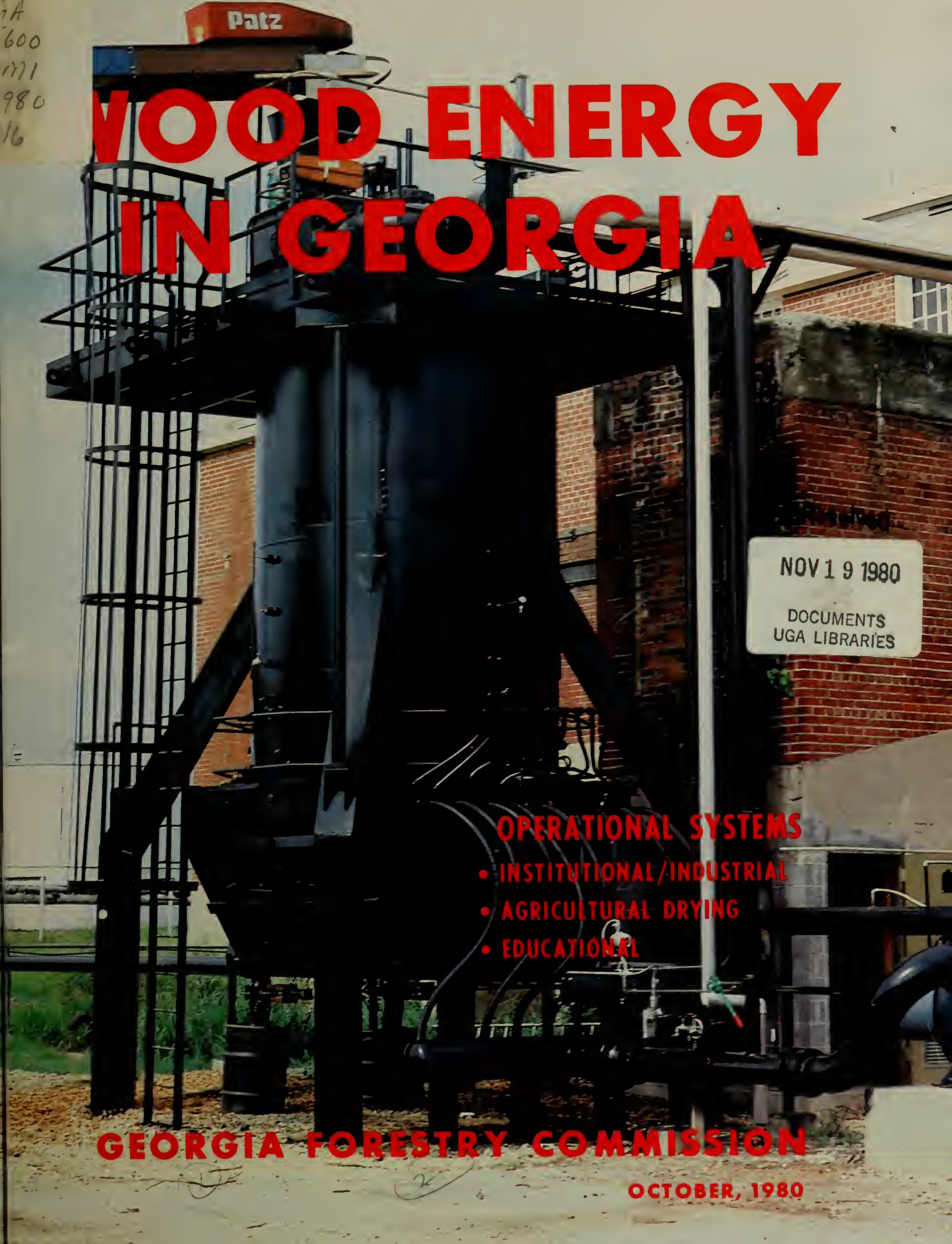
WOOD ENERGY IN GEORGIA



OPERATIONAL SYSTEMS

- INSTITUTIONAL/INDUSTRIAL
- AGRICULTURAL DRYING
- EDUCATIONAL

GEORGIA FORESTRY COMMISSION

OCTOBER, 1980

INTRODUCTION

The 1973 oil embargo by the OPEC Countries, combined with extreme weather in January and February of 1977, caused a severe change in energy supply and demand situations. Wood energy had not been considered an alternate fuel source since fossil fuels were relatively cheap and available. In the winter of 1977, natural gas and heating oils were in short supply. Eighty-three industries and/or businesses in Macon were closed from a few days to weeks due to fuel shortages. Similar conditions existed in the northern half of the state.

The Forestry Commission and Georgia Tech Experiment Station invited business leaders to meet and explore wood for energy. The Commission had inventoried the state wood supply and determined an enormous quantity of forest biomass was available. A model of a gasification system using wood chips was demonstrated and wood stoves and heaters were displayed and promoted.

Governor George Busbee and the General Assembly appropriated $500,000 to the Commission for wood energy effective July 1, 1978, an equal amount on July 1, 1979, and $400,000 on July 1, 1980.

Through a research study, a method of inventorying a timber stand in tons per acre was developed. Wood harvesting equipment has been tested and proven effective to harvest sawtimber, peeler logs, poles, pulpwood, and energy wood chips in the same logging operation.

A wood gasification combustion process has been installed and is now operating at the Northwest Georgia Regional Hospital at Rome. A 500 h.p. boiler was retrofited to burn wood gas produced from whole tree chips with a maximum 65 percent moisture content. The gas is piped to the burner in the boiler and replaces oil and natural gas. It is the largest gasification system using green chips that we know of in existence. It is automatically operated and has a three-and-a-half day fuel storage supply system.

Another major development is the agricultural crop dryer now ready for commercial use. It uses whole tree chips (green) for fuel; is automatically operated using electric current existing on the farm; and can dry all kinds of grains, soybeans, and other crops with the exception of tobacco and peanuts. Hopefully, it can be modified to cure tobacco.

A new automatic fuel chip system has been installed in a junior high school at Blairsville, Georgia. It is now operating and has replaced an oil system.

The Commission employed Georgia Tech Experiment Station as consultant for the gasifier. Commission personnel have been responsible for the agricultural dryer, the school systems, and other activities. Two additional school systems have wood chip facilities under construction. One replaces oil and the other electricity. The new Correctional facility in Dodge County will have a wood chip system, and $200,000 has been alloted for it. Other state facilities are being investigated and data collected for wood energy application.

—A. Ray Shirley, Director
Georgia Forestry Commission

THE SOURCE

IT ALL STARTS IN THE ABUNDANT FORESTS THAT BLANKET THE STATE

Georgia has 24 million acres of commercial forest land. Presently, the growth amounts to approximately 24 million cords annually. Tree removal amounts to 14 million cords on 640,000 acres annually, leaving a surplus of 10 million cords.

On the average, 22 tons of waste per acre remains in the forest from logging operations. A cord of wood is equivalent to 3.3 barrels of oil for energy use. Another 35 million cords of cull trees are in the forest that are not merchantable unless used for energy. If 25 percent of the logging waste, excess growth and cull trees are used for energy, they would replace 42.5 million barrels of oil annually, representing a value of over $1 billion. This will be a major source of fuel for industry, institutions, schools and other businesses in the state.

The Forest Management Department of the Commission has detailed data on the above assumptions.

The Forestry Commission has conducted ten harvesting demonstrations in north and middle Georgia. A publication by the Research Department of the Forestry Commission explains the whole tree chipping process (Research Paper No. 4). Twenty-nine operators are presently using total tree harvesting machines in Georgia.

Detailed forest field studies have been conducted by the Commission and the U. S. Forest Service to determine the tons per acre of the biomass or the total tree chips. Volumes from 70-80 tons per acre are common on the test sites. Some areas of cull hardwoods are producing 100 tons per acre or more. Some studies have been conducted concerning storage and hauling wood chips.

Removing the low grade hardwoods is a tremendous benefit to the forest owner. Average cost for heavy mechanical site preparation in Georgia is $135 per acre plus $44 for mechanical tree planting, including trees. The site preparation can be eliminated by using total tree harvesting.

Certain total tree harvesting operations are taking every stem down to one-inch diameter. This is excellent site preparation for the establishment of a desirable stand of trees. Instead of having the above expense, the landowner can actually receive a profit by carrying out this type site preparation.

A forester, at left, examines a cull tree that could be harvested for wood energy purposes. The scene above is a small portion of the 24 million acres of forests that play a tremendous role in the economy of the state.

The Commission has established several one-acre study plots to demonstrate the various methods of harvesting and improving timber stands. Located on property of Berry College, the plots are visited by timberland owners and other interested persons.

Commission personnel serve as guides to point out the advantages of certain practices made on the property.

COMMERCIAL HARVEST PLOT

The commercial harvest plot is actually a demonstration of the conventional method of harvesting.

The plot shows the vast amount of material left in the forest after the logger has taken out choice trees and left broken stems, large limbs, tops, and other residue that were once considered waste but now represents a valuable resource when converted into chips or used for firewood.

It is material that could not be feasibly removed some years ago, but with the modern machinery of today - including the feller buncher, grapple skidder and chipper - it represents potential added income to the landowner and a valuable contribution to the campaign to ease the energy shortage.

	Bd. Ft.	Cords	Tons
Estimate			
Pine Sawtimber	2,885		20.0
Pine Pulpwood		1.5	4.0
Hardwood Sawtimber	0		0
Hardwood Pulpwood		10.0	28.0
Actual Volume Harvested			
Pine Sawtimber	2,881		20.0
Pine Pulpwood		1.5	4.0
Hardwood Sawtimber	0		0
			24.0
Biomass Remaining on Plot			
Hardwood Pulpwood (no market)		10.0	28.0
Tops, Undersize stems, limbs			5.0
			33.0
Estimate of Total Biomass			57.0

A Commission forester advises a landowner on the wisest and most profitable use of his timber. The bulk of Georgia's forests - some 23,267,500 *acres - belongs to private landowners.*

CONTROL PLOT

Two one-acre plots in the demonstration area are left in their natural state in order that the observer can compare them with adjacent plots in which harvesting and other forest management practices have been carried out.

By leaving the stand intact, foresters are able to point out several alternatives that a landowner could take if similar property were to be managed.

	Bd. Ft.	Cords	Tons
Estimate			
Pine Sawtimber	1,100		7.7
Pine Pulpwood		3.7	9.8
Hardwood Sawtimber	455		3.4
Hardwood Pulpwood		3.5	10.2
Total Merchantable Volume			31.1
Volume of tops, limbs, cull and undersized trees			33.9
Estimate of Total Biomass			65.0

CLEAR CUT

The clearcut, or harvest cut plot, demonstrates total removal of the timber stand for the purpose of regenerating a more valuable acre of timber. Foresters graded the timber in the plot and it was sold for its highest value. After removal of the sawtimber, the undesirable trees, limbs and remaining biomass were chipped. The two fold objective of the demonstration is to show landowners how this method of harvest can save the cost of site preparation, which would run approximately $135 on the type area shown, and at the same time realize additional income from the sale of chips produced from biomass

	Bd. Ft.	Cords	Tons
Estimate			
Pine Sawtimber	1,700		12.0
Hardwood Sawtimber	70		.6
Actual Volume Harvested			
Pine Sawtimber	1,714		12.0
Hardwood Sawtimber	75		.6

		Tons
Estimate of Total Biomass		93.0
Actual Biomass Yield After Chipping		96.0
Estimated Site Preparation Cost - $0.00		
Estimated Cost of Planting (Including Seedlings)	-$44.00	

SELECTIVE THINNING

The plot devoted to selective thinning-sometimes called environmental harvesting-consists of typical North Georgia hardwood. Forestry crews cut out the small stems, hollow trees, species with poor form and other undesirable growth in the understory. Desirable trees are left for future timber crops.

The object of the study is to show landowners how they can vastly improve their timber stand and at the same time realize revenue from low grade and cull materials that can be converted to chips.

Estimate	Bd. Ft.	Cords	Tons
Pine Sawtimber	2,442		17.1
Pine Pulpwood		0	0
Hardwood Sawtimber	1,324		9.9
Hardwood Pulpwood		6	17.4
Biomass in tops, limbs, etc.			20.9
Actual Volume Harvested (cull, unmerchantable trees)			48.2
Estimate of Total Biomass			113.5

SELECTIVE THINNING CONTROL PLOT

Estimate	Bd. Ft.	Cords	Tons
Pine Sawtimber	1,000		7.0
Pine Pulpwood		2.0	5.3
Hardwood Sawtimber	1,200		9.0
Hardwood Pulpwood		5.0	14.5
Cull Unmerchantable Trees			61.2
Estimate of Total Biomass			97.0

FIREWOOD PLOT

An acre consisting mostly of hardwood is set aside as a firewood plot to show the type of trees that can be profitably harvested for this purpose. It is also emphasized that by taking out poor quality trees for fuel purposes, the entire stand is vastly improved.

Estimate	Bd. Ft.	Cords	Tons
Pine Sawtimber	770		5.4
Pine Pulpwood		.5	1.3
Hardwood Sawtimber	1,350		10.1
Hardwood Pulpwood		6.2	17.3
Estimated Volume for Firewood		6.0	16.8
Actual Volume Harvested - Firewood		6.7	18.8
Biomass in Tops, Limbs, Slash			25.5
Estimate of Total Biomass*			79.0

FIREWOOD PLOT (MARKED)

Estimate	Bd. Ft.	Cords	Tons
Pine Sawtimber	2,420		16.9
Pine Pulpwood		2.9	7.7
Hardwood Sawtimber	1,575		11.8
Hardwood Pulpwood		7.0	20.3
Total	3,995	9.9	56.7
Undersized Trees			7.5
Firewood Marked		7.0	
Understory, Tops, Limbs, Etc.			33.8
Estimate of Total Biomass			98.0

*Due to estimated and actual figures, the total biomass does not reflect the sum of the column.

The demonstration clearcut plot is shown at the top, while the other photo provides a view of a plot harvested by the conventional commercial method.

The plot at right represents an improvement, or thinning cut. Poor quality trees taken from the plot were converted into chips, while high grade stock was released for better growth.

The control plot is left undisturbed so landowners and others can compare it with surrounding plots on which the various forestry harvest practices have been carried out.

The ribbon designates the trees in this firewood study plot to be left for higher quality products. The non-designated trees will be removed for firewood.

These three machines have revolutionized the harvest of forests in recent years and have made it feasible and profitable to reclaim woodland materials that were formerly considered wastes. The powerful feller buncher above is shown shearing a tree at ground level. The grapple skidder top right transports several trees at a time to the chipper shown at right. The chips are blown into a waiting van for transit directly to the Northwest Regional Hospital or to other locations where they will be used for other purposes.

GASIFICATION

A METHOD OF EXTRACTING ENERGY FROM THE FORESTS OF GEORGIA

The project to design, construct and install a wood gasification system had its beginning in 1978 when the Forestry Commission, with the engineering assistance of the Technology Applications Laboratory at Georgia Tech, began work on this important development that would greatly enhance the utilization of wood energy.

A statewide search was made for a demonstration site, and the Northwest Georgia Regional Hospital in Rome was chosen. Three companies entered bids for the construction and installation of a wood gasification system, and the contract was awarded to Applied Engineering Company of Orangeburg, South Carolina.

The gasification system has been completed and is now in operation. The economics of the system are being closely monitored to verify that the gasifier meets the performance criteria. Favorable results will bring about similar installations in other state facilities and in private industry.

The green total tree chips, approximately 2" x 2" mixed hardwoods and softwoods, are delivered to the hospital by chip vans with a capacity of 22-25 tons. The chip vans are unloaded by a Phelps Hydraulic Unloader into a live action hopper, which will hold one van load of chips. From the hopper, the wood chips are conveyed to a silo, which will hold 3½ days supply of wood (23,000 cu. ft.) for the gasifier. The chips move from the silo by a conveyor to the 25 million BTU/hr. updraft gasifier as illustrated in Figure 1.

The low BTU gas (150 BTU/ft.^{3}) is piped 100 feet from the gasifier to the wood gas burner. This burner has been designed to replace the conventional natural gas and oil burner on the existing 500 h.p. boiler.

The total tree harvesting contractor who provides the wood chips will unload each van upon delivery and activate the automative system that will carry the wood chips to the silo. The system is designed to allow the one boiler attendant on duty to operate the wood gasifier as the natural gas or oil boilers have been operated in the past. A detailed control panel inside the boiler room will keep the boiler attendant informed of data relating to the operation of the gasifier.

The gasifier will use about three tons per hour of total tree wood chips with a moisture content of approximately 45-50 percent. The system will provide enough energy to produce 19,000 pounds of steam per hour, which will meet most of the hospital's steam needs for much of the year. Certain peak demands will require part-time use of another boiler. The wood gasifier will be utilized year-round since an absorption unit is used to air condition the hospital during the summer.

The wood chips enter the gasifier through a rotary air lock. The vertical pressure vessel is about 20 feet high and 8 feet in diameter. Temperatures inside the unit reach 2,000°F., high enough to chemically convert the wood chips to the combustible low BTU gas. Some drying of the wood chips occur in the top of the vessel as the hot gases move through the chips before going to the burner as shown in Figure 2. Ash is automatically removed with an auger system.

This system is a fully operational, first generation system, which will provide real advantages over conventional fuels such as oil and natural gas. Applied Engineering Company indicates that the state should receive a payback on its investment in approximately two years.

A view of the gasifier at Rome is shown on the cover while another is presented at left. Energy produced by the equipment will be used to both heat and air condition the hospital.

WOOD GASIFICATION SYSTEM

NORTHWEST REGIONAL HOSPITAL

ROME, GEORGIA

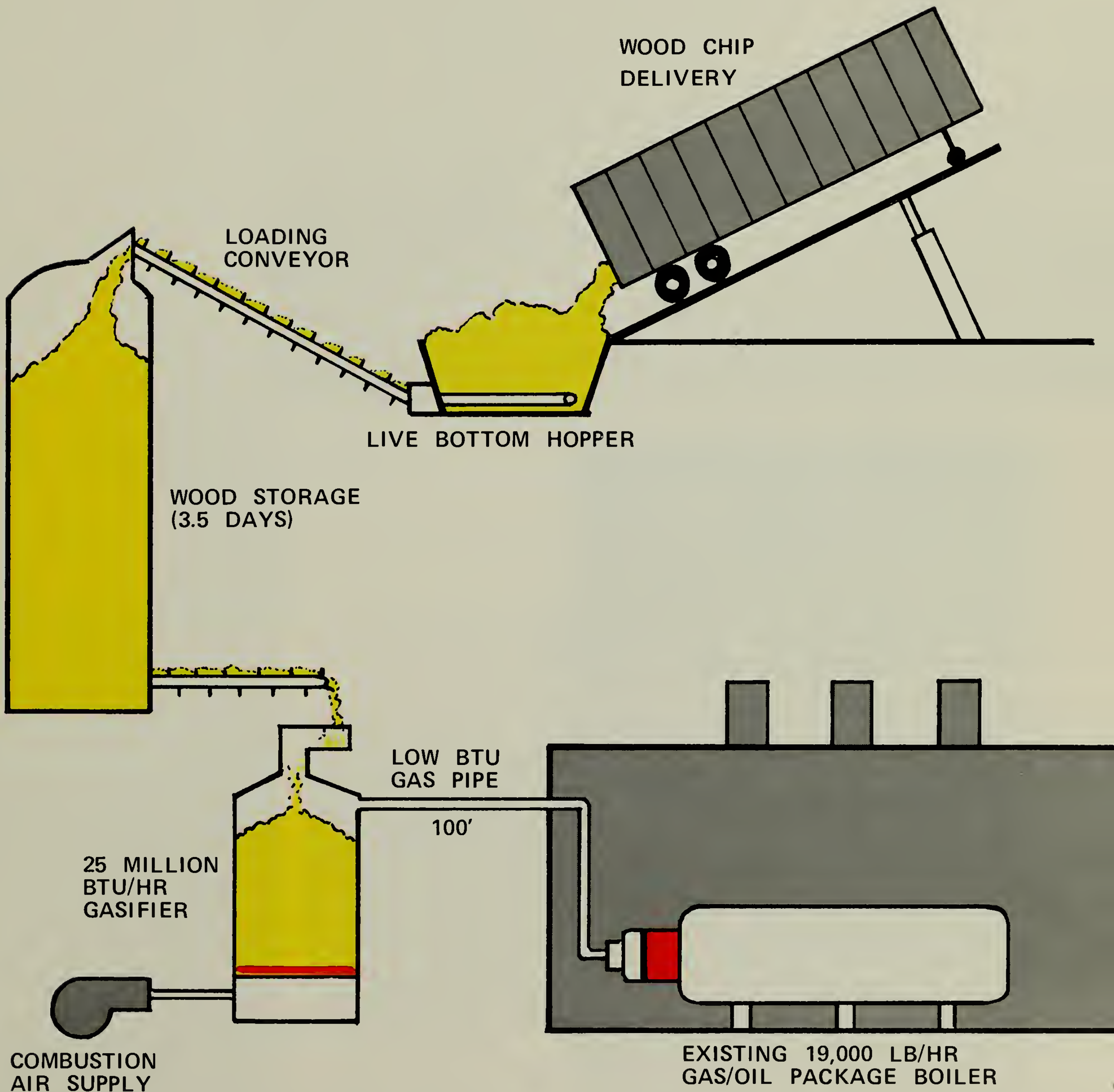


Figure 1

At left, green wood chips are transported directly from the forests in conventional chip vans. Below, chip storage studies are being conducted by the Commission to determine BTU content, moisture content, deterioration and pile design.

WOOD GASIFIER

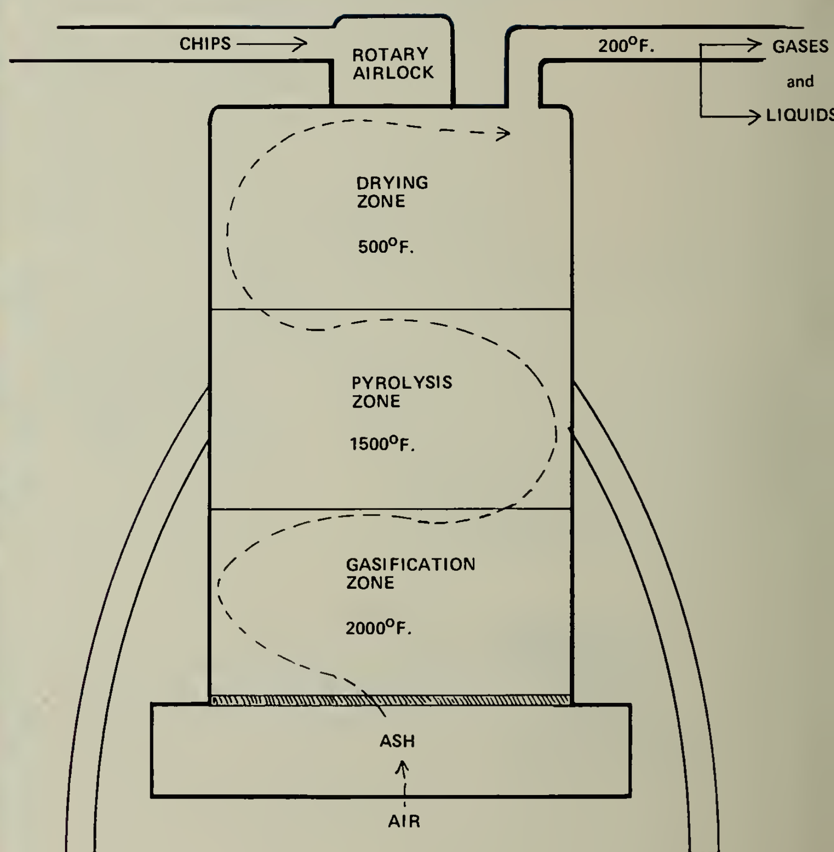


figure 2

DRYING WITH WOOD

WOOD CHIPS USED AS FUEL IN DRYING AGRICULTURAL CROPS

Georgia's farmers presently spend 20 million dollars per year on propane gas for crop drying. After studying several systems, with plans to develop a wood agricultural dryer, a unit originally designed for lumber drying was selected and modified to attach to a crop dryer. This wood chip furnace, developed by Rettew Associates, Inc., will burn green total tree wood chips and will generate up to 3 million BTU/hr.

The wood chip furnace is mounted on a trailer to allow easy moves from one farm to another. A conventional John Deere forage trailer was tested and proved very successful as a storage vehicle for the wood chips. A Patz heavy duty agricultural conveyor was added to the unit to enable the wood chips to be conveyed from the forage trailer to the wood furnace. The forage trailer and conveyor was synchronized with the electronic control panel of the furnace. Various safety devices are present on the furnace, enabling safe operation and shut-down if necessary.

The wood chips are conveyed from the forage trailer to a rotary air lock on the furnace. The chips pass through the rotary air lock and slide down a sloping wall to the pinhole grate, where the fuel is burned. Underfire air is blown through the pinhole grate to keep the wood chips burning. From the area above the grates, the hot gases pass over a six-inch firewall into a secondary combustion chamber and then into the firetubes of the heat exchanger.

The agricultural crop dryer produces hot air up to 200^{O}F. The hot air is moved from the furnace at 16,000 CFM. The wood chip furnace was tested as the heat source for a conventional agricultural dryer. Preliminary data indicated that the fuel cost can be reduced by one-half using wood chips instead of propane.

This system is being demonstrated throughout the state to show farmers that wood can be used to dry agricultural crops. Also, the Commission is studying the possibility of using the wood system to heat poultry houses and serve the agricultural and manufacturing interests of the state in other ways.

The scene at left depicts how millions of BTU's are wasted each year as land is cleared and the biomass burned. The wood burning unit, shown above, was designed to dry lumber but is being adapted by the Commission to dry corn, soybeans and other grains.

Many farmers dry their grains on the farm today before storing. The wood burning furnace using green wood chips, shown above, is demonstrated on a farm in South Georgia. A conventional forage box, at left, is used to transport the green wood chips from the local sawmill to the farm where the wood chip dryer is located.

HEATING WITH WOOD

WOOD SOURCE OF FUEL USED TO HEAT A GEORGIA PUBLIC SCHOOL

The Union County Junior High School in Blairsville, Georgia, is believed to be the only public school in the Southeast in modern times to be heated by wood chips.

A system installed by the Forestry Commission is now operational at the school and features the use of green wood chips from a local sawmill as fuel.

Unlike the pot-bellied wood stove that stood in the classroom corner in a bygone era, the system at Blairsville is a fully automated method engineered by Dr. John G. Riley, a professor at the University of Maine. The system had met the requirements at three installations during the harsh winters of that state before it was installed in the Georgia school.

The wood chips are transported to the school from the sawmill in a New Holland forage trailer, and then moved onto a live bottom hopper in the boiler room by means of a conveyor.

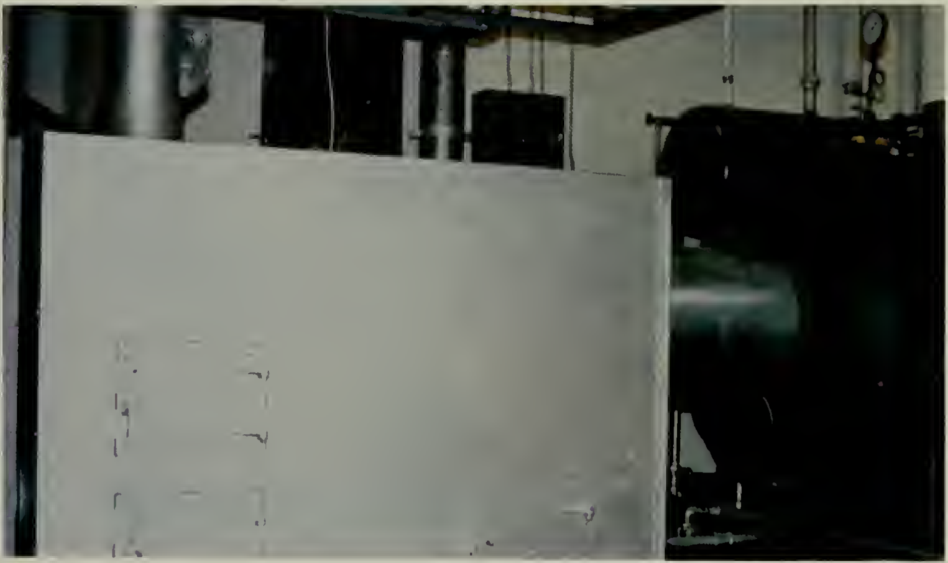
From the hopper, the chips travel by a screw conveyor to a firebox which was constructed on the boiler room floor. The Dutch oven-type firebox is direct fired and generates approximately 500,000 BTU/hr. The steam from the wood fire boiler heats a portion of the school building. Because of the extremely high combustion temperatures, the stack emissions are very low.

The system replaces a fuel oil burner, which has been retained to provide the school with a dual system in the event of an emergency.

One unique feature of the system is the routing of excess heat from the stack to the chip storage area to help dry the material.

The system will use approximately 700 pounds of chips per twenty-four hour day of operation and school officials have declared that the cost compared to the fuel formerly used shows a a significant savings.

This project was a cooperative effort between the Georgia Forestry Commission, Tennessee Valley Authority, and the Union County School System.



A wood burning unit at the junior high school, top left, is shown with an inside chip bin in the background. Bottom scene shows green wood chips which are available from many sawmills in the state. Schools may purchase wood chips from local mills or from total tree harvesters. The Dutch oven type firebox, above, is connected to a boiler that provides steam for heating a portion of the school.

RELATIVE ENERGY COSTS

CALCULATIONS $/Million BTU

FUEL	PRICE	ENERGY COST	AVERAGE COST - ROME - Oct. 1980	AVERAGE COST ROME Oct. 1977
WHOLE TREE WOOD CHIPS 8 million BTU/ton	PER TON $10.00 15.00 20.00 25.00 30.00	PER MIL. BTU $ 1.25 1.87 2.50 3.12 3.75	WHOLE TREE WOOD CHIPS (delivered to Rome) Per Ton $16.32 ($2.04)*	WHOLE TREE WOOD CHIPS (delivered to Rome) Per Ton $13.60 ($1.70)*
NATURAL GAS 1,000 BTU/cu.ft.	PER THERM. $ .25 .30 .40 .50 .60	PER MIL. BTU $ 2.50 3.00 4.00 5.00 6.00	NATURAL GAS Per Therm. $ .35 ($3.50)*	NATURAL GAS Per Therm $ .19 ($1.90)*
NO. 2 FUEL OIL 140,000 BTU/gal.	PER GALLON $ .60 .70 .80 .90 1.00	PER MIL. BTU $ 4.29 5.00 5.71 6.43 7.14	NO. 2 FUEL OIL Per. Gal. $ .86 ($6.20)*	No. 2 FUEL OIL Per Gal $ .43 ($3.05)*
ELECTRICITY 3,415 BTU/KWH	PER KWH $ .030 .035 .040 .045 .050	PER MIL. BTU $ 8.78 10.25 11.71 13.18 14.64	ELECTRICITY Per KWH $ .045 ($13.18)*	ELECTRICITY Per KWH $ .038 ($10.98)*
PROPANE 92,000 BTU/gal.	PER GALLON $ .45 .50 .55 .60 .65	PER MIL. BTU $ 4.89 5.43 5.98 6.52 7.07	PROPANE Per. Gal. $ .68 ($7.40)*	PROPANE Per Gal $ .45 ($4.89)*

*Per Million BTU

ACKNOWLEDGEMENTS

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—BERRY COLLEGE

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GEORGIA
FORESTRY
COMMISSION

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Quantity 10,000