Residential Space Heating Fuels in Minnesota

Minnesotans spend about $2 billion annually to heat their residences. The heating fuels they use vary significantly in different regions of the state, reflecting availability, fuel and heating system costs, and other factors. This information brief presents count-by-county use of residential heating fuels based on survey data compiled by the U.S. Census Bureau. It also contains information on fuel price trends over time, residential conservation, federal fuel assistance, and Minnesota’s Cold Weather Rule.

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Introduction

Approximately one-half of the 431 trillion Btus consumed by Minnesota homes in 2014 was used to heat those residences.\(^1\) Minnesota’s collective residential heating bill that year was about $1.9 billion.\(^2\) Individual heating expenditures vary significantly throughout the state, depending on the size of the home, the type of fuel used, furnace efficiency, lifestyle, and weather. These differences, given a heating season that lasts six months or longer, can amount to thousands of dollars annually for a household.

Statewide Distribution of Residential Space Heating Fuels

Statewide data on fuels used for space heating in Minnesota is presented in Table 1. The left-hand columns compare the distribution of space heating fuels among occupied housing units in Minnesota and the United States in 2015. Minnesota differs from the national profile in several respects. A much larger proportion of Minnesota’s housing units are heated with natural gas and propane, a result of the state’s relative proximity to natural gas supplies in Texas, Oklahoma, and Kansas and its position as a large importer of Canadian natural gas. (Two-thirds of propane supplies are produced from the processing of natural gas.) Conversely, the share of units heated with electricity and fuel oil in the state are both less than half the national average.

<table>
<thead>
<tr>
<th>Fuel</th>
<th>U.S. (percent)</th>
<th>Minnesota (percent)</th>
<th>Minnesota (units)</th>
<th>Change in Minnesota Units</th>
<th>Percentage Change in Minnesota Fuel Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>48.2%</td>
<td>66.1%</td>
<td>1,420,349</td>
<td>59,416</td>
<td>(1.3%)</td>
</tr>
<tr>
<td>Electricity</td>
<td>38.2</td>
<td>17.1</td>
<td>366,326</td>
<td>96,008</td>
<td>3.7</td>
</tr>
<tr>
<td>Propane</td>
<td>4.7</td>
<td>10.5</td>
<td>225,549</td>
<td>10,529</td>
<td>(0.1)</td>
</tr>
<tr>
<td>Fuel Oil</td>
<td>5.1</td>
<td>2.0</td>
<td>41,930</td>
<td>(56,729)</td>
<td>(2.9)</td>
</tr>
</tbody>
</table>


### Distribution of Residential Space Heating Fuels by County

The statewide figures in Table 1 mask the considerable variations in the fuels used to heat Minnesota homes in different regions of the state. The following map (Figure 1) shows the use of natural gas for heating fuel by county, based on data obtained from the U.S. Census Bureau’s American Community Survey (ACS). The ACS combines samples from five consecutive years to produce estimates that are statistically reliable for small populations, such as those found in some of Minnesota’s smaller counties. Counties whose proportion of homes heated with a given fuel fall within the ranges shown in the maps and are shaded identically. Lighter shadings indicate less use of that fuel, darker shadings indicate heavier use.

Figure 1 shows that the highest proportion of residences that are heated with natural gas—the darkest areas on the map, indicating that 60 percent or more of housing units heat with natural gas—are located in the Twin Cities metropolitan area and counties directly south. This is confirmed in the first column of Table 2 (on page 5), which lists the ten counties with the highest proportion of residences heated with natural gas. In the seven metropolitan counties, the proportion ranges from 77 percent to just under 85 percent. Most of the other counties in which natural gas is used in more than 40 percent of homes are located in the southern third of the state.

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Figure 1
Percentage of Housing Units Using Natural Gas as a Heating Fuel, 2010-2014

Statewide Average: 66.1 Percent
- less than 20 percent
- 20 to 39.9 percent
- 40 to 59.9 percent
- 60 percent and higher

Source: U.S. Census Bureau, American Community Survey five-year estimates
<table>
<thead>
<tr>
<th>Natural Gas</th>
<th>Electricity</th>
<th>Propane</th>
<th>Fuel Oil</th>
<th>Wood</th>
</tr>
</thead>
<tbody>
<tr>
<td>County</td>
<td>% of Homes</td>
<td>County</td>
<td>% of Homes</td>
<td>County</td>
</tr>
<tr>
<td>Scott</td>
<td>84.9</td>
<td>Clay</td>
<td>36.4</td>
<td>Traverse</td>
</tr>
<tr>
<td>Anoka</td>
<td>84.9</td>
<td>Lake of the Woods</td>
<td>36.1</td>
<td>Aitkin</td>
</tr>
<tr>
<td>Dakota</td>
<td>83.6</td>
<td>Red Lake</td>
<td>35.9</td>
<td>Grant</td>
</tr>
<tr>
<td>Washington</td>
<td>83.4</td>
<td>Marshall</td>
<td>34.5</td>
<td>Murray</td>
</tr>
<tr>
<td>Hennepin</td>
<td>81.2</td>
<td>Norman</td>
<td>34.0</td>
<td>Cook</td>
</tr>
<tr>
<td>Ramsey</td>
<td>78.9</td>
<td>Beltrami</td>
<td>32.5</td>
<td>Kanabec</td>
</tr>
<tr>
<td>Carver</td>
<td>77.1</td>
<td>Becker</td>
<td>31.9</td>
<td>Cass</td>
</tr>
<tr>
<td>Olmsted</td>
<td>74.3</td>
<td>Hubbard</td>
<td>31.9</td>
<td>Lincoln</td>
</tr>
<tr>
<td>Sherburne</td>
<td>71.2</td>
<td>Mahnomen</td>
<td>30.7</td>
<td>Faribault</td>
</tr>
<tr>
<td>Blue Earth</td>
<td>70.3</td>
<td>Grant</td>
<td>30.2</td>
<td>Mahnomen</td>
</tr>
</tbody>
</table>

Source: U.S. Census Bureau, American Community Survey five-year estimates.
Since natural gas is the most economical home heating fuel at the end-user level (see Table 4 on page 13), the question arises: Why isn’t it used more widely throughout the state?

The geographic distribution of natural gas service results from the interplay between economic and demographic factors. As is the case with electricity, natural gas is delivered by means of a physically connected capital-intensive system that can extend over hundreds of miles or more to bring energy to each individual customer location. Transporting natural gas from producing areas to a residential customer is expensive. Interstate pipelines cost from $1.9 million to $3.6 million per mile to construct, depending on the pipe’s diameter; distribution pipelines, which bring gas from the interstate line to the customer’s location, cost about $1.5 million per mile.4

The expansion of rural electricity was promoted by federal government programs initiated in the 1930s that were designed to reduce the costs and risks of borrowing by public agencies and rural cooperatives seeking to build that infrastructure. No similar assistance has been available in rural areas to expand or support expansion of natural gas service.

These high fixed costs have two important implications for the provision of natural gas service. First, the further a community is located from an interstate natural gas pipeline, the more expensive it is to construct a distribution pipeline to provide service there. Second, the smaller the population of the community seeking service (absent a large industrial customer), the fewer gas units over which there are to recover high fixed costs; this results in high, sometimes prohibitive, retail prices.

These principles underlie the distribution of natural gas service shown in Figure 1. Northern Natural Gas Company is the only domestic pipeline that serves Minnesota, transporting natural gas from Midwestern and Gulf states. Its pipelines are concentrated in the southern half of the state, where most of Minnesota’s urban and suburban populations live, with extensions to Duluth and several communities on the north shore of Lake Superior, and to Iron Range cities. Four Canadian pipelines cross the state from northwest to southeast, serving adjacent communities, but most of the northwest quadrant of the state is unserved, as shown by the more lightly-shaded counties in that region in Figure 1. Here, the small size of many communities is the controlling factor. According to census data, Minnesota contains 2,021 cities and organized towns with a population below 1,000.5

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4 IHS Economics, The Economic Benefits of Natural Gas Pipeline Development on the Manufacturing Sector, prepared for the National Association of Manufacturers, May 2016, pp. 26-27, www.nam.org/Data-and-Reports/Reports/Natural-Gas-Study/Energizing-Manufacturing-Full-Report/. These estimates are based on the following assumptions for transmission and distribution pipelines, respectively: length: 200 miles, 10 miles; capacity: 700 million cubic feet per day, 10 million cubic feet per day; pressure: 900 pounds per square inch gauge, 100 pounds per square inch gauge.

5 Minnesota State Demographic Center, Data by Place, City and Township, http://mn.gov/admin/demography/data-by-place/.
A recent study by the Oregon Public Utilities Commission examining the expansion of natural gas service to unserved areas illustrates the importance of these principles. It found that while every city with a population of 10,000 or more has natural gas service, only one out of four cities with a population below 1,000 does. Almost all unserved cities with populations over 1,000 are located more than 10 miles from an interstate natural gas pipeline. No city under 1,000 located more than 15 miles from a pipeline has natural gas service, nor do half of those located closer.6

In Minnesota, natural gas service extensions are funded through a monthly bill surcharge paid by the new customers, which must be approved by the Minnesota Public Utilities Commission. In 2014, for example, the commission approved a $33.50 monthly surcharge to residents of Ely Lake for a period of 20 years to repay the cost of extending natural gas service to that community, a charge that amounts to more than $8,000 per customer over the period.7, 8

Other heating fuels dominate areas of the state where natural gas service is unavailable. Figure 2 shows the distribution of homes using electricity for space heating. The heaviest use occurs in counties in the northwestern quadrant of the state, ranging from 30 percent to 36 percent of all homes, as confirmed in Table 2 (on page 5). Electricity is used in 20 percent to 30 percent of homes in a group of counties located in the west central region. Electric heating is less widespread in the eastern half of the state.

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8 In 2015, the Minnesota Legislature enacted a bill allowing up to one-third of the cost of natural gas extensions to be allocated to a utility’s existing natural gas customers. Minn. Stat. § 216B.1638.
Figure 2

Percentage of Housing Units Using Electricity as a Heating Fuel, 2010-2014

Source: U.S. Census Bureau, American Community Survey five-year estimates
Propane and fuel oil are delivered to customers by trucks that obtain these fuels from bulk storage stations supplied by pipelines or rail cars. The use of propane as a heating fuel is less geographically concentrated than are natural gas and electricity, as shown in Figure 3. High-use areas (30 percent and above) are found in all regions of the state except the metropolitan area and the southeast corner. Areas of moderate use (20 percent to 30 percent) include much of western Minnesota and the southeast.

Figure 3

**Percentage of Housing Units Using Propane as a Heating Fuel, 2010-2014**

Source: U.S. Census Bureau, American Community Survey five-year estimates
Although the use of fuel oil for space heating has declined to just 2 percent of homes statewide, in some areas of the state it is used in 10 percent to 20 percent of homes, as shown in Figure 4. These include groups of counties in the northeast, northwest, west central, and south central/southwest portions of the state. Fuel oil is used least frequently in the southeastern quadrant of the state.

Figure 4
Percentage of Occupied Housing Units Using Fuel Oil as a Heating Fuel
2010-2014

Statewide Average: 2.0 Percent
- less than 4 percent
- 4 to 6.9 percent
- 7 to 9.9 percent
- 10 percent and higher

Source: U.S. Census Bureau, American Community Survey five-year estimates
Heating with wood includes burning both firewood and manufactured wood pellets. As shown in Figure 5, wood is used most heavily in northern Minnesota. In 15 counties, wood is the primary heating fuel in more than 10 percent of the county’s residences.

Figure 5

**Percentage of Housing Units Using Wood as a Heating Fuel, 2010-2014**

Source: U.S. Census Bureau, American Community Survey five-year estimates
Residential Space Heating Fuel Prices

One factor that influences a homeowner’s choice of fuel for space heating is cost. Table 3 shows the average price for residential heating fuels over the past five heating seasons. Both propane and fuel oil prices fluctuated significantly during this period, varying by almost 100 percent, while natural gas prices have been more stable.

<table>
<thead>
<tr>
<th>Heating Season*</th>
<th>Natural Gas ($/Mcf)</th>
<th>Propane ($/gal)</th>
<th>Fuel Oil ($/gal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011-2012</td>
<td>8.12</td>
<td>2.08</td>
<td>3.58</td>
</tr>
<tr>
<td>2012-2013</td>
<td>7.61</td>
<td>1.56</td>
<td>3.65</td>
</tr>
<tr>
<td>2013-2014</td>
<td>8.97</td>
<td>2.41</td>
<td>3.56</td>
</tr>
<tr>
<td>2014-2015</td>
<td>9.16</td>
<td>1.83</td>
<td>2.70</td>
</tr>
<tr>
<td>2015-2016</td>
<td>7.67</td>
<td>1.26</td>
<td>1.88</td>
</tr>
</tbody>
</table>

*October through March


An accurate measure of relative fuel costs must go beyond a simple comparison of the commodity fuel prices in Table 3. Such an analysis lacks a crucial element: the amount of fuel that must be input into a heating system in order to produce a given amount of heat—in other words, the efficiency of the heating unit. Table 4 incorporates this important variable by presenting the cost of producing an output of one million Btus of heat via furnaces of different efficiencies using different fuels, based on the average fuel prices reported in Table 3, as well as a range of electricity prices.

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9 Electricity prices are not reported in Table 3 because no data source calculates an average price specifically for space heating customers. Some utilities offer lower rates for space heating than for other residential electricity consumption; others offer a lower rate if the customer participates in programs that allow the utility to reduce the customer’s consumption during peak demand periods.
Table 4  
Estimated Cost of Residential Heating per Million BTUs,  
by Fuel Source and Furnace Efficiency

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Price per Unit</th>
<th>Furnace Efficiency/Price per Million BTU</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>80%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>90%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>95%</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>$8.31/Mcf</td>
<td>$10.39</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$9.22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$8.76</td>
</tr>
<tr>
<td>Propane</td>
<td>$1.83/gal.</td>
<td>$31.28</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$25.42</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$22.59</td>
</tr>
<tr>
<td>Fuel Oil</td>
<td>$3.07/gal.</td>
<td>$36.56</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$31.32</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$25.80</td>
</tr>
<tr>
<td>Electricity</td>
<td>Furnace Only</td>
<td>$17.58</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$8.79</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$6.76</td>
</tr>
<tr>
<td></td>
<td>ASHP 2.0*</td>
<td>$23.44</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$11.72</td>
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<td></td>
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<td>$9.02</td>
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<td>ASHP 2.6*</td>
<td>$29.30</td>
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<td>$14.65</td>
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<td>$11.27</td>
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<td></td>
<td>$35.16</td>
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<td></td>
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<td>$17.48</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$13.53</td>
</tr>
</tbody>
</table>

* Electric furnace and air source heat pump, with a coefficient of performance as shown.

Sources: Column 2: Average Statewide Annual Heating Season Price, 2011-2016, Table 3.  
Columns 3 to 5: Duke Energy, Ohio: Estimating Costs with Changing Prices,  
www.duke-energy.com/ohio/savings/heating costs.asp.

As shown in the upper portion of Table 4, based on Minnesota’s average heating season fuel  
prices over the past five years, natural gas is the lowest-cost option, followed by propane and  
fuel oil, which each cost about three times as much per unit of heat produced. As furnace  
efficiencies rise for each fuel, the effective cost declines, although the price ratios among the  
fuels are largely maintained. Of course, more efficient furnaces have a higher initial purchase  
cost, which is not reflected in the table; neither are furnace maintenance costs included.

The lower portion of Table 4 presents a similar analysis based on four different end-user  
electricity rates. Even at the low rate of six cents per kilowatt hour, an electric furnace is  
significantly more costly than natural gas; at 12 cents per kilowatt hour, it is more expensive than  
a low-efficiency (65 percent) propane furnace, and slightly less expensive than a low-efficiency  
fuel oil furnace.

The analog to a higher efficiency furnace with respect to electric heat is the addition of an air-  
source heat pump to the system. A heat pump, powered by electricity, uses a liquid refrigerant in  
its outdoor copper coils to extract heat from the outside air, evaporating the refrigerant into a gas.  
Indoor coils release the heat from the refrigerant as it condenses back into a liquid. The  
efficiency of this operation—the heat produced per unit of electric energy needed to operate the  
heat pump—is known as the unit’s coefficient of performance. As shown in the table, heat  
pumps can reduce the cost of electric space heating by up to two-thirds.
Energy Conservation

The amount of energy used to heat homes has been declining as a proportion of total residential energy use for several decades. While the increase in electricity use for new appliances has increased the denominator of that ratio, technology has lowered the numerator by vastly improving the efficiency of space heating furnaces, by developing new building materials, and by employing advanced building designs that result in a tighter building envelope. These innovations reduce the amount of heat that must be produced in order to maintain a given temperature in a residence.

Residential building codes have played a key role in this trend. The International Energy Conservation Code (IECC) is revised every three years and has been regularly adopted in Minnesota. Residences constructed to conform to the 2015 IECC are estimated to use 45 percent less energy than homes in compliance with the building code in effect in 1975.10

One way to measure the extent of conservation of home heating fuels is to examine use per customer over time. Figure 6 shows the weather-normalized consumption of natural gas per residential customer in Minnesota between 1967 and 2012.11 Use per customer began to decline in the early 1970s and has continued steadily, with only a few exceptions, reaching approximately half the level of its highest point in 1973.

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11 Seventy percent of the natural gas in U.S. homes that heat with that fuel is used for space heating, with the balance used for cooking and water heating. This figure is likely to be several percentage points higher in Minnesota’s colder climate. U.S. Department of Energy, Buildings Energy Database, Table 2.1.5, 2010 Residential Energy End-Use Splits, by Fuel Type, http://buildingsdatabook.even.doe.gov/docs/ xlspdf.2.1.5.pdf.
Significant declines in energy consumption for space heating have occurred even though the size of homes in the Midwest has grown steadily, from 1,585 square feet in 1975 to 2,608 square feet in 2015, a 65 percent increase.12

Financial Assistance for Residential Space Heating

The federal Low-Income Home Energy Assistance Program (LIHEAP) provides financial assistance to households whose income is below 50 percent of the state median income (currently $47,194 for a family of four). Grants are paid directly to utilities and other energy suppliers, and averaged about $500 for each of the 156,068 successful applicants in 2014, when the state received $114.5 million in federal funds.13

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In its 2016-2017 LIHEAP plan, the Minnesota Department of Commerce proposed the following allocation of federal funds: 58.5 percent to heating assistance; 19 percent to crisis assistance (imminent energy disconnection); 4.5 percent to weatherization assistance; 5 percent to services to reduce household energy consumption, including energy audits; 3 percent to be carried over into the following year; and 10 percent to administration.\(^\text{14}\)

In 2014, the Minnesota Legislature appropriated $20 million to supplement LIHEAP funding, as a result of very cold conditions and a significant spike in the price of propane.\(^\text{15}\)

**Minnesota’s Cold Weather Rule**

State law provides protection from utility service disconnections during winter months for certain space heating customers using natural gas or electricity. Public utilities, cooperative electric associations, and municipal utilities are prohibited from disconnecting heating customers whose income is below 50 percent of the state median income between October 15 and April 15 of the following year, provided the customer has entered into and makes reasonably timely payments under a payment agreement with the utility that is based on the financial resources and circumstances of the household. A customer under a payment agreement to a public utility may pay no more than 10 percent of household income under such an agreement, unless the customer concurs. A public utility is also prohibited from disconnecting a customer of any income level if the customer makes timely payments under a payment agreement that reflects the customer’s financial circumstances and is accepted by a utility. These protections against disconnections of heating service do not apply to those heating with propane, fuel oil, or wood.\(^\text{16}\)

*For more information about energy, visit the utility regulation area of our website, [www.house.mn/hrd/](http://www.house.mn/hrd/).*

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\(^{15}\) *Laws of Minnesota 2014*, ch. 145, as amended by ch. 254, § 24.