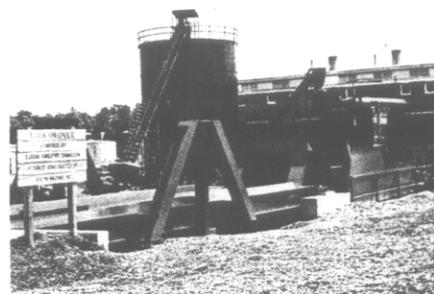
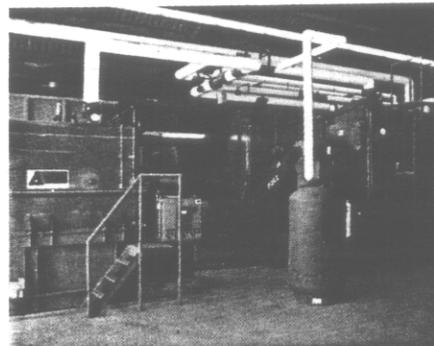


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## A SURVEY OF GEORGIA USERS OF WOOD FOR ENERGY

By:

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# A SURVEY OF GEORGIA USERS OF WOOD FOR ENERGY

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## ABSTRACT

Georgia's forest products industries are energy intensive. Among 84 firms responding to the 1984 survey, energy expenditures totaled \$316,949,800. Average annual energy costs were \$395,800 for lumber and wood products firms, \$23,699,000 for pulp and paper mills, \$2,198,600 for nonwood manufacturers, and \$109,200 for government institutions with wood burning installations.

The use of wood residues and chips for energy has been highly cost efficient. Firms, institutions, and households in Georgia spent an estimated \$194.7 million on 10,116,385 tons of residues, chips, and roundwood for wood energy in 1984. The cost to generate equivalent energy using fuel oil in 1984 would have been \$462.3 million. The resulting saving to Georgia users of wood energy was \$267.6 million. Additionally, it is estimated that there was an economic benefit of more than \$61 million to Georgia's economy due to the fact that virtually all wood for energy purposes is produced in the state as contrasted with alternative fuels, which are imported. The import of 13.8 million barrels of fuel oil would have been required to generate as much energy for Georgia as from burning wood in 1984.

The survey of wood energy users disclosed that 64 lumber and wood products firms used wood to supply up to 100 percent of their total energy requirements. Pulp and paper mills used wood to supply from 5 to 30 percent of their energy needs. In addition wood has become an increasingly important source of energy among nonwood manufacturers and government institutions in Georgia. Planned expansion in wood energy systems by Georgia firms will increase wood energy demands by more than 227,000 tons annually.

The 14 whole tree chipping operations interviewed by the survey produced 972,800 tons of whole tree fuel chips and 350,800 tons of pulp chips in 1984, allocated 55 percent to hardwood and 45 percent to softwood chips. Chipping operations occurred on 32,400 acres in 32 Georgia counties. Whole tree chipping is a forest management tool that significantly reduces site preparation costs, maximizes forest outputs, and upgrades low-value natural stands. Georgia's forest is a renewable resource that can fuel industrial energy requirements into the distant future.

By far the largest user of wood for energy in Georgia is the forest products industry itself. In 1984 this industry utilized 5.4 million tons of wood fuel as well as an undetermined but large quantity of black pulping liquor. The annual fuel cost savings attributable to the substitution of wood residues and chips for conventional fuels by industry, government, and households exceeded \$267 million, Table 1. In addition to the fuel savings, the substitution of wood energy by Georgia industry, government, and households resulted in an estimated \$61.8 million of additional economic activity in Georgia. Wood fuel is a renewable, locally produced energy source as contrasted with conventional fuels which must be imported into the state. To produce as much energy as Georgia's wood energy, 13.8 million barrels of fuel oil would have had to have been imported in 1984. For every 2,000 tons of wood chips locally produced in supply of this energy substitution it is

estimated that one job is directly or indirectly created in Georgia.

Georgia's potential supply of wood for energy is abundant in relation to current and anticipated demand. The demand for wood energy constitutes no serious competition for the timber requirements of lumber mills, pulp and paper mills, and other forest products manufacturers. As the principal consumer of wood for fuel, the forest products industry obtains most of its wood energy from manufacturing residues, as contrasted with in-the-woods produced fuel chips. Moreover, present methods of harvesting timber and the prevalence of cull trees having no value except as fuel leaves ample wood waste for fuel chipping. Indeed, in-the-woods fuel chipping contributes to the long run productivity of the forest in that the reforestation of chipped-over land costs only one-fourth to one-third as much as conventionally harvested timberland.

TABLE 1  
Wood Energy Used by Georgia Industry, Government, and Households

	1984		Equivalent Fuel Oil Cost	Savings
	Wood Fuel Tons	Cost		
Lumber and Wood Products	1,228,164	\$15,966,132	\$56,122,182	\$40,156,050
Pulp, Paper, and Board	4,148,598	45,634,578	189,574,334	143,939,756
Nonwood Industry	721,439	7,214,390	32,966,877	25,752,487
Government Institutions	55,239	662,868	2,524,201	1,861,333
Households	3,962,945	125,229,062	181,090,735	55,861,673
<b>Total</b>	<b>10,116,385</b>	<b>\$194,707,030</b>	<b>\$462,278,329</b>	<b>\$267,571,299</b>

### Procedures

To determine the characteristics of Georgia's users of wood for energy and of the in-the-woods chipping operations the study attempted a survey of all firms and institutions known to be involved with wood energy, numbering more than one hundred in 1984. Sixty-four lumber and wood product firms, 13 pulp and paper mills, seven nonwood industry firms, 12 governmental institutions, and 14 chipping operators participated in the survey. With respect to the estimates of overall use of wood residues and chips for energy, estimates were made for firms not participating in the survey. Otherwise, data presented in this report are not necessarily additive since some questions did not apply to all firms.

### Findings

#### Energy Sources

The industries and institutions surveyed by the study relied upon a variety of energy sources other than wood, Table 2. Among firms utilizing wood energy in the lumber and wood products industry, electricity was the most frequently mentioned source other than wood, accounting for as much as 95 percent and as little as five percent of the total energy requirements of 71 firms. Natural gas and fuel oil were the next most frequently mentioned energy sources for lumber and wood products firms.

Thirteen firms in the state's pulp and paper industry relied upon wood energy for as much as 30 percent of their total energy requirements. The black liquor produced in the pulp-making process was the most important energy source.

Twelve firms produced energy from black liquor, which accounted for at least 26 percent and as much as 64 percent of their total energy requirements. For seven of the surveyed pulp mills, coal and coke was an important energy source. Among these firms, the use of coal and coke ranged from 18 percent to 40 percent of their total energy requirements. Natural gas was mentioned by 10 mills, with a range of from six percent to 29 percent of their total energy requirements. Fuel oil and purchased electricity are common energy sources, but they account for a relatively small share of the pulp and paper industry's total energy requirements.

Among the nonwood manufacturing firms using wood for energy, wood accounted for at least 35 percent and for as much as 94 percent of their total energy requirements. Natural gas and electricity were the most important alternative energy sources for these few nonwood industry firms.

Several governmental institutions, e.g. prisons, schools, and hospitals, have recently added wood-burning equipment to supplement their more conventional energy sources. For these institutions, wood accounts for at least 18 percent and for as much as 90 percent of their total energy requirements. Six of these wood-using institutions reported the use of natural gas, with this source accounting for as little as 10 percent and for as much as 82 percent of their energy requirements. Six institutions mentioned electricity, with a range of from 15 to 71 percent of their total energy requirements, and four mentioned fuel oil, with a range of from eight to 32 percent of total energy requirements.

#### Energy Expenditures

Firms utilizing wood for energy are energy intensive. Energy expenditures by 57 lumber and wood products firms totaled \$22.6 million in 1984 and averaged \$395,775 per

firm, Table 3. The 12 pulp and paper firms spent \$284.4 million on energy and averaged \$23.7 million per firm in 1984. The four nonwood firms in the survey utilizing wood energy spent a total of \$8.8 million on energy from all sources, averaging \$2.2 million per firm. Eleven governmental institutions using wood for energy in 1984 spent a total of \$1.2 million for energy and had average energy costs of \$109,182 per institution. The firm with the highest energy costs in 1984 was a pulp and paper mill which spent more for energy from all sources than the combined total of all lumber and wood products firms, nonwood industry firms, and governmental institutions in the survey.



*The demand for wood energy constitutes no serious competition for the timber requirements of lumber mills, pulp and paper mills, and other forest products manufacturers.*

Table 2  
Energy Sources Used by Firms Utilizing Wood Energy

Firm Type and Sources	Number	Percent of Total Energy Requirements	
		High	Low
<b>Lumber and Wood Products:</b>			
Electricity	71	95%	5%
Coal and Coke	1	1	
Fuel Oil	13	50	1
Natural Gas	25	74	1
Liquid Propane Gas	—		
Wood	64	100	1
<b>Pulp and Paper Mills:</b>			
Electricity	13	8	1
Coal and Coke	7	40	18
Fuel Oil	12	13	1
Natural Gas	10	29	6
Liquid Propane Gas	2	1	1
Black Liquor	12	64	26
Wood	13	30	5
<b>NonWood Industry:</b>			
Electricity	4	56	5
Coal and Coke	—		
Fuel Oil	—		
Natural Gas	4	52	9
Liquid Propane Gas	1	1	
Wood	5	94	35
<b>Governmental Institutions:</b>			
Electricity	6	71	15
Coal and Coke	—		
Fuel Oil	4	32	8
Natural Gas	6	82	10
Liquid Propane Gas	—		
Wood	12	90	18

Table 3

Energy Expenditures by Firms Utilizing Wood Energy

Expenditures	1984			
	Lumber and Wood Products	Pulp and Paper Mills	Nonwood Industry	Government
Total Energy Cost	\$22,559,200	\$284,395,100	\$8,794,500	\$1,201,000
Average Cost Per Firm	395,775	23,699,592	2,198,625	109,182
Range: High	2,205,400	(withheld)	6,364,500	785,800
Low	10,600	5,828,400	220,000	10,700
Number of Firms	57	12	4	11

## Uses Of Wood Energy

Georgia's wood-using firms and institutions use wood energy to generate steam, heat, and electricity, Table 4. In 1984, 71 lumber and wood products firms burned wood to generate these three energy applications, of which 26 generated steam only, 18 heat only, 26 steam and heat, and one steam and electricity. Of these firms using wood to fire their boilers, 31 reported having boilers capable of using alternative fuels. Natural gas as well as wood could fire the boilers of 16 firms. Coal could be used as a substitute for wood by seven lumber and wood products firms, fuel oil by four firms and fuel oil or natural gas by four firms.

Of the 13 pulp and paper firms in the survey, one reported using wood to fire boilers to generate steam, one for heat,

seven for steam and electricity, and four for steam, electricity, and heat. All 13 pulp and paper firms have boilers capable of using alternative fuels. Five firms reported a boiler capability of using either fuel oil, natural gas, or coal as a substitute for wood.

The five nonwood industry firms in the survey all reported a boiler capability for alternative fuels to wood. However, only two of the 12 governmental institutions using wood to fire their boilers, mainly for the generation of heat, reported a capacity of using coal as a substitute for wood.

Because of their substantial energy requirements forest products firms self-generate a significant proportion of their total energy requirements. Although virtually all firms in the survey purchase energy, most also rely upon wood residues or chips to generate their own energy, Table 5.

Table 4

### Firms Using Wood Energy to Generate Steam, Electricity, and Heat

1984

	Lumber and Wood Products	Pulp and Paper Mills	Nonwood Industry	Government
<b>Firms Using Wood To Generate-</b>				
Steam	26	1	2	—
Heat	18	1	1	11
Steam and Heat	26	—	—	1
Steam and Electricity	1	7	—	—
Steam, Electricity, and Heat	—	4	2	—
Total	71	13	5	12
<b>Boilers Capable of Using Alternative Fuels:</b>				
Fuel Oil	4	3	—	—
Natural Gas	16	—	1	—
Coal	7	—	—	2
Fuel Oil and Natural Gas	4	2	4	—
Fuel Oil and Coal	—	3	—	—
Fuel Oil, Natural Gas, and Coal	—	5	—	—
Total	31	13	5	2

Table 5

### Purchased and Self-Generated Energy by Georgia Firms

	Lumber and Wood Products	Pulp and Paper	Nonwood Industry	Government
<b>Purchased:</b>				
No. of Firms	72	14	4	12
Range: High	100%	70%	100%	100%
Low	0	1	6	11
<b>Self-Generated from Wood:</b>				
No. of Firms	67	14	4	10
Range: High	100%	68%	94%	89%
Low	1	4	39	15
<b>Self-Generated from Other fuels</b>				
No. of Firms	2	11	1	0
Range: High	100%	70%	35%	—
Low	1	26	35	—

## Delivered Prices

The delivered price per ton for wood residues and chips reported by firms in the survey varied widely, Table 7. The delivered prices of residues used to produce energy by 55 lumber and wood products firms ranged from a low of \$6.50 per ton to a high of \$25.00 per ton. The range of reported prices for residues was much less for the pulp and paper industry, nonwood industry firms, and governmental institutions, from a low of \$8.04 per ton reported by one of the 12 pulp and paper mills to a high of \$15.00 as reported by a pulp mill and one of the nonwood industry firms in the sur-

vey. The average delivered prices per ton of residues reported for each class of wood energy user ranged from \$9.63 per ton for the five nonwood industry firms to \$12.87 per ton for the lumber and wood products firms. Wood chips were much less commonly used for energy than wood residues. Only five firms reported using wood chips for energy and only three of them reported a delivered price, the average of which was \$13.33 per ton. In contrast, eight government respondents, a majority of the institutions using wood for energy, used wood chips rather than wood residues. The delivered prices reported by these institutions ranged from \$10 to \$20 a ton and averaged \$15.62.

Table 6

### Residues and Chips Used for Wood Energy By Georgia Firms in 1984\*

	Lumber and Wood Products	Pulp and Paper Mills	Nonwood Industry	Government
<b>Residues:</b>				
No. of Firms	87	12	7	4
Total Tons	1,249,164	3,811,269	721,439	46,563
Average	14,358	317,606	103,063	11,641
<b>Chips:</b>				
No. of Firms	1	4	1	8
Total Tons	4,000	337,329	1,500	8,676
Average	4,000	84,332	1,500	1,085

\*Includes estimated wood energy use of firms not reporting to survey.

Table 7

### Price per Ton for Residues and Chips Used for Wood Energy by Georgia Firms and Institutions

1984

	Lumber and Wood Products	Pulp and Paper Mills	Nonwood Industry	Government
<b>Delivered Price per Ton:</b>				
No. of Firms	55	12	5	4
Range: High	\$25.00	\$15.00	\$15.00	\$12.53
Low	6.50	8.04	9.00	10.00
Wgt'd. Average	12.87	11.16	9.63	12.14
<b>Chips:</b>				
No. of Firms	1	3	1	8
Range: High	D	\$15.00	D	\$20.00
Low	D	12.75	D	10.00
Wgt'd. Average	D	13.33	D	15.62

(D) Data not reported.

## Residues Used

The kind and form of wood used for energy production in the forest products industries was directly dependent upon the kind of wood being processed and the nature of the wood processing. By the same token, the kind and form of wood available to nonwood industry firms and governmental users is largely a by-product of wood processing in their areas. Even so, except for governmental institutions, there does not appear to be a material difference between the kind and form of wood being used to produce energy and that which users would prefer, Table 8.

Wood energy is considered to be a viable substitute for five conventional fuels: electricity, coal and coke, fuel oil, natural gas, and liquid propane gas (LPG). Among all four types of wood energy users, wood energy was considered

to be most readily substituted for fuel oil and natural gas, Table 9. Among firms in the lumber and wood products industry, 58.1 percent and 73.0 percent, respectively, indicated that wood substitutes for fuel oil and natural gas. Similarly, high proportions of the respondents in the pulp and paper industry, nonwood industries, and government indicated wood is a feasible substitute for fuel oil and natural gas.

Wood energy users were queried further as to the percent of energy requirements now provided by conventional fuels that could be supplied by wood. With appropriate systems investment, wood energy was considered to be a feasible alternative for as much as 100 percent of the energy presently being supplied by specific conventional sources, Table 10. This opinion was not unanimous, however, as indicated by the responses at the lower end of the range of energy requirements that could be supplied by wood.

Table 8  
Kind of Wood Used and Preferred for Wood Energy  
(Number of Firms)

	1984			
	Lumber and Wood Products	Pulp and Paper Mills	Nonwood Industry	Government
<b>Used:</b>				
Pine	25	---	2	---
Hardwood	17	---	1	---
Bark	10	6	---	9
Pine and Hardwood	9	---	1	---
Pine and Bark	8	1	---	---
Hardwood and Bark	4	---	---	---
Pine, Hdwd, and Bark	2	7	1	3
Total	75	14	5	12
<b>Preferred:</b>				
Pine	28	1	3	---
Hardwood	21	1	2	7
Bark	10	5	---	---
Pine and Hardwood	3	---	---	4
Pine and Bark	5	2	---	---
Hardwood and Bark	4	2	---	---
Pine, Hdwd, and Bark	---	3	---	1
No Preference	4	---	---	---
Total	75	14	5	12

Table 9  
Wood Energy as a Substitute for Conventional Fuels  
(Number and Percent of Respondents)

Conventional Sources	1984							
	Lumber and Wood Products		Pulp and Paper Mills		Nonwood Industry		Government	
	No.	%	No.	%	No.	%	No.	%
Electricity	27	36.5	4	28.6	3	60.0	--	--
Coal and Coke	33	44.6	7	50.0	--	--	7	58.3
Fuel Oil	43	58.1	10	71.4	3	60.0	12	100.0
Natural Gas	54	73.0	8	57.1	4	80.0	11	91.7
LPG	32	43.2	4	28.6	2	40.0	7	58.3
None	7	9.5	1	7.1	--	--	--	--



Fourteen total tree chipping operations produced over 970,000 tons of fuel chips.

Table 10

Percent of Total Energy Requirements Presently  
Supplied by Conventional Fuels That Could be Supplied  
by Wood

1984

Conventional Sources	Number of Respondents	Range of Energy Requirements That Could Be Supplied by Wood	
		High	Low
<b>Lumber and Wood Products:</b>			
Electricity	23	100%	2%
Coal and Coke	12	100	100
Fuel Oil	18	100	5
Natural Gas	27	100	20
LPG	13	100	40
<b>Pulp and Paper Mills:</b>			
Electricity	3	100	2
Coal and Coke	3	100	5
Fuel Oil	7	100	10
Natural Gas	5	90	5
LPG	--	---	--
<b>Nonwood Industry:</b>			
Electricity	2	100	30
Coal and Coke	--	---	--
Fuel Oil	3	100	95
Natural Gas	4	95	60
LPG	1	100	--
<b>Government:</b>			
Electricity	7	100	25
Coal and Coke	2	100	80
Fuel Oil	9	100	80
Natural Gas	10	100	80
LPG	2	85	80

Table 11

## Opinions

Major Reasons for Converting Energy Requirements from  
Conventional Fuels to Wood  
Percent of Responses Ranking No. 1 and No. 2

Reason	1984							
	Lumber and Wood Products		Pulp and Paper Mills		Nonwood Industry		Government	
	%1's	%2's	%1's	%2's	%1's	%2's	%1's	%2's
Conventional fuels too expensive.	40.0	16.9	75.0	16.7	60.0	40.0	100.0	---
Wood supply was readily available at competitive cost	25.7	32.3	8.3	41.6	40.0	20.0	---	100.0
Cheaper to burn wood for fuel than to dispose of it	27.1	32.3	16.7	---	---	---	---	---
Investment in wood burning equipment pays for itself in a few years	4.3	12.3	---	25.0	---	40.0	---	---
Wanted to become energy independent	2.9	6.9	---	16.7	---	---	---	---
Total Responses	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Percent	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Number	12	65	12	12	5	5	12	12

Table 12

Characteristics of Firms That Plan an Additional  
Investment in Wood Energy Systems or Equipment

	1984			
	Lumber and Wood Products	Pulp and Paper Mills	Nonwood Industry	Government
Number of Firms	6	3	0	1
Tons of Wood Used per year				
Currently	53,750	1,123,697	---	---
After Expansion	75,250	1,328,697	---	540
Percent of Total Energy from Wood				
Currently: High	75%	29%	---	---
Low	30	14	---	---
After Expansion:				
High	100%	41%	---	100%
Low	25	14	---	---
Expected Annual Rate of Return on Investment:				
High	100%	40%	---	25%
Low	10	22	---	---

Table 13

1984

## Conditions Affecting Industry's Future Demand for Wood Energy

Number of Times Mentioned by:

Conditions	Lumber and Wood Products		Pulp and Paper Mills		Nonwood Industry		Government	
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
Fuel and power prices	40		9		3		8	
Boiler efficiency	3		2		---		1	
Wood supply reliability	3		3		---		---	
Awareness of saving	3		---		---		1	
Improved harvesting and transportation	1		2		---		---	
Environmental restrictions on use of coal	---		1		---		---	

Table 14

## Sources of Supply for Wood Used as Energy

1984

Source <sup>1/</sup>	Lumber and Wood Products		Pulp and Paper Mills		Nonwood Industry		Government	
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
4	49	77.8	1	7.7	---	---	---	---
1	3	4.8	---	---	---	---	3	27.2
2	2	3.2	---	---	3	60.0	4	36.4
3	---	---	1	7.7	---	---	---	---
1,2	---	---	---	---	1	20.0	4	36.4
1,3	3	4.8	---	---	---	---	---	---
2,4	5	7.9	7	53.8	1	20.0	---	---
3,4	1	1.5	---	---	---	---	---	---
4,5	---	---	1	7.7	---	---	---	---
1,2,3,4	---	---	3	23.1	---	---	---	---
Total	63	100.0	13	100.0	5	100.0	11	100.0

<sup>1/</sup> Source

1. Independent contractors from private lands
2. Residues from other forest products manufacturers
3. Company lands
4. Wood residues from company mill operations
5. Company sawmill residues

## Major Reasons for Converting to Wood Energy

Each respondent was asked to rank in order of importance the major reasons that influenced their decision to convert a portion of their energy requirements from conventional sources to wood. The reason that conventional sources of fuel were becoming too expensive was ranked first by 40 percent of lumber and wood products firms, by 75 percent of firms in the pulp and paper industry, by 60 percent of nonwood industry firms, and by all of the government institutions in the survey, Table 11. The ready availability of wood for energy at a competitive cost was the second most significant reason for converting from conventional fuels to wood. Interestingly, a desire to be energy independent was not ranked as an important reason for converting to a wood burning system. Among lumber and wood products firms, the imperative of disposing of wood waste was a significant reason being ranked first by 27.1 percent of the firms and second in importance by 32.3 percent of the firms.

## Planned Investments in Wood Energy Systems

Based upon a favorable experience from using wood energy, six lumber and wood products firms, three pulp and paper mills and one government institution indicated plans to make additional investments in wood energy systems or equipment, Table 12. These planned expansions would increase the demand for wood for energy by 227,040 tons annually. When completed, the percent of total energy requirements supplied by wood will rise from a present high of 75 percent to a high of 100 percent for a lumber and wood products firm and from a present high of 29 percent to a high of 41 percent for a pulp and paper mill. The range of expected annual rates of return on the additional investment in wood energy systems and equipment extended from a low of 10 percent to a high of 100 percent.

## Future Demand for Wood Energy

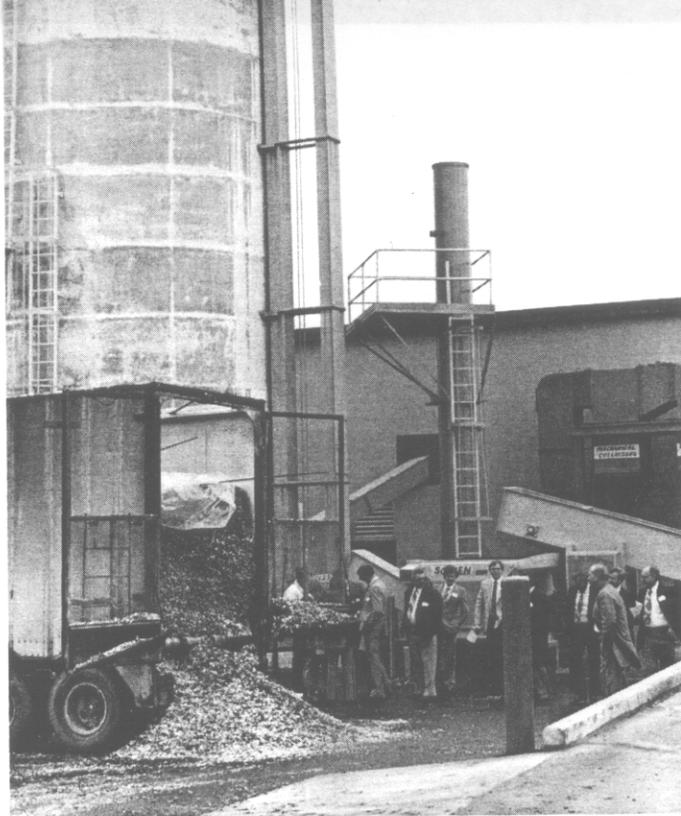
Based upon open-ended responses, a number of conditions were cited by respondents that will influence the future demand for wood as an energy source, Table 13. The price of alternative fuels and of electricity was the most frequently cited condition, exceeding by an overwhelming margin such concerns as boiler efficiency, reliability of wood supply, and improvements in the harvesting and transporting of wood. The marked decline in energy prices since the survey was taken should, therefore, inhibit industry's plans for future growth in the use of wood for energy.

## Supply of Chips and Residues

Wood for energy is procured by industry from five sources:

1. Independent contractors from private land
2. Residues from other forest products manufacturers
3. Company lands
4. Residues from company mill operations
5. Company sawmill residues

Wood residues from company mill operations was the only source of wood energy at 49 or 77.8 percent of 63 lumber and wood products firms in the survey, Table 14. Wood residues from their own mill operations and those from other forest product manufacturers are the principal sources for pulp and paper mills. Outside residues are typically obtained from manufacturing concerns that are operating units of the parent corporation of the pulp and paper mill. Wood chips originating from private lands and furnished by private contractors was a supplemental source used by only three lumber and wood products firms and no pulp and paper firms. One pulp and paper mill maintained whole tree chipping operations on its company land. Three of eleven governmental institutions



*Visitors view a chip storage silo and other facilities of a wood energy system installed at a prison complex.*

reported they were solely dependent upon the supply of chips from independent contractors operating on private lands. Four other institutions used chips supplied by contractors in conjunction with wood residues from forest products firms and four were solely dependent upon the latter source.

## Chip Production

Fourteen whole tree chipping operations in Georgia were interviewed to determine the characteristics and experience of fuel chip producers. These firms produced a mix of wood outputs including pulp chips, pulpwood and sawlogs as well as fuel chips. In 1984 the 14 operations produced 972,807 tons of whole tree fuel chips and 350,750 tons of pulp chips, equivalent to 529,423 cords of wood. In addition to chips, these firms produced 9,595,000 board feet of sawlogs and 2,400 cords of pulpwood.

The chip production of the 14 whole tree chipping operations interviewed can be allocated as 727,780 tons of hardwood chips and 595,777 tons of softwood chips. Timberlands owned by nonindustrial landowners were the origin of 822,633 tons of chips, while 500,924 tons originated from timberlands owned by forest industries. In producing these chip tonnages the chipping operations clearcut 25,276 acres and selectively cut 7,162 acres of timberland. Whole tree chipping operations reportedly paid as little as \$0.40 and as much as \$10.40 a ton for whole tree chipping stumpage.

Whole tree chipping is a forest management tool that can upgrade low-value natural stands, maximize forest outputs, and significantly reduce site preparation costs. Since most whole tree chipping uses the clear cutting harvesting method, land can be planted readily at a much lower cost to the landowner than for land harvested by conventional methods, where it is necessary to site prepare the land.

## In-the-Woods Whole Tree Chip Production

In 1984 chip using firms and institutions bought 832,717 tons of chips from the 14 in-the-woods chip producers in the survey, equal to 63 percent of chip sales. Chips produced

under contract from forest industry and delivered to the company accounted for 490,840 tons or 37 percent of chip sales.

The delivered prices for in-the-woods whole tree chips received by producers ranged between \$16.80 and \$24.00 per ton for pulp chips and between \$10.00 and \$23.00 per ton for wood energy chips. The price per ton for chips produced and delivered under contract from company lands ranged from a low of \$10.00 to a high of \$14.00 per ton.

#### Counties in Which In-the-Woods Chips Were Produced and Sold

Based upon data from responding operations, 779,596 tons of chips were produced in 32 Georgia counties, Table 15. Five counties producing more than 50,000 tons each accounted for almost half the chip production in 1984. These were Crawford, 100,000 tons; Bibb, 75,000 tons; Talbot, 65,000 tons; Richmond, 62,500 tons; Harris, 60,000 tons. Only two counties were reported as having in-the-woods chipping locations by more than one chipping operation.

Sales of 489,476 tons of whole tree chips were concentrated in nine Georgia counties, Table 16. Recording sales of more than 50,000 tons each, Bibb, Chatham, Early, and Wayne counties represented more than 83 percent of sales by the whole tree chipping operations interviewed. The concentration of chip sales in a relatively few counties is explained by the location in these counties of major chip consuming industries and institutions. In 1984 three Georgia whole tree chipping operations produced 109,057 tons of chips in Alabama, Florida, and South Carolina for delivery to Georgia firms and institutions. Virtually all of the chips produced out-of-state for consumption in Georgia were used for wood energy. Conversely, of 135,475 tons of chips produced in Georgia for sale in Alabama and Florida only 4 percent were used in generating wood energy.

#### Equipment Requirements for Chip Production

The production capacities of individual chipping operations ranged from a low of 50 tons per day to a high of 750 tons per day. The combined chipping capacity of the 14 firms interviewed was 4,454 tons per eight hour day. The chipping operations interviewed employed 150 workers. Chip output per worker varied between 10.0 and 50.0 tons per day. Operations with smaller daily chipping capacities tended to have a higher output per worker day.

To produce 1,323,557 tons of chips in 1984, the 14 Georgia operations utilized the equipment listed in Table 17. The typical chipper used by a whole tree chipping operation had a 22 inch maximum log diameter size and produced 50,906 tons of chips in 1984. On average, each chipper was fed by one or two skidders and feller bunchers and required the transportation of 7 chip trailers. The investment in the chipper and supporting equipment ranges from about \$500,000 to well over \$1,000,000. An investment of this magnitude requires operation at near capacity levels and high quality management.

Among the 14 firms interviewed, eight chipping operations shipped all production by their own chip trucks, while six operations shipped from 5 to 60 percent of their chip output by leased trucks. The maximum hauling distance for whole tree chips destined for fuel use ranged from a low of 20 miles to a high of 125 miles. The maximum distance reported for pulp chips was 90 miles.

#### Expansion Plans

The in-the-woods whole tree chipping operations interviewed expanded production from 1,265,159 tons in 1981 to 1,323,557 tons in 1984, a gain of 4.6 percent. Among eleven firms expanding production the increase in chipping capacity ranged from 5 percent to 100.0 percent. Three firms reported a decrease in production over the three year period.

Table 15

#### Number of Georgia Counties in Which Whole Tree Chips Were Produced

1984		
Production (tons)	Number of Counties	Total Tons of Chips
50,000 and more	5	362,500
25,000 — 49,999	7	231,890
15,000 — 24,999	4	72,000
10,000 — 14,999	6	67,546
5,000 — 9,999	4	30,515
Under 5,000	6	15,145
<b>Total</b>	<b>32</b>	<b>779,596</b>

Table 16

#### Number of Georgia Counties in Which Whole Tree Chips Were Sold

Sales (tons)	Number of Counties	Total Tons of Chips
50,000 and more	4	408,674
25,000 — 49,999	1	44,520
15,000 — 24,999	1	20,000
10,000 — 14,999	1	10,882
5,000 — 9,999	0	---
Under 5,000	2	5,400
<b>Total</b>	<b>9</b>	<b>489,476</b>

Table 17

#### Number and Types of Equipment Used by Surveyed Chipping Operators

Type	Number	Tons of Chips per Unit of Equipment
Chipper	26	50,906
Feller Bunchers	34	38,928
Skidders	41	32,282
Truck Tractors	101	13,105
Chip Trailers	181	7,154
Maintenance Trucks	25	52,942
Pickup Trucks	37	35,772
Other Vehicles	10	132,356

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