DISCUSSION

4.1. Results

Our results show that low-income households in Maine have high energy burdens. Statewide, average (mean) home energy burden for low-income households is 19 percent. In contrast, the mean energy burden for all households in the state is 6 percent.

For comparison, ACEEE's 2018 national study of home energy burden found that New England and Mid-Atlantic rural households with incomes less than 200 percent of the federal poverty limit (higher than the income threshold used in our analysis to define low income) experience a median home energy burden of 10.6 percent, and an upper quartile home energy burden of 18 percent.

We also find:

- Low-income homeowners in our sample pay far more in energy costs than their renter counterparts. Average home energy expenditures for homeowners are nearly $4,000

per year, more than 50 percent greater than for renters. Likewise, low-income homeowners experience higher home energy burdens than renters, with home energy burdens of 22 and 16 percent respectively.

- Home energy expenditures are highest for those low-income households using propane to heat their homes, and these households experience a higher average home energy burden (41 percent) than those using any other fuel considered in this analysis. Low-income households with wood heating systems as the primary source of heat spend the second most on in-home energy, and their energy burden is second highest (19 percent, tied with natural gas). While expenditures for low-income households burning fuel oil for heat have the third highest home energy expenditures, households with natural gas heating systems experience a higher home energy burden on average (19 percent, relative to an average energy burden of 18 percent for low-income households with fuel oil heat).

- Average low-income home energy burden tends to be highest in the central part of Maine and somewhat lower in the northernmost and southernmost counties.

5. CONCLUSIONS AND RECOMMENDATIONS

Policies to address energy burden are needed and should seek to: (1) help those with high burdens manage energy costs; (2) promote customer equity and affordability;[18] (3) reduce ratepayer costs associated with utility bad debt and collection efforts on unpaid bills; and (4) lower the environmental impacts of energy use. Energy efficiency can help with all four of these objectives.

This analysis suggests that there is a need for policies that target homeowners and households with propane heating systems. Homeowners face fewer barriers to participation in energy efficiency programs. However, efficiency programs targeting remote, northern households may be difficult to implement cost-effectively. With detailed data, programs can target propane consumption with weatherization measures. Households using more polluting and expensive heating fuels such as propane and fuel oil should be encouraged to switch their heating systems to ones running on cleaner, less expensive fuels (such as electric heat pumps). Barriers to switching heating fuels should be assessed, and programs that enable that switch should be offered. While programs that encourage fuel switching can be higher cost than other efficiency programs, these costs should be considered relative to the total benefits of the program.

[18] We note that Maine has in place an Arrearage Management Program "An Act to Assist Electric Utility Ratepayers" (35-A M.R.S. §3214 et seq.), This program is designed to help low-income customers with electric bill arrearages manage their usage and lower their bills. The program is designed to utilize energy efficiency programs to assist these customers in reducing their usage.

APPENDIX A: ENERGY BURDEN METHODOLOGY

Home Energy Expenditures

Synapse's analysis of home energy expenditures began with the 2015 New England county-level LEAD file. This dataset identifies county-level housing counts, income, and energy expenditures for different combinations of residence status, income level, home heating fuel, and other household characteristics. The LEAD tool identifies income levels in terms of percentage of AMI, with brackets ranging from 0-30 percent of AMI to over 100 percent of AMI. This presented an analytical challenge, since AMI varies across counties in Maine and LIHEAP eligibility in Maine is identified in terms of FPG rather than AMI. Our analysis was thus designed in part to convert from income bins defined in terms of percentage of AMI to ones defined in terms of percentage of FPG.

Our analyses proceeded through the following steps:

1. We used the LEAD dataset to calculate total housing counts and average energy expenditures for each combination of AMI income bracket (*e.g.,* 30-50 percent of AMI), residence status (own vs. rent), county, and other variable of interest (*e.g.,* home heating fuel type).

2. We used U.S. Department of Housing and Urban Development (HUD) data to identify the AMI thresholds for 2-person households in each fair market rent (FMR) area in Maine as of 2015.[19] We used a representative 2-person household size because Maine households have an average of 2.3 people in them.[20] For those counties that contain multiple FMR bins, we took the simple average of AMI thresholds for each census tract within each county.

3. We identified income bins defined relative to the FPG for analysis. Consistent with LIHEAP eligibility criteria, we generally defined low-income households to be those with income less than or equal to 150 percent of the FPG. However, for purposes of comparing across income levels we assessed bins ranging from 0 to 100 percent of the FPG to more than 300 percent of the FPG.

4. For each FPG bin, we used U.S. Department of Health and Human Services (HHS) data to identify the associated 2015 income level for a 2-person household.

5. We used the proportion of each AMI bin (in terms of dollars of income) falling into each FPG bin to allocate households in each AMI bin to one or more FPG bins. For example, if the 0-30 percent AMI bin for a given county covered an income range from $0-$20,000 and the 0-150 percent FPG bin covered an income range from $0-$40,000, we would assign 100 percent of households in the 0-30 percent AMI bin to the 0-150 percent FPG

[19] We used 2015 AMI data for consistency with the 2015 data presented in the LEAD tool.

[20] U.S. Census Bureau. QuickFacts Maine: Persons per household, 2013-2017. https://www.census.gov/quickfacts/fact/table/me,US/HSD310217#HSD310217.

bin. If the 30-50 percent AMI bin then covered an income range from $20,000-$60,000, 50 percent of households in the 30-50 percent AMI bin would be assigned to the 0-150 percent FPG bin, because (40,000-20,000)/(60,000-20,000)= 50%. We note that this step assumes an even distribution of households across the AMI income bins. Fortunately, we found that the desired FPG bins generally matched up fairly closely with the AMI bins contained in the LEAD tool.

6. We calculated weighted-average energy expenditures for each FPG bin by multiplying the average energy expenditure for each AMI bin by the percentage of total households included within a given FPG bin that come from that AMI bin.

Energy Burden

We calculated home energy burden as home energy expenditures divided by gross income. We describe our calculations of home energy expenditures above. County-level average income levels for each combination of FPG bin, residence status, and home heating fuel type were calculated following the same process as for home energy expenditures, as described above.

Data Limitations

We note that limitations on available data constrained our analysis. Maine utilities provided electricity usage data for the GDS study participants, but many records were missing (25 of 68 were not available), and the sample of available records was not well distributed within the state. Given the lack of Maine-specific data on consumption of electricity and other fuels by low-income populations, we turned to the LEAD tool as our primary data source for in-home energy consumption. Income brackets within LEAD are defined in terms of area median income (AMI), rather than in terms of income or FPG. This required making assumptions regarding the distribution of income within the AMI bins, in order to allocate households to FPG bins. In addition, the LEAD data is primarily grounded in ACS data. ACS is a survey and as such likely includes inaccuracies related to how the data are collected. Also, ACS collects information on fuel costs for a single, unreported month of the year, rather than for the entire year. Future research efforts should seek to incorporate more local, granular energy data. As the state gains more data from advanced meters, there should be greater opportunities for finer-scale analysis. With appropriate protections for consumer privacy, these data should be made available for research.