USE OF WOOD FOR ENERGY IN THE UNITED STATES--A THREAT OR A CHALLENGE?

John W. Koning, Jr.
and
Kenneth E. Skog, Research Forester
Forest Products Laboratory
Madison, Wisconsin 53705-2398

ABSTRACT

The use of wood for energy--including the burning of solid wood and black liquor from pulping--has been growing at a rate significantly greater than that for all other uses such as lumber, pulp, or particleboard. This could threaten to increase the price of wood for those other uses, or it can stimulate us to seek more creative ways of using untapped wood resources for fuel.

On the basis of estimates of heavy wood energy use relative to other uses for wood, and estimates of continuing high costs for fossil fuels, we suggest here the feasibility of meeting the demand for fuelwood through small-scale cooperatives. Such an approach can improve forestry practices and can avoid unduly increasing the cost of wood for other end uses.

In: Klass, Donald, ed. Energy from biomass and wastes X. Chicago: Institute of Gas Technology; 1987: 1309-1319.

USE OF WOOD FOR ENERGY IN THE UNITED STATES-- A THREAT OR A CHALLENGE?

INTRODUCTION

The primary use of wood in the world today is for energy, with most of it being used as a cooking fuel. Use for cooking fuel is greatest in less developed countries and levels of supplies have reached crisis conditions in some places. However, it might come as a surprise that, in the United States, the end use of most timber is not lumber or pulp and paper, but fuel for energy--and this energy use has been growing at a substantial rate (Fig. 1). Wood energy use estimates for 1972 to 1983 are given in Table 1 and shown in more detail for 1983 in Table 2.

Though these wood energy use estimates are surprisingly high, they are conservative because they may underestimate the wood burned by industrial firms outside the forest industry; relatively little information about that component is available (11).

Wood is burned both in solid form and in the form of black liquor from the pulping process. Even if the substantial black liquor tonnage used for energy is subtracted, the amount of wood used for energy is still more than the use of wood for all other wood products combined.

Such continued increase in the use of wood for energy could increase the cost of certain wood materials, and challenges foresters and woodland managers to look more carefully at available sources of fuelwood.

THE THREAT

Currently we have ample unused hardwood and waste wood for fuel in the United States (13); their production exceeds use. But, if the rate of use of wood for energy shown in Figure 1 continues in a linear fashion, this Nation could face fiber cost increases depending on local abundance of wood by the year 2000--14 years from now--because of increased competition for wood. Higher wood prices would support better forestry but the payoff in more timber growth would take many years. If the linear trend continues we will use over 280 million tons per year (15% MC) (238 million ovendry tons) for fuelwood by the year 2000. This represents less than 1.5 percent of the total weight of aboveground tree biomass presently on commercial forest land (280 million tons divided by 20.7 billion tons (15% MC)) (8).

Although the increase may not be linear, increases in nonwood fuel prices will cause people to use more wood in place of natural gas and oil in residential, commercial, and industrial applications. Mid-level projections from

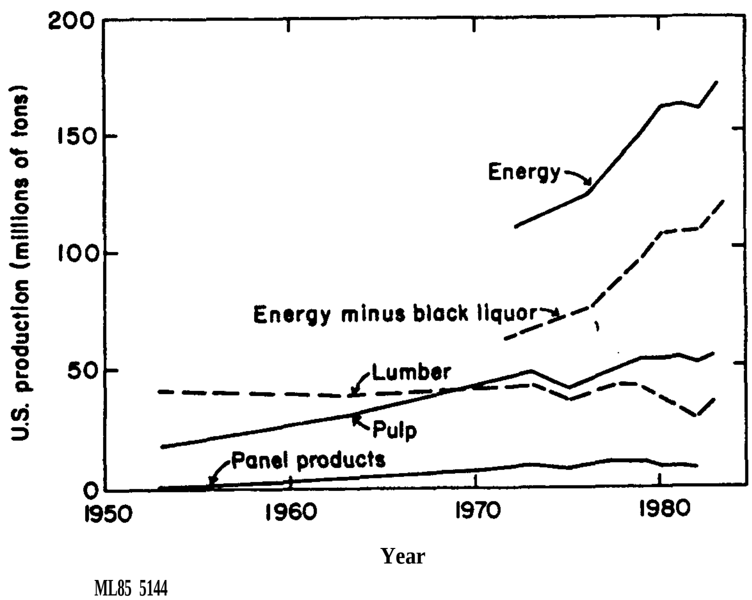

Figure 1. Major end uses of timber and bark in the United States. ("Energy minus black liquor" is the total energy with the black liquor subtracted from it.) Values for lumber and panel products are from "U.S. Timber Production, Trade, Consumption and Price Statistics, 1950-83" (9). Values for pulp are from the American Paper Institute as reported in Paperboard Packaging (1). (ML85 5144)

Table 1. Wood energy use, 1972-1983.

Use	Estimated consumption of wood or wood equivalent								
	1972	1974	1976	1978	1979	1980	1981	1982	1983
	Million tons at 15% MC								
Lumber and wood products industry[1]	23.7	25.1	26.6	28.2	29.0	29.9	27.6	23.0	27.6
Pulp and paper industry[2]									
As hog fuel	3.0	4.1	5.3	6.6	7.1	8.2	10.2	11.3	14.6
As bark	6.0	6.0	6.0	6.3	6.2	6.8	6.9	7.4	7.8
As black liquor	46.8	48.8	50.1	54.2	53.5	54.2	54.2	51.5	54.9
Other industry[3]	2.5	2.6	2.7	3.0	3.0	3.1	3.1	2.9	3.2
Residential[4]	26.7	26.1	33.8	43.7	51.1	57.4	58.0	62.5	61.6
Commercial[5]	.6	.6	.8	1.0	1.2	1.4	1.4	1.5	1.5
Utilities[6]	.2	.1	.1	.1	.1	.3	.2	.2	.2
Totals	109.5	113.4	125.4	143.1	151.2	161.3	161.6	160.3	171.4

[1]Amounts for 1980 through 1983 are million ovendry tons (MMODT) (11, p.7) x 1.15. Amounts for 1972 through 1979 are computed assuming a constant rate of increase from 19.4 MMODT in 1970 (5, p.46) to 26 MMODT in 1980 (11, p.7).

[2]Amounts of hog fuel and bark are MM tons at 50% moisture content (2) x (1.15 ÷ 2.00). Black liquor is (quads (2) ÷ (17.2 MM Btu/ODT)) x 1.15.

[3]Other industry consumption is computed as 3% of total industry consumption (11, p.17).

[4]Amounts for 1980 through 1983 are MM cords (11, p.27) x 1.16 ODT/cord (this is ((29.1 OD lb/ft³) x (80 ft³/cord)) ÷ 2000 lb/ton) x 1.15 (See fn 2 of Table 2). To compute amounts for 1972 through 1979: MMODT (10, p.95) x .86 cords/ODT (11, p.27) converts the DOE estimate to a correct cord estimate. Second, x 1.16 ODT/cord to obtain a correct ODT estimate. Next, x 1.15. Finally, ÷ .95 to account for an underestimate (11, p.59).

[5]Amounts for 1980 through 1983 are MMODT (11, p.43) x 1.15. Amounts for 1972 through 1979 are MMODT (10, p.111) ÷ 0.8 (this is a correction factor (11, p.61)) x 1.15.

[6]Amounts for 1980 through 1983 are MMODT (11, p.43) x 1.15. Amounts for 1972 through 1979 are MMODT (10, p.122) x 1.15.

Table 2. Wood energy use in 1983 by four measures.

Use	Estimated wood energy use in 1983				Wood use from primary data source		
	MM tons				Amount		Source
	(15% MC)[1]	MMODT	MM cords[2]	Quads			
Lumber and wood products industry	27.6	24.0	20.7	[3].40	24.0	MMODT	(11)
Pulp and paper industry							
As hog fuel	14.6	12.7	10.9	.21	12.7	MMODT	(2)
As bark	7.8	6.8	5.9	.12	6.8	MMODT	(2)
As black liquor	54.9	[4]47.7	41.1	.82	.82	Quads	(2)
Other industry	3.2	2.8	2.4	.05	2.8	MMODT	(11)
Residential	61.6	[5]53.6	46.2	[6].92	46.2	MMcords	(11)
Commercial	1.5	1.3	1.1	[7].02	1.3	MMODT	(11)
Utilities	.2	.2	.1	[8]--	.15	MMODT	(11)
Total	171.4	149.1	128.4	2.54			

[1]1983 ODT estimates x 1.15.

[2]1983 ODT estimates ÷ (1.16 ODT/cord), except for residential use. 1.16 ODT/cord = (29.1 OD lb/ft^3 x 80 ft^3/cord) ÷ 2000 lb/ton. Hardwood is 32.8 OD lb/ft^3, softwood is 27.4 OD lb/ft^3. Estimating 31% of wood harvested is hardwood and 69% is softwood, then (32.8 x .31) + (27.4 x .69) = 29.1 OD lb/ft^3. Wood at 15% MC contains 1.15 x 1.16 ODT/cord = 1.33 tons (15% MC)/cord.

[3]1983 ODT estimate x 17.2 MM Btu/ODT (11).

[4]1983 quad estimate ÷ 17.2 MM Btu/ODT (11).

[5]1983 cord estimate x 1.16 ODT/cord.

[6]1983 cord estimate x 20 MM Btu/cord.

[7]1983 ODT estimate x 17.2 MM Btu/ODT (10).

[8]Less than .005 quad.

the Department of Energy show that prices for natural gas and oil (without inflation) will be 35 percent to 65 percent higher in 1995 than in 1984 (Q). Commercial and industrial users of natural gas and oil, assuming mid-level projections, could afford $60 to $87 per cord of wood (1984 dollars) by 1995 versus $43 to $63 in 1983 (Table 3). These cordwood costs must, of course, cover any higher costs to store wood and to build and operate woodburning plants. Wood is much less likely to replace low-priced coal used by large plants to make steam.

Of the 171.4 million tons (15% MC) used for fuel in 1983, only that for residential use (61.6 million tons (15% MC)) came largely from roundwood from forests. Less than a quarter of residential use comes from timber usable for other products (6). The remaining 109.8 million tons is wood waste from making other wood products. Continued growth in wood energy use will require use of more roundwood from forests and/or untapped sources of wood waste. Data in "A National Energy Pro ram for Forestry" (7) sug est "waste" sources could provide 600 million ovendry tons (690 million tons at 15% MC) per year without diminishing timber for other products. Amounts physically available include (among others):

	Million Tons
Forest	
Harvest sites	
Logging residues from growing stock and nongrowing stock	184
Standing live and dead trees	23
Timberland	
Excess growing stock	247
Mortality	109
Total, forest	564
Urban	
Tree removals and wood wastes	81
Other	
Forest products industrial waste	23
Waste wood from land clearing	23
Total, other	46
Total, all sources	690

However, much of the wood physically available is only available at prohibitively high costs. As use of wood for fuel grows, market forces may not lead us directly to use these dispersed waste materials, particularly where wood fuel markets are not well organized.

Table 3. Wood costs equivalent to projected cost for selected nonwood fuels.[1]

Sector and fuel	Equivalent costs				
	1973	1984	1995[2]		
			Mid price + mid growth	Mid price + high growth	High price + mid growth
	- - - - - - - 1984 dollars per green cord - - - - - - -				
Commercial					
Natural gas	19	56	83	95	82
Heating oil	28	63	87	87	116
Coal for steam	9	21	24	24	24
Industrial					
Natural gas	10	43	71	82	70
Residual fuel oil	16	44	60	59	78
Coal for steam	9	19	24	24	24

[1]Prices for selected nonwood fuels from DOE (12) are converted to cordwood cost assuming a cord of green wood contains 20 MM Btu; 10 MM must be used to convert water in wood to steam and the remaining 10 MM Btu are converted to energy at the same efficiency as the fuel that wood replaces. These assumptions imply a cord of green wood (containing 10 MM usable Btu) would have a value 10 times the price charged for 1 MM Btu of nonwood fuel. For example, if natural gas costs $10/MM Btu we could afford to pay up to $100/green cord to replace natural gas.

[2]For three assumptions regarding world oil price and U.S. economic growth rate.

If fuelwood needs were satisfied by conventional logging practices, we could face several ecologically or economically unsound situations:

(1) High grading (removal of only high-quality trees) of present timber stands with loss of future high-value large timber;

(2) depletion of the forest nutrient supply;

(3) 1oss or change of some wildlife;

(4) negative impact on recreation; and

(5) increased imports of wood fiber.

A threat--yes, but not a crisis if we act now.

THE CHALLENGE

If this potential problem is properly addressed within the next 10 years, through research and adoption of appropriate technology, we can turn this threat to opportunity and reap considerable benefits from wood energy.

Already wood energy use has reduced U.S. dependence on imported oil. Replacement of oil with wood and energy conservation efforts in the pulp and paper industry alone have reduced fuel oil use from 500 trillion Btu’s in 1972 to 230 trillion Btu’s in 1984, a drop of more than 50 percent. At the same time, production of paper has increased.

Over 61 million tons (15% MC) of wood were used for residential fuel in 1983, greatly relieving economic hardships caused by higher oil prices. In the process, this use of wood has created thousands of jobs and helped stem the hemorrhage of U.S. dollars in our balance of payments. (Unfortunately, the home use of wood is not without its problems-- such as air pollution; thus, industrial or residential use with proper air pollution controls should be preferred.)

A s fuelwood use grows, harvest of large quantities of wood can be used to improve forest management. A substantial portion of this wood can come from less intensively managed nonindustrial private forest land. Fifty-eight percent of U.S. timberland is in nonindustrial private ownership. Twenty percent of this land is in parcels of less than 100 acres (3). Given these factors, the problem becomes one of how to fill the need for wood fuel from many private ownerships,

The challenge is to supply wood fuel from known, existing, untapped sources, as demand increases.

A SOLUTION

One solution is removal of low-quality wood using small equipment--called “low-grading’’--from private woodland through farm or farm-like cooperatives.

An independent farmer/landowner could chip undesirable species and multiple-stemmed, improperly spaced, or poorly formed trees up to 6-8 inches in diameter using a tractor-mounted or independently powered chipper. The whole-tree chips would be trucked to a concentration yard run by a local farm co-op, or wood co-op patterned after the farm co-op, for consolidation, storage, and shipment, or they would be trucked directly to the customer. If trucked directly to the customer, the co-op would act as the broker.

The co-op would have at least two marketing options: a) screen and clean the chips to upgrade them for pulp or b) sell the mixed material as fuel. Companies could buy chips from the co-op, and ship them in bulk by rail or truck.

The idea helps meet the challenge to both supply fuelwood and improve forest productivity. This approach satisfies the need for small regional fuelwood markets to meet the demands of small businesses that could not support large-scale chipping contractors. A conscious decision to encourage low-grading by owners of small woodlands recognizes that ownership of the majority of commercial timberland is private, and that stands are typically unmanaged and include large quantities of small diameter hardwood trees.

The cooperative provides a new means for collecting, concentrating, and transporting scattered wood material. The use of existing co-ops reduces overhead costs. Because they are member-owned, the operation and management are accepted by the farmer. Because existing farm co-op facilities can be used, the need for investment in new facilities is reduced. The addition of chips strengthens the co-op by broadening its product line.

The use of a tractor-mounted or independently powered chipper--rather than a large whole-tree chipping system--minimizes landowner capital investment. Co-ops can buy small-scale chipping equipment and rent it to members, or (4) hire a crew and do chipping for landowners. The use of small-size chipping equipment encourages the removal of the small low-quality trees rather than the well-formed larger trees. It results in less damage to the remaining trees and ecosystem, and frees desirable trees for maximum growth. Poor-quality large trees can be cut for firewood or reduced in size and chipped.

The accumulation of chips from a number of small landowners at a co-op helps reduce the high cost per ton for a single small landowner to arrange sale and transport of a small quantity of chips to a buyer. Consolidation of small quantities of chips would allow bulk shipment by rail or truck, and many co-ops are located at railheads. The co-op can upgrade the whole-tree chips to pulp chips or particleboard chips, or can sell unprocessed chips as fuel, depending on market conditions.

Centralized marketing facilitates the acquisition of wood chips by a pulp and paper company, fuel supplier, or fuel buyer by allowing them to deal with a single organization rather than a multitude of landowners. Centralized marketing will also stabilize the supply of wood chips for buyers.

An additional benefit of the cooperative idea is that the rights of the landowner are given protection from interference in land management because buyers are dealing with the landowner's co-op rather than the owner directly.

The increased demand for wood for energy is a reality. That we can meet the demand with an as-yet-untapped resource is a possibility. Current means of timber harvesting have economic and ecological problems when used to supply small regional markets. The alternative of low-grading with the aid of cooperatives can serve as a silvicultural treatment that will yield multiple forestry benefits and return a profit to the landowner. Committing ourselves to innovative ideas can assure tomorrows bounty--in this case, turning the threat of fuelwood shortages into an exciting challenge.

REFERENCES CITED

1. American Paper Institute, "How Long Will Good Times Last," Paperboard Packaging 69(8), 18-46 (1984).

2. American Paper Institute, "U.S. Pulp, Paper and Paperboard Industry Estimated Fuel and Energy Use," 24 p., New York, NY (1984) March.

3. Birch, T. W., Lewis, D. G., and Kaiser, H. F., "The Private Forest-land Owner in the United States," USDA Forest Serv. Resour. Bull. WO-1, 61 p. (1982).

4. Brusila, B., "Forest Management and Marketing Cooperatives: Are They a Viable Alternative?" p. 110-114. IN: Proceedings, Fuelwood Management Utilization Seminar, 152 p., November 9-11, 1982. East Lansing, MI: Michigan State University.

5. Goetzl, A., and Tatum, S., "Wood Energy Use in the Lumber and Wood Products Industry," Forest Prod. J. 33 (3), 44-48 (1983).

6. Skog, K. E., and Watterson, I. A., "Residential Fuelwood Use in the United States: 1980-81," Nat. Tech. Inf. Serv. ADA 131724, 120 p., Springfield, VA (1983).

7. USDA Forest Service, "A National Energy Program for Forestry," USDA Forest Serv. Misc. Publ. 1394, 16 p., Washington, DC (1980).

8. USDA Forest Service, "Tree Biomass--a State-of-the-Art Compilation," Gen. Tech. Rep. WO-33, 34 p., Washington, DC (1981).

9. USDA Forest Service, "U.S. Timber Production Trade, Consumption, and Price Statistics: 1950-83," USDA Forest Serv. Misc. Publ. 1442, 83 P., Washington, DC (1984).

10, U.S. Department of Energy, Energy Information Administration, "Estimates of U.S. Wood Energy Consumption from 1949 to 1981," DOE/EIA-0341, 149 p., Washington, DC (1982).

11. U.S. Department of Energy, Energy Information Administration, "Estimates of U.S. Wood Energy Consumption 1980-1983," DOE/EIA-0341 (83), 61 P., Washington) DC

12. U.S. Department of Energy, Energy Information Administration, "Annual Energy Outlook, 1984," DOE/EIA-0383(84), 354 p., Washington, DC (1985).

13. Wahlgren, H. G., and Ellis, T. H., "Potential Resources Availability with Whole Tree Utilization," Tappi 61 (11), 37-39 (1978).