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Wood Fuel for Heating

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Wood is a plentiful and accessible fuel for many Missourians. It is relatively clean and comes from a renewable resource — the forest or wood lot.

Coal and oil supplies are limited, are not renewable and, therefore, are "expensive" fuels in terms of national resources.

The heating value of properly prepared fuel wood compares favorably with other fuels. When you can get fuel wood from a woodland through timber-stand improvement, the woodland also benefits. During power failures or national emergencies, wood can be an important source of heat.

Wood, however, does have disadvantages for industrial or home heating that have contributed to a decline in its use. These include: (1) storage problems because wood creates greater bulk per unit of heat content; (2) wood must be dry for best performance; (3) Possible chimney-fire hazard because low pipe or flue temperatures cause residues to condense; and (4) inefficiency of many heating units and methods of fuel wood preparation.

New efficient heating and fuel preparation systems, however, may increase the popularity of wood as fuel. Heating units that use wood as one of a combination of fuels also are increasing in popularity.

How wood burns

When wood burns, three things happen: (1) water is removed by evaporation; (2) chemically, the wood breaks down into charcoal, gas and volatile liquids, with carbon dioxide and water being the chief end products; and (3) the charcoal burns, forming carbon dioxide either directly or with an intermediate conversion to carbon monoxide.

One pound of very dry (zero moisture content) wood of any species has a calorific value of approximately 8,600 Btu (British thermal unit, which equals the amount of heat required to raise the temperature of one pound of water one degree F). Any moisture in the wood reduces the recoverable heat by carrying heat up the chimney during vaporization. Each pound of water vaporized uses about 1,200 Btu.

Additional Btu are lost through the formation of volatile liquids and gases during combustion, but these vary by the type of heating unit and should be considered part of the efficiency factor of the heating unit.

A pound of wood with a 20-percent moisture content contains .17 pound of water and .83 pound of completely dry wood and has a heat value of about 7,000 Btu. **This is the base figure used in the heating comparisons made throughout this publication.**

Improving wood-fuel efficiency

To get as much heat as possible from wood fuels, use specially designed equipment, and operate the equipment by methods adapted to the fuel. Many types of heaters, furnaces and fireplaces exist, but their efficiency varies because of design and construction.

Most fireplaces, including Franklin-type stoves, are inefficient because their open front allows lots of heat to escape up the chimney. Installing glass fire screens with proper draft controls, or "heatilators," often increases fireplace efficiency. Properly designed fireplaces also can decrease heat loss. Modern fireplaces may have metal side walls and backs with space for air to circulate between the walls and the fireplace setting. Inlets near the floor and outlets near the mantel provide convection-air heating and circulation in addition to the radiant heat from the fireplace.

The old technique of admitting room air under the fire and letting it flow up through the fuel bed and then into the chimney flue is inefficient. To heat efficiently, combustible gases released during the burning process must be mixed with ample oxygen at a minimum temperature of 1,100 degrees.

For complete combustion of the wood gases, supply about 80 percent of the air needed over and around the fuel. The desirability of having air supplied over the fire bed has led to the design of "down-draft" combustion heating units. Such units force combustible elements to pass along a circuitous route where they are mixed with a current of hot air and nearly all burned. In less-efficient units these elements escape up the chimney or are deposited in the flue in the form of soot and creosote.

Best woods for burning

The fuel value of wood varies by the type of wood and depends on its density and moisture content. Any wood will burn, but the denser (heavier)

Table 1. Approximate weight per standard cord (80 cubic feet of solid wood content) of various woods (green and air-dried to 20-percent moisture content) and potential heat of air-dried wood.

	Pounds green[1]	Pounds air-dried[2]	Million Btu available[3]
Ash	3,940	3,370	23.6
Basswood	3,360	2,100	14.7
Box elder	3,500	2,500	17.5
Cottonwood	3,920	2,304	16.1
Elm (American)	4,293	2,868	20.1
Elm (red)	4,480	3,056	21.4
Hackberry	4,000	3,080	21.6
Hickory (shagbark)	4,980	4,160	29.1
Locust (black)	4,640	4,010	28.1
Maple (silver)	3,783	2,970	20.8
Maple (sugar)	4,386	3,577	25.0
Oak (red)	4,988	3,609	25.3
Oak (white)	4,942	3,863	27.0
Osage orange	5,480	4,380	30.7
Pine (shortleaf)	4,120	2,713	19.0
Red cedar	3,260	2,700	18.9
Sycamore	4,160	2,956	20.7
Walnut (black)	4,640	3,120	21.8

[1] Approximate weight of standard cord (occupying 128 cubic feet of space and containing 80 cubic feet of solid wood), for the first two columns of figures.
[2] To 20% moisture content.
[3] Potential available heat from standard cord with 100% unit efficiency. Heat at 20% moisture content.

woods, if properly dried, will deliver more Btu per cord. The advantages of drying wood to at least a 20-percent moisture level are indicated by Table 1. The average moisture content of green wood varies considerably by wood species. By looking at Table 1, you can see that if you bought a cord of green red oak and burned it without proper seasoning (to 20-percent moisture content), you would, for all practical purposes, reduce the amount of available Btu by the number it takes to vaporize 1,379 pounds of water.

Comparing wood to other fuel

Table 2 compares the basic heating value of wood with averages of other common fuels when figured at 100-percent burning efficiency. Because no heating unit performs at that efficiency, you need to know or estimate the relative efficiencies of the heating units you are considering or currently using.

Following are examples showing how the type of heating unit and its efficiency change the cost of heating with wood:

Example 1: You buy a standard cord of air-dried red oak for $40.

Available heat units equal 25.3 million Btu.

Assume your fireplace efficiency is 10 percent.

Your cost is $\dfrac{\$40.00}{25.3 \times .10}$ **= $15.81 per million Btu**

Example 2: Instead of a fireplace, you burn wood in a stove properly designed, constructed and installed, getting 50-percent efficiency. This lowers your cost per unit of heat available.

Your cost is $\dfrac{\$40.00}{25.3 \times .50}$ **= $3.16 per million Btu**

These examples show how an efficient heating unit can give more useful heat for the wood burned and save on your fuel bill.

Other examples will show how to compare the cost of wood fuel with other fuels **assuming equal efficiencies of the heating units**.

From Table 2 you find that a cord of air-dried red oak will provide a potential heat value of 25.3 million Btu. It would take 180.7 gallons of No. 2 fuel oil to provide the same number of Btu. At this ratio, if the price of oil were 45 cents a gallon, a cord of red oak would be worth (180.7 x .45) $81.32 as fuel.

Of course, the efficiency of the burning unit is important. If the wood burner is a fireplace with 20-percent efficiency, then you get only 5,060,000 Btu (25,300,000 x .20) from the cord of wood. On the other hand, if the stove burning the fuel oil operates at an efficiency of 50 percent, it provides (140,000 x .50) 70,000 Btu a gallon. At those efficiencies, the cord of red oak would be equivalent to only (5,060,000 ÷ 70,000) 72.3 gallons of oil, which at 45 cents a gallon would give the cord of red oak a value of (72.3 x .45) $32.54.

Seasoning wood

To get the most heat value, allow wood to dry following cutting and splitting. This usually requires several months. Most dense hardwoods require at least one year to season fully.

The more wood surface exposed to air, the faster it dries. Stack the wood in loose piles off the ground. The best place is a storage area exposed to sunlight. Covered storage, open on the sides, helps prevent rewetting from rain or snow.

Burn wood safely

You can use wood safely in home heating units. But each year, because of disregard for safety, many costly, tragic fires occur.

This doesn't have to happen. You simply need to use common sense and take the following precautions against fire:

- Construct the chimney properly, and keep it in good repair and clean of tars and creosote.
- The heating unit must be well-designed and

Table 2. Equivalent heat of other fuels compared to a cord of air-dried wood (80 cubic feet of solid wood content at 20-percent moisture) based on a heating-unit efficiency of 100 percent. (Note: Most wood-burning stoves sold today operate at less than 50-percent efficiency.

	Wood[1]	#2 Fuel[2] oil	Anthracite[3] coal	Natural[4] gas	LP[5] gas	Electric[6] heat
	available heat/cord in million Btu	gal. needed to equal cord	tons needed to equal cord	100 cu. ft. needed to equal cord	gal. needed to equal cord	kilowatt hrs. needed to equal cord
Ash	23.6	168.6	0.98	236	259.3	6,941
Basswood	14.7	105.0	0.61	147	161.5	4,324
Box elder	17.5	125.0	0.73	175	192.3	5,147
Cottonwood	16.1	115.0	0.67	161	176.9	4,735
Elm (American)	20.1	143.6	0.84	201	220.9	5,912
Elm (red)	21.4	152.9	0.89	214	235.2	6,294
Hackberry	21.6	154.3	0.90	216	237.4	6,353
Hickory (shagbark)	29.1	207.9	1.21	291	319.8	8,559
Locust (black)	28.1	200.7	1.17	281	308.8	8,265
Maple (silver)	20.8	148.6	0.87	208	228.6	6,118
Maple (sugar)	25.0	178.6	1.04	250	274.7	7,353
Oak (red)	25.3	180.7	1.05	253	278.0	7,441
Oak (white)	27.0	192.9	1.13	270	296.7	7,941
Osage orange	30.7	219.3	1.28	307	337.4	9,029
Pine (shortleaf)	19.0	135.7	0.79	190	208.8	5,588
Red cedar	18.9	135.0	0.79	189	207.7	5,559
Sycamore	20.7	147.9	0.86	207	227.5	6,088
Walnut (black)	21.8	155.7	0.91	218	239.6	6,412

1 Wood available heat at 20% moisture 7,000 Btu/pound (128 cubic feet with 80 cubic feet wood volume).
2 No.2 fuel oil available heat 140,000 Btu/gallon.
3 Anthracite coal available heat 12,000 Btu/pound.
4 Natural gas available heat 1,000 Btu/cubic foot.
5 LP gas available heat 91,000 Btu/gallon.
6 Electricity available heat 3,400 Btu/kilowatt hour.

constructed so burning coals, sparks and smoke cannot escape.

• Set the unit on an inflammable base large enough so coals or sparks cannot spill on a flammable floor surface.

• Protect flammable walls or ceilings by keeping the stove or pipes an adequate distance away or use a heat shield.

• Don’t place wood, clothing or other flammable materials where the heat from the unit could ignite them.

• Don’t place or store oils, gases or volatile liquids where open flames can ignite fumes.

• Don’t fully load a heating unit, set the draft and immediately leave because the fuel may flare up and overheat.

• Provide adequate ventilation so oxygen consumed by combustion can be replaced.

• Don’t use volatile liquids to start a fire.

• Be careful when removing ashes; live coals are often present, which might fall or otherwise contact flammable materials.

• Avoid fuels such as large pieces of cardboard or dry Christmas greenery, which produce high flames that can cause flue fires. Some materials you should never burn in a fire include plastics, poison ivy twigs and stems and chemically treated woods such as discarded poles and railroad ties. Many people are sensitive to small amounts of these smoke-associated chemicals.

When wood is harvested and seasoned properly and burned in an efficient and safe heating unit, it is a safe, efficient, economical and desirable fuel from a renewable resource. See Table 3 on page 4 for information about which firewood will work best for you.

How to buy firewood

Most wood is purchased by the cord although nationally, there is a trend toward selling firewood by weight and by small bundle. However, a cord is the accepted unit of measure.

A standard cord is 128 cubic feet. This may be 4 feet by 4 feet by 8 feet or 4 feet by 2 feet by 16 feet or any other combination yielding 128 cubic feet. A measure of one-third or one-half cord commonly has been called a “rick,” although a rick is really only a pile of wood.

Actual volume of solid wood in a cord varies from 65 cubic feet for small, crooked sticks, increasing with the size and straightness of the sticks up to

Table 3. Whether buying or cutting wood, these ratings may help you decide on the right kind of wood for your wood-burning stove.

Ratings for firewood

	Relative amount of heat	Easy to burn?	Easy to split?	Have heavy smoke?	Pop or throw sparks?	General rating and remarks
Hardwood Trees						
Ash, red oak, white oak, beech, birch, hickory, hard maple, pecan, dogwood	High	Yes	Yes	No	No	Excellent
Soft maple, cherry, walnut	Medium	Yes	Yes	No	No	Good
Elm, sycamore, gum	Medium	Medium	No	Medium	No	Fair — too much water when green
Aspen, basswood, cottonwood, yellow poplar	Low	Yes	Yes	Medium	No	Fair — but good for kindling
Softwood Trees						
Southern yellow pine	High	Yes	Yes	Yes	No	Good, but smoky
Cypress	Medium	Medium	Yes	Medium	No	Fair
Eastern red cedar	Medium	Yes	Yes	Medium	Yes	Good — good for kindling

From USDA Leaflet No. 559, *Firewood for Your Fireplace.*

about 90 cubic feet.

Average for this region is about 80 cubic feet. The shrinkage in volume between a cord of green wood and a cord of seasoned wood is about 8 percent.

Another common measure used in selling firewood is the “face cord” (4 feet by 8 feet by 24 inches). The length may vary from 18 inches to 24 inches. “Rank” and “fireplace cord” also are used to describe the amount of wood in a face cord.

Another element of the wood business is the firewood bundle, often seen at supermarkets. Seasoned oak or other dried hardwood weighs about 3,600 pounds per cord. Bundles, weighing about 36 pounds represent about 1⁄100 cord. Another measuring method may be by bundle size. For example, a bundle 1 foot by 1 foot by 2 feet would be 2 cubic feet or 1⁄64 cord.

Missouri law requires that in the sale of firewood a bill of sale be provided showing the name and address of the purchaser and the seller and the cords or fractions of a cord involved in the sale.

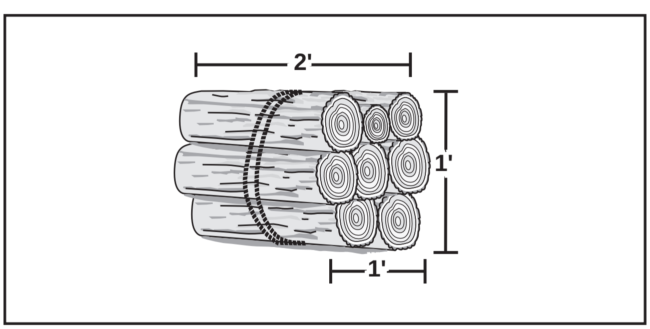

Figure 1. Fireplace bundle (fraction of cord. Example: 1⁄64 cord is 1 foot by 1 foot by 2 feet.

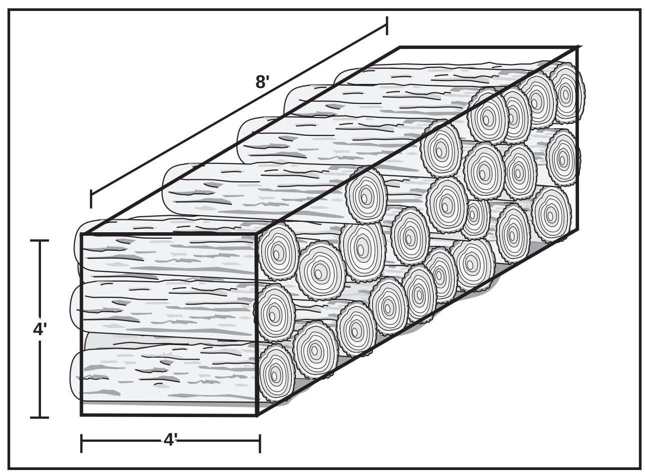

Figure 2. Standard cord of wood.

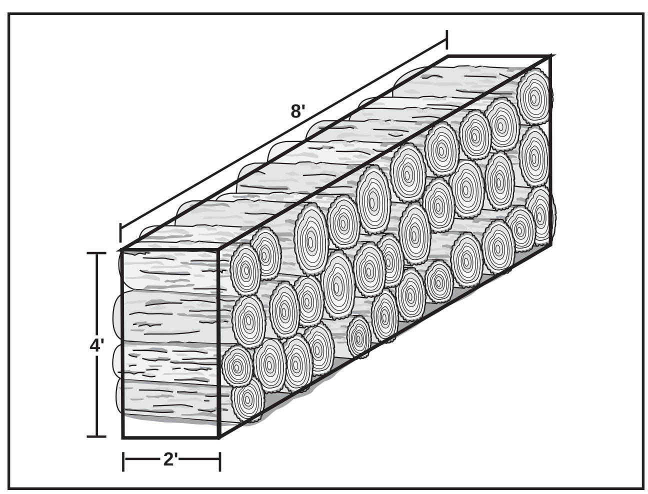

Figure 3. Face cord.

Which trees to cut

If you cut wood wisely, the remaining woodland will be more productive. Owners frequently cut the straight, well-pruned trees for firewood because they split easier than crooked trees with many limbs. This practice, coupled with leaving low-quality trees, reduces woodlots to junk lots.

Cut only those trees that, when removed, will give more room for growth to the most desirable trees in the woodlot. Removing inferior trees for firewood can solve one of the most difficult problems in building up forest resources. It can provide an income to the timber owner during the period when the best trees are making their most valuable growth. Also the better trees grow faster without excessive competition from inferior trees.

These are the most important classes of material you should use for fuelwood (one set of rules doesn't exactly fit every situation):

1. Sound dead trees and logging wastes, such as tops and large limbs.
2. Diseased or insect-infested trees (if the wood can be burned in a short period of time to prevent pest spreading).
3. Brushy, crooked or broken hardwoods.
4. Trees that have been seriously overtopped and stunted by others.
5. "Wolf" trees (those with unusually large spreading tops occupying excessive space).

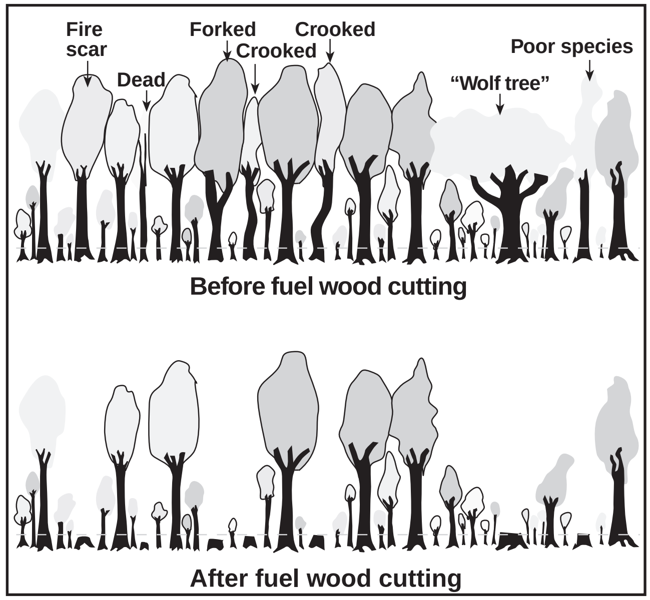

Figure 4. If you cut low-quality trees and crooked trees with many limbs for your firewood, you'll help woodland develop.

6. Undesirable species.

Before felling, mark trees to be cut.

Free technical advice is available through the Service Foresters of the Missouri Department of Conservation. Also see MU Publication G 5150, *Increase Woodland Products Through Timber Stand Improvement*.

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