Is Wood a Good Energy Source for Home Heating?

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Knowing a few basic principles about how wood burns will help you understand why wood can be a good energy source for home heating, given the right conditions. This understanding will also help you burn your wood more cleanly and efficiently.

As firewood burns, it goes through three phases. During the first phase of combustion, all the moisture in the wood is heated to boiling and evaporates up the chimney, using a lot of the energy contained in the wood. The wetter the wood, the more energy it takes to evaporate all of the water, which means there is less energy left over to heat the house.

During the second phase of combustion, the wood continues to heat up and starts to produce smoke. During this process, large organic molecules are being broken down into smaller molecules, which consist of combustible gases and tar droplets. The gases are called primary gases and are a mixture of carbon dioxide, carbon monoxide, and volatile organic compounds.

When the temperature reaches 540° F, the smoke ignites and burns, releasing heat and producing flames. Smoke that does not burn goes into the chimney, where it either condenses as creosote or is vented to the outside as wood-smoke pollution. Unburned smoke indicates that the wood stove or furnace is not 100% efficient, because this smoke contains a large part of the potential energy in the wood.

As the primary gases burn, large amounts of secondary gases are released. These are a mixture of methane and methanol, more volatile organic compounds, water vapor, and more carbon dioxide. These secondary gases contain up to 60 percent of the potential heat in wood. They need to burn if you want to achieve high combustion efficiency. (Combustion efficiency can be defined as the proportion of useful heat that is extracted from a fuel source. For example, if combustion efficiency is 100 percent, then all the wood is converted to heat and none escapes as smoke.) Secondary gases will burn when there is sufficient oxygen and a temperature of at least 1100° F.

The final stage in the process of wood combustion is the burning of charcoal. After most of the gases and tars have burned off, the glowing embers are almost pure carbon. Oxygen in the air reacts with the charcoal, producing very high temperatures between 1100 and 1900° F. Charcoal burning is important for two reasons. First, additional heat is released, which is important to overall combustion efficiency. Also, charcoal burns slowly, so a good charcoal bed will burn a long time.

The cost of heating with wood and the amount of wood-smoke pollution it creates will vary widely, depending on these factors:

1) How the wood is prepared before use;

2) What type of stove or furnace is used;

3) Whether the stove or furnace is maintained properly.

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To maximize the combustion efficiency or heat value of your wood, allow it to dry thoroughly after you cut and split it. For fresh wood that is 50 percent moisture, about 13 percent of the energy in the wood has to be used to boil off the water during the first phase of combustion. For air-dried wood that is only 15 percent moisture, only about 2 percent of the energy in the wood has to be used for evaporation.

This is why it is important to season firewood and store it where it can stay dry, since this will reduce the moisture content from about 50 percent to less than 20 percent and increase your combustion efficiency. Most dense hardwoods require at least one year to season fully. A covered storage area, exposed to sun and open on all sides, will allow the wood to dry and prevent it from getting soaked by rain or snow.

Complete combustion is necessary during the second phase of wood burning (when the smoke that contains primary and secondary gases and tar droplets is burned) in order for wood to be an efficient and clean heat source. In order for the secondary gases to burn, a very hot fire with a well-directed air supply is needed. Older wood stoves usually do not achieve complete combustion; however, stoves that are certified as clean burning by the U.S. Environmental Protection Agency (EPA) use advanced technologies that burn most of the primary and secondary gases and produce about 90 percent less smoke than conventional stoves.

One wood stove design feature that encourages secondary combustion is catalytic combustion. A newer type of advanced technology does not use a catalyst, but combines three design features: a heated air supply, baffles, and an insulated firebox. Conventional wood stoves that are not EPA-certified do not include these advanced heating technologies and are not as efficient.

Choosing the proper wood stove will help you burn your wood more cleanly and efficiently. However, proper operation and maintenance of the stove are also necessary. The stove must be the correct size for the space to be heated and have a correctly installed chimney. The burning techniques for your particular combustion system must be learned and used.

The challenges in burning wood efficiently are to reduce the amount of water in the wood that must be boiled off, and to make sure that all of the smoke is burned up before it can escape through the chimney. This will reduce the amount of wood needed to heat your home and will decrease the amount of wood-smoke pollution you are adding to the environment.

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