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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 and are not renewable and, therefore, are "expensive" fuels in terms of national resources.

Heating value of properly prepared fuel wood compares favorably with other fuels. Where fuel wood can be obtained from a woodland as a result of "timber stand improvement," the woodland also benefits. During power failure or times of national emergency, wood can be an important source of heat.

Wood has disadvantages for industrial or home heating that have contributed to a per-capita decline in its use. These include (1) greater bulk per unit of heat content which creates storage problems; (2) wood must be dry for best performance; (3) low pipe or flue temperatures cause residues to condense, creating a chimney fire hazard; and (4) many heating units for burning wood and methods of fuel wood preparation are inefficient. However, new efficient heating and fuel preparation systems may increase the popularity of wood as a fuel source in the future. Heating units which use wood as one of a combination of fuels for the system are also increasing in popularity.

How Wood Burns

When wood burns, three things happen: (1) water is removed by evaporation; (2) there is a chemical breakdown of the wood 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 (0 moisture content) wood of any species has a calorific value of approximately 8,600 BTUs (BTU is a British Thermal Unit, which equals the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit). 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 BTUs.

Additional BTUs are lost through the formation of volatile liquids and gases during combustion, but these vary greatly by the type of heating unit and should be considered as 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 having a potential heat value of about 7,000 BTUs. THIS WILL BE THE BASE FIGURE USED IN THE HEATING COMPARISONS MADE THROUGHOUT THIS PUBLICATION.

Improving the Efficiency of Wood Fuel

To recover as much heat as possible from wood fuels, specially designed equipment should be used and operated by methods adapted to the fuel. Many types of heaters, furnaces and fireplaces are available but their efficiency varies greatly because of design and construction. Efficiency can vary from actually having a net heat loss from the house to perhaps 10 percent in a poorly designed fireplace to as high as 60 percent for properly designed stoves or furnaces.

Most fireplaces, including Franklin-type stoves, have low efficiency because their open front allows large volumes of heated air to escape up the chimney. Installing glass fire screens, with proper draft controls, or "heatilators", can often increase fireplace efficiency. Properly designed fireplaces can also cut down on loss of heat. 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 directly into the chimney flue is very inefficient. For efficient heating the combustible gases released during the burning process must be mixed with ample oxygen at a minimum temperature of 1,100 degrees Fahrenheit.

To attain complete combustion of the wood gases, about 80 percent of the air needed should be supplied 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 largely on its density and its moisture content. Any wood will burn but the denser (heavier) woods, if properly dried, will deliver more BTUs 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 be reducing the amount of available BTUs by the number it takes to vaporize 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. Since no heating unit performs at that efficiency you will need to know or estimate the relative

Table 1. Approximate Weight per Standard Cord *(80 cubic feet of solid wood content)* **of Various Woods** *(green and air dried to 20% moisture content)* **and Potential Available Heat of Air Dried Wood.**

	Approximate Weight of Standard Cord (occupying 128 cu. ft. of space and containing 80 cu. ft. of solid wood)		*Potential Available Heat from Standard Cord with 100% Unit Efficiency*
	Pounds when Green	*Pounds when Air Dried (20% moisture content)*	*Million BTU's of Available Heat at 20% Moisture Content*
Ash	3940	3370	23.6
Basswood	3360	2100	14.7
Box Elder	3500	2500	17.5
Cottonwood	3920	2304	16.1
Elm (American)	4293	2868	20.1
Elm (red)	4480	3056	21.4
Hackberry	4000	3080	21.6
Hickory (shagbark)	4980	4160	29.1
Locust (black)	4640	4010	28.1
Maple (silver)	3783	2970	20.8
Maple (sugar)	4386	3577	25.0
Oak (red)	4988	3609	25.3
Oak (white)	4942	3863	27.0
Osage Orange	5480	4380	30.7
Pine (shortleaf)	4120	2713	19.0
Red cedar	3260	2700	18.9
Sycamore	4160	2956	20.7
Walnut (black)	4640	3120	21.8

Table 2. Equivalent Heat of Other Fuels Compared to a Cord of Air Dried Wood *(80 cubic feet of solid wood content at 20% moisture)* **Based on a Heating Unit Efficiency of 100%.***

	Wood[1]	*#2 Fuel*[2] *Oil*	*Anthracite*[3] *Coal*	*Natural*[4] *Gas*	*LP*[5] *Gas*	*Electric*[6] *Heat*
	available heat/cord in million BTUs	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	.98	236	259.3	6,941
Basswood	14.7	105.0	.61	147	161.5	4,324
Boxelder	17.5	125.0	.73	175	192.3	5,147
Cottonwood	16.1	115.0	.67	161	176.9	4,735
Elm (American)	20.1	143.6	.84	201	220.9	5,912
Elm (red)	21.4	152.9	.89	214	235.2	6,294
Hackberry	21.6	154.3	.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	.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	.79	190	208.8	5,588
Red Cedar	18.9	135.0	.79	189	207.7	5,559
Sycamore	20.7	147.9	.86	207	227.5	6,088
Walnut (black)	21.8	155.7	.91	218	239.6	6,412

[1] Wood available heat at 20% moisture 7,000 BTUs/pound (128 cu. ft. with 80 cu. ft. wood volume)
[2] Number 2 fuel oil available heat 140,000 BTUs/gallon
[3] Anthracite coal available heat 12,000 BTUs/pound
[4] Natural gas available heat 1,000 BTUs/cubic foot
[5] L.P. gas available heat 91,000 BTUs/gallon
[6] Electricity available heat 3,400 BTUs/kilowatt hour

* NOTE: MOST WOOD BURNING STOVES SOLD TODAY OPERATE AT LESS THAN 50 PERCENT EFFICIENCY.

Ratings for Firewood

	Relative amount of heat	Easy to burn?	Easy to split?	Does it have heavy smoke?	Does it 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—contains 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 redcedar	Medium	Yes	Yes	Medium	Yes	Good—excellent for kindling

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

efficiencies of the heating units you are considering or presently using.

Here 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 at $40.

Available heat units = 25.3 million BTUs

Assume your fireplace efficiency is 10 percent

$$\text{Your cost is } \frac{\$40.00}{25.3 \text{ X } .10} = \$15.81 \text{ Per Million BTUs}$$

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.

$$\text{Your cost } = \frac{\$40.00}{25.3 \text{ X } .50} = \$3.16 \text{ per million BTUs}$$

These examples show how an efficient heating unit can give more useful heat for the wood burned and thus save on 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 will find that a cord of air-dried red oak will provide a potential heat value of 25.3 million BTUs. To provide the same number of BTUs it would take 180.7 gallons of No. 2 fuel oil. At this ratio, if the price of oil were 45 cents per 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 very important. If the wood burner is a fire-place with a 20 percent efficiency, then you are getting only 5,060,000 BTUs (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 would provide (140,000 x .50) 70,000 BTUs per 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 per gallon would give the cord of red oak a value of (72.3 x .45) $32.54.

Seasoning Wood

To obtain maximum heat value, wood should be allowed 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 the drying. Stack the wood in loose piles, off the ground. Storage areas exposed to sunlight are preferred. Covered storage, open on the sides, helps prevent rewetting from rain or snow.

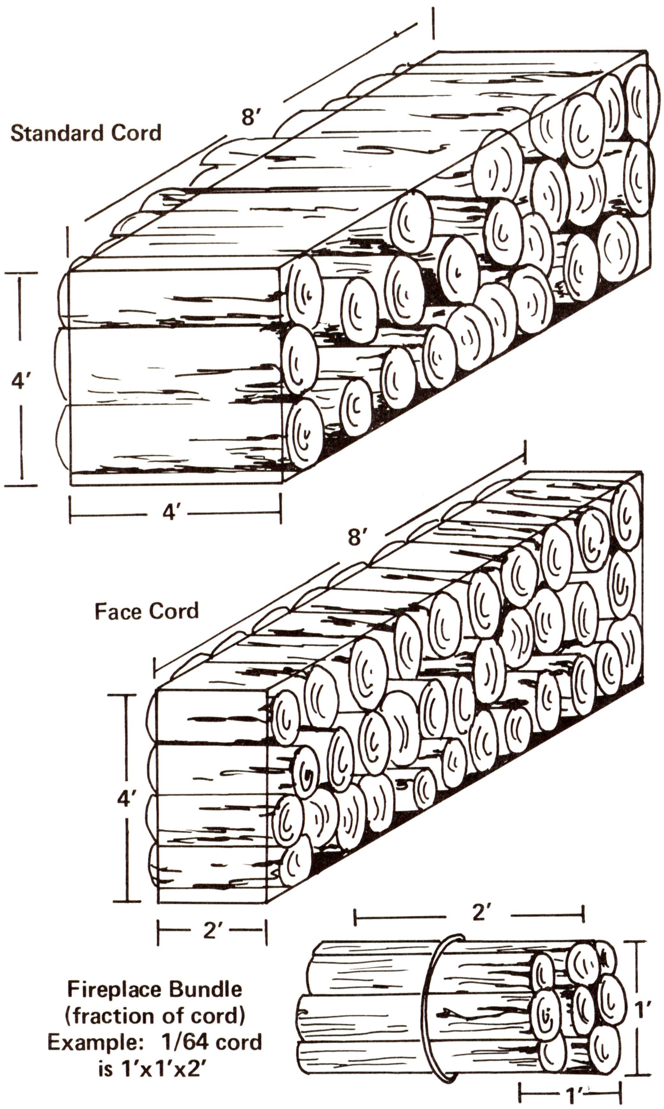
Burn Wood Safely

Wood can be used safely in home heating units. But, each year, because of disregard for safety, many costly and often tragic fires occur.

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

- The chimney must be properly constructed, in good repair, and kept clean of tars and creosote.
- The heating unit must be well designed and constructed so burning coals, sparks, and smoke cannot escape.
- The unit must be set on an inflammable base large enough so coals or sparks cannot spill on a flammable floor surface.
- Flammable walls or ceilings must be protected by adequate distance from the stove or pipes or by a heat shield.
- No wood, clothing, or other flammable materials should be placed where the heat from the unit could ignite them.
- No oils, gases, or volatile liquids should be placed or stored where fumes can be ignited by open flame.
- Do not fully load a heating unit, set the draft, and immediately leave, as the fuel may flare up and overheat.
- Provide adequate ventilation so oxygen consumed by combustion can be replaced.
- Don't use volatile liquids for starting a fire.
- Be careful when removing ashes; live coals are often present which might fall or otherwise contact flammable materials.
- Avoid fuels such as cardboard or dry Christmas greenery, which produce high flames that can cause flue fires. Some materials that should never be burned in a fire include plastics, poison ivy twigs and stems, and chemically treated woods such as discarded poles and railroad ties. Many persons are extremely 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.



How to Buy Firewood

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

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

Actual volume of solid wood in a cord varies from 65 cubic feet for very small crooked sticks, increasing with the size and straightness of the sticks up to 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′ x 8′ x 24 inches). The length may vary from 18 to 24 inches. "Rank" and "fireplace cord" are used also to describe the amount of wood in a face cord.

Another element of the wood business is the firewood bundle, often seen these days at supermarkets. Seasoned oak or other dried hardwood weighs about 3,600 pounds per cord. So, 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.

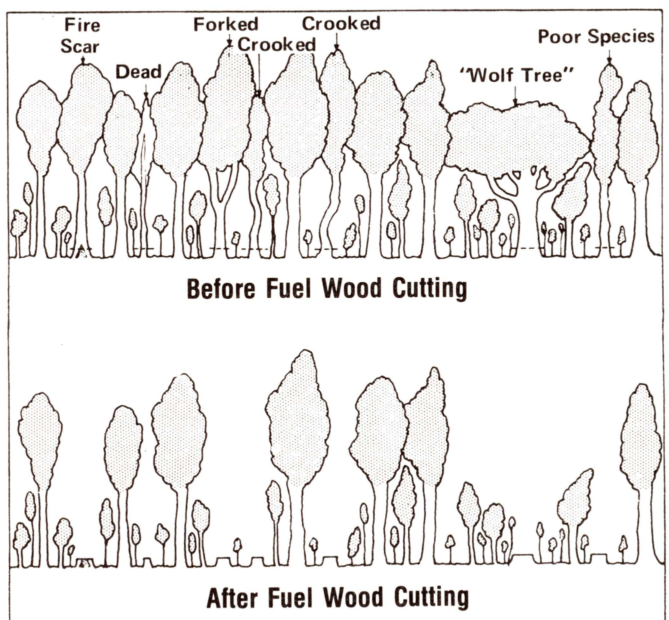
Missouri law requires that in the sale of firewood a bill of sale be provided showing the name and address of the purchaser and the seller and the cords or fractions of a cord involved in the sale.

Which Trees to Cut

If a fuelwood cutting is made wisely, the remaining woodland will be more productive. Owners frequently cut the straight, well pruned trees for firewood because they split easier than crooked, limby trees. This practice, coupled with leaving low-quality trees, reduces woodlots to junklots. Cut only those trees that when removed will give more room for the growth of the most desirable trees in the woodlot. Removing cull and 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 that should be used 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).
6. Undesirable species.



Before the actual felling is started, mark trees to be cut. Free technical advice is available through the Service Foresters of the Missouri Department of Conservation. Also see UMC Guide 5150 "Increase Woodland Profits Through Timber Stand Improvement."

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