

# Fuel poverty, excess winter deaths, and energy costs in Vermont: Burdensome for whom?



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## HIGHLIGHTS

- Those spending 10 percent of their monthly income or more on energy services are in “fuel poverty”.
- In this study we analyze the energy burden in Vermont by household income deciles.
- We calculate that excess winter deaths caused potentially by fuel poverty kill more Vermonters each year than car crashes.
- We conclude with implications for energy planners and policymakers.

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## ABSTRACT

Energy, whether from electricity, natural gas, heating oil, propane, kerosene, or wood, is essential for the well-being of many Americans, yet those who spend more than 10 percent of their income of energy services can be considered “fuel poor.” This study assesses the extent and severity of fuel poverty in Vermont. It analyzes energy burdens in Vermont by household income deciles, using data from the Census Bureau's American Community Survey. Approximately 71,000 people suffered from fuel poverty in Vermont in 2000, and in 2012 the number rose to 125,000, or one in five Vermonters. Startlingly, fuel poverty grew 76 percent during this period. Excess winter deaths, caused potentially by fuel poverty, kill more Vermonters each year than car crashes. The article then provides 12 policy recommendations based on a small sample of elite semi-structured research interviews. These include suggestions that the Vermont legislature better fund investments in weatherization among low-income households; that community groups and social service agencies scale up the training of energy efficiency coaches; that state agencies endorse improvements in housing efficiency and appropriate fuel switching; and that utilities and fuel providers offer extra assistance for disconnected households and allow for on-bill financing of efficiency improvements.

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## 1. Introduction

In many ways, the green, small state of Vermont is known for being an innovative laboratory for progressive energy and climate policies.<sup>1</sup> Readers unfamiliar with Vermont may be surprised to learn that it was recognized for “sustained excellence” by the U.S. Environmental Protection Agency (EPA) for its contribution to the Energy Star efficiency program and that Harvard University named

Efficiency Vermont one of the five best government programs in the United States. Vermont's electricity sector is the cleanest and least fossil fuel intensive in the nation. Vermont has also pursued one of the most proactive smart grid policies in the United States. The Vermont Electric Cooperative (VEC) exemplified this leadership by installing advanced meters in roughly ninety percent of homes by the end of 2011.

Yet such advances may have begun to come with certain costs, especially as they relate to the affordability of energy services for the poor and vulnerable. Energy, whether from electricity, natural gas, heating oil, propane, kerosene, or wood, is essential for the well-being of all Vermonters. We need it for warmth during much of the year, to cook our food, and to power the appliances in our

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<sup>1</sup> Sovacool et al., 2014.

homes. More of us are coming to depend on air conditioning in the summer. Energy is essential not merely to a modern standard of life, but to physical and mental health. The expense required for the purchase of energy can be a significant burden, especially for those with relatively low incomes.

In this study, we investigate the extent and severity of fuel poverty in Vermont. We analyze energy burdens in Vermont by household income deciles, using data from the Census Bureau's American Community Survey. We find that approximately 125,000 Vermonters, or one in five, live in fuel poverty. We also calculate that approximately 72 percent of Vermonters in the lowest income decile suffer from fuel poverty. Alarmingly, fuel poverty grew 76 percent from 2000 to 2012. The article then provides 12 policy recommendations based on a small sample of elite semi-structured research interviews.

To be sure, while we hope our study is of value to planners in Vermont and the rest of the United States, it also offers broader value beyond North America for three reasons. First, it hammers home the point that the affordability of energy services is not a function merely of price. For the same quantity of energy, rising prices impose a greater burden when incomes fail to rise as fast. In other words, what matters to users of energy is not the price, per se, but the size of the energy bill and how it compares to income. Though people with smaller incomes generally use less energy and have smaller bills in absolute terms, our study shows how they must spend a larger fraction of their income on this energy than households with greater income. This means that the financial burden for lower-income households is more severe even with reduced consumption of energy, a finding with clear implications for both energy affordability as well as energy justice.<sup>2</sup>

Second, our study reveals how one particular household energy security concern, affordable warmth, is also a significant public health issue. People who lack sufficient energy to keep warm in winter face serious, if sometimes subtle, health risks. For example, in a review of the research on the connection between fuel poverty and human health, Liddell and Morris<sup>3</sup> list risks including stroke, heart attack, pulmonary embolism, influenza, pneumonia, asthma, arthritis, depression, anxiety, and accidents within the home, which are presumed to result from reduced mobility and flexibility, especially for those with arthritis or similar conditions. Together, these health impacts result in an effect known in the public health community as “excess winter mortality.” When homes are cold and damp, children appear more likely to miss school and to have respiratory problems.<sup>4</sup> In their review of US-based research regarding children 3 years old and younger, a vicious cycle for poor families in cold climates can occur: children require more calories to maintain healthy development if they are in cold conditions, yet poor families must balance food purchases against fuel purchases. Liddell and Morris lastly found that poor families reduced food intake by an average of 10 percent (measuring in terms of calories) during winter, shifting money toward heating fuels.<sup>5</sup> It is not surprising that another study comparing low-income households that did or did not receive winter fuel subsidies found that infants in households without the subsidies were less developmentally advanced, had lower weight-to-age measure, and faced an increased chance of requiring emergency medical care.<sup>6</sup> The elderly are another group at greater risk to fuel poverty, given that they are likely to be retired and/or on fixed incomes yet spend large periods of time in their homes where they wish to keep comfortable and have greater demands for

winter warmth.<sup>7,8</sup> One study even found that to some older people, “heating is more important than food.”<sup>9</sup>

Third and lastly, given these health concerns, this study shows how the co-benefits to investing in energy efficiency, especially among the poor, can become quite large. Over the years 1999–2011, Vermont averaged 172 excess winter mortalities per year.<sup>10</sup> This represented 3.3 percent of all deaths in that period, more than double the rate of deaths from automobile and other transportation accidents.<sup>11</sup> Our analysis does not allow us to definitively identify the causes of death, and therefore to fully attribute these excess winter mortalities to fuel poverty. Nonetheless, fuel poverty appears to be the most likely explanation for the consistent increase in wintertime death rates in Vermont. That means that eradicating fuel poverty produces huge savings in avoided mortality and morbidity, a potent reminder that low income energy efficiency programs can pay for themselves quite quickly, producing measurable benefits (which are not often or always monetized) that can far exceed costs.<sup>12</sup>

## 2. Definitions and research methods

This section of the paper defines fuel poverty and introduces the primary and secondary methods utilized in the study, namely a quantitative analysis of Census data to determine energy burdens and qualitative research interviews to determine policy recommendations.

### 2.1. Defining fuel poverty

Generally, those who spend more than 10 percent of their monthly income of energy services can be considered “fuel poor” or suffering from “fuel poverty.” The World Health Organization defines minimum adequate warmth in the home as 21 °C (69.8 °F) in the main living space and 18 °C (64.4 °F) in other rooms.<sup>13</sup> Though readers may consider this a surprisingly warm standard, keep in mind that the standard must account for those who are most vulnerable, including young children, the elderly, and those with chronic or otherwise serious health conditions.

Different writers have adopted different methods to identify the fuel poverty threshold.<sup>14</sup> The earliest definition in the research literature set the fuel poverty threshold at twice the median—that is, if median expenditure is X percent of household income, then households are in fuel poverty if they spend 2X percent or more of their income on household energy.<sup>15</sup> For reasons of analytical and explanatory simplicity, we adopt the definition of fuel poverty as occurring when more than 10 percent of income goes toward energy purchases.<sup>16</sup> In the UK, where significant research into fuel poverty has occurred, the twice-median measure has generally given similar results to the 10 percent measure, though they do sometimes diverge.<sup>17</sup>

Readers should be aware of another nuance in fuel poverty definitions. UK researcher Brenda Boardman's definition, in her landmark 1991 book *Fuel Poverty: From Cold Homes to Affordable Warmth*, focused on the amount that a household would “need to spend” to maintain acceptable conditions (specifically with regard

<sup>7</sup> Warriner, 1981.

<sup>8</sup> Wright, 2004.

<sup>9</sup> O'Neill et al., 2006.

<sup>10</sup> We define “winter” as December through March. Data from Centers for Disease Control.

<sup>11</sup> Centers for Disease Control.

<sup>12</sup> Sovacool, 2015.

<sup>13</sup> World Health Organization, 2007, p. 4.

<sup>14</sup> Liddell, et al., and Sovacool, p. 44.

<sup>15</sup> Liddell, et al., p. 27–28.

<sup>16</sup> Liddell, et al., p. 28, and Sovacool, p. 44.

<sup>17</sup> Liddell, et al., p. 28–29.

<sup>2</sup> Sovacool, 2013; Jones et al., 2015.

<sup>3</sup> Liddell and Morris, pp. 2988 and 2992.

<sup>4</sup> Liddell and Morris, pp. 2991–2992.

<sup>5</sup> Liddell and Morris, p. 2992.

<sup>6</sup> Liddell and Morris, p. 2992.

to warmth), acknowledging that actual spending might fall below this level.<sup>18</sup> Subsequent research in the UK found that a great many low-income households spent much less on energy than was required to keep their homes warm enough,<sup>19</sup> thus putting those residents at increased risk for the health impacts listed above. Due to limitations on available data, we use the simpler definition whereby the threshold is pegged at 10 percent of actual spending.

## 2.2. Calculating energy burdens

To calculate and estimate fuel poverty, we rely on the notion of an energy burden. Energy burden is defined as *expenditure on energy as a percentage of income*. There are three variables involved in ascertaining the energy burden: the quantity of energy consumed, the price of energy, and income. The two-step formula for determining the energy burden is

- 1) quantity of energy consumed  $\times$  price of energy  
= spending on energy
- 2)  $\frac{\text{spending on energy}}{\text{income}} = \text{energy burden}$

When energy burdens are significant, those enduring such burdens are said in the research literature to be in “fuel poverty.”<sup>20</sup>

To map the prevalence of fuel poverty in Vermont, we relied on data from the Census Bureau’s American Community Survey.<sup>21</sup> This survey provides data on household income as well as household expenditures for electricity, natural gas, and “other fuels,” which includes heating oil, propane, kerosene, wood, coal, and coke. Our results, explored in detail below, show the energy burdens for each of those three energy categories as well as the sum of all expenditures for energy in the household.

Consequently, our analysis does have some limitations and caveats. It will not identify households as being in fuel poverty if the household fails to spend over 10 percent of its income on energy, even when that failure means that the household is maintained at unacceptably low temperatures. On the other hand, our analysis below will count households as being in fuel poverty even if the reason for their spending being above 10 percent of annual income is due to their maintaining their home at a higher temperature than is needed to sustain good health.<sup>22</sup> We believe that, while far from ideal, our definition provides useful information in identifying meaningful financial stress—or lack thereof—for Vermont households due to the cost of using energy.

Moreover, it is important to understand that fuel poverty can occur even when the household in question is not identified as otherwise being in poverty.<sup>23</sup> A family may have enough income to be above the poverty line, yet spend more than ten percent of its income on energy—these expenditures may be high enough that the family’s ability to manage the rest of its financial needs is hampered, possibly significantly so. A study by Fisher, Sheehan, and Coltan found that, in 2012, Vermont households with income

between 185 and 200 percent of the Federal poverty line spent, on average, 14 percent of their income on energy.<sup>24</sup> Our research, discussed in detail below, reveals that, in 2012, average energy burdens for the bottom three deciles of Vermont households were above the fuel poverty threshold; for the bottom decile, the average energy burden was a whopping 28 percent. Also, keep in mind that our analysis focuses exclusively on the financial burden of energy used within the household. Spending on transportation energy (i.e., gasoline and diesel) is excluded, though it certainly can impose a financial burden and would make for a valuable follow-up study.

## 2.3. Determining policy recommendations

Our secondary research tool involved elite semi-structured research interviews, conducted to acquire qualitative data about policy recommendations. These interviews were “elite” given that they involved a small sample of influential planners and policy-makers, meaning they are not representative of “ordinary” or “normal” people.<sup>25</sup> To best determine recommendations with the most achievable potential, the authors interviewed various stakeholders and inquired what each of these actors could do to address energy and fuel poverty in Vermont. These were semi-structured interviews in which each interviewee was asked four questions:

1. What could the state legislature do to address energy and fuel poverty in Vermont?
2. What could state agencies do to address energy and fuel poverty in Vermont?
3. What could community groups do to address energy and fuel poverty in Vermont?
4. What could energy companies do to address energy and fuel poverty in Vermont?

Eight of the interviews were conducted via telephone or Skype, in which interviewees did not have access to the questions beforehand. One interview was conducted via email, in which the interviewee had time to plan his/her answers.

In collecting data from these interviews, we spoke with representatives from the Regulatory Assistance Project (RAP), Vermont Fuel Dealers Association (VFDA), Capstone Community Action, Department of Public Service (DPS), Vermont Energy Investment Corporation (VEIC), Vermont Natural Resources Council (VNRC), Vermont Communities Foundation and High Meadows Fund (VCF), and Green Mountain Power (GMP).<sup>26</sup> The interviewees all recognized that an energy burden exists for many Vermont low-income households, as well as the need to proactively combat this trend. We present the data from these interviews below with direct attribution to the particular respondent.

As we will see in the second half of the paper, the data gleaned from these interviews suggests that there are many things these four primary sets of actors can do in advocating for low-income households to decrease energy burdens in Vermont.

## 3. Determining the extent of fuel poverty in Vermont

This part begins to present the study’s results, first measuring the extent of fuel poverty in Vermont over time. The next section offers a suite of policy recommendations to combat it.

<sup>18</sup> Liddell, et al., p. 28.

<sup>19</sup> Boardman, 2012, p. 143.

<sup>20</sup> Though it might seem intuitive to use the term “energy poverty” instead of “fuel poverty,” the term energy poverty is used to describe the condition in developing nations in which people lack physical access to modern energy sources and systems, while fuel poverty refers to the situation in which modern energy sources are technically available but too costly—due to some combination of price, inefficiency in utilization, and income—for reasonable use. Some researchers use “energy insecurity” or “lacking affordable warmth” as synonyms for fuel poverty.

<sup>21</sup> Income and spending data are from Census Bureau, American Community Survey. Energy prices are from Energy Information Agency and Vermont Department of Public Service.

<sup>22</sup> Similarly, our analysis cannot weed out other discretionary, expensive uses of energy, such as those with indoor marijuana growing operations.

<sup>23</sup> Sovacool, p. 46.

<sup>24</sup> Fisher, Sheehan, and Coltan.

<sup>25</sup> Dexter, 1970; Richards, 1996; Woods, 1998.

<sup>26</sup> The interviewees are named in the Acknowledgments section at the beginning of this report.

## Average annual expenditures for all energy used in the household in Vermont, by

## Percentage of households in fuel poverty in 2012, by decile

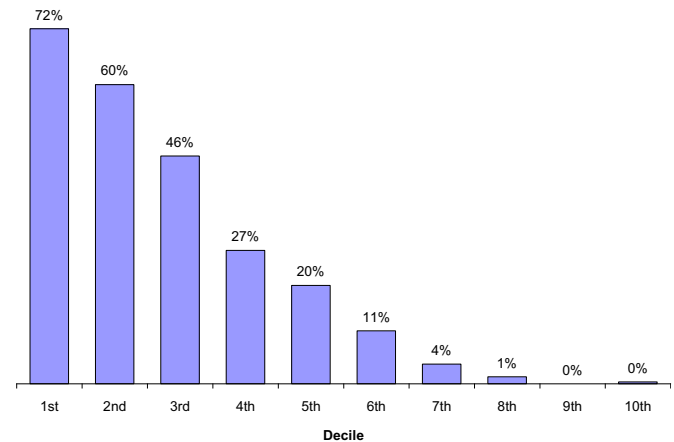
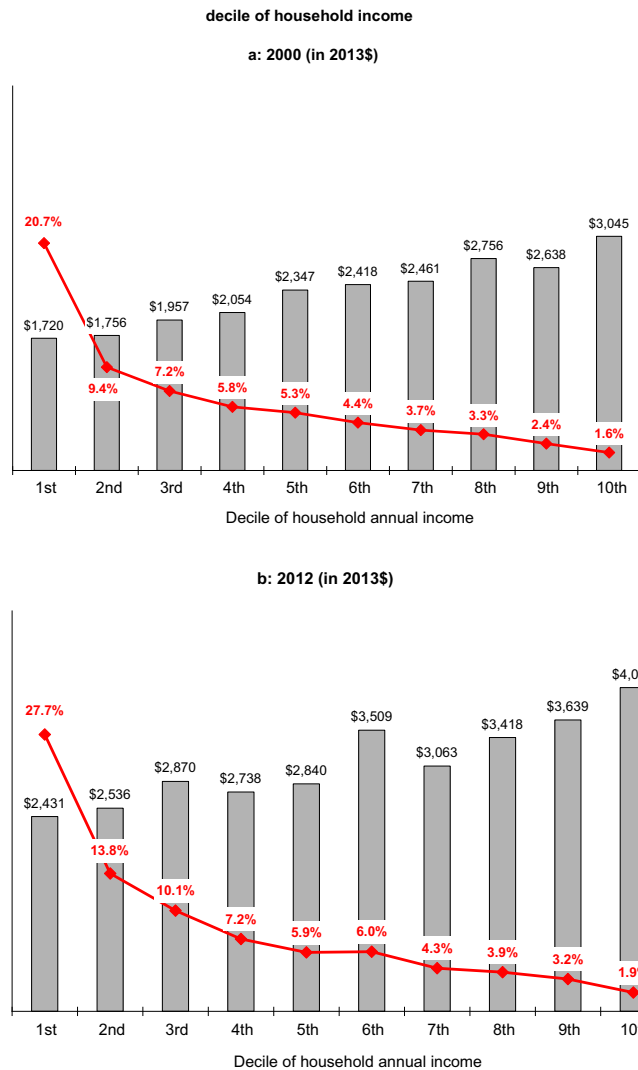


Fig. 2. Percentage of households in fuel poverty in 2012, by decile.

strictly so, there is a clear tendency for households with more income to spend more money on energy. Despite lower absolute levels of expenditure on energy by households in lower deciles, these purchases take up a greater fraction of their income. The energy burden is quite low for the top decile. Moving to the left, the increase in burden on each lower decile is at first fairly modest, then rises rapidly for the lowest deciles.

As is apparent, the burden in 2012 was greater than in 2000: a greater average quantity of (inflation-adjusted) money was spent on energy by households in each decile, and this quantity was a greater percentage of average household income for each decile. If incomes had grown faster than energy expenditures, then the cost burden would have fallen despite the growing expenditures. Clearly, this has not been the case. Growth in energy expenditures outstripped growth in income.

In 2000, only the lowest-income decile had, on average, an energy burden sufficient to qualify as fuel poverty. Recall that these values are averages for the deciles, so it is possible for some households in the lowest decile *not* to be in fuel poverty, per se, despite their low incomes—and indeed there were such households. In turn, given that the average burden for the second decile was only slightly below the fuel poverty threshold at 9.5%, a large portion of households in the second decile were in fuel poverty. In fact, even the 6th and 7th deciles included nontrivial fractions of households experiencing fuel poverty in 2012, as is seen in Fig. 2. To be sure, the impact of a high energy burden on a relatively high-income household is unlikely to be as extreme as on a low-income household. Fuel poverty by itself is an incomplete measure of financial strain.

The statistics indicated above are also a reminder that fuel poverty only partly correlates to financial poverty—not all of Vermont's poorest households are in fuel poverty, and more than a few households with income well above the “poverty line” nonetheless experience fuel poverty. In 2012, the official US poverty line for a family of four, including two children, was \$23,624 (inflation-adjusted to 2013\$ value).<sup>30</sup> As seen in Table 1, this is approximately the threshold between the 2nd and 3rd deciles. Yet even in the 5th decile, where average incomes are roughly double the poverty line, one in five households was experiencing fuel poverty in 2012.<sup>31</sup>

Fig. 1. Average annual expenditures for all energy used in the household in Vermont, by decile of household income.

In the first part of this study we analyze the energy burden in Vermont by household income deciles.<sup>27</sup> Fig. 1 shows snapshots of the energy burden in the years 2000 and 2012, respectively. The vertical bars show the average dollar amount spent by households within each decile on all energy used in the household. Throughout this study, all monetary values have been adjusted for inflation and are displayed in “real” 2013 dollars.<sup>28</sup> The red lines show how much of a burden those expenditures are, measured as a percentage of the average household income within each decile.

Due to limitations in the data, these results likely understate energy burdens. Many renters have some or all of their energy costs included in their rent, and therefore show little or no energy expenditure in the survey. As a result, when calculating energy expenditures as a percentage of income, these households likely return misleadingly low values.<sup>29</sup>

That said, a few patterns are visible in both years. Though not

<sup>27</sup> A “decile” is 10 percent of the population—in this case, counted as households, and ordered from lowest to highest by annual income.

<sup>28</sup> Inflation adjustment was made using the CPI-U index from Bureau of Labor Statistics.

<sup>29</sup> Additional, and more sophisticated, analysis in the future may allow us to correct for this factor.

<sup>30</sup> Census Bureau, “Poverty Data – Poverty thresholds.”

<sup>31</sup> It is worth noting that the method for determining the official US poverty line has been heavily criticized for many years. For example, see Blank. That said, this paper is not the place to analyze that debate.



**Table 1**  
Household income decile thresholds.

Income decile	2000	2012
10th	\$121,824 and higher	\$133,933 and higher
9th	below \$121,824	below \$133,933
8th	below \$94,698	below \$98,421
7th	below \$72,674	below \$78,757
6th	below \$60,877	below \$64,937
5th	below \$50,731	below \$53,168
4th	below \$39,638	below \$42,980
3rd	below \$31,453	below \$33,078
2nd	below \$22,741	below \$23,844
1st	below \$13,501	below \$14,205
Official US poverty line in 2012 (family of four including two children)		\$23,624

Note: To be in decile, household must have real income.

**Table 2**  
Percent of renter households in each decile in 2012.

Income decile	Renters	Average
10th	4.2%	14.8%
9th	10.8%	
8th	11.3%	
7th	27.4%	
6th	20.5%	
5th	33.7%	39.7%
4th	34.5%	
3rd	35.6%	
2nd	48.0%	
1st	46.4%	

For the lower deciles in general, one possible contributing factor is that these households are less likely to be able to afford efficiency upgrades to their homes, which generally require significant up-front expense. This is exacerbated by rising energy burdens on lower-income households, leaving them less discretionary money with which to make investments in efficiency. Further exacerbating the situation is the fact that lower-income households are more likely to be renters, and therefore have less ability to implement efficiency improvements even if they desire and can afford to do so. Table 2 shows rates of rented housing in 2012. We speculate a further exacerbating factor for renters, that landlords providing rental housing to lower-income households are less likely than landlords providing housing to higher-income households to be interested in investing in energy efficiency improvements to their properties.

The impact of rising prices is aggravated by more-or-less stagnant household incomes for all but the top decile. Table 3 shows average annual rates of change in household incomes by decile.

Fig. 3 shows changes in real prices for the most common energy sources from 2000 to 2012. Note that Fig. 3 does not suggest that natural gas has a similar price to propane or heating oil, or that electricity has a similar price to wood; instead, it shows that—relative to their prices at the beginning of the study period, the prices of the three fossil fuels have risen in a similar fashion, while the prices of electricity and wood have held relatively stable.

Two things are clear. First, electricity prices have risen much more slowly than prices for the fossil fuels commonly used for home heating (and, in the case of propane and natural gas, cooking).<sup>32</sup> Second, those fossil fuels have, on average, risen in

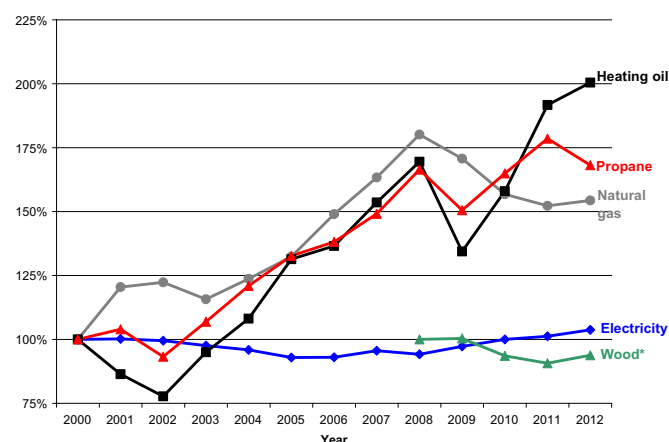
**Table 3**  
Changes to average real household income, 2000–2012.

Income decile	Average annual change in real income <sup>a</sup>	Change as % of average annual real income <sup>b</sup>
10th	\$2,372	1.2%
9th	\$445	0.4%
8th	\$337	0.4%
7th	\$348	0.5%
6th	\$281	0.5%
5th	\$303	0.6%
4th	\$202	0.5%
3rd	\$123	0.4%
2nd	(\$20)	(0.1%)
1st	\$40	0.4%

<sup>a</sup> The second column was calculated by measuring the change from each year relative to the prior year, and then averaging the results. Values are in 2013 dollars.

<sup>b</sup> The third column was calculated by dividing the result in the second column by the average of annual real income in the decile for all the years covered.

**Percent change in real price of energy source, 2000–2012**



\* Data on wood prices date only to 2008 and are based on small, unscientific surveys.

**Fig. 3.** Percent change in real price of energy source, 2000–2012.

price far faster than incomes have risen for any of the deciles. Electricity has risen in price more slowly than the average increase in household income for the upper seven deciles. Income gains by the lowest three deciles have been only just sufficient or slightly insufficient to keep pace even with the low rate of increase in real electricity prices.

Perhaps not surprisingly, there has been a shift in fuels used for heating. The primary changes have been a reduction in reliance on heating oil and an increase in reliance on wood, as shown in Fig. 4. The percentage of Vermont households relying on heating oil as their primary source of heat has fallen from 61 percent in 2000 to 46 percent in 2012. The percentage of households relying on wood has increased from 9 percent in 2000 to 18 percent in 2012.<sup>33</sup>

Households from different deciles have pursued fuel switching to different degrees. As seen in Fig. 5, those with more income have, in general, switched out of oil and into wood to a greater extent than those with less income.

Fig. 6 shows the trends in energy cost burden in Vermont from 2000 to 2012. These trends are displayed in terms of *income remaining after spending on the energy category*. Visually, the greater the proportion of income spent by a household on energy, the lower the household will appear in the figure. A household

<sup>32</sup> As of 2012, wood was the second most common fuel for home heating. However, there are very limited statistics on wood prices, so we are unable to analyze and compare how those prices have changed over the study period.

<sup>33</sup> Note that this represents only the *primary* heating fuel. For example, a household switching from oil to wood for primary heating fuel does not necessarily cease to use oil, and may rely on wood only slightly more than on oil.

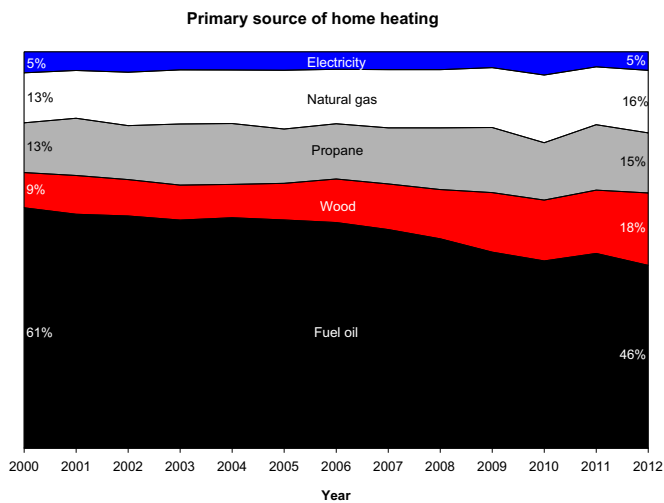


Fig. 4. Primary source of home heating.

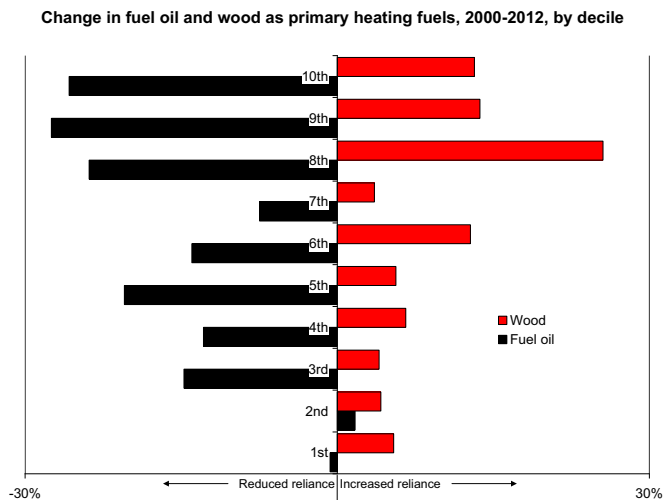


Fig. 5. Change in fuel oil and wood as primary heating fuels, 2000–2012, by decile.

spending more than 10 percent of income on energy has crossed the fuel poverty threshold, highlighted in the figures by the gray shading. Each figure covers a different energy category: electricity, natural gas, other energy (heating oil, propane, kerosene, wood, etc.), and all household energy combined. Energy consumed for transportation is excluded.<sup>34</sup> In Fig. 6a–d, each dot represents the average for an income decile in a particular year. The lines show trends for the deciles.<sup>35</sup> The five lowest-income deciles are shown individually. Because the upper deciles all fall below a 5 percent energy burden in each measure, the 6th through 10th deciles are shown combined, to avoid unnecessary visual clutter.

Again, three patterns are clear: (1) each higher-income decile experienced a smaller cost burden for energy expenditures as compared to lower-income deciles, (2) each higher-income decile experienced a flatter trend in the change of cost burdens over the time period studied as compared to lower-income deciles, and (3) there is less variation in burden from year to year for each higher-income decile as compared to lower-income deciles.

Interestingly, the cost burden of electricity has actually fallen—

Average income remaining after spending on energy, as a percentage of total

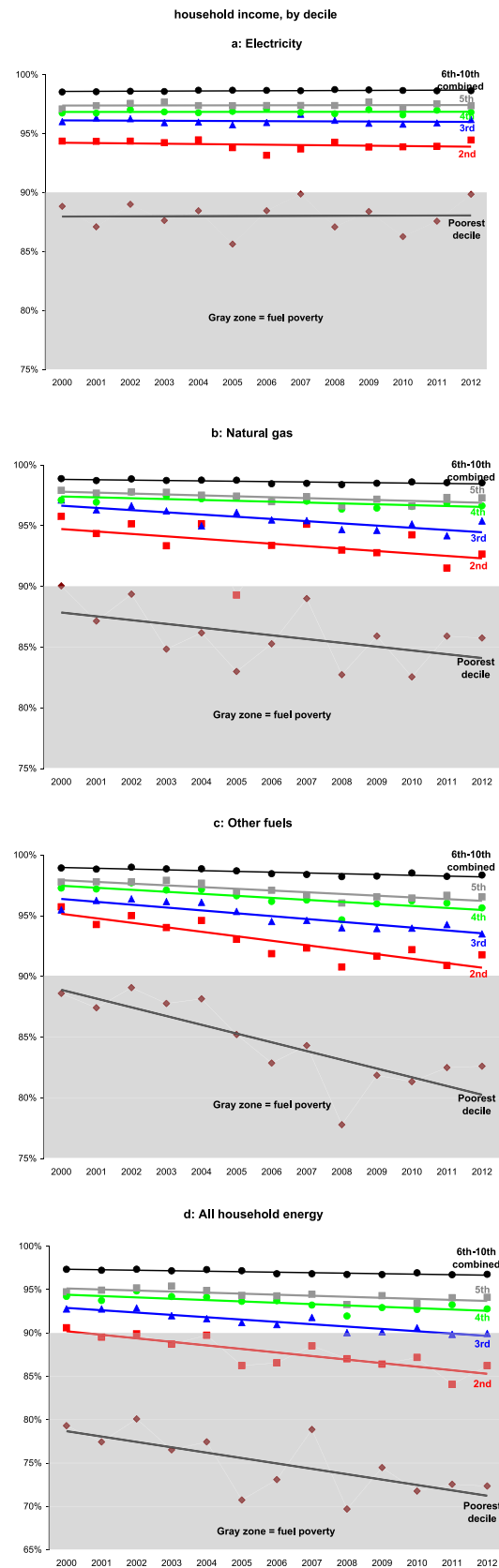


Fig. 6. Average income remaining after spending on energy, as a percentage of total household income, by decile.

<sup>34</sup> Households using plug-in electric vehicles are theoretically included, but there were so few such vehicles in Vermont in the study period that they can be safely ignored.

<sup>35</sup> Specifically, these are linear (ordinary least squares) regressions.

### Draft home energy efficiency label being considered by Efficiency Vermont

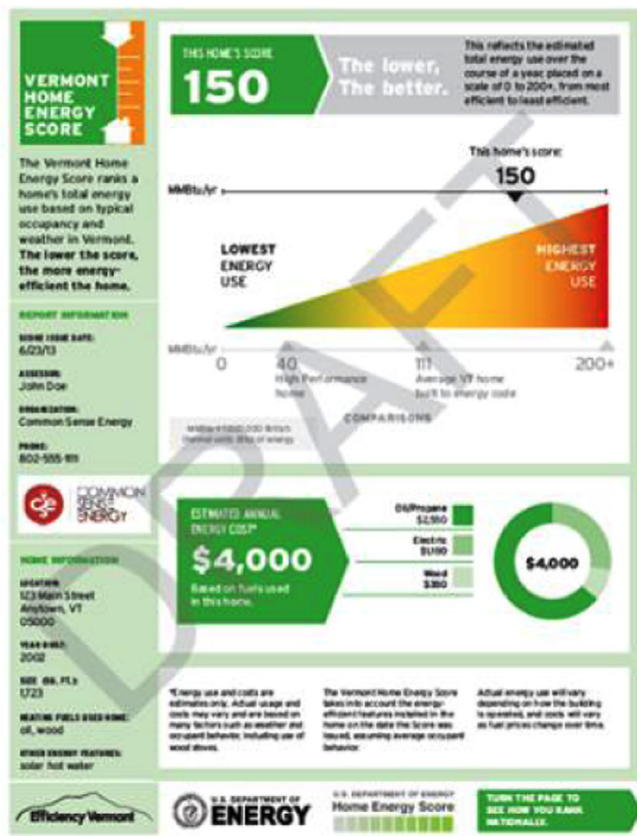


Fig. 7. Draft home energy efficiency label being considered by Efficiency Vermont.

though only very slightly—for most deciles. For the other categories of energy consumption, the trends for the upper-income deciles show very shallow increases in burden (reductions in post-energy disposable income).

As can be seen, the lowest decile experiences a significantly greater cost burden than other deciles for each energy category. In fact, spending for any one category of energy alone is enough to push the 1st decile well into fuel poverty. Though the burdens shown in Fig. 7d for “all energy” are not a simple summation of the burdens from the other three, the combined effect of purchasing multiple forms of energy is to push low-income households into an extreme degree of fuel poverty.

Also apparent are the differences in trends for different energy categories. The trend for electricity is effectively flat, for natural gas it is clearly down-sloping, and for other fuels it is more steeply downward. When analyzed together as all energy, the cumulative effect is a trend that is steeper than for any of the individual energy categories.

One other clear finding from our results is that fossil fuels in the household are the energy sources imposing the greatest burdens, and the most rapidly growing burdens. To date, Vermonters' have had only modest luck in reducing use of these fuels outside of fuel switching, where some fuel switching is between one fossil fuel and another. Since their prices are largely unregulated (natural gas is the exception<sup>36</sup>), and the state's taxing authority affects

heating oil and propane prices at the margins), and since the most important financial impact on households comes in the form of the bill, conservation and efficiency are the main strategies available to reduce fuel poverty. Care must be taken with conservation, since poor households aren't done any favors when, for example, they set their thermostats below healthy temperatures. That leaves efficiency as the most important strategy to pursue, along with measures to increase household incomes. Fuel poverty expert Brenda Boardman writes, “We have learnt a lot about what fuel poverty is and is not, since the mid-1970s when the term first came into use.... [w]hile fuel prices and low incomes are constituent factors, the real cause of fuel poverty is the energy inefficiency of the home.”<sup>37</sup>

Boardman's conclusion is based largely on research conducted in the UK and Ireland, where homes are frequently old and constructed with solid masonry walls providing little insulation value, and therefore does not apply in full to Vermont. However, like those countries, Vermont has a relatively old housing stock, making comparisons useful. As is noted below, some Vermonters with an inside perspective on fuel poverty put a stronger emphasis on poverty in general as the principal issue behind fuel poverty. Specific ideas for addressing energy burdens and fuel poverty in Vermont are listed in the Twelve Policy Recommendations section to come.

#### 4. Policy recommendations for addressing fuel poverty

This section of the study presents twelve policy recommendations on fundamental ways to decrease the energy burden for Vermont low-income households, organized by each of four primary sets of actors. This data comes from our secondary method of semi-structured elite research interviews, described above.

##### 4.1. The Vermont legislature

Our interview data suggests three recommendations for the Vermont legislature:

1. Increase funding for low-income weatherization;
2. Continue supplementing federal programs; and
3. Mandate energy efficiency labeling for homes.

As Hal Cohen from Capstone Community Action explained, “What's the biggest hurdle to alleviating fuel poverty in Vermont? The answer is simple: it's a shortfall of funds.”<sup>38</sup> To counter this shortfall, we recommend first that the legislature increase support for the low-income Weatherization Assistance Program (WAP) by expanding the Fuel Gross Receipts Tax.<sup>39</sup> “For every \$1 invested, the program returns about \$2.51 to the household and society, including \$1.80 in reduced energy bills and \$0.71 in non-energy benefits (e.g., increased local employment and improved housing quality)” and better health and safety.<sup>40</sup>

Weatherization and efficiency measures are a tried and true solution to reducing energy bills, improving quality of life in the home, or both. Across the United States, the average household receiving weatherization through WAP has first-year energy

(footnote continued)

the regulated gas utility to recover costs.

<sup>37</sup> Boardman, p. 143.

<sup>38</sup> Semi-structured research interview with the research team, July 14 2014.

<sup>39</sup> All deliveries of kerosene, heating oil, and other dyed diesel fuels to customers' residential or business locations are subject to the fuel gross receipts tax.

<sup>40</sup> Vermont Department for Children and Families, p. 38.

<sup>36</sup> Keep in mind that, with limited exceptions, the state cannot regulate prices so strictly that it prevents the suppliers from being able to garner a fair return on investment. Thus when wholesale prices rise, regulations must (more or less) allow

savings of \$466.48.<sup>41</sup> Assuming that value for Vermonters, providing WAP to all eligible households would reduce the number of households in fuel poverty by approximately 19 percent.

In Vermont, the low-income housing stock tends to be older and less efficient than housing available to higher-income households. Currently, the Fuel Gross Receipts Tax is low, generating only about 0.5 percent of all revenues raised. Gradually raising this tax to 2 percent or greater would provide an important increase in money available for WAP.

Our second recommendation is that the legislature continue supplementing the Federal Low Income Home Energy Assistance Program (LIHEAP). Although weatherization and efficiency should be primary measures, they cannot reach everyone in the time needed to ensure all Vermonters are warm in the frigid winter months of the next few years. Capstone Community Action informs us that it has a waiting list of 18 months for people wanting to get weatherization assistance. Low-income assistance must remain available as a safety net. Funding from the state for the program may be an opportunity to design programs that can use the funding more efficiently and reach more Vermonters, with their tax dollars ideally going further than the federal money could.

Third, we recommend that the legislature mandate energy efficiency labels in housing. The legislature did set up a working group on energy disclosure. The working group concluded with a vote of 12-0 “to support a requirement that property sellers provide a disclosure of building energy performance, delivered through a mechanism such as an online tool with no cost to the end user, and tracked through a database of a form to be determined,” with two abstentions and two absences.<sup>42</sup> We agree with the working group that, for any disclosure tool required of sellers, “that tool should have no cost to the end user,” and that for “any buyer tool requirement... costs for such a tool would need to be subsidized” for low-income users.<sup>43</sup> The next step is for the legislature to recognize and incorporate one labeling scheme in order to set minimum standards across all of Vermont’s housing stock. One draft for how this labeling scheme could work is shown in Fig. 7.

#### 4.2. Community groups and social service agencies

Our data suggests that community groups and social service agencies:

1. Provide and prioritize energy efficiency audits and coaching;
2. Distribute energy conservation and efficiency materials; and
3. Ramp up educational awareness and outreach programs.

First, Vermont needs more energy efficiency coaches, people who are trained in low-income outreach, energy efficiency strategies, and community-based social marketing concepts. This is currently taking place within Vermont’s Sustainable Energy Resources for Consumers program.<sup>44</sup> Other Vermont groups can adopt and expand on the concept. The benefit of this program is that it is a more rigorous approach to weatherization, helping clients every step of the way to make sure that not only are efficiency technologies installed, but that they are enhanced by proper guidance and behavior change to ensure that efficiency is actually achieved.

Second, we believe that social service agencies and health clinics serving lower-income populations should be utilized as points of distribution for energy conservation and efficiency materials. Materials that would otherwise require payment by the low-income recipient should be subsidized to the extent possible. These materials might be offered individually or in kits, which need not cost more than \$50 to \$150 each, and could include:

- CFL or LED light bulbs,
- low-energy night lights,
- window plastic kits,
- hot water temperature gauges,
- faucet aerators,
- refrigerator thermometers,
- information on WAP, and
- information for owner-occupied and rental-property efficiency improvement programs and subsidies.

These materials should come with pamphlets describing the savings that can be achieved through energy conservation and efficiency, explanations for how to effectively use the materials, and other tips for safely reducing energy consumption. In addition to the direct efficiency benefits they provide, they can also serve as a first-step introduction to weatherization, and a great tool for advertising various Vermont energy programs. If people have a positive experience with efficiency, they are more likely to do it again or change other behaviors.

Third and lastly, educational programs need to be refined and likely scaled up. As Richard Sedano from RAP told us, “due to a mix of social stigma and lack of knowledge, it’s unclear whether those most in need of energy assistance are getting access to it here in Vermont.”<sup>45</sup> Robert Dostis from GMP adds that “many Vermonters are not aware of the availability of existing assistance programs or they are reluctant to take advantage of them.”<sup>46</sup> Community groups should understand the importance of fuel poverty and connect Vermonters with resources. A good way to position low income energy-efficiency policies is to re-cast low income weatherization in a light that is less stigmatizing, as many who are in fuel poverty do not see themselves as in “poverty” and will not seek out or accept assistance.<sup>47</sup> Personal success stories are a great way to build trust and confidence that these programs, whether assistance, efficiency, or weatherization, are worthwhile. As Riley Allen from RAP explains, “Community action is a vital element for overcoming fuel poverty here.... We need a mechanism for raising awareness and connecting customers to potential service providers and making the public aware of the support mechanisms that exist.”<sup>48</sup>

#### 4.3. Other state agencies

Our respondents stated that Vermont’s government agencies can help address fuel poverty and energy burdens by directly or indirectly supporting residential efficiency efforts and energy affordability through appropriate fuel switching. As Johanna Miller, VNRC’s Energy Program Director, noted, these agencies “need to be [sufficiently] funded and have a trained and educated workforce to help reduce consumption and make energy savings.”<sup>49</sup> We therefore have three recommendations for state agencies other

<sup>41</sup> Eisenberg, p. v. The value has been inflation adjusted from the original (2010) to 2013 value.

<sup>42</sup> Working Group on Building Energy Disclosure, p. 3.

<sup>43</sup> Working Group on Building Energy Disclosure, p. 23.

<sup>44</sup> Department of Energy, Office of Energy Efficiency and Renewable Energy, “Sustainable Energy Resources for Consumers (SERC) Vermont Highlight.”

<sup>45</sup> Semi-structured research interview with the research team, July 8 2014.

<sup>46</sup> Semi-structured research interview with the research team, July 7 2014.

<sup>47</sup> Heffner and Campbell, 2011.

<sup>48</sup> Semi-structured research interview with the research team, July 11 2014.

<sup>49</sup> Semi-structured research interview with the research team, July 10 2014.



than those directly providing social services:

1. Train staff in energy efficiency;
2. Focus on improvements to multi-family housing; and
3. Incentivize appropriate fuel switching, cold climate heat pumps, and heat pump water heaters

First, agency staff across the entire Vermont government should receive basic training in the value of energy efficiency and in the existence of leading energy programs in the state. Vermont's government employees not only communicate with a large fraction of the state's residents in any given year, they are themselves residents and from a social science perspective represent "nodes" in the social network. Concerns regarding energy affordability are liable to crop up in communication that agency employees have with residents, even when the ostensible subject seems unrelated, such as regarding permitting of various activities. Simple awareness of energy concerns and of the existence of programs to address them—from Weatherization Assistance to Efficiency Vermont rebates—enables agency staff from all Vermont agencies to act as conduits for sharing useful information.

Second, relevant agencies should focus on multi-family housing units for weatherization programs, especially those that serve low-income renters. Rental properties are prone to the problem of "split incentives," which occur when one party (the property owner) is responsible for the cost of an energy efficiency upgrade, but another party (the renter) will reap the energy savings benefit. Programs can confront split incentives by providing rebates or incentives that cover the incremental cost of more energy-efficient upgrades and equipment. Efficiency Vermont has programs in place to support energy efficiency improvements to rental properties.<sup>50</sup>

Promoting rental property improvements and transparency regarding energy costs is tricky but necessary to address Vermont's widespread fuel poverty and significant energy burdens. Vermont's government agencies can utilize carrots (such as direct or indirect assistance to rental property owners) and sticks (such as legal requirements for energy use reporting or building efficiency standards). Some of these efforts may be within existing regulatory powers, while others will require legislative authorization.

State agencies that deal with rental property owners can, at the very least, promote utilization of Efficiency Vermont's existing programs whenever communicating with rental property owners. Regarding rental housing, relevant agencies could span those related to economic development and the environment (such as the Agency of Commerce and Community Development, Agency of Natural Resources, or Natural Resources Board) to those dealing with social justice, empowerment, and human rights (such as the Vermont Commission on Women, Vermont Human Rights Commission, or Vermont Office of Veterans Affairs). Though not always state agencies, municipalities, the Vermont Apartment Owners Association, real estate agents, Vermont Center for Independent Living, and Vermont Legal Aid can also play supportive roles.

Thirdly, Vermont's agencies should consider when and how they might support households in switching to wood, natural gas, or—especially—electricity in the form of heat pumps.<sup>51</sup> At current

energy prices in Vermont, heat pumps deliver heat at a lower cost than most other alternatives; unvented natural gas room heaters and (cord) wood stoves operate at slightly lower cost (assuming wood is purchased),<sup>52</sup> though each of these types of heating entails small risks of carbon monoxide or other negative health impacts. If natural gas and electricity prices continue their general trends, cold climate heat pumps will be more affordable to operate in the near term. At current prices, wood pellets and natural gas utilized in vented room heaters or central boilers or furnaces are slightly more expensive to operate than heat pumps, though still significantly less expensive than systems fueled by propane or heating oil.

Regarding fuel switching, relevant agencies may include, but are not necessarily limited to:

- Agency of Agriculture, Food, and Markets;
- Agency of Commerce and Community Development;
- Agency of Natural Resources;
- Department of Public Safety;
- Department of Public Service;
- Natural Resources Board;
- Public Service Board;
- Vermont Commission on Women;
- Vermont Economic Development Authority;
- Vermont Housing and Conservation Board;
- Vermont Office of Veterans Affairs;
- Vermont State Housing Authority; and
- municipal housing authorities.

To offer some guidance to these agencies, Efficiency Vermont already provides rebates for heat pump water heaters, a program worth continuing. A recent improvement to the current Vermont statute, Section 1. 30 V.S.A. § 209, may enable Efficiency Vermont funding to be used to promote cold climate heat pumps as well. This statute, through S. 202, signed into law on June 11th, 2014, has been amended to bring in the possibility of using the electricity efficiency charge to cover thermal efficiency achieved with heat pumps. The Public Service Board may authorize the use of funds raised through an energy efficiency charge on electric ratepayers to reduce the use of fossil fuels for space heating by supporting electric technologies that may increase electric consumption, such as (cold climate) air source or geothermal heat pumps. As seen in Fig. 5 above, approximately 5 percent of Vermont households currently use electricity as their primary heating fuel, and it is likely that most of those are using less-efficient and therefore more costly resistance electric heating. For many Vermonters, there is great savings potential in switching to electric space and water heating, when the heat is provided through heat pumps. The relatively high up-front cost of the technology can be lessened by a rebate or subsidy from state agencies. Despite the high upfront cost, the payback on the installations is short, owing to the fact that they greatly reduce heating bills. Energy savings may be felt across the state from switching to space heating with heat pumps: even if the market penetration is only at 10 percent, Vermonters could save \$15 million annually in reduced fuel costs; at 50 percent market penetration the estimate is \$85 million in energy bill savings.<sup>53</sup> The efficiency of heat pumps, in combination with Vermont's relatively low-carbon electric supply, has the added benefit of reducing greenhouse gas emissions when replacing

<sup>50</sup> Information on Efficiency Vermont's rental property programs is available at <https://efficiencyvermont.com/For-My-Business/Solutions-For/Residential-Rental-Properties>.

<sup>51</sup> Information on cold climate heat pumps and heat pump water heaters is available through Efficiency Vermont at, respectively, <https://efficiencyvermont.com/For-My-Home/ways-to-save-and-rebates/Audits-Heating-Insulation/Cold-Climate-Heat-Pumps/Overview> and <https://efficiencyvermont.com/For-My-Home/ways-to-save-and-rebates/Appliances/Heat-Pump-Water-Heater/Overview>.

<sup>52</sup> Energy Information Administration, "Heating Fuel Comparison Calculator," with prices adjusted to represent recent Vermont prices (as of July 2014). The calculator incorporates typical system efficiencies to estimate the cost of delivered heat from each fuel source.

<sup>53</sup> Letendre et al., 2014, p. 6.

fossil heating fuels.<sup>54</sup> State agencies can improve marketing and outreach to convey all of these benefits to Vermont consumers.

Efficiency Vermont currently offers rebates for central wood pellet boilers and furnaces.<sup>55</sup> The Air Quality and Climate Division within the Agency of Natural Resources also maintains an outdoor wood boiler change-out program.<sup>56</sup> This program was created primarily to address concerns over air pollution from older outdoor wood boilers, and its incentives may be applied toward replacement equipment, such as propane fired furnaces or boilers, whose operation may increase spending on fuel. The program's administrator should be encouraged to keep up to date on the relative operating costs of equipment supported by the program, so that s/he may advise applicants accordingly.

Vermont has in the past offered incentives to replace older, less-efficient wood stoves with EPA-certified alternatives, a program also administered by the Air Quality and Climate Division. The financial gains to be had from the efficiency these change-outs provide are modest, but sufficient to warrant the state considering offering the program again. (Admittedly, this would require legislation, and so is somewhat beyond the scope of agency discretion.)

In the part of Vermont that has natural gas service, agencies should consider promoting its use by eligible residences not currently doing so, though as indicated above this is likely to be less effective than adoption of cold climate heat pumps for reducing energy burdens in all but the short term.

#### 4.4. Vermont utilities and fuel providers

Our final three recommendations derived from the interview data are for utilities and fuel providers. We recommend that these private sector stakeholders:

1. Provide extra assistance for those about to be disconnected;
2. Utilize on-bill financing or PACE for efficiency improvements; and
3. With regard to fuel dealers, diversify into energy services companies.

First, we recommend that Vermont utilities and fuel providers set up an arrangement for customers to be put in contact with social service agencies whenever the customers are about to be disconnected or no longer supplied with fuel, other than due to switching to a competing fuel provider. With electricity in particular, the coming smart grid will likely make these disconnections increasingly automatic and impersonal. It would be beneficial for households facing disconnection to receive assistance from social service agencies. No Vermonter should be disconnected without knowing what other options and safety nets are out there to help them. Customer service representatives at Vermont energy companies could be trained in directing customers to assistance programs once they see a pattern in unpaid bills and before they send out disconnection notices.

Second, we strongly suggest that these companies consider utilizing on-bill financing for efficiency improvements, whether or not the financing is provided by the companies themselves. From

improved boilers to thermal efficiency, these improvements can be paid as part of the monthly billing scheme. Although on-bill financing programs are relatively new, there is a growing body of evidence indicating these programs are both effective and inclusive.<sup>57</sup> On-bill financing also allows efficiency improvements to become a more affordable option for Vermont households. Because on-bill financing does not create traditional consumer debt, it has the potential to overcome most of the first-cost related barriers to investing in energy efficiency upgrades and it can reach a majority of Vermonters, including low-income homeowners as well as landlords. Perhaps most importantly, on-bill tariffed financing allows all utility customers—including those who do not qualify for traditional loans—to install energy efficiency upgrades with no upfront payments and no personal debt obligation.<sup>58</sup> On-bill financing can be used for the purchase of infrastructure or capital improvements that will remain with the house or apartment. In California, a Financing Initiative for Renewable and Solar Technology (FIRST) program in Berkeley allows financing for efficiency upgrades or investments in renewable energy to be paid back through a line item on the property tax bill.

Vermont already offers a similar program through Property Assessed Clean Energy (PACE).<sup>59</sup> PACE programs enable local governments and state governments to fund the up-front capital expense of energy improvements and retrofits on commercial and residential properties, which are then paid back by the property owners over time, usually 10–20 years.<sup>60</sup> This empowers property owners to implement upgrades or investments without an initial large outlay of cash, meaning it addresses two significant barriers to energy efficiency commitments at the local level: lack of capital, and hesitancy to make investments in properties they may rent out or not own for a long period of time.<sup>61</sup> (The PACE investment stays with the property rather than the owner or investor). Some of the more established programs such as Sonoma County's Energy Independence Program and Boulder County's Climate Smart Loan Program have so far raised millions of dollars' worth of efficiency improvements. Although far from a panacea, even some critics concede that PACE "is a creative new method of financing renewable energy systems and energy efficiency improvements for residential buildings."<sup>62</sup> In sum, there are advantages in offering financing through the utility bill rather as well as through property taxes.

Third, we propose that company managers accelerate the transition of traditional fuel dealers into energy service companies. These energy service companies could become capable of profitably providing valuable efficiency improvements to their customers. The Efficiency Excellence Network, a collaboration between the Vermont Fuel Dealers Association and Efficiency Vermont, is off to a great start.<sup>63</sup> A number of fuel dealers are participating in this pilot program. They have already made available \$6.5 million dollars for loans and they are planning to market themselves to customers as "energy service providers," not just fuel dealers. They could transition into a more holistic

<sup>57</sup> See, e.g., Sonja Persram, *Property Assessed Payments for Energy Retrofits*, David Suzuki Foundation, 31 (Mar. 2011), <http://www.davidsuzuki.org/publications/downloads/2011/Property%20Assessed%20Payments%20for%20Energy%20Retrofits.pdf>

<sup>58</sup> Marianne Tyrell Colin Hagan, Rebecca Wigg, *Financing Energy Efficiency in Vermont*.

<sup>59</sup> For information on PACE, see <https://www.efficiencyvermont.com/For-My-Home/Financing/Financing/PACE-Overview>.

<sup>60</sup> U.S. Department of Energy, 2015.

<sup>61</sup> National Renewable Energy Laboratory, 2010.

<sup>62</sup> Cox, 2011, p. 83.

<sup>63</sup> For more information on the Efficiency Excellence Network, see <https://www.efficiencyvermont.com/For-My-Home/ways-to-save-and-rebates/Audits-Heating-Insulation/Find-A-Contractor/een>.

<sup>54</sup> The greenhouse gas emission impact of wood is hotly debated by researchers, with many complex factors, such as the time scale and method of harvest considered, affecting the results. Depending on the analysis utilized, electrically powered heat pumps may result in fewer or more GHG emissions than wood.

<sup>55</sup> For information, see [https://www.efficiencyvermont.com/For-My-Business/Ways-To-Save-and-Rebate/Heating-Ventilation-Air-Conditioning-\(HVAC\)/single-item/index/central-wood-pellet-boilers-and-furnaces](https://www.efficiencyvermont.com/For-My-Business/Ways-To-Save-and-Rebate/Heating-Ventilation-Air-Conditioning-(HVAC)/single-item/index/central-wood-pellet-boilers-and-furnaces).

<sup>56</sup> For information, see <http://www.anr.state.vt.us/air/hm/OWBchangeoutprogram.htm>.

business wherein they also help their customers get more efficient boilers, solar hot water and heat pumps. To the extent that fuel dealers adopt the recommendation above to provide on-bill financing for these products and related services, they increase their value to customers and enhance this transition into energy services providers.

## 5. Conclusion and implications

Despite being a comparatively wealthy and small state known for its progressive, low-carbon innovations in electricity, energy efficiency, and the smart grid, fuel poverty is a serious and growing problem in Vermont. By our estimate, just over 71,000 people suffered from fuel poverty in Vermont in 2000, and in 2012 this number had grown to more than 125,000, or one in five Vermonters. Put another way, fuel poverty has grown by 76 percent over the past 13 years, despite major efforts by local and state actors in addition to federal government to fight poverty and stimulate the economy. Moreover, close to three-quarters of Vermonters in the lowest income decile are currently struggling with fuel poverty. Absent significant efforts from the public and private sectors, this problem will only grow more severe. Having a warm, comfortable, well-lit home is something, sadly, all too many Vermonters aspire to rather than experience.

Critically, our study does offer a poignant reminder that progressive energy and climate planning may have unintentional regressive effects on the poor that need corrected by government intervention. If, as some of us have argued, promoting energy security or sustainability is about managing tradeoffs,<sup>64</sup> such tradeoffs certainly arise in Vermont pitting some elements of environmental stewardship and decarbonization against elements of affordability and social vulnerability. When energy prices rise and households cannot compensate with sufficient improvements in efficiency or increased income, it is functionally the same as if they lacked access to reliable energy services altogether. In addition, less affluent Vermonters spend a larger share of their income on heat and electricity than other households, even though they consume less energy, hindering the accumulation of wealth needed to make investments to escape their poverty. When it doesn't kill and sicken people directly, fuel poverty forces households to cope by resorting to wearing coats and outdoor clothing indoors, sleeping together with pets or in one room to keep warm, relying on hot drinks, or even staying with relatives—actions that can all negatively impact mental health. Clearly, this is an issue that Vermont's people and leaders must recognize and address as a crisis, one that takes its toll on the state more seriously (in terms of fatalities) than automobile crashes.

With this in mind, our study offers recommendations for the Vermont legislature. Our data suggests they need to better fund investments in weatherization among low-income households; supplement federal weatherization programs; and endorse energy efficiency labels for homes, especially rented homes and apartments, which is where many of the fuel poor reside. Our study proposes that community groups and social service agencies scale up the training of energy efficiency coaches, disseminate energy conservation and low-cost efficiency materials (including information), and incorporate awareness and outreach on energy burdens into their existing programs. Our findings imply that other state agencies engage the problem in creative ways—whether or not through specific, identifiable programs—in order to support the sharing of information; improvements in housing

efficiency, with an emphasis on rental properties; and appropriate fuel switching, with an emphasis on cold climate heat pumps. Our data lastly recommend that utilities and fuel providers offer extra assistance for disconnected households, allow for on-bill financing or PACE billing of efficiency improvements, and pursue (or at least consider) a business strategy of diversifying into energy services companies.

Ultimately, if fuel poverty is to be addressed in Vermont, and possibly elsewhere, then multiple actors need to be engaged in a concerted effort to implement a comprehensive suite of policy recommendations.

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<sup>64</sup> Heffron et al., 2015; Sovacool et al., 2015; Sovacool and Linnér, 2015; Sovacool and Saunders, 2014.