For Additional Information on:

- Home heating with wood
- Wood stove installation
- Wood safety
- Woodlot management
- Cutting and storing of wood

Write to:

The National Solar Heating and Cooling Information Center
P.O. Box 1607
Rockville, MD 20850

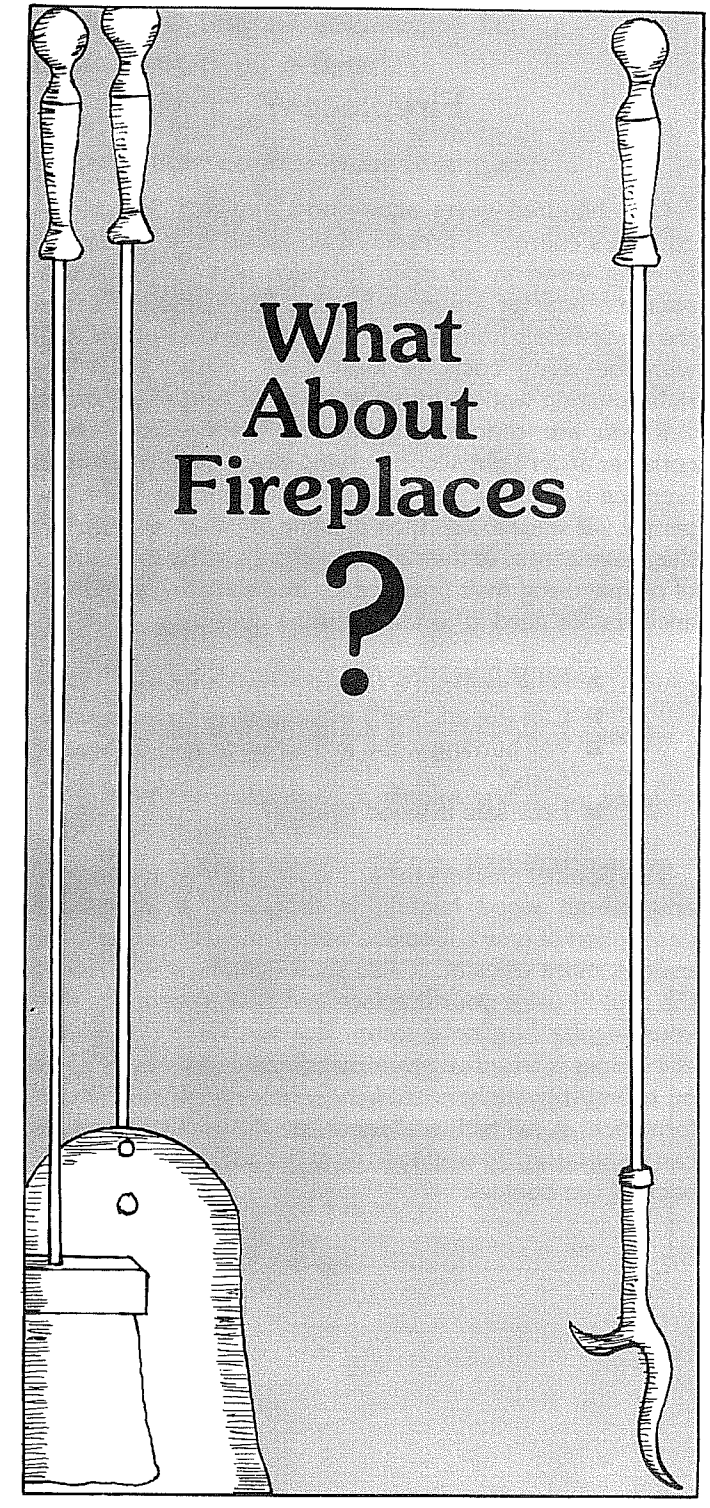
If you have further questions, or if you would like a report on fireplace efficiency measurements, "Determination of In Situ Fireplace Performance" M. P. Modera LBL-10701, write the author:

Richard C. Diamond
Lawrence Berkeley Laboratory 90-3076
University of California
Berkeley, CA 94720

Lawrence Berkeley Laboratory
University of California
Berkeley, California 94720

Prepared for the U.S. Department of Energy under Contract W-7405-ENG-48

Technical Information Department/Pub 313/500/Sept. 1980



What About Fireplaces?

Prepared for the U.S. Department of Energy

What About Fireplaces?

One hundred years ago, wood provided 75% of the country's energy; at present, it accounts for less than 1%. Burning wood in an open fireplace was the traditional source of heat for American houses. Today, more than half the single-family homes in the U.S. still have fireplaces and, with the rising costs of fossil fuels, many people are rediscovering wood-burning as a way to heat their homes.

If you are serious about wood heating, you should consider an air-tight, wood-burning stove, because an open fireplace is an inefficient way of heating a house. But many people will want to use their existing fireplace, especially if they have access to their own wood supply. As the number of people using their fireplace for home-heating increases, answers are needed to the following questions:

- How well can a fireplace heat a house?
- Can the efficiency of a fireplace be improved?
- Will burning wood in a fireplace save on heating costs?
- How safe is wood heating?

This booklet answers these and other questions that may arise about wood heating in fireplaces. It contains a description of how a fireplace works, and suggests ways to make it more efficient. It also shows you how to calculate the cost of using your fireplace and how to compare it to your regular heating system. This section on costs and efficiencies is based on actual measurements recently taken by energy researchers studying whole-house energy performance. A full technical report on these measurements can be obtained by writing to us at the address given on the back of the booklet.

What are the advantages to using wood as a fuel?

Like any fuel, wood has its advantages and disadvantages. These are some of the advantages:

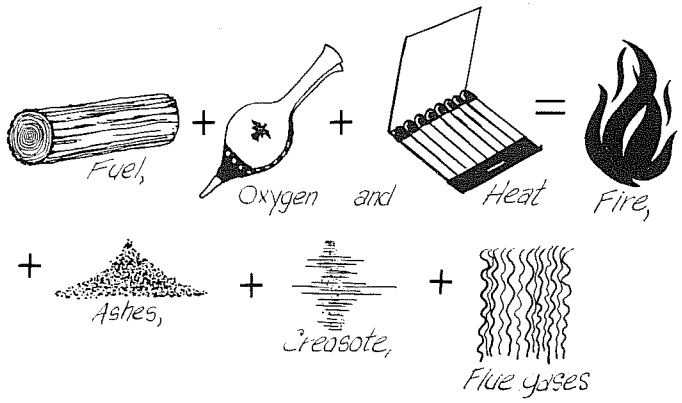
- Wood is a renewable resource, unlike fossil fuels.
- A fireplace can provide a back-up source of heat during a power failure or fuel shortage.
- Firewood is inexpensive if the user is willing to supply the labor for cutting, splitting, and handling.
- Wood is a safe fuel when properly used.
- A wood fire is aesthetically pleasing.

Some of the disadvantages are listed below:

- A fireplace usually heats only the room in which it is located.
- Wood is bulky to transport and store.
- For firewood to be an economic alternative to other fuel, the labor for producing it must be provided by the user.
- Wood burning adds smoke and other visible pollutants to the air.
- Increased-wood cutting may lead to damage in forests and watersheds.

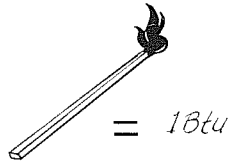
Whether you plan to burn wood to heat your whole house through the winter, or just to light an occasional fire to take the chill out of the air, it is important to understand how a fireplace works, so you can enjoy it both safely and economically.

How a Fire Burns



Three things are needed for a fire to burn: fuel, oxygen, and a high enough temperature to start combustion. The fire produces heat and a few by-products — ashes and creosote — formed by the incomplete combustion of the wood. Creosote is a sticky flammable substance left behind on the inner walls of the chimney by the escaping flue gases.

How much heat can you get from wood?



Heat is energy and may be measured in Btu (British thermal units). One Btu is about equal to the heat given off by a blue-tip match.

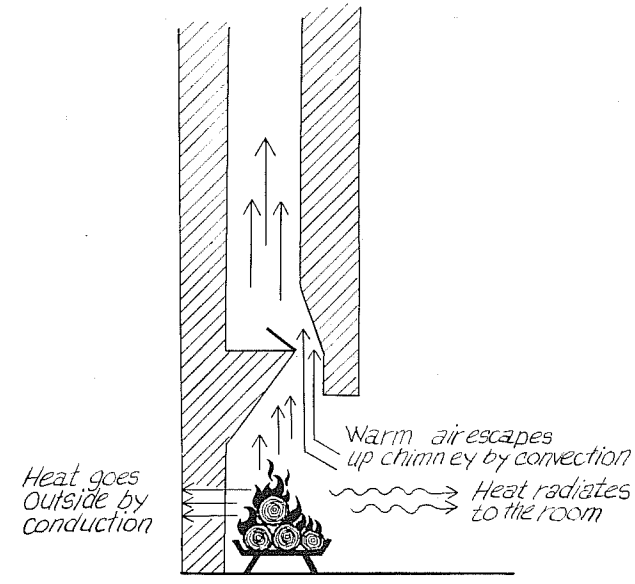
A good-sized fire will burn 10–12 pounds of wood per hour, giving off 100,000 Btu/hour. (An average furnace provides 80,000–100,000 Btu/hour). But most of the heat produced by the fire is lost to the outside, and doesn't warm the house. To understand why this happens, it is necessary to know something about how heat travels, and how a fireplace works.

How Heat Travels

Heat travels by radiation, conduction, and convection. **Radiation** leaves the fire and warms the surfaces of a room, heating the walls and furniture, as well as people and pets. It does not heat appreciably the air; radiant energy is why the sun feels warm on a windless winter day when the air temperature is below freezing. Nearly all the useful heat from an open fireplace comes as radiant energy, which warms only those objects in direct view of the fire.

Conduction is heat transfer through a material or from one material to another by direct contact. When holding a warm cup of coffee, your hand is heated by conduction.

Convection is the heat transferred by air movement. Since warm air rises, most of a fire's heat is lost up the chimney by the buoyant flue gases.



The diagram above shows how these mechanisms of heat transfer occur when a fire is burning. Radiation from the flames and glowing wood heats the room directly as well as bouncing off the walls and sides of the fireplace to add reflective radiation. The hot gases released from the wood rise up the chimney by convection, drawing in room air up the chimney as well. At the same time, heat travels by conduction through the back wall of the fireplace and chimney to the colder outside. The net effect of these actions is summarized on the next page.

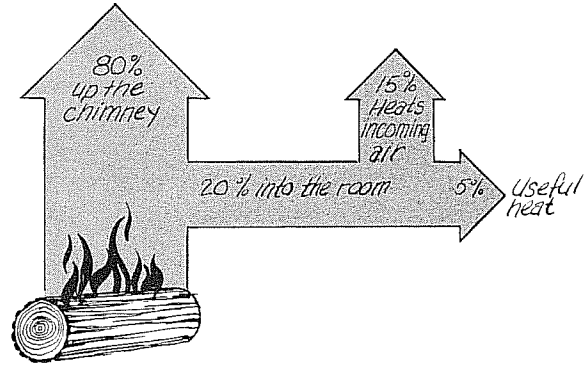
How Much Heat Gets Into the House?

Two main actions control the useful heat provided by the fireplace to the house:

- Radiant energy released to the room.
- Hot gases rising up the chimney.

The upward draft of air in the chimney draws in room air which, in turn, draws outside air into all rooms of the house. ***Fireplaces typically draw in air from the room at a rate ten times greater than the air needed for combustion.*** The net result is that most of the energy from the fire is used to heat the excess cold air pulled in from the outside.

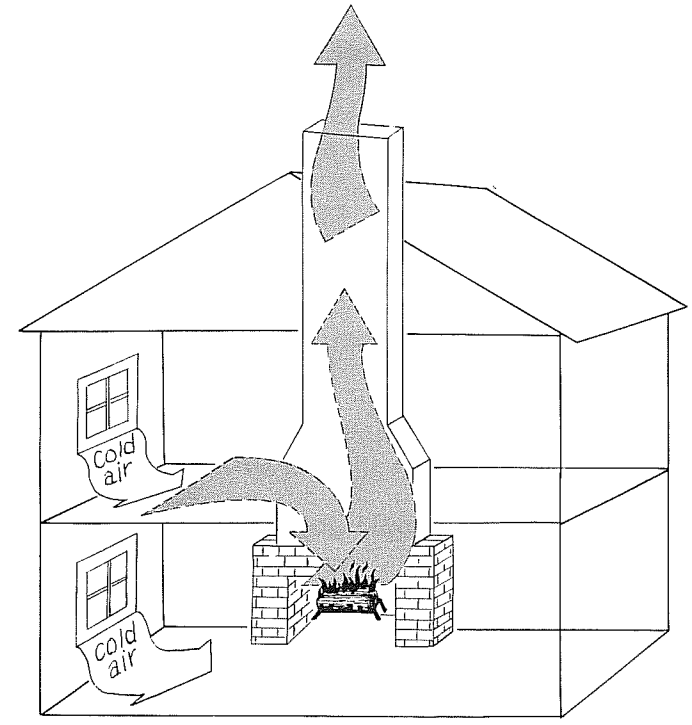
The following example shows a typical fireplace efficiency:



In an average fire, of the 100,000 Btu produced each hour, 80,000 Btu are lost up the chimney in the hot flue gases. Of the remaining 20,000 Btu of radiant heat, 15,000 are used to heat the outside air drawn in by the fire. So, of the original 100,000 Btu, only 5,000 Btu finally warm the house — giving a net efficiency of 5%!

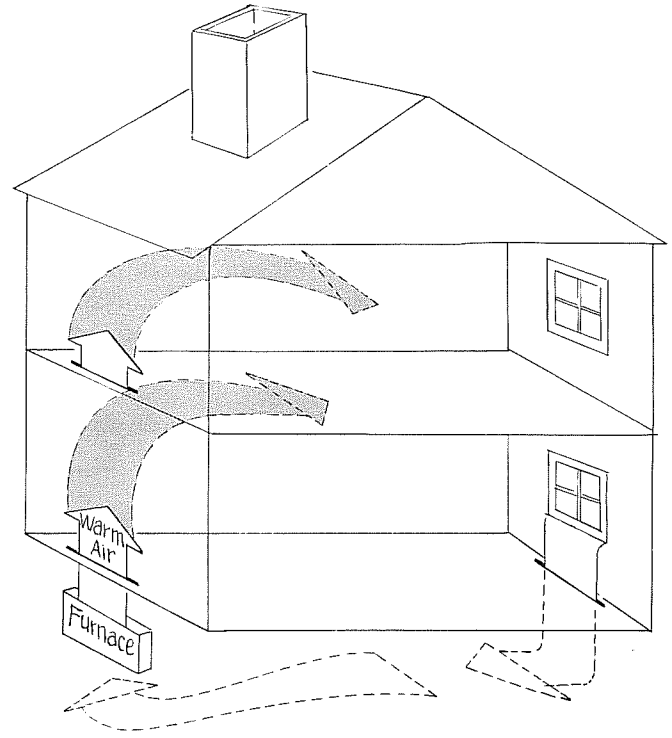
In very cold weather, the fireplace will draw in cold air faster than the fire can heat it. The outer rooms of the house, which don't benefit from the radiant gains, will drop in temperature. This gives the fireplace a ***negative efficiency,*** and explains why the fireplace cannot heat the entire house in winter.

How a Fireplace Heats a House



A fireplace is a local heater, radiating heat to one room. Because an open fireplace draws so much outside air into the house, rooms not getting direct radiation will cool down. During the night, when the fire has burned down, warm air will continue to escape up the chimney, and the house will cool even further.

How a Furnace Heats a House



In central heating, a single furnace supplies heat to the whole house by ducting hot air or by circulating hot water and steam through pipes to each room. The furnace is controlled by a thermostat which senses the temperature in one location. If the thermostat is in the same room with the fireplace, the furnace will not go on when the fire is burning, even though the rest of the house is cooling down. If the thermostat is in a different room from the fireplace, the furnace will go on when the outer rooms start to cool. ***By setting the thermostat back, you will keep the fireplace from turning the furnace on.***

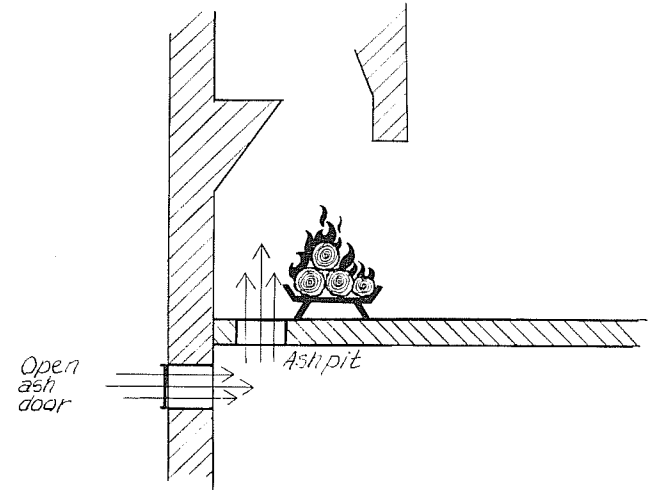
Get the Most From Your Fireplace

Reduce the setting of your thermostat when the fire is burning especially if the thermostat is located in a room away from the fireplace. Remember that rooms not heated by the fire will be cooled by the outside air needed to replace the air drawn up the chimney. It doesn't pay to have your furnace work harder when you are trying to save energy by burning wood.

Use the fireplace in mild weather. Burning wood in an open fireplace in very cold weather brings in so much cold air that you actually cool rather than heat your house.

If the fireplace smokes when you light a fire, there is insufficient draft in the chimney. In a two-story house, make sure all windows upstairs are closed and no unnecessary exhaust fans are running. Fans or open upstairs windows tend to depressurize the house, bringing smoke back down the chimney. If the fireplace still smokes, try opening a downstairs or basement window. Once the fire is going, the window should be closed.

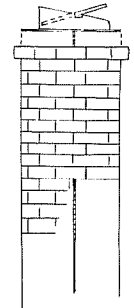
If your fireplace smokes persistently during fires, you may have to introduce outside air directly to the fireplace. If you have an ash pit with an exterior door, you can open it to let air in while the fire is burning. This stops uncomfortable drafts of cold air along the floor. A direct outside air supply will decrease excess cold air infiltration through outer rooms and may thus raise fireplace efficiency. Make sure such vents are well-sealed when not needed, or you will lose heated air through them.



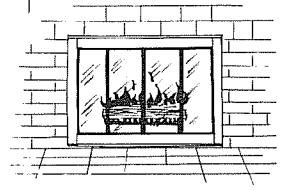
Fireplace Improvements

When you aren't having a fire, it is important to have the fireplace sealed off to prevent the warm inside air from escaping up the chimney. A damper in the fireplace is designed to prevent this loss, but often it is broken, warped, or even missing, in which case you must replace it, or seal the fireplace another way. Leaving the damper open (or not having one at all) is like having a window open night and day!

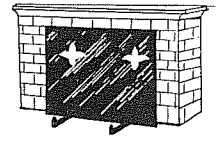
There are several ways to seal off a fireplace — using fireplace covers, glass doors, or chimney-top dampers. Perhaps the easiest solution is to crumple newspaper or use a piece of dense insulation to stuff the chimney opening. ***Be sure to remove this material before lighting a fire.***



A chimney-top damper is attached to the top of the chimney and is operated by a chain that runs down into the fireplace. There are several different models, but they all attach to the top of the chimney and are operated by a chain that runs down into the fireplace. They are easier to install than a conventional damper, and fit standard chimney sizes. You can buy one for under $100 and install it yourself.



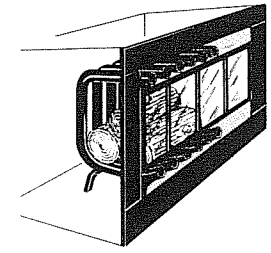
Glass doors, when correctly installed, are an effective way to seal the opening of a fireplace. Keep the glass doors closed during a fire as they have air intakes at the bottom which allow controlled amounts of air to enter. While the glass doors block more than half the radiant energy to the room, they more than make up for this heat loss by preventing warm room air from going up the chimney.



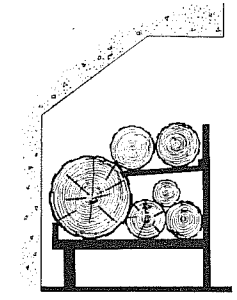
Fireplace covers are metal shields that seal the front of the fireplace. They are useful when the damper must be kept open for a dying fire because they keep warm room air from going up the chimney.

Fireplace Accessories

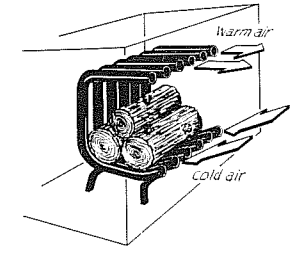
A number of products designed to increase the efficiency of the fireplace are now on the market. They are specifically designed either to increase the heat added to the room, or to stop the flow of warm air up the chimney; some units are a combination of both.



Convective grates have an array of tubes that cradle the fire while drawing in room air and sending heated air back into the room. They rely on natural convection or use fans to circulate the air.



Radiant grates are designed to increase the radiant energy of a fire by exposing a greater surface area of burning wood to the room. They also tend to hold more wood than ordinary grates, creating a bigger, hotter fire.



A combination unit combines a convective grate with a glass screen across the front of the fire to block the room air flow up the chimney. The heat in the air coming from the tubes is greater than the radiant energy stopped by the glass doors.

A shell unit is a metal box inserted into the fireplace where it operates like a combination unit by circulating air around the heated box. High efficiencies are possible with this accessory by using the adjustable damper.

These accessories may increase the efficiency of the fireplace by 5–30%, depending on the model and type. The section of this booklet on costs will show you how to calculate the efficiency of these devices for your fireplace.

Wood stoves have efficiencies of 60–70%. Some models

can be installed in existing fireplaces and connected to the chimney. Although less efficient than the free-standing models because they radiate less heat, they are cheaper and easier to install.

What Wood To Burn?

That available heat or heating value from a ***pound*** of any wood is about the same. However, wood is sold by volume not by weight, which means that the density of the wood is the important factor in getting the most energy per cord. So, per cord, a dense wood like white oak has more energy than a light wood like white pine, even though their heating values are similar.

To get the most heat out of a log, it is important to burn well-seasoned wood, or wood that has a low moisture content. Freshly cut, or green wood has a high moisture content. In order for it to burn, energy must first be used to boil off the water in the wood.

Burning green wood not only reduces the heat output of the fire, but also increases the creosote build-up in the chimney and poses a serious fire hazard. However, you can buy green wood cheaply, then split and season it yourself. Wood will take 6–12 months to air dry; split wood will dry faster. Wood distributors should be able to tell you the moisture content of the wood they sell.

While any type of well-seasoned wood is suitable for burning, different types of wood do have special burning characteristics. Pine and other soft woods burn quickly and are suitable for kindling or to start a fire when you want to get a lot of heat fast. Denser woods, like oak and hickory, burn more slowly and give longer-lasting coals. Cedar, as well as wood from most fruit trees, provides aromatic fires.

Where to get wood

Check your local newspaper or yellow pages under "firewood". Federal and state forests often allow supervised cutting for a nominal fee; contact your nearest forest service district ranger or your local state forestry office for information. Street and city park departments have tree-pruning crews who haul wood off to the dump. Because many local ordinances forbid open burning, you can often retrieve firewood there. Check with city dump and landfill authorities for approval. Utilities and phone companies clear trees from their lines and leave wood stacked in piles by the side of the road. Other sources include fruit orchards, which need frequent pruning, and mills and lumber yards, which have scraps of excellent fuel wood.

Safety

No house should be without a fire extinguisher. If you are burning wood frequently, keep a fire extinguisher near the fireplace, not on the mantle where you can't reach it when you need it. Smoke detectors are also recommended and are now fairly inexpensive; some models cost only $25. The occasional false alarm is worth the increase in safety to you and your home. A good fireplace screen — one that curves on the sides and top — will help keep sparks in the fireplace.

Chimney fires are a major hazard associated with wood heating. Creosote accumulates inside a chimney and can ignite, shooting flames and sparks up through the chimney. Not only can flying sparks ignite a shingled roof, but the high temperature of the chimney where it passes through the ceiling can set the house on fire.

Check the yellow pages for a professional chimney sweep, or do it yourself. Clean the chimney with a good stiff chimney brush, or with chains lowered from the top in a burlap sack to knock the soot and creosote from the sides of the chimney. Tape an old sheet across the fireplace opening to prevent the soot from spreading all over the room.

In case of a chimney fire:

- Call the fire department.
- Cover the opening (by closing metal or glass doors) to smother the fire.
- Hose down the roof and look for flying sparks.

Can Fireplaces Save on Heating Costs?

The chart below shows 1980 national price averages for electricity, heating oil, natural gas, and wood. The prices in the last column are the costs of one million Btu of useful heat from each. To find out whether ***your*** fireplace can save you money, fill in the blanks in the following chart with the values calculated for your fireplace and heating system. The diagram and the tables on the next page will tell you your efficiency figures and your comparative heating costs.

Typical Costs of Heating with Wood and other Fuels

A Fuel	B Price (U.S. average)	C Price per Million Btu	D Efficiency (Typical)	C/D = E Price per Million Btu of Useful Heat
Electricity	$.05/kWh	$14.70	70–98%	$15.00–21.00
#2 Heating Oil	$.78/gal	$ 5.60	40–75%	$ 7.50–14.00
Natural Gas	$.37/Therm	$ 3.60	60–75%	$ 4.80–6.00
_____	_____	_____	_____	
Enter your heating fuel (above)				
White Oak	$100/cord*	$ 4.25	5–30%	$14.20–85.00
Example (shown above) using national averages				
_____	_____	_____	_____	
Enter your wood type (above)				

1. Write the fuel you use and the type of wood you burn on the dotted lines in Column A.

2. In column B write the unit price you pay for fuel and the cost per cord of firewood. Your utility bill will tell you the current price of fuel. If you don't have one handy, use the appropriate value given in the chart — these are national averages.

3. Worksheet 1 will show you how to find the values for column C.

4. Worksheets 2 and 3 will show you how to calculate the efficiencies for column D.

5. Divide the number in column C by the number in column D to get the value for column E.

6. The numbers in column E allow you to compare fireplace and furnace heating on an equal basis. Of course, there may be other benefits you may receive from your fireplace that are not reflected in these figures.

*1 cord equals a stack of wood 4 ft x 4 ft x 8 ft.

WORKSHEET 1

How Much Heat is Available From a Fuel?

To estimate how much heat is available from your wood, without having to do any complicated calculations, try using the graph of worksheet 1. The graph relates the price of your wood, its density, and its moisture content to the cost of the energy you get from your cord, expressed in dollars per million Btu ($/MBtu). Along the horizontal axis of the graph you will find a range of wood prices; extending diagonally across the graph are three lines representing three possible wood densities: low, medium, and high. The vertical scales on the left of the graph give the cost per million Btu for different moisture contents, ranging from 0–40% moisture.

First, use the table below to look up your firewood, and find its approximate density. Next, locate on the bottom scale of the graph the price you pay for a cord of that wood, and draw a line up to the correct density and perpendicular to the graph's bottom scale at that point. As an example, we drew in line **a-b.** Note where your line intersects the diagonal line that matches your wood density. Our line **a-b** — drawn for a $100 cord of high density wood, e.g., birch — intersects the high density diagonal at point **b.**

Now recall the approximate moisture content of your wood, and draw in a new horizontal line to your left from the point where your wood price and your wood density intersect (point **b** in our example), until the line you have just drawn reaches a point directly below the approximate moisture content of your wood, shown on the top scale. (This point is marked **c** in our example, to register the assumed 30% moisture content of our imaginary birch cord. Because point **c** happens to fall on the $5/MBtu line, we know we are paying that price for every million Btu of energy our cord produces.

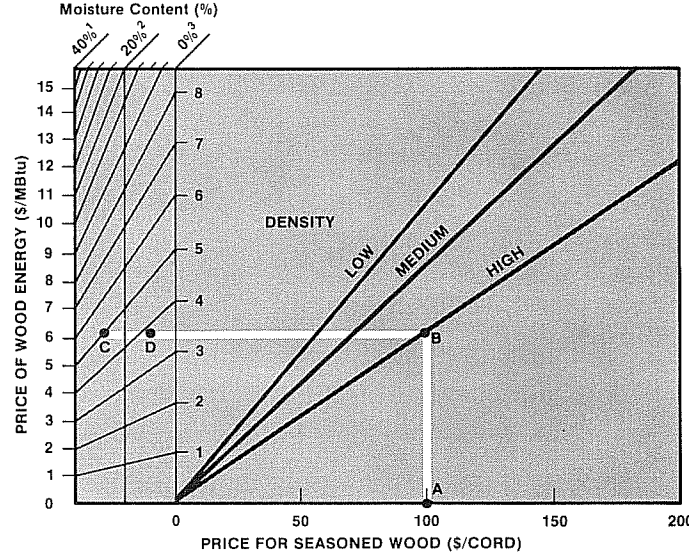
But what if your cord's moisture and its density do not determine a point exactly on a $/MBtu price line, as at point **d** in our example? In that case, simply note the two diagonal lines above and below the relevant point. In our example, point **d** falls about two thirds of the distance between the $3/MBtu and the $4/MBtu lines. So point **d** corresponds to a price of $3.67/MBtu. Once you have found the price of a million Btu for your cord, write that price in column **C.**

WORKSHEET 1

For Your Wood

Densities

High	Medium	Low
Ash	American Elm	Aspen
Birch	Black Walnut	Cedar
Black Locust	Douglas Fir	Chestnut
Hickory	Juniper	Cottonwood
Oak	Magnolia	Redwood
Slash Pine	Red Maple	Spruce
Sugar Maple	Sycamore	White Pine
Yew	Western Larch	Willow

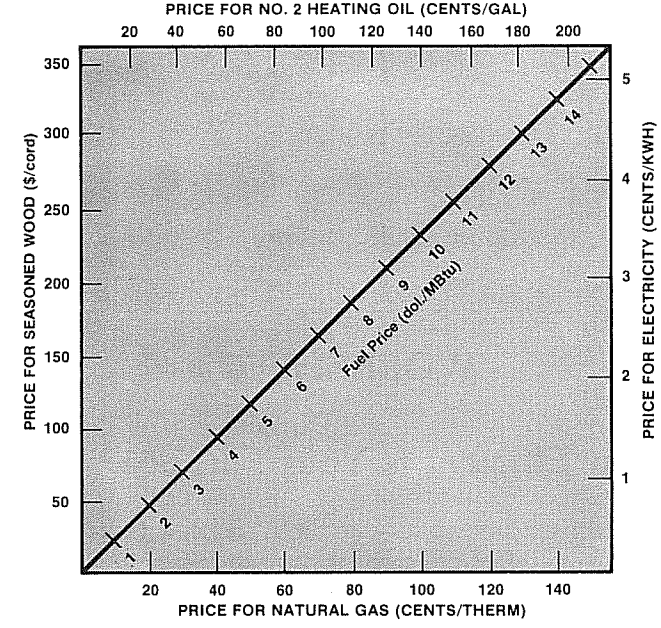


[1]Fresh-cut wood
[2]Seasoned wood
[3]Oven-dried wood

WORKSHEET 1

For Your Furnace

Locate the correct scale for your fuel type and, using the price from column **B,** go straight to the diagonal line to find the cost per million Btu for that fuel. Write this number on the appropriate line in column **C.**



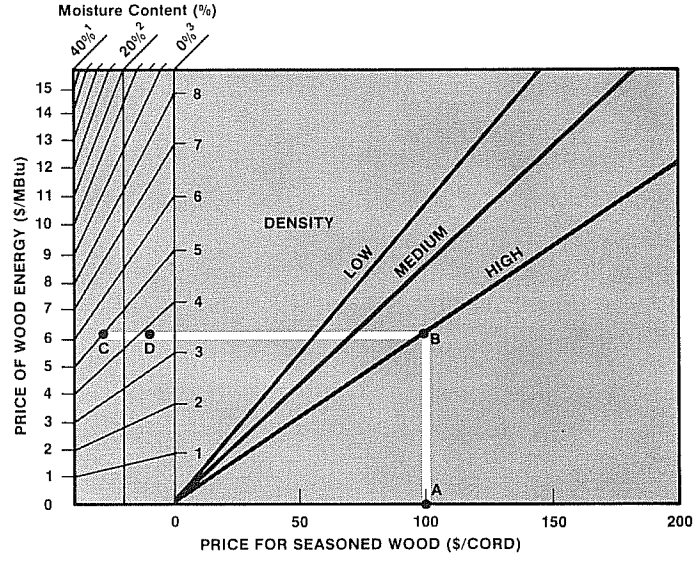
Next page for Worksheet 2 and 3.

WORKSHEET 1

For Your Wood

Densities

High	Medium	Low
Ash	American Elm	Aspen
Birch	Black Walnut	Cedar
Black Locust	Douglas Fir	Chestnut
Hickory	Juniper	Cottonwood
Oak	Magnolia	Redwood
Slash Pine	Red Maple	Spruce
Sugar Maple	Sycamore	White Pine
Yew	Western Larch	Willow

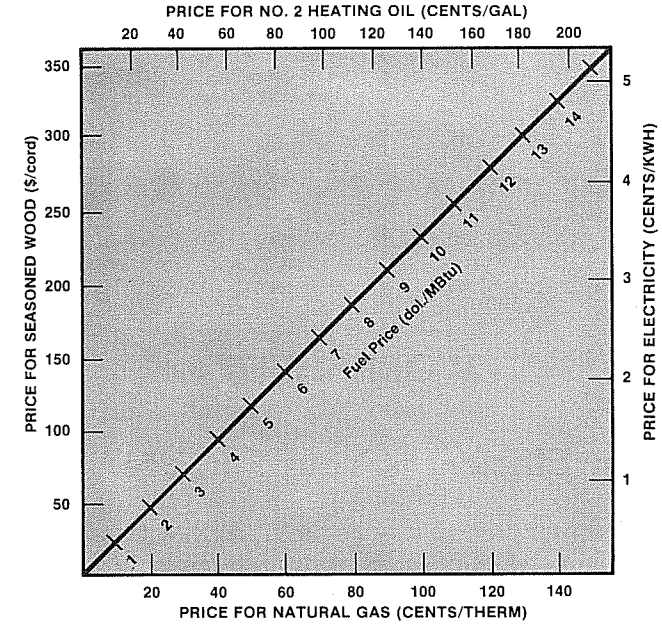


[1]Fresh-cut wood
[2]Seasoned wood
[3]Oven-dried wood

WORKSHEET 1

For Your Furnace

Locate the correct scale for your fuel type and, using the price from column **B**, go straight to the diagonal line to find the cost per million Btu for that fuel. Write this number on the appropriate line in column **C**.



Next page for Worksheet 2 and 3.

WORKSHEET 2

How Efficient is Your Fireplace?

Find your fireplace type in the left column. Starting with the average efficiency given, add or subtract, as indicated, to find the efficiency under various outdoor temperature conditions. Write this result in column **D.**

Fireplace	Average Efficiency	Correction for Outside Temperature	Your Fireplace
Open Fireplace	5%	Add 1% for every 10° above 40°F; subtract 1% for every 10° below 40°F.	_____ %
Radiant Grate	7%		_____ %
Convective Grate	10%		_____ %
Combination Unit	20%	Add 1% for every 20° above 40°F; subtract 1% for every 20° below 40°F.	_____ %
Shell Unit	30%		_____ %

WORKSHEET 3

How Efficient is Your Furnace?

Find your furnace type in the left column. Starting with the average efficiency given, add or subtract as appropriate, writing the result in column **D.**

Furnace Type	Average Efficiency	Ducts/Pipes Insulated and in Unheated Space #	Ducts/Pipes Uninsulated and in Unheated Space #	Your Furnace
Oil (forced air)	60%	-6%	-18%	_____ %*
Gas (forced air)	75%	-8%	-23%	_____ %
Electricity (forced air)	98%	-10%	-30%	_____ %
Oil (hot water)	60%	-2%	-10%	_____ %*
Electricity (baseboard)	100%	—	—	_____ %

#No correction necessary if ducts/pipes in heated space.

*If your oil burner was tuned in the last six months, add 10%.

Pointers to Remember:

- Buy an air-tight wood-burning stove for efficient wood heating.
- Don't use the fireplace on very cold days.
- Keep damper closed when not having a fire.
- Use glass doors or a metal cover to seal off the front of the fireplace.
- Turn down furnace thermostat when fire is burning.
- Don't burn green wood.
- Clean chimney periodically to prevent chimney fires.