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Home Heating Fuels

Should I switch to firewood or wood pellets?

J. Reeb

With rising costs for natural gas, fuel oil, and electricity, more people are thinking of burning firewood or wood pellets to heat their homes. How do you know when it is time to switch from one heating source to another? This publication can help you make that decision by comparing the costs of available energy sources.

Firewood

Firewood is usually sold in units called cords. A cord of firewood is a stack of wood that is 4 feet high, 4 feet wide, and 8 feet long (128 cubic feet) or any combination of width, height, and length equaling that volume (Figure 1). For example, a 4-foot high stack could consist of two 12-inch long pieces stacked end to end (2 feet wide). To equal 128 cubic feet, the stack would need to be 16 feet long.

Although a cord of stacked firewood takes up 128 cubic feet of space, some of that space is occupied by air. Thus, a tightly stacked cord is usually defined as about 80 to 85 cubic feet of solid wood.

Firewood heating values (BTU content) can vary significantly. The most important factor affecting BTU content is the moisture content of the wood. All firewood has water in it. For every 1 percent increase in moisture content, there is about a 1 percent decrease in heating value. For example, if a piece of firewood has a heating value of 8,500 BTU/pound at 0 percent moisture content (bone dry), it will have an approximate heating value of only 1,700 BTU/pound at 80 percent moisture content. The difference is the energy necessary to evaporate the water in the wood.

All firewood dried to the same moisture content contains approximately the same heating value per pound—about 8,000 to 9,500 BTU/bone-dry pound and about 6,500 to 7,500 BTU/pound for air-seasoned wood with about 20 percent moisture content.

Energy sources, units, and heating values

Depending on the source, energy is sold in various units. To compare different sources of energy, you need to know their heat content per unit. In the U.S., the most common measure of heat content is the British Thermal Unit (BTU). One BTU is the amount of energy needed to raise the temperature of 1 pound of water by 1 degree Fahrenheit.

U.S. energy facts

For 2007, the U.S. Department of Energy reported that per-capita energy use in the United States was 337 million BTUs. The U.S. accounted for about 22 percent of the world's total energy use that year.

Although energy prices fluctuate, costs are, in general, increasing. For example, in June, 1999, natural gas sold for $2.13/million BTU. In June, 2007, it sold for $7.30/million BTU, and in June, 2008, it sold for $12.86/million BTU.

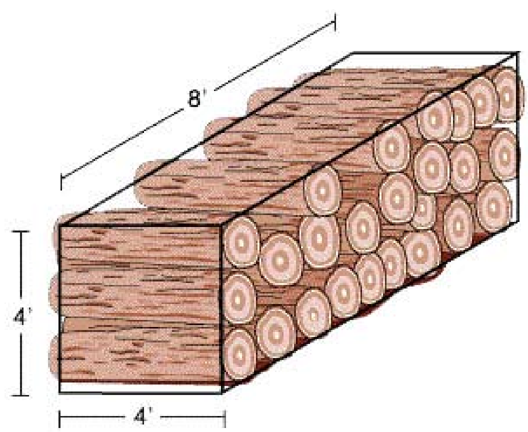

Figure 1.—A cord of firewood occupies a space measuring 128 cubic feet (typically 4 feet high, 4 feet wide, and 8 feet long).

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Drier wood also produces less creosote in chimneys and stovepipes. Creosote buildup can cause chimney and stovepipe fires.

Well-seasoned, air-dried wood that is protected from the rain and snow should equilibrate to a moisture content of less than 25 percent. To achieve this moisture content in western Oregon, you need to stack and season the wood through a dry summer and then protect it from getting wet throughout the rainy season. Seasoning over two summers is even better. Stacked wood should allow free air flow through the openings to facilitate drying (Figure 2).

Another important factor affecting heating value is tree species. The difference in heating value between two cords of firewood at the same moisture content is due to differences in wood density. For the same volume and moisture content, a higher density species (such as white oak) has more wood, fewer air spaces, and more weight than a lower density species (such as red alder or true fir). Generally, denser hardwoods provide longer burning fires and the greatest total heating value per unit of volume. Softwoods usually burn more quickly and contain less total heating value per unit of volume.

Wood pellets

Wood pellets (Figure 3) are usually sold in 40-pound bags. Prices are often expressed in dollars per ton (fifty 40-pound bags). Pellet fuels typically have a moisture content of around 5 to 10 percent. Good-quality wood pellets at 5 to 10 percent moisture content have a heating value of approximately 16,500,000 BTU/ton or about 8,250 BTU/pound.

Figure 3.—Wood pellets.

Figure 2.—Stacked firewood should have good airflow so that it dries properly.

Other fuel sources

Other less common fuel sources include kerosene (about 135,000 BTU/gallon) and coal. Although coal is rarely used for heating homes on the West Coast of the United States, it is burned to generate electricity for some Oregonians. Coal has about 28,000,000 BTU/ton. Used vegetable oil (biodiesel) has a heat value of about 1[illegible]0,000 BTU/gallon, regular gasoline has a heat value of about 12[illegible],000 BTU/gallon, and diesel has a heat value of about 139,900 BTU/gallon.

Health concerns

Smoke from a wood fire often triggers good memories of sitting around a campfire or keeping warm near a fireplace on a cold winter day. However, wood smoke is not good for you to breathe.

Smoke consists of a complex mixture of gases and fine particles. The major health threat from smoke comes from fine particles. These particles can get into the eyes and respiratory system, where they can cause burning eyes, a runny nose, and illnesses such as bronchitis. Fine particles can aggravate chronic heart and lung diseases and have been linked to premature deaths in people with these conditions (http://www.epa.gov/woodstoves/healtheffects.html).

Healthy people rarely suffer long-term ill effects from wood smoke. Still, it's a good idea to avoid breathing smoke if you can help it.

Modern wood and pellet stoves produce much less particulate matter than either open fireplaces or older models of wood stoves. The U.S. Environmental Protection Agency (EPA) estimates that, on average, a new wood stove emits up to 70 percent less particulate matter and uses 30 percent less wood than older stoves (http://www.epa.gov/woodstoves/pdfs/epa_bcflyer_press_rev4.pdf).

Highly efficient pellet stoves emit even less particulate matter than wood stoves.

In recent years, wood stove manufacturers have further reduced air emissions by increasing the air flow volume passing through the stove, thereby increasing the burn rate. These wood stoves produce the smallest amount of particulate matter of any wood stoves on the market.

When purchasing a new stove, look for a U.S. EPA emissions testing certification label. An EPA-certified wood stove can be identified by a temporary paper label attached to the front of the wood stove and a permanent metal label affixed to the back or side of the stove.

If a stove does *not* have a certification label, it could be one of the newer low-emission models. These stoves have such a high air flow and such low emissions that they do not fall under the requirements of the EPA wood stove certification program. If you have the stove identification and air flow information, you can ask the Oregon Department of Environmental Quality (DEQ) or the U.S. EPA to verify that the stove does meet these criteria before you make a purchase. The U.S. EPA maintains an updated list of stoves that are tested and meet U.S. EPA certification (http://www.epa.gov/Compliance/resources/publications/monitoring/caa/woodstoves/certifiedwood.pdf).

Other factors to consider

Cost is not the only consideration when deciding whether to switch to firewood or wood pellets. Other factors include the following.

- Firewood and wood pellets must be stored in a dry environment.
- You have to load the wood or pellet stove and dispose of the ash. (Pellet stoves produce less ash than wood stoves.)
- Electricity is used to operate the stoker in pellet stoves. If the electricity goes off, your pellet stove will not work unless you have a backup battery system.
- If you use wood as a fuel, you should clean your chimney or wood stove pipe at least once a year or have a professional chimney sweep clean and inspect for damage.
- Check with the insurance agent who carries your homeowner's policy to ensure that there are no additional costs or inspections necessary when heating with wood.
- If you are building a new house, local codes may require an electric or gas furnace as the primary heating appliance.

Comparing costs of wood or wood pellets and other fuels

Table 1 compares several types of fuel based on their cost per million BTUs of available heat at a given price.

We can see from Table 1 that, at these prices, well-seasoned dense hardwoods such as oak and madrone are very cost-competitive with alternative fuels, as are larch and Douglas-fir. Wood pellets are also cost-competitive at $250/ton.

Table 1.—Price per million BTUs of available heat for alternative fuels, firewood, and wood pellets.

Fuel	Cost per unit	Cost per million BTUs of available heat
Natural gas	$1.962/therm[1]	$24.52
Electricity	$0.0653/KWH[2]	$19.12
Heating oil	$2.987/gallon[1]	$25.75
Propane	$2.501/gallon[1]	$34.35
Firewood at $150/cord		
Oregon white oak		$8.40
Madrone		$8.40
Western larch		$11.40
Douglas-fir		$11.85
Alder		$13.95
Ponderosa pine		$14.70
Firewood at $250/cord		
Oregon white oak		$14.00
Madrone		$14.00
Western larch		$19.00
Douglas-fir		$19.75
Alder		$23.25
Ponderosa pine		$24.50
Wood pellets at $200/ton		$15.20
Wood pellets at $250/ton		$19.00

[1] U.S. Department of Energy, Energy Information Administration, November 10, 2008.

[2] Actual cost of residential electricity October/November, 2008, Newport, OR.

Doing your own comparisons

To make a decision about changing to a different fuel source, you'll need to compare the actual costs of fuels in your area. To determine these costs, check your utility bills or contact your utility and local suppliers of other fuels.

An Excel spreadsheet that can compare costs of alternative heating fuels is available at:
http://extension.oregonstate.edu/lincoln/forestry/
Enter values for local fuel costs into the spreadsheet, and it will calculate cost comparisons for you.

You can also use the information in Table 2 and information on actual fuel costs in your area to manually compare costs of different types of fuel. Table 2 lists several types of fuel, units of sale, and heat value (BTU/unit). It also shows the heating efficiency of various types of appliances, the available heat (BTU/unit), and the number of units required to produce 1 million BTUs of available heat.

Appliance efficiency

When comparing fuels, an important factor is the efficiency of your home's heating appliance. Efficiency is measured by how well your heater turns fuel into useful heat. Only electricity is considered to be 100 percent efficient.

New Environmental Protection Agency-approved stoves are at least 60 percent efficient, and some are as much as 80 percent efficient. An open fireplace is not nearly as efficient as a highly efficient pellet stove (Figures 4 and 5). To compare these two options, you would have to assume a lower heating efficiency for the open fireplace, probably as low as 10 to 15 percent.

Table 2.—Comparing alternative fuel sources and the number of fuel units required to generate 1 million BTUs of available heat.

Fuel	Unit of sale	Unit heat value (BTU/unit)	Heating efficiency (%)	Available heat/unit (BTU)	Units required for 1 million BTUs available heat
Natural gas	Therm	100,000	80	80,000	12.50
Electricity	KWH	3,415	100	3,415	292.83
Heating oil	Gallon	145,000	80	116,000	8.62
Propane	Gallon	91,000	80	72,800	13.74
Oregon white oak	Cord	30,000,000	60	18,000,000	0.056
Madrone	Cord	30,000,000[1]	60	18,000,000	0.056
Western larch	Cord	22,000,000[1]	60[2]	13,200,000	0.076
Douglas-fir	Cord	21,000,000[1]	60[2]	12,600,000	0.079
Alder	Cord	18,000,000[1]	60[2]	10,800,000	0.093
Ponderosa pine	Cord	17,000,000[1]	60[2]	10,200,000	0.098
Wood pellets	Ton	16,500,000	80	13 200,000	0.076

[1] Approximate values for wood species based on a cord of firewood equal to 85 cubic feet of solid wood. Wood is at 20 percent moisture content calculated by the wet basis.

[2] Combusted in an airtight wood stove.

Figure 4.—Pellet stoves are more efficient than an open fireplace.

Figure 5.—Wood pellets in a pellet stove hopper.

Example 1—Calculating the payback period for a new wood stove or insert

Assume you now heat with natural gas and use 600 therms per year. You expect the cost per therm to remain $1.962. A new wood stove is 70 percent efficient, and total installed cost is $3,000. You plan to burn mostly Douglas-fir at 20 percent moisture content, and you can purchase cords (85 cubic feet of solid wood) for $200. How long will it take to recover the cost of installing a wood stove?

1. **Calculate the amount of available heat you are using.**
   therms/year x available heat/unit = BTUs/year:
   600 therms x 80,000 BTUs/therm = 48,000,000 BTUs/year

   You need 48,000,000 BTUs to heat your house.

2. **Calculate your current annual heating cost.**
   therms/year x cost/therm = annual heating cost:
   600 therms x $1.962/therm = $1,177.20

   You currently spend $1,177.20 per year to generate 48,000,000 BTUs and heat your house.

3. **Calculate the amount of wood needed to generate 1 million BTUs.**
   a. unit heat value x efficiency = available heat/cord:
   21,000,000 BTUs/cord x 0.70 = 14,700,000 available BTUs/cord

   b. 1 million ÷ available BTUs/cord = cords required for 1 million BTUs:
   1 million ÷ 14,700,000 = 0.068 cord

   It will take 0.068 cord of firewood to generate 1 million BTUs of available heat.

4. **Calculate the amount of Douglas-fir firewood needed to heat your house.**
   BTUs used x amount of wood/1 million BTUs ÷ 1 million = amount of wood:
   48,000,000 BTUs x 0.068 cord ÷ 1 million = 3.264 cords

   You will need 3.264 cords of firewood to heat your house each year.

5. **Calculate the cost of the firewood.**
   number of cords x cost/cord = cost of firewood:
   3.264 cords x $200 = $652.80

   It will cost $652.80 each year to heat your house with firewood.

6. **Calculate the annual savings of using firewood.**
   annual cost of natural gas – annual cost of firewood = annual savings:
   $1,177.20 – $652.80 = $524.40

   With the wood stove, you will save $524.40 each year in fuel costs.

7. **Calculate the payback period for purchasing a wood stove.**
   cost of stove ÷ annual savings = years to pay back stove cost:
   $3,000 ÷ $524/year = 5.7 years

   It will take 5.7 years to recover the cost of your investment in the new wood stove. There may be state or federal tax incentives for purchasing high-efficiency wood-burning appliances. Such incentives would decrease the payback period.

Example 2: Comparing the heating value of two fuels

How much heating oil or natural gas would be replaced by one cord of firewood?

available heat/cord ÷ available heat/unit of alternative fuel = amount replaced:

Natural gas: 18,000,000/cord ÷ 80,000/therm = 225 therms

Heating oil: 18,000,000/cord ÷ 116,000/gal = 155 gallons of heating oil

The heating value of a cord of well-seasoned dense hardwood is equal to the heating value of about 225 therms of natural gas or about 155 gallons of heating oil.

Example 3: Calculating the break-even cost of firewood to replace current fuel

Assume you use 35,000 KWH of electricity to heat your home, and the cost of electricity is $0.0653/KWH. How much Douglas-fir firewood would you need to heat your home? At what price of firewood would you break even on the cost of heating your home with firewood instead of electricity?

1. **Calculate the KWH value of a cord of firewood.**

   available heat/cord of firewood ÷ available heat/unit of alternative fuel:

   12,600,000 BTUs/cord ÷ 3,415 BTUs/KWH = 3,690 KWH/cord

   A cord of firewood is equal to about 3,690 KWH of electricity.

2. **Calculate the amount of firewood needed to replace the total BTUs of electricity.**

   BTUs of electricity to replace ÷ KWH/cord:

   35,000 KWH/year ÷ 3,690 KWH/cord = 9.48 cords/year

   To replace 35,000 KWH of electricity, you would need approximately 9.5 cords of Douglas-fir firewood.

3. **Calculate your current cost of electricity.**

   cost/KWH x electricity used:

   $0.0653/KWH x 35,000 KWH/year = $2,285

   You currently spend $2,285 to heat your home with electricity.

4. **Calculate the break-even cost of firewood.**

   cost of electricity ÷ 9.48 cords:

   $2,285 ÷ 9.48 = $240

   You can break even if the cost of Douglas-fir firewood is $240 per cord. If the cost per cord is less than $240, you will save money on fuel costs by burning firewood.

For more information

The U.S. Department of Energy Information Administration tracks some fuel prices: http://www.eia.doe.gov/

For Oregon fuel prices, go to the Oregon Public Utility Commission: http://www.oregon.gov/PUC/index.shtml

For information on wood and pellet stoves, see the U. S. Environmental Protection Agency site for Cleaner Burning Wood Stoves and Fireplaces: http://www.epa.gov/woodstoves/index.html

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