Industry and Residences Use Wood for Energy

The use of wood for energy is projected to reach between 2.8 and 3 quadrillion BTU's in 2000. The forest products industries themselves are the major users of wood for fuel, accounting for 69 percent of wood fuel consumed in 1992. Residential use, utilities, and other industries consume the remaining 31 percent. Production of liquid fuels from woody biomass is not economical at this time, but research is being conducted to lower costs.

USDA's Forest Service estimated wood-energy use as part of a 1993 assessment of the U.S. demand and supply of forest resources (*3*). Long-term, energy-use projections were based on various assumptions about trends in the prices of fossil and wood fuels and projected increases in energy use by various sectors such as residences, industry, and liquid fuels. Wood energy use is projected to increase from a base of 2.67 quads (quadrillion BTU's) in 1986 to about 3 quads in 2000, 3.35 quads in 2020, 3.5 in 2030, and 3.7 quads in 2040.

The U.S. Department of Energy (DOE) also has made projections for wood energy consumption, which are broken down into nonelectric and electric uses. Nonelectric uses include steam production for industry and heat for residential dwellings. Wood is the biggest supplier of renewable energy for nonelectric uses (table 12). In 1993, wood and wood waste accounted for 97 percent of nonelectric renewable energy consumption, excluding ethanol. Wood for nonelectrical uses is expected to increase from 2.09 quads in 1993 to 2.61 quads in 2010, an annual growth rate of 1.3 percent in about 17 years.

Table 12--Projected consumption of renewable energy for nonelectric uses

Energy source	1993	2000	2010	Annual growth rate 1993-2010
	Quadrillion BTU			Percent
Geothermal	0.01	0.02	0.04	7.3
Wood and wood waste	2.09	2.32	2.61	1.3
Solar thermal	0.06	0.08	0.09	2.3
Total	2.16	2.42	2.74	1.4

Source: Annual Energy Outlook, 1995, With Projections to 2010, DOE/EIA-0383(95), U.S. Department of Energy, Energy Information Administration, Washington, DC, 1995.

For electrical power generation, DOE projects wood use at approximately 0.5 quad in 2000 and about 3 quads in 2030, assuming that wood comprises more than half the energy derived from forest and agricultural residues and municipal solid waste (*2*). DOE also projects that energy crops will contribute less than 0.5 quad in 2000 but will eventually overtake agricultural and forest residues as a source of electricity before 2020. This assumption of large-scale production of short-rotation energy crops is the major difference between these DOE projections and those made by the Forest Service.

Industries Are the Biggest Users of Wood Energy

Until the turn of the 20th century, wood was the major source of energy in all sectors of the U.S. economy. But with greater popularity of low-priced coal, oil, and natural gas, use of wood fuel declined rapidly. As wood became less important as a fuel for residential heating, industrial uses of wood and wood wastes took up the slack. In 1992 (the last year for which data is available), the industrial sector accounted for 1.6 quads or 71 percent of total U.S. wood energy consumption (table 13).

The largest industrial users of wood and wood byproducts are the forest products industries themselves. In 1992, the pulp and paper industry alone used 79 percent of the wood energy consumed by the industrial sector (table 14). Black liquor (the leftover fluid from chemical pulping), wood, and bark are burned for heating, steam production, and electrical energy. Lumber mills and other primary processing industries use mill residues—such as log trimmings, sawdust, and bark—for energy. These industries are responsible for another 18 percent of industrial wood energy use. Other industries account for the remaining 3 percent.

Regional differences in wood energy use are due to the location of wood resources and wood-consuming industries. The

Table 13--U.S. consumption of wood energy by sector, 1949-92

Sector	1949	1969	1989	1990	1991	1992
			Trillion BTU			
Industrial	486	1,014	1,556	1,562	1,528	1,593
Residential	1,055	415	918	581	613	645
Electric	6	1	13	12	10	11
Total	1,529	1,430	2,487	2,155	2,150	2,249

Source: Estimates of U.S. Biomass Energy Consumption, 1992, DOE/EIA-0548(92), U.S. Department of Energy, Energy Information Administration, Washington, DC, May 1994.

Table 14–Industrial woodfuel consumption by sector and region, 1992

Sector or region	Trillion BTU	Percent of total
Sector		
Paper and allied products	1,258	79
Lumber and wood products	287	18
Other industries	48	3
Total	1,593	100
Region		
Northeast	119	7
South	1,027	64
Midwest	96	6
West	350	22
Total	1,593	100

Source: Estimates of U.S. Biomass Energy Consumption, 1992, DOE/EIA-0548(92), U.S. Department of Energy, Energy Information Administration, Washington, DC, May 1994.

South has the largest share of consumption, followed by the West, the Northeast, and the Midwest.

Areas such as New England, the upper Midwest, and parts of the South that have a surplus of low-grade hardwood trees and other biomass continue to be the focal point of biomass and biofuels energy production. For example, Weyerhaeuser Company in cooperation with Amoco Corporation, Carolina Power and Light, and Stone Webster Engineering Corporation are assessing the economic merits of expanding the use of biomass at Weyerhaeuser's New Bern, North Carolina, facility to produce both electric power and liquid fuel. Weyerhaeuser determined that a combined-cycle power system of 60 megawatts for internal use and sale has the potential for significantly increased efficiencies.

The production of electricity from wood has been highly successful in moderate-scale facilities in northern New England and the upper Midwest. In Vermont, New Hampshire, and Maine, over 700 megawatts of electrical-generating capacity have been added since 1980. About 30 cogeneration and free standing plants have been built. Many of these plants are cogeneration facilities located at pulp and paper or other forest-product mills that produce both steam and electricity. Other cogeneration facilities are located in the South, West, and Canada.

New technologies are being developed for cofiring biomass in coal-fired boilers. Dry densified wood fuels, such as pellets and brickettes, can be burned efficiently in furnace/boiler units and wood stoves by commercial or residential users. For instance, wood or biomass is pelletized and fed into coal boilers at about a 15-percent share. This low-cost supplemental fuel helps dispose of wood wastes, lower emissions of sulphur dioxide and other undesirable gases, and reduce fossil-fuel consumption. One company, Energy Performance Systems of Minneapolis, Minnesota, has developed a technology that only uses wood. It's whole-tree-energy system is designed for a 100-megawatt plant.

Residential Use Remains Despite Energy Price Changes

Until the advent of fossil fuels in the late 19th century, wood was the dominant fuel used to heat homes. Roundwood (trees from farm woodlots) remained an important but declining source of fuel through the 1940's. Residential use of wood fuel dropped 61 percent between 1949 and 1969, as farm population fell. Abundant, cheap, and convenient access to fossil fuels made wood less attractive until the energy crisis of the 1970's, when crude-oil supplies were disrupted and the delivery of natural gas curtailed. Wood's popularity grew during the 1970's and 1980's. The number of wood-burning stoves in the United States reached 14 million in 1980, up from 2.6 million in 1970 and 7.4 million in 1950.

The use of wood as a main heating source peaked during 1984-87, dipped thereafter, and leveled off. The decline in use since then has been triggered not only by lower fossil-fuel and natural-gas prices, but also by environmental concerns about using wood stoves during certain times.

Liquid Fuels From Wood a Future Possibility

The processes for making liquid fuels from wood have been known for more than a century. Considerable technological advances were achieved in Germany and Japan during World War II to compensate for lack of fossil fuels. Methanol or wood alcohol is the first and most common liquid fuel that can be produced from wood. Using a process invented by Braconnot in 1819, ethanol has been produced from wood in the United States during World War I, in Europe during World Wars I and II, and recently in the former Soviet Union. A number of other possible fuels or fuel additives can be produced from wood, including diesel fuel, methyl tertiary butyl ether, ethyl tertiary butyl ether, isopropyl alcohol, sec-butyl alcohol, tertiary butyl alcohol, and tert-amylmethyl ether.

Methanol was once derived from wood as a byproduct of charcoal manufacture, but had low yields. High-yield methanol production from wood requires producing synthesis gas, a process similar to coal gasification. Ethanol can be made using a two-stage hydrolysis process. Neither process is economically feasible at this time.

However, DOE has proposed an ambitious program, which is part of its National Energy Strategy, to produce up to 20 percent of U.S. liquid-fuel requirements from short-rotation woody plantations and other biomass. A major goal of the program is to reduce the cost of producing ethanol from energy crops from $1.27 per gallon in 1990 to less than $1 per gallon by 2005 and under 70 cents by 2010. For ethanol from cellulosic waste materials, the goals are 50 cents per gallon in 2005 and 34 cents in 2010 (*1*). This can be achieved through continued technology improvements and efficient utilization of the entire feedstock rather than just the cellulosic portion. Another goal of the program is to reduce the estimated cost of biomass-derived methanol from 93 cents per gallon in 1990 to 50 cents by 2010 using energy crops.

With practices similar to modern agriculture, plantations of high-yield, fast-growing trees could produce up to 10 tons of biomass per acre. The establishment of such plantations on a large scale could provide a steady source of renewable fuel for cogeneration power plants to produce electricity and steam or as a raw material for chemical or alcohol production. [Thomas Marcin, (608) 231-9366, and Anton Raneses, (202) 219-0752]

1. *Biofuels: At the Crossroads, Strategic Plan for the Biofuels Systems Program.* U.S. Department of Energy, Washington, DC, July 1994.

2. *Electricity From Biomass: National Biomass Power Program Five-Year Plan (FY 1994-FY 1998).* U.S. Department of Energy, Solar Thermal and Biomass Power Division, Washington, DC, 1993, pp. 14-15.

3. Skog, Kenneth E. "Projected Wood Energy Impacts on U.S. Forest Wood Resources." *First Biomass Conference of the Americas: Energy, Environment, Agriculture, and Industry.* National Renewable Energy Laboratory, Golden, CO, Vol. 10, September 1993, pp. 18-32.