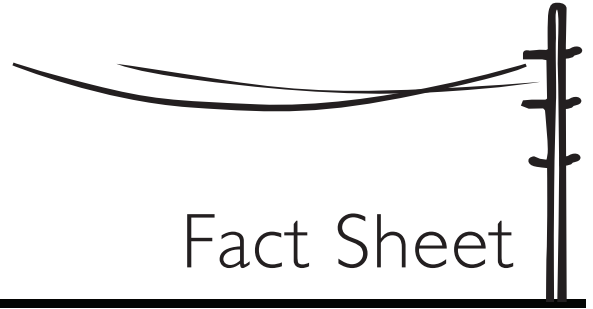




# WOOD <sup>to</sup> ENERGY



## Fact Sheet

### Heat and Power Applications

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While many communities are considering using wood to generate electricity, a number of industries and facilities such as hospitals and schools see wood as a very attractive source of heat or heat and power. This fact sheet describes how these systems can be used in the southern United States.

#### Combined Heat and Power Applications for Wood Energy

The largest use of wood energy in the United States is in industrial combined heat and power (CHP) facilities, also known as cogeneration applications. CHP systems recover the waste heat from the electricity production process to use as heat or steam. Large pulp and paper manufacturing plants use their waste wood or by-products internally instead of fossil fuels such as natural gas. However, many smaller facilities both inside and outside the forest products industry successfully use CHP systems as well. Many large institutional facilities such as state hospitals and colleges also use these systems. Frequently, institutions will combine CHP systems with district heating and cooling systems to distribute energy to several buildings.

Most power plants use fuel to generate steam with boilers and then generate power by passing the resulting steam through steam turbines. Under a typical scenario, only about one-third of the fuel's energy can be converted to electrical energy. The rest of the energy, called waste heat, is in the form of low temperature steam, hot water, or hot air. Although large quantities of waste heat may be available from a power plant, the usefulness of this energy depends on its temperature because heat transfer requires a temperature difference. Unfortunately, waste heat from steam-cycle power plants is typically less than 200°F, which is not useful for most other applications.

Table 1 summarizes the advantages of a CHP system. In this example, the industrial facility needs 45 units of steam and 30 units of electricity. If the facility purchases the electricity from the local power company (which uses 98 units of fuel to generate 30 units of electricity at 31 percent efficiency), the facility would also need to install a boiler (or purchase steam from another source, such as a nearby industrial plant) to provide 45 units of steam, which require 56 units of fuel at 80 percent efficiency.

Alternatively, a CHP system could be installed at the facility, which would provide the same 30 units of

**Table 1. Comparison of Two Energy Systems** EPA 2007

	Fuel units required	Heat (steam) units required	Electricity units required	% recoverable energy
<b>Separate heat and power sources</b>	154			49
<i>Electricity from power company</i>	98		30	31
<i>Heat from on-site boiler</i>	56	45		80
<b>Combined heat and power (CHP) system</b>	100	45	30	75

electricity and 45 units of steam. The CHP system would require only 100 units of fuel (versus the 154 units required by separate sources of steam and electricity) and would have an overall system efficiency of 75 percent. In addition, self-generating power can provide a means of standby power, depending on the system's design.

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**Standby power is the capability to generate electricity independent of the electric utility should a facility be cut off from the grid.**

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CHP applications work best when there is a steady, year-round demand for both electricity and heat. Thus, certain industries (e.g., kilns for drying lumber) and institutions (e.g., hospitals, prisons, and colleges) are good candidates for CHP systems (Box 1).

Determining the minimum size of a wood-fueled system to provide steam and power that is cost effective is not easy, as it depends on several factors. However, in general, smaller wood-fired boilers that generate in the range of 600 boiler horsepower (BHp) and 300 kilowatts (kW) to 1000 kW of electricity in CHP applications may be cost effective given certain conditions. Typically, these conditions require that any electricity produced must be used by the plant instead of sold (to obtain the full retail value of the electricity) and significant revenue must be obtained from the thermal energy produced by the system. See case studies *Using a Mix of Fuels to Produce Heat and Power* and *Waste-to-Energy Program* for examples of

facilities that utilize wood in CHP systems. All of our materials are available at <http://www.interfacesouth.org/woodybiomass>.

## Thermal Applications for Wood Energy

It is not necessary for institutional, commercial, and industrial facilities to generate electricity to benefit from the use of wood for energy. Industries that require large quantities of heat can operate a separate boiler system

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### **Backpressure versus condensing turbines—what's the difference?**

The amount of power generated by a steam turbine depends on the flow rate of steam and the drop in pressure as the steam flows through the turbine and energy is transferred from the steam to the turbine. Steam turbine electricity generators are classified as either condensing or backpressure turbines.

The condensing turbine system generates the most electricity but the waste is in the form of low temperature water, which has limited value. The backpressure turbine system provides higher value waste heat in the form of low-pressure steam, but the process reduces the amount of electricity produced. However, the CHP recovers the most total energy (heat and electricity) from the fuel that was originally fed into the boiler.

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### **Box 1. Combined Heat and Power at the La-Z-Boy Furniture Company**

La-Z-Boy Furniture Company, a major manufacturer of upholstered furniture, uses wood waste to fuel CHP systems in all of its furniture manufacturing plants. The company purchases green lumber from sawmills and kiln dries the wood on-site. The wood, which is about 90 percent maple, is processed for furniture frame components, and all the residual sawdust and wood scraps are conveyed to silos for storage. This approach has been used since the company's first wood-fired boiler was installed in 1974 at its Dayton, Tennessee facility.

The original boiler system has been upgraded to improve controls and efficiencies, and to increase capacities due to plant expansions. The current system now consists of a wood-fired boiler producing 30,000 pounds of steam per hour and powering two backpressure turbines each rated for 350 kW. The heat is used for the drying kilns, heating 900,000 square feet of floor space, air conditioning, and generating electricity. When building heat is required, steam from the backpressure turbines is used to heat water that is circulated throughout the plant to unit heaters. If cooling is required, the steam from the backpressure turbines is sent to an absorption chiller, which chills water in the same circulation loop that is used for heating. During the spring and fall of the year when mornings are chilly and afternoons hot, the same system is used for heating in the morning and cooling in the afternoon. The CHP system saves the company from purchasing electricity, eliminates disposal of 10,000 tons per year of wood waste, and creates improved working conditions for plant employees.

solely for thermal energy applications and purchase electricity off the local power grid. This can be cost effective because generating electricity adds significant extra capital, operating, and maintenance costs. Additionally, large-scale electricity generation is very cost-competitive. See case studies *Wood and Paper Trim the Energy Bill* and *Wood Power Heats a Public School* for examples of facilities that use wood for thermal applications.

Many traditional industrial and commercial users of natural gas, fuel oil, and propane for heat production have experienced sharp increases in their energy bills and are searching for less expensive energy sources. In addition, community leaders are anxious to assist these industries in finding less expensive sources of energy in order to keep industries competitive and sustain economic viability for the community.

Boilers and furnaces originally designed to use natural gas, propane, and fuel oil can sometimes be converted to use wood. This conversion is performed by installing a wood gasification system beside the boiler or furnace and then piping the gas generated by the gasifier to the boiler or furnace. There are several suppliers of wood gasification systems, and there are several examples of such systems installed around the country. See the fact sheet, *Systems that Convert Wood into Energy*, for more information.

## Summary

Wood can be used to fuel boilers to generate steam for process heat or for heating and cooling buildings. Wood can also be used to fuel boilers to generate electricity.

Roughly two-thirds of the energy in the fuel used to make electricity becomes waste heat. Therefore, the most efficient way to generate electricity is to have a beneficial use for the waste heat from the electricity generation process. Such systems are called combined heat and power (CHP) systems.

Many facilities such as hospitals, colleges, and paper mills can use CHP systems instead of using power from the local electrical grid. In addition to more efficient energy use, the advantages of using wood for combined heat and power applications include cost savings, a means of standby power, less landfill waste, and use of renewable energy sources. In some cases, these systems may also provide backup power.

For more information about using wood to produce energy, visit <http://www.interfacesouth.org/woodybiomass> and read other fact sheets, community economic profiles, and case studies from this program, or <http://www.forestbioenergy.net/> to access a number of other resources.

## Reference

EPA. 2007. Efficiency benefits, Combined Heat and Power Systems. <http://www.epa.gov/chp/basic/efficiency.html> (accessed on August 8, 2007).

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