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Arkansas Wood Fuels: A Feasibility Study

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ARKANSAS WOOD FUELS: A FEASIBILITY STUDY

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Abstract

This report presents estimates of quantities and location of logging residues in Arkansas. Six sites are determined as potential fuel use sites for these residues. Estimates of the demand for wood fuel at these sites are made. The supply and demand for wood fuels are studied to determine the feasibility of utilizing logging residue as a fuel at these six locations in Arkansas.

1. INTRODUCTION

The recent interest in wood as an energy source represents a return to a fuel which was once an important source of energy in the United States. Wood fuel use reached its peak in the late 1800's with total use estimated at 3 quadrillion BTU's. This figure accounted for approximately 75 percent of total energy consumption. More recently, energy use has risen to 75 quadrillion BTU's, while wood fuel use has fallen to 1.1 quadrillion BTU's.[1]

The Arkansas economy is sensitive to issues of energy prices and fuel supply shortages because the state's leading manufacturing industry, the wood products industry, is very energy intensive. This industry has already begun to utilize greater quantities of wood fuels. Large numbers of sawmills in Arkansas and elsewhere have shifted from oil and natural gas to wood waste fuel in firing their dry kilns. Paper mills are currently using their plant by-products as well as logged wood fuel. In 1979 only about ten percent of sawmill residues remained unutilized in Arkansas. However, logging residues are virtually untouched in the state.

In this country, wood was the original fuel used for industrial steam production. It now appears that the pulp and paper industry is witnessing renewed interest in the burning of wood wastes. Individual mills in Arkansas are currently burning up to 80,000 tons of logged fuel annually. However, the continued price increased in oil and natural gas as well as potential shortages of these fuels continue to leave this industry in a precarious position, energy-wise.

For purpose of this report, the Arkansas pulp and paper industry is identified as a candidate for even greater use of wood residue fuel. There are six mill locations which are studied. Production capacity at these locations rance from 331 tons/day to 1,700 tons/day. Current energy consumption patterns of natural gas, oil, liquor fuel and hogged wood are used to estimate the potential demand for wood residue fuel at each site.

Supplies of logging residues are subject to widely varying densities. Factors which affect the quantity of logging residues which exist at a particular point depend upon method of harvest, terrain, species of tree, etc. As a result there is little agreement among industry spokesmen as to even the "average" amount of residue which might remain after a harvesting operation. Estimates of logging residue quantities were assumed to be a function of sawlog production. Sawlog production in each county of Arkansas was determined by severance tax reports for 1979. It was assumed that ten percent of forest volume remained as logging residue after the harvest. It was assumed that four percent of pulpwood forest volume remained on the forest floor.

2. HISTORICAL OVERVIEW

The early emphasis on wood fuel in the American economy stemmed, in part, from its ready availability. The process of converting woodland into cropland provided a large energy source. With the exception of the mechanical energy needs of some industries, which were supplied by water and wind power, wood provided nearly all of the economy's energy needs.

The first important movement away from the use of wood fuel occurred in the steel industry with increased demand for coal in the mid-19th Century. The American Industrial Revolution in the last half of the century coincided with the development of two new energy forms--oil and gas. Three factors contributed to the general decline in importance of wood fuels from 1870-1920: (1) the increase in the demand for timber by the wood products industry, (2) the development of a national energy market with wood remaining a regional energy source, and (3) the continued increase in national energy demand which surpassed the ability to harvest sufficient quantities of wood for energy purposes.[2]

Perhaps the most significant factor which served to reduce the supplies of wood which were available as fuel was the development of the wood products industry and the alternative uses for wood which it created. It is somewhat ironic that one of the major industries which contributed to the decline in wood fuel use now stand as one of the industries best suited to reverse this historical trend.

3. FOREST PRODUCTS INDUSTRY

A large quantity of oil and natural gas could be saved by expanding the industrial use of wood fuel. The forest products industry is especially suited to this task for a number of reasons. This industry is a very energy intensive industry, and it has ready access to large quantities of wood fuel. In addition it has the technical expertise and requisite level of technology to use wood fuel.[3]

The forest products industry consumed approximately 1.3 quads of oil and natural gas during 1974. The largest proportion of this figure was used by the pulp and paper sector (see Table 1). Nationwide, the pulp and paper industry is approximately 40 percent self-sufficient and uses 1.1 quads of fuel each year.[4] This self-sufficiency arises from the use of black liquor fuel which is a by-product of the pulping process. Southern mills have achieved above average fuel self-sufficiency due to the high portion of softwood feedstocks which are used. The high resin content of softwoods is the major source of the black liquor.

TABLE 1

FUEL AND ELECTRICITY PURCHASED BY THE FOREST PRODUCTS INDUSTRY IN 1974[5]

	Pulp/Paper (Quads)	Wood Products (Quads)	
Fuel Oil	0.54	0.18	0.72
Natural Gas	0.51	0.08	0.59
Coal	0.29	0.01	0.30
Electricity	0.12	0.05	0.17
Total	1.46	0.32	1.78

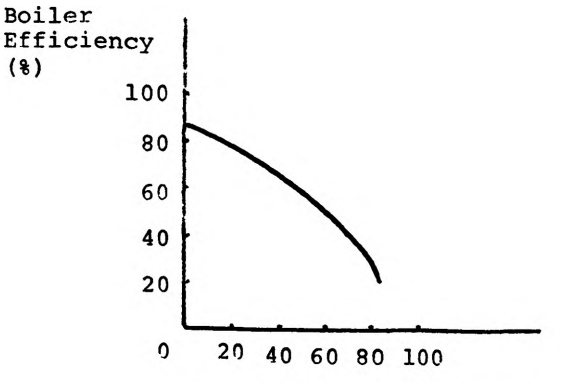
4. WOOD FIRED BOILERS

Wood was the fuel which fired all early boilers in this country. More recently, increasing attention has been given to the use of wood for boiler fuel. The pulp and paper industry has become extensively involved in this recent trend. The last 50 years has seen a gradual development of wood burning boilers from primitive pile burners to units capable of producing 500,000 pounds of steam per hour.[6]

The cost of fuelwood used to fire a boiler depends on the price of the wood, the heating value of the species collected, the moisture content and the efficiency of the boiler. The price of the wood depends upon the stumpage price as well as the cost of harvesting and transporting the wood to the fuel use site. (This aspect of cost will be discussed later in the paper.) The heating value of a given weight of softwood is higher than that for hardwood species. This is due to the high resin content of softwood. Wood fuel of mixed species will typically average 8,500 BTU per dry pound of wood. Typical moisture content of harvested wood chips will vary from 40 to 60%. Moisture content is important because it will affect the efficiency of the boiler. The approximate relationship which exists between residue moisture content and boiler efficiency is shown in Figure 1.

FIGURE 1

EFFECTS OF FUEL MOISTURE ON BOILER EFFICIENCY[7]



5. LOGGING RESIDUE SUPPLY AREAS

Six locations were chosen as potential sites for the utilization of logging residue fuel. These locations were picked because of the existence of a pulp and paper mill at each site. Several other candidate industries such as sawmills and electric power plants have been studied for their potential use of logging residue. However, the pulp and paper industry in Arknasas is especially vulnerable to curtailments of natural gas and rapidly rising prices of fuel oil.

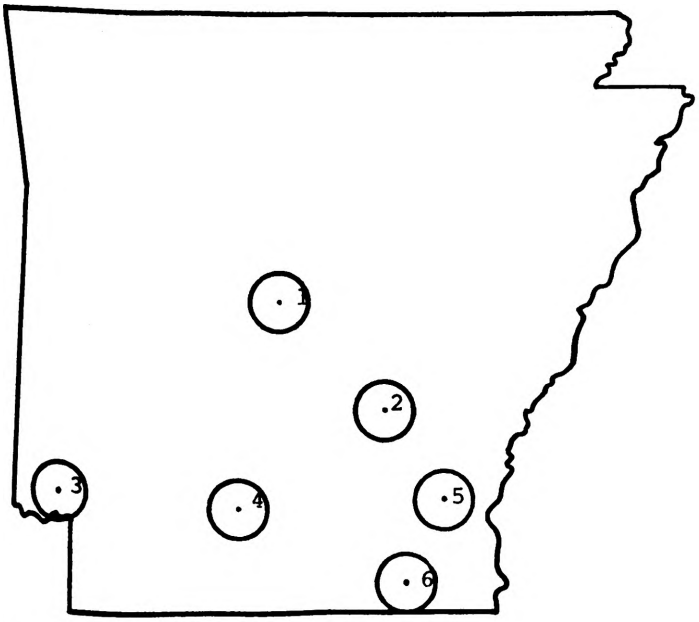
There are currently pulp and paper mill operations in the following six locations; Ashdown in Little River County: Morrilton in Conway County; Pine Bluff in Jefferson County; Crossett in Ashley County; Camden in Ouachita County and McGehee in Desha County. The following set of maps show the logging residue supply markets which were studied. These maps show market radii which range from 10 miles to 60 miles from each mill site.

The quantities of logging residue which were estimated to remain on the forest floor were calculated on the basis of lumber production as reported in the 1979 Severance Tax Report for each county in Arkansas. It is recognized that the quantity of logging residue at a particular point depends upon several factors including: terrain, species, method of harvest, etc. Previous studies which have been conducted are very site-specific and cannot be applied to this case. In addition, sufficient research funds for carrying an extensive residue inventory were not available. Faced with these constraints, percentage factors were used to determine the quantity of logging residue in each county. It was assumed that 10 percent of standing forest volume remained after sawlog harvests and 4% of forest volume remained after pulpwood harvesting operations.

These percentage factors were then combined with each county's reported lumber production to determine the total residue remaining in each county. In order to calculate the total logging residue within a given radius of each use-site it was assumed that the residues were evenly distributed throughout each county. A planemiter was used to estimate the area of each county that was contained within the regions. For example, if 25% of a county was included within a given radius of the fuel use-site and there were 100,000 tons total residue located in that county, then 25,000 tons would be included as part of the residue supply to that use-site. In instance where the wood residue supply areas of two or more use-sites overlapped, then the quantity of residue was divided evenly between the competing sites.

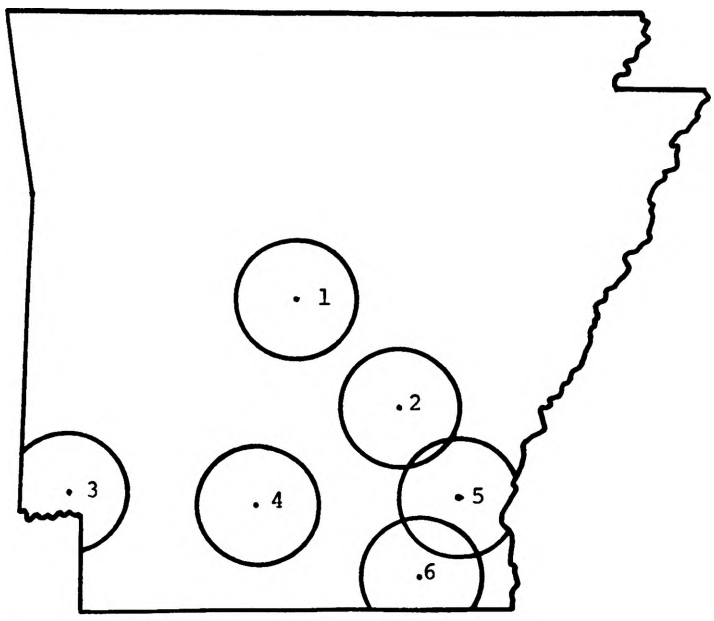
The estimates of the quantities of available logging residue are presented in Figure 3. It reveals that the Camden area contains logging residues in excess of the other five regions especially for distances greater than twenty miles. For a distance up to twenty miles from the use-site approximately the same quantity of residue is available at Camden and Ashdown. It is also shown that for a distance up to thirty miles there is

FIGURE 2a
FUEL USE AREA
(10 Mile Radius)



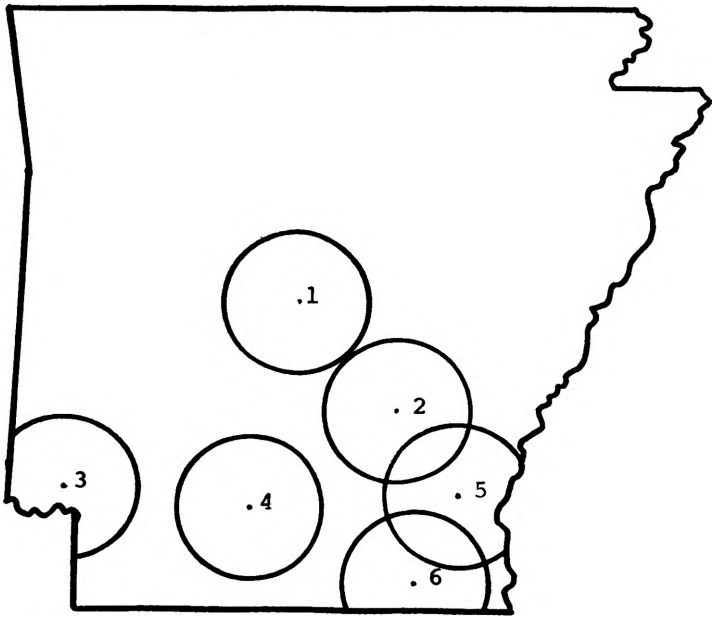
1 - Morrilton
2 - Pine Bluff
3 - Ashdown
4 - Camden
5 - McGehee
6 - Crossett

FIGURE 2b
FUEL USE AREA
(20 Mile Radius)



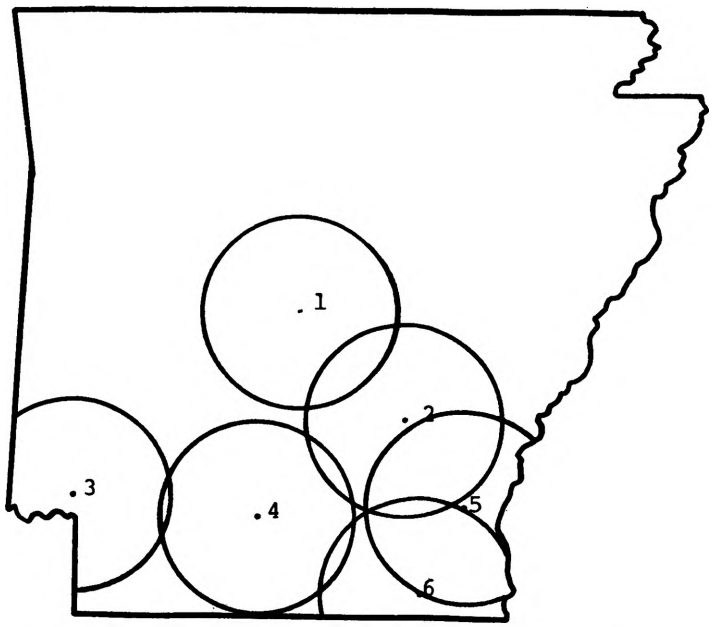
1 - Morrilton
2 - Pine Bluff
3 - Ashdown
4 - Camden
5 - McGehee
6 - Crossett

FIGURE 2c
FUEL USE AREA
(30 Mile Radius)



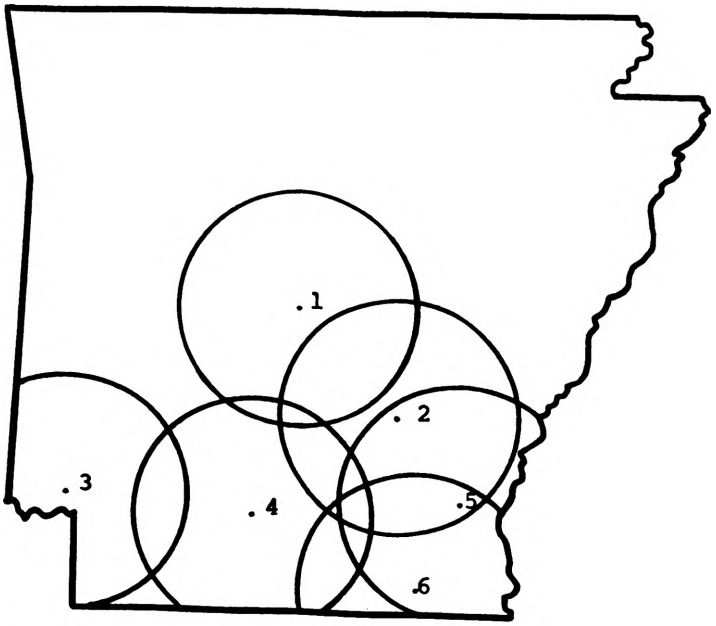
1 - Morrilton
2 - Pine Bluff
3 - Ashdown
4 - Camden
5 - McGehee
6 - Crossett

FIGURE 2d
FUEL USE AREA
(40 Mile Radius)



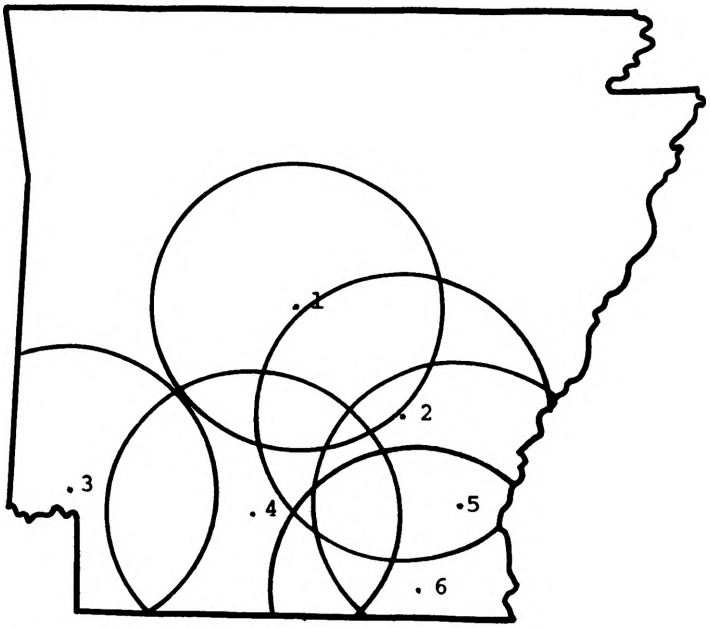
1 - Morrilton
2 - Pine Bluff
3 - Ashdown
4 - Camden
5 - McGehee
6 - Crossett

FIGURE 2e
FUEL USE AREA
(50 Mile Radius)



1 - Morrilton
2 - Pine Bluff
3 - Ashdown
4 - Camden
5 - McGehee
6 - Crossett

FIGURE 2f
FUEL USE AREA
(60 Mile Radius)



1 - Morrilton
2 - Pine Bluff
3 - Ashdown
4 - Camden
5 - McGehee
6 - Crossett

no sugnificant difference in the quantities of residue available at Morrilton or McGehee. One qualification should be noted in interpreting the results shown in Figure 3. The quantieies available at the Ashdown and Crossett sites are understated due to the fact that a significant portion of their market area is contained outside of Arkansas. Ashdown is located near a heavily forested area of Texas and Crossett is located near substantial forest land in Louisiana. While the McGehee site is located near the state of Mississippi, much of this land area is cropland and does not seriously distort the availability of residue at that site.

6. LOGGING RESIDUE DEMAND

The demand for logging residue fuel at each mill is considered equivalent to the amount of wood fuel which would be necessary to replace currently purchased fossil fuels. Table 2 shows the levels of energy demand for each of the six locations in the state. It should be pointed out that the that the energy demand figures are based upon industry averages due to the desire of individual mills to maintain the confidentiality of their productivity and costs of production. The output level at each mill was determined from published data. For example, annual output at the Crossett mill is 431 million tons. An industry average of 13,000 lb./steam per ton of output was assumed. This yielded an estimated annual steam production level of 5,603 million pounds. From this figure it was determined that 2,521 million pounds of steam were produced by purchased fuels. Arkansas mills utilize a significant amount of their by-products (black liquor) as a recovery fuel. For purposes of this study an industry average of 55 percent of total steam production was produced from black liquor fuel.

Figure 4 illustrates the logging residue supply for each location. This figure shows the delivered cost of a ton of wood residue to each fuel use-site. The cost of delivering logging wood residue is the sum of stumpage price, harvest cost and transport cost of the wood. A range of alternative costs were considered. Harvesting costs which were considered ranged from $10/ton to $30/ton and transportation rates studied varied from 15¢ per ton/mile to 30¢ per ton/mile. Stumpage was assumed to be $1/ton.

FIGURE 3
AVAILABILITY OF LOGGING RESIDUE

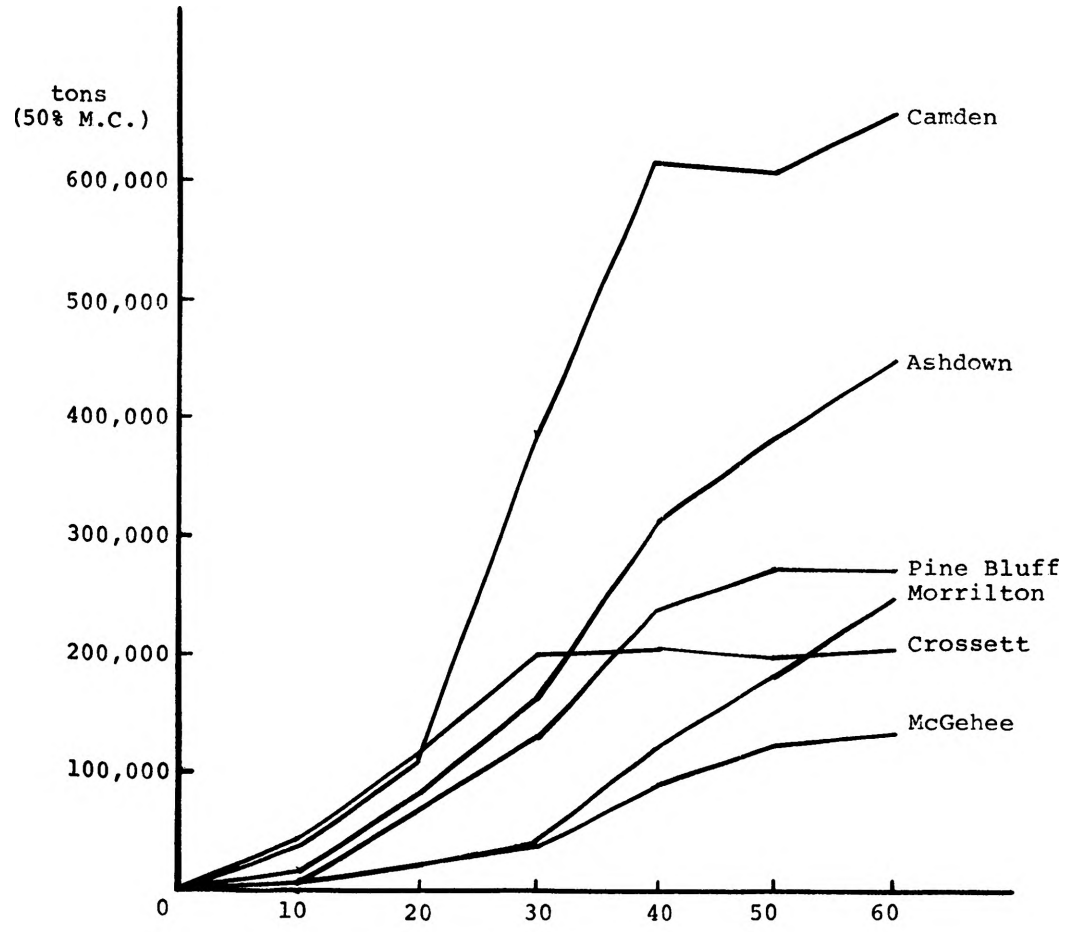


FIGURE 4
LOGGING RESIDUE SUPPLY

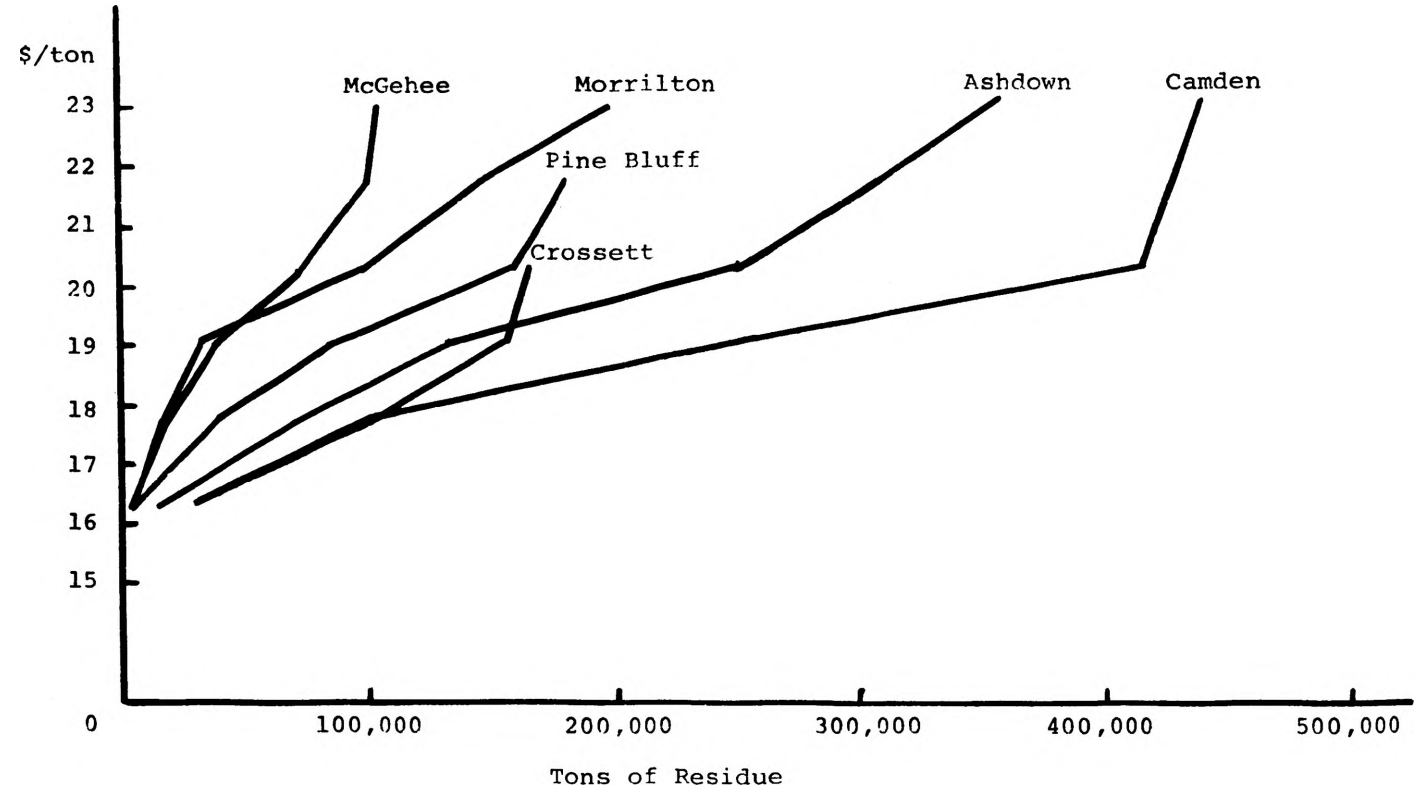


FIGURE 5
LOGGING RESIDUE MARKET (Morrilton)

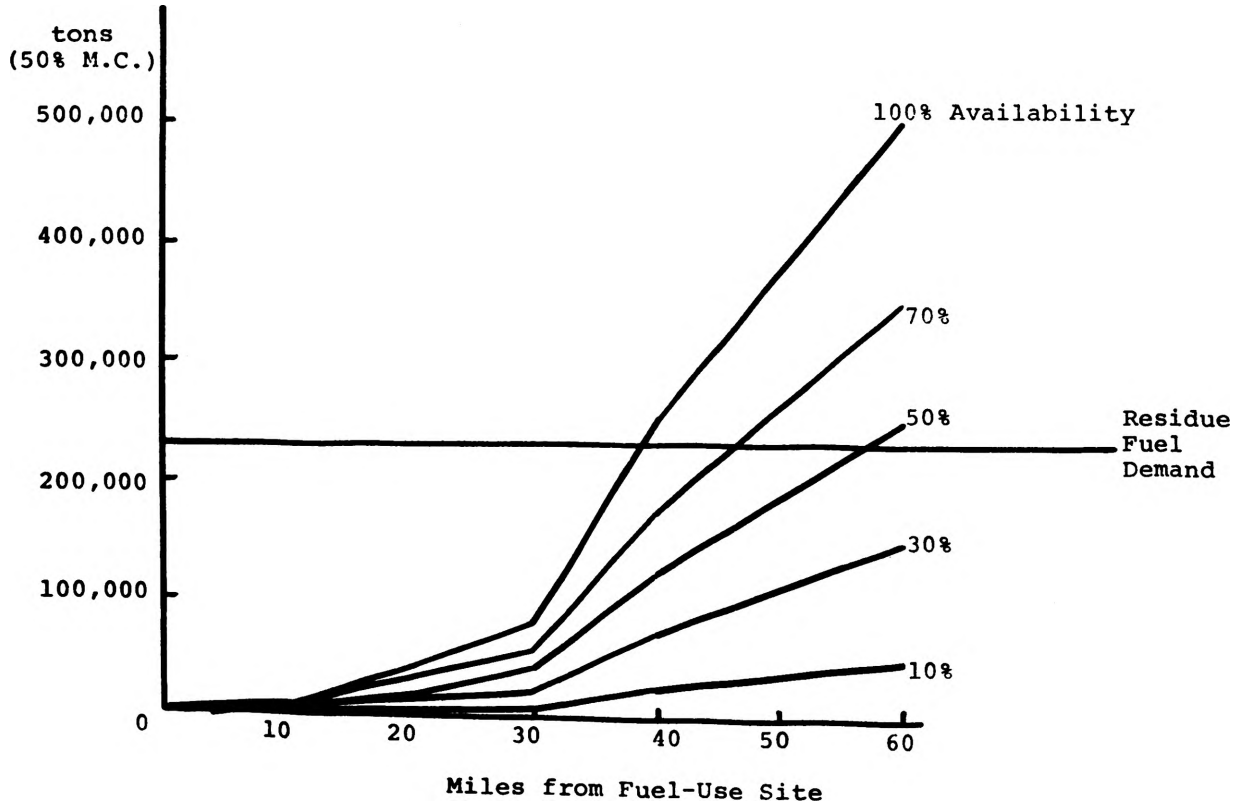


TABLE 2
ENERGY DEMAND

	Assumed Output (thousand tons)	Total Steam Production (million lbs.)	Demand for Purchased Energy (mission lbs. of steam)	Potential Annual Demand for Wood Fuels (thousand tons)
Crossett	431	5,603	2,521	290
Camden	221	2,873	1,292	148
Pine Bluff	612	7,956	3,580	412
Ashdown	538	6,994	3,147	362
McGehee	142	1,846	830	95
Morrilton	340	4,420	1,989	229

Figure 4 is drawn on the basis of $15/ton harvesting cost and 20¢per ton/mile. It shows that for a delivered cost of $20/ton (50% M.C.) less than 80,000 tons of logging residue can be delivered to the McGehee mill. This compares to approximately 100,000 tons at Morrilton; 138,000 tons at Pine Bluff; 146,000 tons at Crossett; 240,000 tons at Ashdown and over 400,000 tons at Camden.

7. LOGGING RESIDUE MARKET

The market for logging residue at each of the six locations can be determined by comparing the availability of logging residue with the demand for this fuel. For example, Table 2 indicates a potential annual demand of 229,000 tons of wood fuel at Morrilton. Figure 5 shows this level of residue fuel demand relative to the quantity of residue fuel which is available. If 50% of the total amount of residue lying on the forest floor is economically accessible, then this level of demand could be supplied by a radius of approximately 58 miles from the mill. Using the cost estimates shown in Figure 4, this residue can be delivered to Morrilton for an estimated $23 per ton.

March, 1980, spot prices ranged from $6.50/ton to nearly $14/ton for wood fuels. As a result the delivered cost of logging residue is not competitive with market prices for other w od fuels. However, the price of wood residue fuel is competitive with the price other purchased fuels, especially fuel oil. At a delivered price of $23/ton and assuming a boiler efficiency of 73% the cost of steam may be estimated at $4.50 per 1,000 pounds of steam. Fuel oil costing $20/Bbl will produce steam at approximately the same cost.

In summary, it appears that there are sufficient quantities of logging residues physically available to satisify an important portion of the total energy demand of Arkansas paper mills. However, the cost of these residues currently exceed the price of other wood fuels by a factor of 200-300 percent. However, the comparative advantage of logging residue is related to the higher price conventional fuels and their uncertain supplies.

8. REFERENCES

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(4) Ibid.
(5) Junge D.C., "Energy Alternatives for the Forest Products Industry," in Wood Residue as an Energy Source, Forest Products Research Society, Madison, Wisconsin, 1976.
(6) Aton, op. cit., p. V-8.
(7) Hewett, C and High, C, "Construction and Operation of Small, Dispersed, Wood-Fired Power Plants," Resource Policy Center, Dartmouth, March, 1979.

9. BIOGRAPHY

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