REPORT OF THE
VIRGINIA COAL AND ENERGY COMMISSION

An Examination of Policies to Promote Greater Use of Wood Processing Industry Wastes for Fuel in State Facilities

TO THE GOVERNOR AND
THE GENERAL ASSEMBLY OF VIRGINIA

HOUSE DOCUMENT NO. 23

COMMONWEALTH OF VIRGINIA
RICHMOND
1993

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REPORT OF THE
VIRGINIA COAL AND ENERGY COMMISSION
Pursuant to House Joint Resolution 69

AN EXAMINATION OF POLICIES TO PROMOTE GREATER USE OF WOOD PROCESSING INDUSTRY WASTES FOR FUEL IN STATE FACILITIES

A Report of the
Virginia Center for Coal and Energy Research
and the Brooks Forest Products Center

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December 16, 1992

Table of Contents

1992 Virginia House Joint Resolution No. 69 Study Report:

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Executive Summary

The 1992 House Joint Resolution 69 directed the Virginia Coal and Energy Commission, with the assistance of the Virginia Center for Coal and Energy Research (VCCER) and the Brooks Forest Products Center (BFPC), to *"examine policies necessary to promote greater use of wood wastes for fuels by state facilities."* This report contains the results of investigations conducted by VCCER and BFPC at the request of the Virginia Coal and Energy Commission to achieve the objectives of House Joint Resolution 69.

For the purposes of this study, "wood wastes" are defined as raw wood byproducts from wood processing and wood product manufacturing industries, including sawdust, chips, bark, and planer shavings. In conducting the study, VCCER and BFPC gathered background information from a number of sources, including state facilities currently using wood-waste fuels and other state agencies; interviewed persons involved with state agency boiler purchase decisions; and examined Virginia's capital project funding policies.

In situations favorable to use of wood-waste fuels, the benefits of such use can include reduced heat energy costs to the state and an economic stimulus to local wood products industries. There is a lack of quantitative information on the the nature and costs of wood-waste fuels that might be available to the state at specific locations at present and over the long term. Virginia's wood processing industries may face impediments to increased production because of limited byproduct markets, but the nature and extent of those impediments (and, hence, on the degree of economic stimulus that would be provided by increased state wood-waste fuel purchases) are not well documented.

Currently, wood waste fuels can be purchased at less cost per energy unit than conventional fossil fuels where they are available, but the capital, labor, and management inputs required to utilize wood-waste fuels are generally greater than the corresponding requirements of fuel oil and natural gas. Wood-waste fuels are bulkier, on an energy-content basis, than fossil fuels, and they must be stored away from the weather. Many of the factors that are important to successful wood-waste fuel utilization must be evaluated locally, including the existence of accessible and reliable wood-waste fuel supplies; labor and management resources that can be allocated to wood-waste fuel utilization without affecting performance of other essential functions; and a physical facility that allows for sufficient on-site storage and fuel deliveries.

State policies require that boiler-choice decisions include comparison of life-cycle costs associated with various fuels. No overt policy or procedural barriers to use of wood wastes, or other non-conventional fuels, were found to exist. Nonetheless, barriers to increased wood-waste fuel utilization by state facilities were identified. These include:

- lack of quantitative information on potential availability of wood-waste fuels;
- difficulties faced by persons making boiler-choice decisions in obtaining information on wood-waste fuel burning and handling equipment, and on costs required to operate and maintain that equipment;
- lack of incentive for state agencies making boiler choice decisions to specify non-standard equipment; and
- lack of a mechanism for incorporating the positive economic impacts of purchasing fuels originating from in-state sources into the boiler-choice decision.

If the state chooses to take action to promote increased utilization of wood wastes for fuels in state facilities, actions available include the following:

- Direct an appropriate agency to conduct a study which will identify availability and prices of wood wastes capable of being used for fuel in the state.
- Direct the Department of General Services to assemble information on wood-waste burning and handling equipment, and the requirements of operating and maintaining that equipment, for use by state agencies making fuel-choice decisions.
- Direct the Department of Planning and Budget to require that wood wastes and other non-traditional fuels available for purchase from in-state suppliers be included in fuel-comparison analyses conducted to evaluate boiler purchases, if there is evidence that such fuels could be available for a reasonable price, over the long term.
- Direct the Department of General Services to alter its boiler-fuel comparison analysis guidelines, so as to enable consideration of the positive economic impacts of boilers likely to utilize fuels purchased from in-state sources.

Study Purpose and Rationale

Economic development is often hindered by the lack of a critical factor, such as investment capital, trained labor, or infrastructure. However, the Southside Virginia Economic Development Commission was informed of a surplus that may be acting as a hindrance to economic growth.

The Commission, formed by the 1990 Virginia General Assembly (House Joint Resolution 106), was told by members of the southside Virginia wood products industry that a surplus of sawdust, bark, and other wood processing byproducts is limiting their abilities to expand production. Regulatory restrictions on landfilling and burning do not allow continuation of previous disposal practices. Moreover, landfilling costs are increasing. Although some of these wastes are marketed for pulp chips, fuel, mulch, animal bedding, and other uses, hauling costs to markets can be greater than revenues received. Southside Virginia wood products industry leaders informed the Commission that restricted wood processing byproduct markets present their industry with a serious impediment to expanded production. The Commission was told that this restriction affects the industry's ability to take advantage of the region's growing timber resources to serve expanding domestic and export wood-product markets.

Although the Southside Economic Development Commission focused on the wood products industry within southside Virginia, that region is not unique. Wood product manufacturing industries in other regions of the state may face similar problems. High costs of byproduct disposal can place an industry at a competitive disadvantage, when revenue-generating byproduct markets are available and accessible to competitors located elsewhere.

In response to these concerns, House Joint Resolution 69 (HJR 69; see Appendix A), approved by the 1992 Session of the Virginia General Assembly, directed --

> *... That the Coal and Energy Commission, with the assistance of the Virginia Center for Coal and Energy Research and the Brooks Forest Products Center at Virginia Polytechnic Institute and State University, examine the policies necessary to promote greater use of wood wastes for fuel by state facilities. The Commission shall include in its study consideration of current practice in the public and private sectors. ...*

If in-state wood product manufacturers' processing wastes could be purchased for use in heating plants at state facilities, the results could be beneficial. State taxpayers would benefit if such a facility were to produce heat energy at reduced costs, relative to fossil fuels. If such energy purchases were to displace fuels originating out-of-state, more of the state's energy expenditures would stay within Virginia and state tax collections would increase. If such purchases were to remove a limitation on expanded production by one or more wood product manufacturing firms, additional economic benefits would occur. Environmental benefits would also result to the extent that wood-waste fuel purchases by the state were to reduce landfill disposal.

This study was conducted to identify actions that might be taken by the state to allow the above benefits to be achieved.

Study Methods

In order to comply with HJR 69, Virginia Center for Coal and Energy Research and the Brooks Forest Products Center have carried out the following activities:

1. Prepared a draft study plan, with input and assistance from the Coal and Energy Commission's Division of Legislative Services staff, and presented that plan to the full Commission at its August 5 meeting.

2. Gathered background information on the use of wood wastes for fuel, and on policies affecting such use, from the following sources:

   - Three state facilities currently using wood wastes: Augusta Correctional Center, Piedmont Geriatric Hospital, and Longwood College.

   - Virginia agencies whose jurisdictions would be affected by increased wood utilization in state facilities: Department of Forestry, Department of Waste Management, Department of Air Pollution Control.

   - National and regional organizations concerned with wood utilization.

   - Other states that have active state-facility wood-energy utilization programs in place.

3. Worked with Department of General Services to identify centrally heated state facilities located in wood-producing areas, where heating plant replacements or upgrades are being considered.

   Identified persons responsible for these heating plant upgrade/replacement decisions; contacted these persons, and discussed rationale and process for such decisions.

4. Examined Virginia's capital project funding procedures and policies.

Based on the above activities, we identified policy options capable of being employed, should the state choose to promote greater use of wood wastes for fuel in state facilities. This report contains study findings.

Findings

Background

Virginia's Wood-Waste Generating Industries

The wood products industry produces a wide variety of residues that can be difficult to market. Harvesting of timber for pulpwood, sawlogs, and even firewood, leaves woody residues on the ground. Wood processing industries produce a wide variety of byproduct materials during the process of transforming harvested wood to paper, lumber, furniture, and similar products. At the other end of the consumption chain, municipal solid wastes (MSW) contain used pallets, old furniture, and wood from the demolition of old structures, as well as prunings and other woody yard wastes.

The assembly of marketable volumes of harvesting residues, woody components of MSW, and other non-manufacturing wastes would be an expensive process. On the other hand, manufacturing facilities such as sawmills and furniture plants generally accumulate large quantities of byproducts in the course of shaping wood. The byproducts are generally of well-defined characteristics that do not vary significantly with time, and they accumulate at a small number of locations in the plant. Wood product manufacturing residues are the focus of the HJR 69 study and this report.

For the purpose of this report, "wood wastes" means any byproduct from the manufacture of lumber, plywood, furniture, or other wood products. Wood wastes include sawdust, bark, slabs and edgings, planer shavings, sander dust, plywood peeler cores, and veneer clippings. They may be produced from green or dried timber. Generally speaking, these products are clean and uncontaminated with wood preservatives, furniture finish, or other chemical treatments.

Wood product manufacturers sometimes object to the use of the term "wastes" to describe their residues because profitable markets and beneficial uses for these materials often exist. But whether they are called wastes, byproducts, or residues, the fact remains that the volume generated is greater than existing markets can absorb. Even where uses can be found, the costs of marketing may exceed the revenues gained, largely because of hauling costs. Rather than providing a source of net revenues, their sale under these circumstances simply serves as a reduced-cost means of disposal.

An unpublished 1989 survey conducted by the Virginia Department of Forestry (DOF, 1989) gives the impression that the problem of unused wood wastes is minimal (Tables 1 and 2). That study showed that 96 percent of wood wastes from sawmills and other primary manufacturing plants found use in pulp mills, particleboard and flakeboard plants; as fuels, mulch, or animal bedding; or in other miscellaneous applications. Only 4 percent of the volume produced did not find uses. However, these data do not reveal anything about the prices received by industrial wood-waste producers, or of the costs borne by producers seeking to access and utilize these markets. Nor do they include data on wood-wastes produced in secondary wood processing plants, such as furniture factories.

Table 1. Used and Unused Residues Produced by Primary Wood Products Manufacturing Plants[1] in Virginia and in Various Regions of the State, 1989 (green tons).

	Used	Unused	Total
Type of Residue:			
Bark	1,458,946	41,959	1,500,905
Coarse[2]	2,046,571	68,221	2,114,792
Sawdust	1,262,298	112,310	1,374,608
Shavings	190,303	8	190,311
Region:			
Coastal Plain	2,477,954	8,728	2,486,682
Southern Piedmont	1,068,050	30,476	1,098,526
Northern Piedmont	453,596	5,244	458,840
Northern Mountains	578,373	2,490	580,863
Southern Mountains	380,146	175,559	555,705
Total	4,958,118	222,498	5,180,616
(as percent)	(96)	(4)	(100)

1. Does not include furniture plants, or other secondary processing facilities.
2. Includes slabs, edgings, and trimmings.
3. Source: Virginia Department of Forestry (DOF), 1989. (Regional totals do not add, due to rounding).

Table 2. Uses for Residues from Primary Wood Product Manufacturing Plants in Virginia, 1989.

Use of Residue	Total (Green Tons)	Total (as %)
Fiber Products[1]	1,816,764	35
Particle/Flake Board	249,671	5
Sawn Product	72,119	1
Industrial Fuel	1,880,119	36
Domestic Fuel	130,154	2
Miscellaneous[2]	800,293	16
Not Used	222,496	4
Total	5,180,616	100

1. Pulp and hardboard
2. Includes mulch and animal bedding
3. Source: DOF, 1989.

With hauling costs often exceeding $1 per mile per truckload, producers of wood wastes distantly located from markets suffer competitive disadvantage to more favorably located producers. Where byproduct disposal results in a net cost to a manufacturer, that company faces a serious disadvantage relative to competitors who are able to generate revenues from byproduct sales.

Two anecdotal cases illustrate the problem that wood wastes can present to producers located far from byproduct markets. One sawmill in Wise County cannot market all of the wood wastes it produces. Hauling wood wastes from the mill to a landfill site on its own property costs that company $100,000 a year. The company is afraid that increasingly stringent water quality regulations will soon prohibit landfill disposal. Another sawmill in Tazewell County hauls its wood wastes to pulp mills and energy-production facilities. With truck hauling costs of $1.10 per mile, the revenues received from the sale of its wastes are less than the costs of hauling. Even with markets, the company's wood wastes are being sold at a net loss.

The Lumber Manufacturers' Association of Virginia[1] represents a segment of the state's wood-waste generating industries. However, there are many wood processing firms in the state which do not choose to hold membership in that organization.

Experience in Other States

There are numerous cases, in Virginia and other states, where wood wastes are used to fuel production of steam and cogenerated electricity in the commercial and industrial sectors. Most commonly, such facilities are located in sawmills, pulp mills, furniture plants and other manufacturing facilities using wood as their primary raw material. Wood is also used in some states by power companies to fuel generating plants. As documented in Appendix B, some eastern states also use wood wastes as a source of heat energy in state-owned facilities.

For example, two of the four existing boilers at the Central State Hospital in Milledgeville, Georgia were converted to wood energy in 1982. The wood-fired systems provide approximately 85 percent of the annual heat energy required for space heating, cooking, hot water, and laundries. The remaining 15 percent is provided by natural gas as demand dictates. The original capital investment was $2.5 million. The facility's managers estimate that the investment has been responsible for $1.5 million in annual fuel savings, a payback period of 1.7 years.

In Montpelier, Vermont, seventeen major buildings in the state capitol complex are heated with wood-waste fuels. The complex had been heated by #6 fuel oil at a cost of $300,000 a year. That cost has been reduced by $100,000 a year with the conversion to a wood-fired system.

Not all installations or conversions to wood-fueled systems have been as successful. But where planning has been effective, and where the capabilities and limitations of wood-fueled energy systems have been recognized, state institutions have had good experiences with the use of wood for fuel.

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[1] P.O. Box U, Sandston, Virginia. 23150-0160.

Current Uses of Wood-Waste Fuels by State Facilities

Three state facilities in Virginia currently use wood-waste fuels: Augusta Correctional Center, Longwood College, and Piedmont Geriatric Hospital (Appendix C). All three facilities use green hardwood sawdust purchased on state contract from local manufacturing facilities. None of the three facilities reported any major operational problems due to use of wood-waste fuels.

The level of satisfaction with these installations was found to vary, depending on to whom we talked. At all three facilities, the persons expressing the highest level of enthusiasm for wood-waste fuels were those closest to, and most familiar with, operations. They found wood-waste fuels to be clean, easy to work with, and economical. They were also enthusiastic about the environmental benefits, and the fact that their institution's fuel purchases were helping to support jobs in the local communities.

Generally speaking, persons further removed from operations tended to express a greater level of dissatisfaction. Although there were no reports of major problems, operation has not been trouble free. We hypothesize that the reason for greater levels of dissatisfaction at upper administrative levels is because involvement by these individuals generally occurs in response to problems; they are further removed from direct experience of the benefits than are on-site personnel.

Managers at all three facilities have maintained data which demonstrate that the wood-waste systems are providing energy at a reduced fuel cost, relative to fossil fuel alternatives. (Appendix D contains fuel cost data from Longwood College.) However, data to conduct a complete economic analysis, which considers capital, fuel, and non-fuel operating and maintenance expenses, are not available for any of the three institutions.

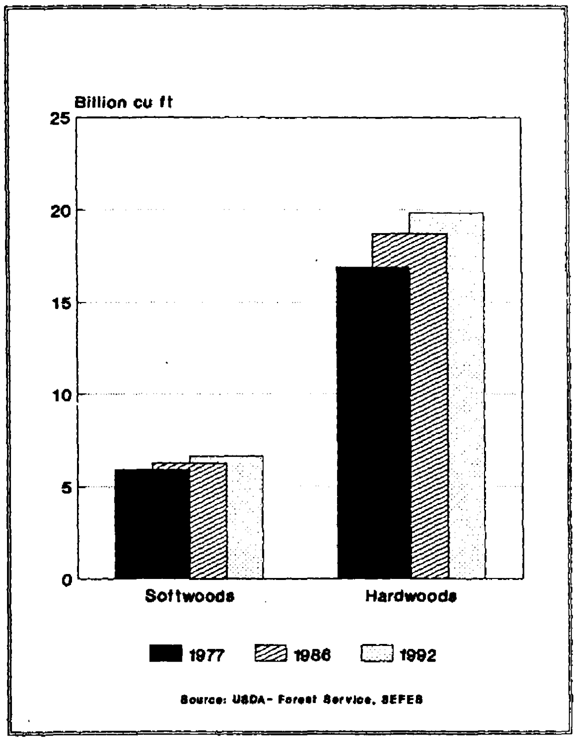
Factors Important to Successful Wood-Waste Fuel Utilization

Fuel Supply

The supply of wood for energy and other uses in Virginia is very favorable. The recently completed inventory of Virginia timber resources (Johnson, 1992) shows that the volume of timber growing stock (trees 5.0 inches in diameter and larger at breast height) has been increasing over the past several decades, and that growth exceeds removals (Figure 1). Surplus growth is occurring in all parts of the state, providing a long term opportunity for expansion of wood product manufacturing industries, as well as byproduct markets.

The first requisite for a successful wood-waste-fueled energy system is an accessible and reliable supply of wood wastes. The literature suggests that, at current gasoline and fuel prices, supply sources should not be beyond 75 miles from the energy plant because of hauling costs. The longest haul from a contract supplier of the three state facilities currently using wood wastes is approximately 35 miles (Buena Vista to Craigsville).

Experience in Virginia and other locations suggests that a plant should not rely on only one supplier of wood-waste fuel. The potential for weather, labor, or raw



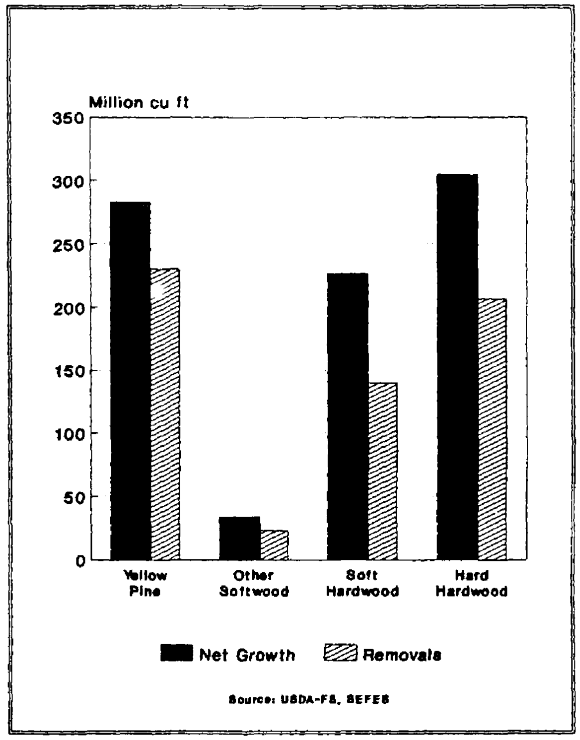


Figure 1. Data on Virginia's timber stocks. (Left) Timber growing stock volumes, 1977, 1986, 1992. (Right) Average net annual growth and removals, 1986-1991.

material supply problems to cause temporary supplier shutdowns dictates that several facilities capable of supplying fuel should be located within an economical hauling distance. The existence of several suppliers is also important to evaluating the long-term wood-waste fuel supply potential at a given location.

The Virginia Department of Forestry survey of wood-waste producers (DOF, 1989) does not provide sufficient information for planning wood-fueled energy system installations or conversions in specific Virginia locations.

Fuel Delivery and Storage

Compared to fossil fuel alternatives, wood fuels are bulky and require a large storage space. The storage area must be covered or enclosed, because of the effects of rain and freezing weather. Of the three state facilities currently using wood-waste fuels, the largest storage facility is maintained by Longwood College: a shell building approximately 30 by 60 feet in size. However, during peak heating season, this storage area is sufficient only to hold about three days' fuel supply.

Fuel storage facilities should be large enough to allow for interruptions in fuel deliveries. Bad weather, and shutdowns during periods of weak demand for fuel suppliers' primary products, have the potential to interrupt fuel deliveries. Fuel storage facilities need to be accessible to large trucks, or otherwise able to accept a constant stream of fuel deliveries. Because of these factors, wood waste fuels cannot be considered feasible at facilities lacking sufficient space for fuel receiving, unloading and storage.

Costs

On a per-Btu basis, wood-waste fuels compare favorably to available fuels at current market prices (Table 3). However, capital costs for wood-waste fuel plants are generally greater than those for an equivalent oil- or gas-fired unit. Boiler and fuel-handling system costs for wood-waste-fired systems tend to be roughly equivalent to coal-fired facilities of similar size. A coal-fired facility suffers an additional cost disadvantage if air emissions control equipment is required.

Table 3: Per Btu Cost Comparison, Various Fuels.

Fuel	Cost	Btu Content	Cost/10^6Btu	Source
Wood Wastes	$13.00/ton	5000/pound	$1.30	(1)
	$9.50/ton		$0.95	(2)
#2 Fuel Oil	$.63/gallon	138,690/gallon	$4.54	(3)
	$.71/gallon		$5.12	(4)
#6 Fuel Oil	$.345/gallon	149,690/gallon	$2.30	(3)
Coal	$52.00/ton	13,500/pound	$1.93	(4)
Natural Gas	$3.00/$10^6$Btu		$3.00	(5)
	$4.72/$10^3ft^3$	1,000/ft^3	$4.72	(3)

Sources of Cost Estimates:
1. Piedmont Geriatric Hospital delivered price.
2. Augusta Correctional Center delivered price.
3. U.S. EIA (1992). Average U.S. price to end users (fuel oil); Average U.S. price to commercial users (natural gas).
4. Cost estimate used in fuel analysis conducted by Piedmont Geriatric Hospital.
5. Cost estimate used in fuel analysis conducted for Staunton Correctional Center by Commonwealth Gas.

The capital cost of a wood-waste fuel installation can vary among facilities. Darwin and Curtis (1990) have developed guidelines for evaluating capital costs of wood-fired installations, which can be applied during preliminary analysis of an industrial conversion.

Scale of Potential Use

A wood-waste-burning facility requires more-or-less constant operator attention. In addition to watching boiler water levels and steam pressures, the operator must be aware of the fuel feeding system. Therefore, a successful wood waste fuel application should be large enough to justify paying personnel to be on site, 24 hours per day, 7 days a week.

Within the state system, only multiple-building institutions with central heating plants meet this requirement. Operation of the boilers at these facilities require that they be staffed and attended at all times, regardless of fuel.

Environmental Controls

The use of wood-waste-fired heating equipment at state facilities would not be expected to create any significant environmental control expenses or problems.

Air Emissions:

Wood has significant advantages over alternate fuels, particularly coal, with respect to air emissions (Table 4). The sulfur content of wood is quite low (Appendix E). In fact, some coal burning energy plants co-fire with wood in order to average down the sulfur content of their air emissions.

If a wood-fueled energy system is moderately sized, properly designed, and operated continuously at design capacity, both particulate and CO emissions are at the lower ends of the ranges shown in Table 4 and present no regulatory compliance problems. Particulate control can be accomplished using inexpensive mechanical cyclone collectors. In contrast, state facilities using coal are under increasing pressure to install baghouses to control particulate emissions; the costs for such installations typically run in six figures.

Table 4. Emission Factors for Uncontrolled Industrial Boilers (pounds/10^6 Btu)

Fuel	Particulates	CO	NOx	SO_2
Natural gas	0.006	0.04	0.62	0.0007
Fuel oil	0.013	0.03	0.13	0.29
Coal	4.7	0.18	0.51	2.12
Wood	0.88-4.7	0.04-4.7	0.28	0.02-0.04

Source: Great Lakes Regional Biomass Energy Program (Undated).

Wood-fired boiler size will influence particulate emissions control requirements. The Clean Air Act Amendments of 1990 are more stringent for boilers sized larger than 30 million Btu/hour input (approximately 20,000 pounds of steam per hour output). The effect of these regulations is that mechanical cyclones will be sufficient to control particulates only for wood-waste boilers sized below this limit. All existing state wood-waste burning facilities are sized below this limit.

Of the three state facilities currently using wood wastes, the only one experiencing any air emissions problems is Augusta Correctional Center. According to officials at that institution, $540,000 has been appropriated to correct a particulate emissions problem. However, these officials also report that the reason for the problem is the facility's design: each of the three boilers is sized identically. During the summer months, the output of any single boiler exceeds the needs of the institution. Emissions problems are occurring as a result of the need to limit heat output, which does not allow full-capacity operation during some seasons.

Solid Waste:

The ash content of wood is typically less than one percent, while that of coal is typically much higher (Appendix E). A wood-fired facility would therefore generate ash in a smaller volumes than a coal-fired facility producing an equivalent amount of energy (Table 5).

The ash produced from burning clean wood is environmentally benign. Landfilling is a common method of disposal and requires no special variances. Wood ash has long been recognized as a beneficial soil amendment; one wood-fueled plant operator reports of being able to dispose of most of his ash by allowing the institution's groundskeepers to apply the ash to lawns, and by allowing local residents to take the ash for application to gardens.

Water Quality:

Wood-waste fueled facilities create no significant water quality protection expenses by virtue of fuel characteristics. In contrast, coal-fired facilities are required to maintain a 90-day fuel supply at all times. Generally, coal storage is open to the weather, requiring runoff and leachate collection and treatment. A number of the state facility managers we spoke with mentioned expenses and problems associated with coal pile runoff control.

Use of fuel oil also presents an environmental liability due to the potential for spills and fuel tank leaks. The Piedmont Geriatric Hospital wood-waste boiler was installed to replace an older oil-fired unit after an oil spill had contaminated six miles of stream, requiring the state to pay for stream remediation.

Pattern of Use

Whether the demand for energy is expected to be continuous or sporadic is an important consideration relative to wood waste fuels. Generally speaking, a wood-waste-fired unit should be considered for baseload operation, where the boiler can be operated continuously at its designed capacity. Generally, it will be advantageous to utilize an alternate fuel to handle the swing load, in order to reduce air emissions from the wood-fired facility.

Other reasons for planning a wood-waste fuel facility to operate on a year-round basis are economic. Because wood-waste boilers have high capital costs and low operating costs, relative to oil and natural gas alternatives, it makes economic sense to design the wood waste fuel system to operate on a near-full capacity basis. Also, a year-round wood-waste fuel user will be more likely to be able to negotiate favorable fuel supply contract terms than a partial-year user.

Other Fuel Supply Factors

One major fuel-choice decision is whether green or dry wood will be burned by a wood-waste-fueled facility. Boiler designs for the two types of fuel are quite different, due to differences in internal boiler temperatures during combustion.

The size of the fuel particles must also be considered by the heating system design. The three current state facilities are equipped to burn sawdust only. The ability to handle chips as well as sawdust would place the state in an improved bargaining position, relative to obtaining contracts for fuel supplies. Most chips are shipped to pulp mills for the production of wood pulp. However, when the pulp market is weak, chips may be available at low cost. Moreover, the ability to handle chips, as well as sawdust, would allow the energy plant to use chipped harvesting residues, should there be a problem with the supply or cost of manufacturing byproducts.

Summary

In the final analysis, planning for the use of wood-waste fuels is no different than planning for the use of other fuels. In all cases, thorough planning should be conducted before construction or conversion of any energy plant is begun. All fuels should be considered with respect to their costs, availability and dependability of supply, and the cost of required facilities.

A major consideration with respect to wood-waste fuel use is that many of the factors essential to a successful application will be site-specific. The feasibility of even considering wood-waste fuels, for example, must be determined based on the existence of local fuel suppliers and the likelihood that fuel will remain available over the long term. Similarly, the boiler and fuel-handling system design must be based on the specific type of wood-waste fuel likely to be available locally. Major factors determining the economic feasibility of a wood-waste system will be whether or not personnel staffing the boiler will have time available for managing the wood-waste operation, and whether the facility manager is able to devote time to wood-waste fuel procurement on a more-or-less weekly basis, without neglecting other important duties.

If these local factors are conducive to a successful wood-waste fuel application, both the state and the local community can benefit. The state can benefit by being able to heat its facility at a lower cost, relative to fossil fuel alternatives, and the local community benefits from the state's fuel purchases from local sources.

Economic Feasibility of Wood-Waste Fuel Utilization

Both initial purchase and operating costs must be included in any analysis which seeks to determine potential cost savings to the state that might be due to use of wood-waste fuels. The resources available to this study were not sufficient to conduct in-depth life cycle cost comparisons of wood wastes vs. conventional fuels. However, Table 5 does contain the results of a limited analysis of annual boiler capital recovery and operating costs, conducted with the assistance of Mr. Murray Lee

Table 5. Comparison of Estimated Annual Capital Recovery, Fuel, and Ash Disposal Costs for 300 Horsepower Boilers using Various Fuels[1].

Cost Component	Wood Wastes	#2 Fuel Oil	Natural Gas	Coal
Capital Costs:				
Initial Investment	$350,000	$125,000	$75,000	$500,000
Annual Cost of Recovering Initial Investment	$33,038	$11,799	$7,079	$47,196
Fuel Costs:				
Annual Fuel Input (10^6 Btu)	63,165	55,269	55,269	55,269
Annual Fuel Use	6,316 tons	398,507 gallons	55,269 $10^3 ft^3$	2,047 tons
Fuel Cost ($/$10^6$ Btu)	$1.30	$5.10	$3.00	$1.93
Boiler Efficiency	70%	80%	80%	80%
Annual Fuel Cost	$82,114	$281,872	$165,807	$106,669
Ash Disposal Cost:				
Ash Content	0.5%			6.0%
Annual Ash Prod. (tons)	32			123
Disposal Cost @ $40/ton	$1,263	$0	$0	$4,913
Total Annual Costs	$116,415	$293,671	$172,886	$158,778
Annual Cost Savings:				
Wood Wastes vs. Alternate Fuel		$177,256	$56,472	$42,364

1. Primary assumptions: 7% interest rate; 20 year capital recovery period; annual operation at 50% of capacity. Labor cost differentials are not considered. Capital costs estimates are approximate, for illustrative purposes only. For additional assumptions, see text.

of Piedmont Geriatric Hospital. Mr. Lee is in the process of evaluating options for upgrading or replacing the coal-fired boilers currently in use at that facility.

The capital cost estimates of Table 5 were supplied by Mr. Lee for a 300 horsepower (approximately 10,300 pounds of steam per hour) boiler. These figures are rough estimates, included only to illustrate potential cost savings available through the use of wood-waste fuels in a favorable situation. The natural gas unit's capital cost estimate is for boiler and supporting equipment only; the figure assumes that a pipeline capable of supplying the unit is close by. The fuel oil unit's capital cost estimate includes a 10,000 gallon storage tank as well as the boiler. The wood-waste and coal cost figures include fuel handling equipment as well as a boiler. Only the coal unit's cost estimate includes air pollution control equipment (a baghouse, or other device to control particulates). All costs include purchase and installation. The analysis was conducted using the capital recovery assumptions specified in life cycle cost analyses guidelines prepared by the Department of General Services (DGS, 1991; Appendix O).

Fuel cost and Btu-content assumptions are taken from Table 2. Major cost factors which are *not* included in Table 5 are:

1. Labor: additional labor will be required to operate the coal and wood-waste units, relative to fuel oil and natural gas.

2. Management: operation of a wood-waste unit requires a greater time investment by management personnel, as fuel procurement is a more-or-less continuous concern.

3. Pollution control: use of coal will require monitoring and treatment of coal-pile runoff. Use of oil presents the risk of a spill and attendant cleanup costs.

4. Future price increases: the analysis is based on current pricing. No attempt has been made to project future prices of various fuels.

The results of the analysis summarized in Table 5 demonstrate the potential to realize substantial cost savings through use of wood-waste fuels in a favorable situation where reasonably priced supplies are available and the labor requirements of operation can be met without additional expense.

In-state Economic Impacts

Virtually all of the oil and gas, and the majority of the coal, used to fuel the energy plants at state facilities in Virginia come from out-of-state sources. Would there be a favorable economic impact if more fuels purchased from in-state sources were used in state facilities? One would expect that, even if all other costs were otherwise comparable, the state would benefit from the additional employment, income, and tax collections that would be realized by depending more on in-state suppliers for its fuels.

This expectation is supported by an economic impact study prepared for the Department of Energy's Southeastern Regional Biomass Energy Program by the Tennessee Valley Authority (1990). The study looked at economic impacts in each of the thirteen southeastern states when fossil fuels are displaced by locally produced wood fuels. Using an input-output model of each state's economy in 1987, the study evaluated the following direct and indirect economic impacts:

- Direct economic impacts resulting from wood fuel production, including income, expenditures, and jobs harvesting and transporting wood-fuels.

- Direct economic impacts due to cost savings by the wood energy consuming sectors, a result of energy cost savings associated with wood fuel use.

- Indirect economic impacts resulting from expenditures by wood-fuel producing and consuming industrial firms and their employees.

- The negative impacts of income and job displacements in conventional energy sectors caused by wood energy use.

The study determined that, in Virginia, all users (including users of self-produced wood wastes) consumed 2,585,161 green tons of industrial fuelwood, with an average delivered price of $11.50 per ton, in 1987. Purchased mill residues totaled 552,237 green tons, or approximately one-fifth of this total. Economic benefits included $23,754 in personal income, and 0.86 jobs, for every 1,000 tons of wood fuels consumed.

Unfortunately, the TVA study does not allow the the impacts of wood-waste fuel purchases to be considered separately from the overall economic impacts of wood fuel use. Therefore, study results cannot be applied to determine economic impacts of increased wood-waste fuel utilization by the state. Two of the major impacts measured by TVA do not apply to the subject of the current study: economic activity generated by wood-fuel harvesting operations, and the economic stimulus provided to wood-fuel consuming industries by decreased energy costs.

No information made available to the current study allows the economic impacts of increased wood-waste fuel purchases by the state to be estimated. Major influences on the actual impacts of such purchases will be site-specific. Essential factors include:

- Whether or not the wood-waste fuel purchase is displacing an in-state fuel source, such as Virginia-mined coal.
- Whether or not the wood-waste fuel purchase is utilizing wastes that would otherwise be landfilled.
- The effect of state purchases which divert wood-waste materials from existing, but lower-valued, markets on the former purchaser.
- The level of economic stimulus provided by the state's wood-waste fuel purchase to the supplying firms.
- Whether or not the wood-waste fuel purchase by the state would relieve a by-product market limitation which is hindering expansion by an in-state industry.

One would expect the economic impacts of wood-waste fuel purchases by state to be greatest if they were to provide markets for wastes that would otherwise be unutilized.

State Policies and Practices

Capital Outlay Process

Boiler purchases and upgrades are funded by the state through the state's capital outlay process. Procedures governing capital outlays are administered by the Department of Planning and Budget (DPB), often with technical input from Department of General Services (DGS). These procedures are formalized and well defined (DPB, 1992; DGS, 1991). At least four separate administrative levels become involved in a successful capital outlay proposal:

1. The process starts within the agency requesting funding for the boiler purchase or upgrade. The agency puts forward a specific request, which includes funding

amount, heating plant size, fuel, location, etc. The extent to which decisions take place at the agency level (vs. the individual facility) during this process will vary depending on the personnel, agency policies, and similar factors. In the case of a new facility, the boiler purchase request is included as one component of the overall capital outlay application.

2. The agency sends the capital project request and supporting documentation to DPB, where it is reviewed with respect to the programmatic needs of the agency.

3. DPB solicits technical input from DGS, which serves as technical adviser to the DPB process. DGS reviews technical capabilities, cost calculations, and similar items, providing the results to DPB.

4. If the DPB review is successful, the capital outlay recommendation is passed on to the Governor through the Secretary of Finance. The Governor may or may not choose to include the recommendation in the budget submitted to the General Assembly.

Specific policies and procedures are in place to guide the preparation of capital outlay request documentation and the DPB-led review of the submission. A number of steps are involved. The boiler fuel decision is most likely to be made during one of the process's initial stages.

1. During the original capital project request submission and review process. (This stage initiates the capital outlay application process, and is required of all capital projects).

2. During preparation of the pre-planning study and its review. (This stage is generally required only for larger projects. Typically, capital requests of greater than $1 million for a new project, or greater than $500,000 for a repair/renovation project, must prepare a pre-planning study.)

Specific Policies:

The narrative submitted with the capital project request is required to contain an "Analysis of Alternatives" (DPB, 1992. Sec. III.B.3, p. 11). The requesting agency is required to "demonstrate why the proposal is the best alternative to meet the needs" of the agency. When a boiler purchase is involved, DPB reviewers generally require a comparison of at least three alternatives (the recommended strategy and two others).

If the project proposal reaches the pre-planning study stage, an analysis of "HVAC system and fuel type" is required (DPB, 1991. Sec. IV.B.2.b.(4), p.22). This clause requires that a detailed "fuel analysis and system analysis" be submitted with the pre-planning documentation. Neither the DPB documentation nor the Capital Outlay Manual include a description of what such analyses might entail. According to DPB personnel, a fuel analysis requires that various fuels be compared on a life-cycle cost basis, in terms of their ability to meet the facility's needs cost-effectively, while a system analysis requires consideration of the overall heating and cooling needs of the facility. Generally, at least three options must be compared (the recommended strategy, and two alternatives).

The Capital Outlay Manual also contains policies and procedures governing boiler expenditures and fuel choices. A section entitled "Central Heating and Chiller Plants" (Chapter VII) directs that "Institutional heating, cooling, and service loads shall be supplied from central heating plants, whenever practical," and that "The most reliable and economic fuels and equipment shall be utilized" (Sec. 7.0). A procedure is specified for determining the most economical fuel, based on a twenty-year life cycle cost analysis (DGS, 1991. Appendix O). Furthermore, the manual states that "The use of coal is encouraged because of its influence on the Commonwealth's economy. Virginia mined coals shall be burned where their physical and chemical characteristics are compatible with load variables and firing equipment requirements peculiar to the institution" (Chapter VII, Sec. 7.1.1).

Practical Effects of these Policies:

Because of these policies, boiler purchases are subject to analysis to determine the most economical fuel choice. Generally speaking, the fuel choice decision will receive much closer scrutiny in a stand-alone boiler purchase or upgrade proposal than within a total facility construction proposal. There are two reasons for this. The first is a result of the fact that DPB personnel only have a limited amount of time available for reviewing each capital project proposal. The second is that the boiler fuel choice, generally speaking, is not considered to be of overriding importance, relative to other factors which must be considered in reviewing a new building or new facility capital request.

There are no clauses present in any of these policies which overtly discriminate against wood wastes or other alternative fuels. Although the DGS Capital Outlay Manual (DGS, 1991) defines coal as the "fuel of choice", it also calls for use of the most economical fuel. None of the people involved in fuel choice decisions to whom we spoke even mentioned the DGS policy statement, much less considered it to be a restriction. Nonetheless, in practice, wood waste fuels are seldom considered, primarily because the system provides no incentive to investigate innovative solutions to common problems. The persons who were considering wood-waste fuel alternatives were straightforward in stating that their motivation for doing so was primarily personal, and that their decision to do so meant additional work for them.

The capital project request may be prepared by state employees within the requesting agency but, more often than not, it is prepared by an outside architectural and engineering (A&E) firm. Preplanning studies are virtually always performed by the A&E firm under contract to the state agency.

In either case, state agency employees will be involved in the boiler fuel choice process. This involvement will be direct, if state employees are charged with responsibility for preparing capital project request documentation, or it will be indirect, as state employees become involved in preparing the scope of work which defines A&E firm involvement. The state employee or employees involved in this process will have other responsibilities and projects. Any activity on their part to generate a non-standard solution to a facility-heating problem will involve extra time, relative to activity required to generate a more-or-less standard solution. If they do extend such effort and develop an innovative system that saves the state money, there is no system in place to provide a reward for successful effort. If, on the other hand, the non-standard system does not perform as expected, they may expect questions.

Generally speaking, the A&E firm does not have incentive to initiate a non-standard solution, either. It will take more of the A&E firm's personnel resources to develop a capital project request, or a pre-planning study, if a non-standard fuel (such as wood wastes) is to be included. If the bid is to be awarded on a competitive basis, an increase in cost will hinder that company's competitive position. In any case, there is less risk involved for the A&E firm if they are able to design a standard system, using locally available off-the-shelf components that they have used before and are familiar with.

Policies Related to the Department of Corrections

Senate Joint Resolution 31 (1988):

This resolution was passed in recognition of the importance of coal to the economy of southwestern Virginia. The Resolution requests the Department of Corrections "to use coal for its raw energy source at all future correctional facilities."

The resolution was seen by persons contacted during this study as having little practical effect. Department of Corrections personnel participating in the study were aware of the Resolution; they consider it to be advisory, but non-binding. They felt that their primary mandate was to meet the heating and cooling needs of each institution cost-effectively and in a manner compatible with the needs of that institution. Coal is considered for all eligible new institutions, especially for facilities built in or near the coalfield counties.

Use of Prototype Designs:

The Department of Corrections policy in this regard is discussed separately because the Coal and Energy Commission, at its August 5, 1992, meeting, directed that the potential to use wood-waste fuels at the planned Lunenberg prison facility be considered by this study.

One factor which prevents practical consideration of wood wastes as fuel at some new facilities is the Department's use of the "prototype design" concept. The Department works with standard prototype design "packages." Frequently, prototype designs are used to allow prison construction to occur in more timely and more cost-effective fashion than would occur if each new prison had to be designed individually. In some cases, the decision to apply a particular prototype to a specific site precludes further decisions regarding fuel type. For example, the proposed prison at Lunenberg will use a medium-security prototype design which includes a heat pump for primary heating and cooling, and propane fuel for auxiliary heating. Thus, there will be no central heating plant constructed at this site, so wood-waste fuels will not be an option.

Persons cooperating with this study expressed opinions that the prototype design concept is cost-effective and beneficial to the state. We found no evidence of negative impacts from the Department of Corrections prototype design policy, other than its possible effect of inhibiting use of wood-waste fuels in areas where they may be available.

Policy Options

Based on the findings summarized above, we have identified factors which we believe to be responsible for the lack of consideration of wood waste fuels for state facilities in recent years, in spite of the potential advantages. These are:

- lack of quantitative information on potential availability of wood waste fuels;
- difficulties faced by persons making boiler choice decisions in obtaining information on wood waste fuel burning and handling equipment, and on the costs and labor required to operate and maintain that equipment;
- lack of incentive for persons making boiler choice decisions to specify non-standard equipment; and
- lack of a mechanism for incorporating the positive economic impacts of boilers that would utilize in-state fuel purchases into the boiler choice decision.

The following policy options describe actions that are available to the state, should it choose to promote increased utilization of wood wastes for fuels in state facilities.

Provide Information on Wood-Waste Fuel Availability

More detailed and current information is needed on the cost and availability of wood wastes. South Carolina provides a good example of an inventory that would be useful to planners (Darwin and Curtis, 1990). It shows the volumes of bark, fines, course, and shavings residues being produced within an approximate 70 mile radius of each county in the state.

> *Policy Option:* *The Virginia Department of Forestry, or the Virginia Tech College of Forestry, should be requested to survey the availability and delivered prices of wood wastes. This survey would ideally show availability within reasonable hauling distances of each county in Virginia from sources within the state, and it should consider the need to assure availability of fuel supplies over the long term. Any such directive should consider that resources will be required to conduct such a study.*

The results of such a survey could include quantitative information to document the extent to which lack of net-revenue-generating byproduct markets are currently restricting or hindering expansion of the state's wood product manufacturing industries. This information would be helpful to the state, in determining the extent to which actions intended to relieve byproduct market limitations might be needed.

If such a survey is to provide useful information, resources to support the study would need to be made available. Possible sources of support include the state and the wood-waste generating industries.

Require Consideration of Locally Available Alternative Fuels

The state's capital budgeting policies and procedures require that life cycle costs of fuel alternatives be considered. However, the fuels which are to be included in this cost comparison are not specified. Persons responsible for boiler choice decisions do not appear to have incentive to include consideration of locally available alternative fuels while making those decisions.

> Policy Option: *The DPB capital outlay proposal and pre-planning study guidelines should be altered to explicitly require consideration of locally available fuels, such as wood wastes, for use in state facilities with central heating plants, on an equal footing with other fuels.*

Such a directive should include statements to the effect that detailed analysis shall *not* be required if the use of wood-waste (or other locally available) fuel can be ruled out by virtue of a lack of local supply, lack of storage space, or other easily identified technical constraints.

The directive may also include a clause placing some responsibility on local wood-waste producers to demonstrate the likelihood that adequate fuel supplies will be available at reasonable cost, over the long term, as a prerequisite for a more detailed analysis that includes wood-waste fuels. In this event, procedures for public notification, or other means of soliciting such information, should also be specified.

Provide Information on Wood Burning Equipment and Operation

Wood-waste fuel burning systems are not standard fare, by any means. Interviews with state personnel and consultants actively involved in specifying energy systems for state facilities revealed a lack of knowledge about wood systems compared with systems using conventional fuels. Several individuals said that they would like to consider wood but had no information about wood-fueled systems. They said information on energy systems using conventional fuels is readily available.

The availability of information on wood-waste burning equipment, and the requirements to operate such equipment, are fundamental if a boiler choice decision is to consider wood wastes.

> Policy Option: *The Department of General Services should assemble information on manufacturers and suppliers of wood-waste handling and burning equipment, capital and operating costs of that equipment, air emission and solid waste disposal requirements, fuel storage requirements, and other considerations of energy systems using wood fuels. The availability of this information should be made known to agencies that specify energy systems for state facilities, and it should be made available to personnel involved in those decisions.*

Alter State Life Cycle Costing Procedures

Purchases of fuels produced in-state will generate favorable economic impacts, relative to fuels purchased from out-of-state, or out-of-country, sources. The DGS life-cycle costing procedure (DGS, 1991; Appendix O) provides no mechanism for incorporating these positive impacts into heating system life cycle cost analysis procedures.

> *Policy Option:* *DGS life cycle cost guidelines should be altered to allow the favorable impact of in-state fuel purchases to be incorporated into the analysis, where choice of a specific fuel (such as wood wastes) can be reasonably expected to generate purchases from in-state suppliers and where a reliable estimate of the in-state economic impact of that fuel choice is available.*

The likely impact of in-state fuel purchases on state tax revenues would be a reasonable criterion for altering these guidelines.

A major problem in implementing this recommendation, however, is a lack of quantitative information regarding what the positive economic impacts of in-state fuel purchases might be. The state, or the Lumber Manufacturers' Association of Virginia, may wish to engage one of the Commonwealth's research institutions to identify an appropriate in-state fuel purchase factor for use with wood-waste fuels.

Conclusions

If state policies were to be altered so as to promote greater use of wood-waste fuels by state facilities, a number of benefits could occur. Such benefits could include reduced heating costs for the state, increased in-state economic activity, and a reduced need for landfill disposal of wood processing wastes. Factors affecting the extent to which increased state utilization of wood-waste fuels would cause these benefits to be achieved include conditions at the state facility making use of wood-waste fuels, the degree of economic stimulus to the supplying industry that would be provided by a wood-waste fuel purchase, and whether the state wood-waste fuel purchase would displace an existing lower-value use or utilize materials that would otherwise be discarded.

There is a lack of quantitative information on the the nature and costs of wood-waste fuels that might be available to the state at specific locations over the long term, the level of economic stimulus that might be provided by increased wood-waste fuel purchases from in-state sources, and on the nature and extent of byproduct market limitations faced by Virginia's wood processing industries. Currently, where they are available, wood-waste fuels can be purchased at less cost per energy unit than conventional fossil fuels.

State policies require that boiler choice decisions include comparison of life cycle costs associated with various fuels. No overt policy or procedural barriers to use of wood wastes, or other non-conventional fuels, were found to exist. Nonetheless, barriers to increased wood-waste fuel utilization by state facilities were identified. These include lack of quantitative information on potential availability of wood-waste fuels; difficulties faced by persons making boiler choice decisions in obtaining information on purchase and operation of wood-waste-fuel burning and handling equipment; lack of incentive for state agencies to specify non-standard heating equipment; and lack of a mechanism for incorporating the positive economic impacts of in-state fuel purchases into boiler choice decisions. Actions are available to the state which appear to be capable of eliminating each of these barriers.

Acknowledgements

This study was conducted by Carl Zipper, of the Virginia Center for Coal and Energy Research, and John Muench, of the Brooks Forest Products Center, at Virginia Polytechnic Institute and State University. Input was also provided by John Randolph, of the Virginia Center for Coal and Energy Research.

Frank Munyan and Arlen Bolstad, of the Virginia Division of Legislative Services, coordinated conduct of this study for the Coal and Energy Commission.

The assistance of Bill Viar, of the Virginia Department of General Services, was essential to the conduct of this study. Other individuals providing cooperation and assistance include the following:

Stuart Ashton, Department of Waste Management, Richmond
Bob Beasley, Department of Air Pollution Control, Richmond
Gene Brooks, Air Pollution Control Board, Cumberland
Bill Brown, Longwood College, Farmville
Charles Chamberlain, Department of Corrections, Richmond
Dave Davis, Augusta Correctional Center, Craigsville
Jim Duff, Eastern State Hospital, James City
Morgan Garrett, Central Virginia Training Center, Lynchburg
David Hines, Blue Ridge Hospital, Charlottesville
Robert Holcomb, Powhatan Correctional Center, Powhatan
Dick Kincaid, Department of General Services, Richmond
Murray Lee, Piedmont Geriatric Hospital, Burkeville
Michael Maul, Department of Planning and Budget, Richmond
Orville Neal, Staunton Correctional Institute, Staunton
Mark Phillips, Greenwood Partnership, Williamsburg
Robert Saunders, State Air Pollution Control Board, Roanoke
Nancy Saylor, Air Pollution Control Board, Richmond
Andrew Sutherland, Department of Mental Health, Richmond
Joe Turner, Turner Engineering, Richmond
Victor Wise, Augusta Correctional Center, Craigsville

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Appendix A: Virginia House Joint Resolution No. 69

1992 SESSION

LD4024168

HOUSE JOINT RESOLUTION NO. 69

Offered January 17, 1992

Requesting the Coal and Energy Commission to examine the policies needed to promote greater use of wood wastes for fuel.

Patrons—Councill, Abbitt, Armstrong, Bennett, Clement and Crouch

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Referred to the Committee on Rules

WHEREAS, the A. L. Philpott Southside Economic Development Commission, through its Task Force on Agriculture, Forestry, and Natural Resources, has recognized the value of forestry industries in ensuring economic development and growth; and

WHEREAS, sawdust, bark, and other wood manufacturing residues have found alternative uses in fuel, mulch, and other products, thereby reducing waste disposal problems while providing additional sources of revenue; and

WHEREAS, while a few state facilities, such as Longwood College and the Piedmont Geriatric Center, currently use wood wastes in their central heating plants, yielding significant cost savings to the Commonwealth, the expanded use of these alternative fuels would increase savings in other state facilities; and

WHEREAS, the development of policies and markets that increase the utilization of wood residues would reduce the accumulation of wood wastes and enhance future wood production efforts; and

WHEREAS, the Coal and Energy Commission, pursuant to § 9-145.1 of the Code of Virginia, has been directed to "stimulate, encourage, promote, and assist in the development of renewable and alternative energy resources"; now, therefore, be it

RESOLVED by the House of Delegates, the Senate concurring, That the Coal and Energy Commission, with the assistance of the Virginia Center for Coal and Energy Research and the Brooks Forest Products Center at Virginia Polytechnic Institute and State University, examine the policies necessary to promote greater use of wood wastes for fuel by state facilities. The Commission shall include in its study consideration of current practice and policy in the public and private sectors.

The Commission shall submit its findings and recommendations to the Governor and the 1993 Session of the General Assembly as provided in the procedures of the Division of Legislative Automated Systems for the processing of legislative documents.

Appendix B. Case Studies

Wood fuels supply the energy for many industrial, commercial and institutional facilities in the United States. By far, most of the process and space heat from wood fuels is in the forest-based industries, where wood wastes are the byproduct of their manufacturing operations. In addition, there are many public facilities that use wood fuels because of their economic advantages. The examples cited here are all from the eastern United States.

Alabama

"We presently have one 150 BHP boiler in one of our prisons. This was installed during the initial construction stages of the prison and the energy savings offset the difference in cost in less than three years. This particular prison was designed to use steam for everything, eliminating several pieces of electrical equipment also. Not only do they heat with steam in the winter, but they have steam kettles in the kitchens, steam dryers in the laundry, and converters for hot water. In hindsight, we should have included absorption air conditioning for the office to increase the summer load. The wood boiler produced such savings that the prison commissioner ordered that the next two prisons, which were on the drawing board, be designed with wood boilers." [Personal letter from Ralph Stanford, Staff Engineer, Alabama Department of Economic and Community Affairs, July 30, 1992]

Georgia

"A $2.5 million biomass retrofit installation, located in Milledgeville, Georgia, showed a fuel cost reduction of $1.0 million in its first year of operation. This retrofit at Central State Hospital, consisted of replacing two existing gas-fired boilers with two 25,000 pound-per-hour wood-fired boilers.

"Using green wood chips for fuel, the boilers supply steam to the hospital for heating, cooling with absorption chillers, domestic water, laundry, and kitchen service. Steam requirements at the state-owned psychiatric facility averaged 53,000 pounds per hour in 1987. Initial indications are that the project will meet the 2.5 year simple payback used as its funding basis.

"Believed to be the world's largest hospital fuel installation, the system is the culmination of a 10 year program designed to show that wood chips are a practical, low cost alternative to fossil fuels. The system at Central State, owned and operated by the Georgia Dept. of Human Resources, was funded and installed in cooperation with the Georgia Forestry Commission." [From "Wood- chip fuel slashes hospital's steam costs," Heating/Piping/Air Conditioning, September 1988, pp 85-90]

In addition to the hospital at Milledgeville, the following listed public facilities in Georgia use wood fuels:

Northwest Georgia Regional Hospital, Rome
Dodge County Correctional Institute, Chester
Georgia Industrial Institute, Alto
Walker County Correctional Institute, Rock Spring

Franklin County High School, Carnesville
Treutlen County High School, Soperton
Mt. View Elementary School, Lafayette
Westside Elementary School, Dalton
Union County Junior High School, Blairesville,
Forestry Center, Georgia Forestry Commission, Macon

Vermont

"Capitol Complex Converts to Wood Heat -- When the Vermont Legislature convenes in January of 1983, it will be warmly received thanks to a native product - wood heat. For the first time since the turn of the century, the Halls of Vermont's State House will once again be heated with steam produced by burning wood.

"Continuing Vermont's program of reducing dependence upon foreign oil, the Division of State Buildings has converted one of the boilers at the Montpelier Heating Plant to wood fuel. The conversion work consisted of rebuilding the fire box to accommodate wood, installing a fly ash separator, and installing a stoker and delivery system. The old coal bunkers were adapted for storage of wood chips.

"When operational, the boiler will have an average firing capacity of 24 tons of wood chips per day. All of the wood chips will be purchased from local sawmill residue, trucked in closed box tractor trailers and dumped through grates into the old coal bunkers.

"The conversion is expected to reduce oil consumption by at least 60%. In addition to reducing dependence upon foreign oil and purchasing the wood fuel on the Vermont market, it is estimated that an annual savings of $25,000 will be realized despite the increase in labor and electrical energy consumption necessary to operate the delivery system. This savings will result in a payback of the $120,000 project in approximately 5 years." [From a press release from the State of Vermont, Agency of Administration, Division of State Buildings, September 16, 1982.]

Actual performance of the wood-fueled system has been better than anticipated in the press release. Using wood chips, rather than #6 fuel oil, to heat the 17 major buildings in the capitol complex has resulted in an annual savings of $100,000. [From a telephone conversion with Norman Hudson, Vermont Department of Public Service, August 3, 1992.]

Appendix C:
Use of Wood Waste Fuels by State Facilities in Virginia

Augusta Correctional Center

Heating System

Three 13,000 pound/hour Nebraska boilers, with a Lambion feed system, were installed at the Augusta Correctional Center when the prison was built in 1985 (Figure C-1). All three boilers use wood-waste fuels. The backup fuel is coal, which would be burned in the same boilers in the event that wood-waste fuel could not be obtained.

The heating system provides hot water, cooking heat, steam for the tailor shop presses, and space heat for the prison in winter. Two boilers are operated during the colder months, while any single boiler is capable of meeting needs during warmer weather; the third boiler is available for backup service.

Six employees are required to operate the system, including the plant superintendent and a mechanic. As in any central heating unit of this size (regardless of fuel), at least one person is on duty at all times to tend the fire and maintain boiler water levels.

Fuel

The fuel is sawdust produced from green hardwoods by milling operations. Three local mills supply fuel on state contract. Moisture contents are typically in the range of 40 to 50 percent. Variations in moisture content can cause problems for the facility, but it has proven infeasible to establish moisture content requirements within the fuel purchase specifications because the suppliers are small businesses that lack the capacity to establish drying or moisture content control capabilities.

The two primary types of wood used by the mills are poplar and oak. Although, technically speaking, these are both "hardwoods", oak sawdust makes a much better fuel than poplar. Because of its burning characteristics, use of poplar fuel tends to cause air emissions problems. The facility manager attempts to purchase fuel from whichever supplier happens to be running oak.

In winter, up to twelve 25-to-30-ton truck loads per week are required. In summer, fuel requirements are less. Fuel cost is $9.50 per ton, delivered.

The primary fuel supply problems to date have been transport-related, with most caused by winter weather. Availability of fuel supplies has not been a problem, although events have occurred to hinder the capacity of individual suppliers. There have been times when fuel could not be obtained from any of the three state-contracted suppliers, so fuel was purchased off contract from other local mills. The Christmas season is a time when fuel availability tends to be restricted, especially if extreme cold weather occurs, because the supply facilities tend to shut down or reduce operations during this season.

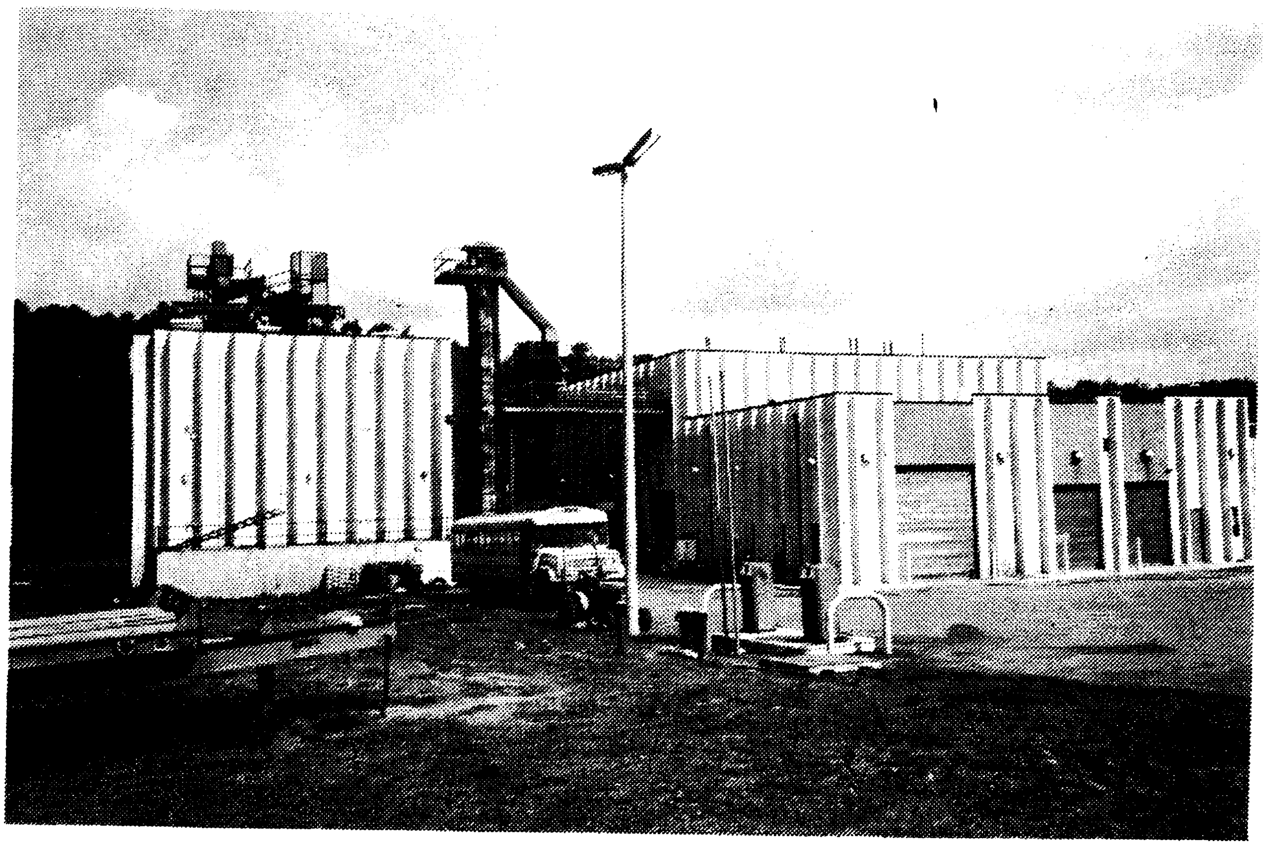

Figure C-1. The Augusta Correctional Center heating plant. The building on the left is for fuel storage. The building on the right houses three wood-waste boilers and attendant equipment.

A backup coal supply is maintained on-site. Although the boilers are described as "dual fuel", wood wastes and coal have very different handling and burning characteristics. These boilers are designed to use sawdust as their primary fuel, and operate much more efficiently using sawdust than coal.

Fuel Handling

Fuel is delivered by truck and deposited directly into an exterior hopper, one truckload at a time. The hopper physically dumps the fuel into a concrete storage silo, with capacity to hold seven thirty-ton truckloads. Microbial decomposition generates heat in the storage silo, which is sufficient to prevent freezing even during the coldest days of winter.

Fuel is fed from the silo via an automatic system manufactured by the Lambion Corporation. The feeding system uses traveling screw, drag chain, and bucket elevator devices to move the fuel into a small hopper. From the hopper, the fuel is moved into the boiler automatically (Figure C-2).

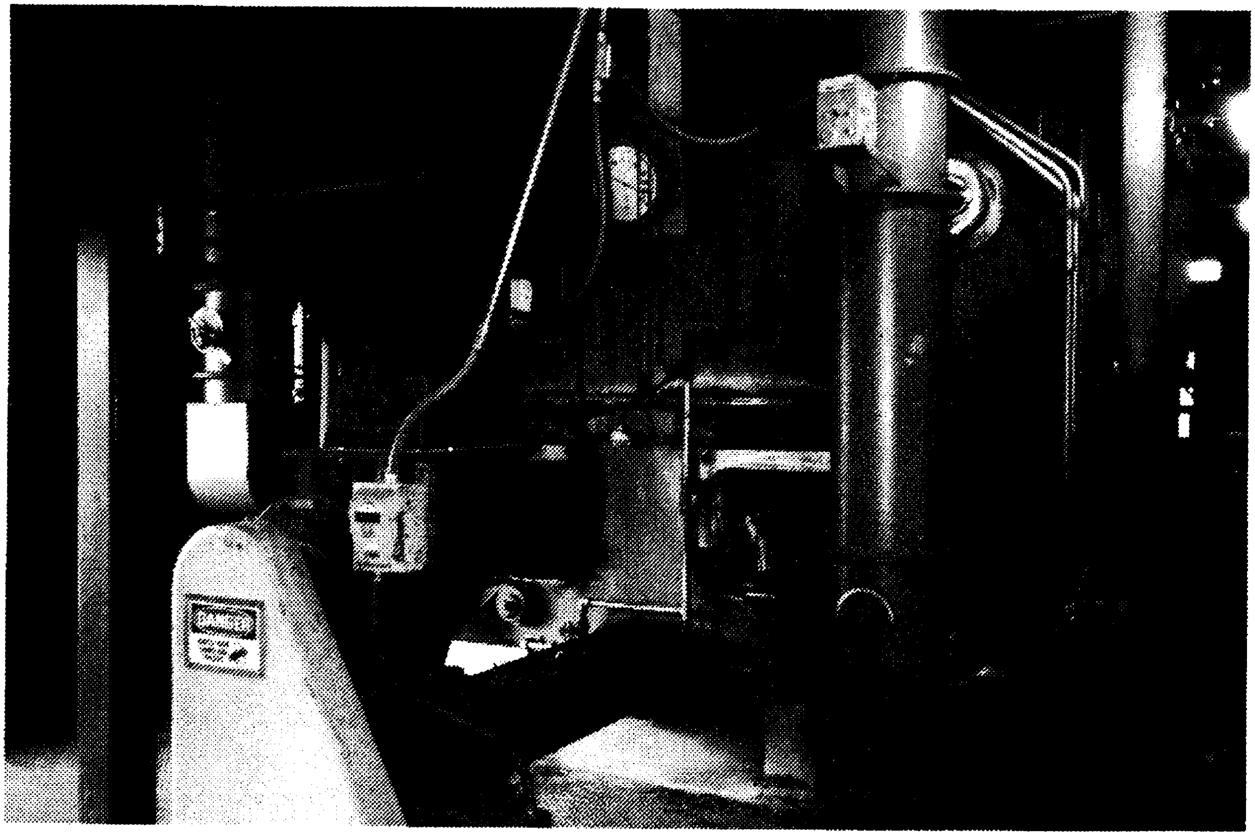

Figure C-2. The front end of a wood-waste fueled boiler at Augusta Correctional Center.

For the most part, the fuel feeding system is located outside of the heating plant building. Although it does contain copper steam lines, extreme winter cold can cause the the high-moisture fuel in the system to freeze.

A smaller silo, with a separate feed system, is available for coal. In the event that both feed systems are out of order (or the sawdust fuel freezes), the boilers can be fed using wheelbarrows and shovels, in an emergency.

Air Pollution Control

The only air pollutant of concern is fly ash, which is removed from the stack gases by an inexpensive gravity collection device. The facility operates on a "batch" basis. Most emissions are produced as the facility starts up or shuts down, when the boiler is not operating with maximum efficiency. A prisoner has complained about air emissions, based on visual appearance of the stack gases during startup and shut down. Testing revealed that emissions reduction will be required to comply with the 1990 Clean Air Act Amendments.

"Modulating controls" will be installed as an air pollution control measure. These controls will allow the boilers operate continually, reducing emissions by minimizing startups and shutdowns.

Solid Waste

The facility produces very little ash, relative to what would be produced by burning coal in an equivalent facility. Fly ash accumulates in an exterior container, which needs to be emptied once per week. The fire box of each operating boiler is cleaned out once a week, producing one wheelbarrow load of bottom ash. The ash is disposed at the county landfill. No special permit is required.

Costs

The capital cost of the power plant was $1.4 million. Annual repair and maintenance costs (exclusive of labor) have averaged $3000 - $3500. Currently, the facility manager is evaluating the need to replace the screw transports in the fuel feed system; he estimates cost will be approximately $20,000. $540,000 has been budgeted for the modulating emissions control system, but bids have not yet been returned.

Longwood College

History

The existing plant was constructed in 1938 and included three water tube boilers equipped with underfeed coal stokers. A fuel-handling system was included to convey the coal to an overhead bunker. In 1963, due to college expansion, a new coal-fired boiler was added.

During the next ten years, the advent of stricter air pollution regulations coupled with the cheap price of oil, prompted college officials to convert the four boilers to oil. The conversion was done in 1973, and included replacing one of the original coal boilers with a new, larger oil-fired unit. Two coal-fired boilers were left in place to serve as emergency stand-by units.

When the conversion was initiated, oil prices were approximately $0.105 per gallon. However, oil prices soared to $1.00 per gallon during the next several years. Oil shortages caused the college to revert back to coal on several occasions. Each time, air pollution control officials took note and requested better pollution control.

Because of the cost of oil, a study was conducted in 1980 to determine the cost of converting back to coal. The study estimated the re-conversion cost to be $1.7 million, with a large portion of that total due to air pollution control requirements.

In 1981, the cost of fuel oil caused college officials to evaluate wood fuel as an alternative. The college sought and received permission from state air pollution control officials to conduct experimental burns of wood products in the two remaining

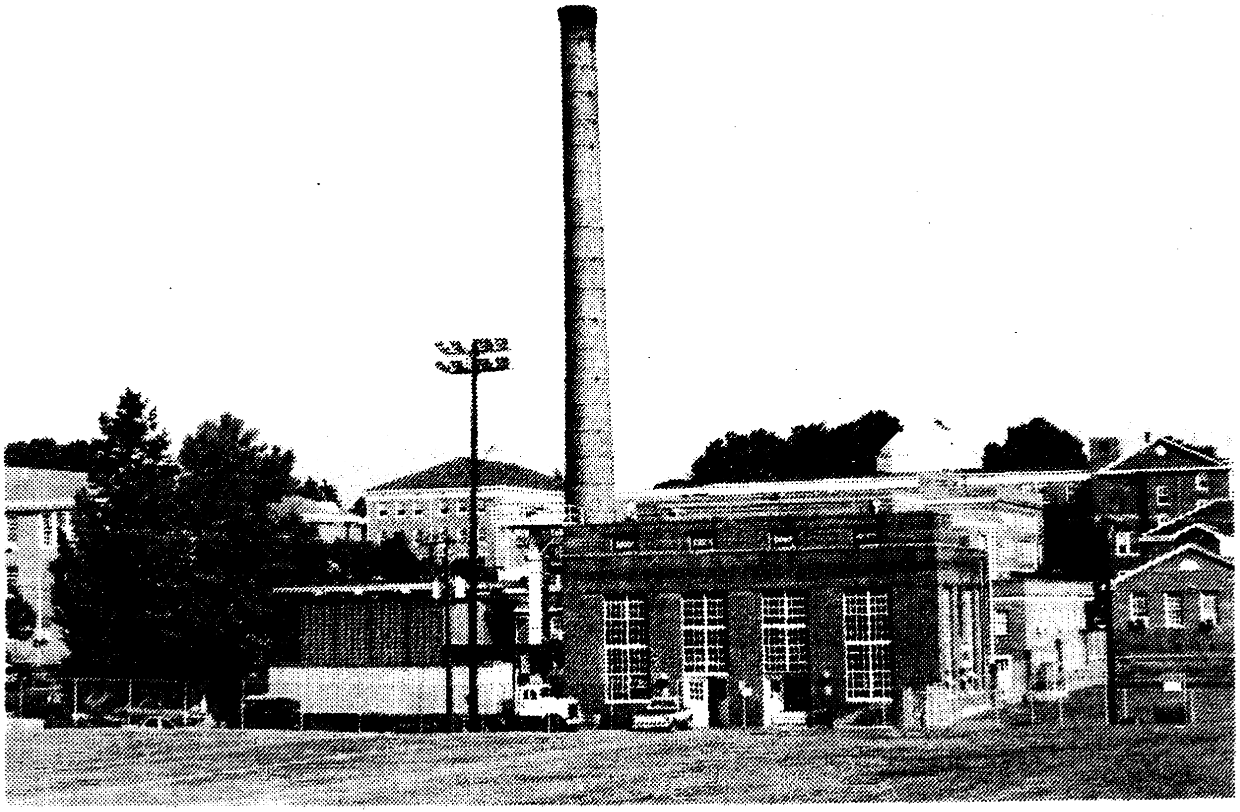

Figure C-3. The heating plant at Longwood College. Wood-waste fuel storage is provided by the metal shell addition to the heating plant at the left-hand side of the photo. The main heating plant building houses two former coal-fired boilers, converted to burn wood wastes, and two oil-fired units which serve as backup to the wood-fired units and handle swing loads. The tractor-trailer unit is used by the College to transport wood-waste fuels.

coal boilers. These were conducted in 1983 by heating plant employees. The results indicated a fuel cost savings of $163,500, compared to 1982 oil costs.

During 1984-85, the conversion of the two original coal boilers to wood fuel was completed. This conversion consisted of internal alterations to accommodate wood fuel. The 1938 fuel-handling system remained in place, as minor modifications allowed it to handle the sawdust fuel. In 1990, a new fuel-handling system was installed at a cost of $319,000. This installation was required by the advanced age of the older fuel-handling system, not because of the transition to wood-waste fuel.

Heating System

The present heating system consists of two converted coal boilers burning wood wastes, and two #6 oil-fired boilers. The wood-waste boilers are the primary heating units, and the oil-fired boilers provide backup. One of the oil-fired boilers is small, relative to the other three units, so it can be activated during periods of extreme low demand. Otherwise, one wood-fired boiler is used during this summer months and two during the cooler months. During extremely cold weather, one of the oil-fired boilers may also be utilized.

Supposedly, the wood-using boilers could be fired with coal if wood were not available. However, this would require changing the grates. This procedure has not been necessary since the conversion.

The heating system supplies hot water, cooking heat, and space heat to the college through a central heating system.

Fuel

Waste hardwood sawdust is supplied three local sawmills. The mills use green wood, and moisture contents are generally in the range of 40-to-50 percent.

The two primary types of wood used by the supplying mills are poplar and oak. Oak sawdust makes a much better fuel than poplar, so the facility manager attempts to purchase oak whenever possible.

The primary fuel supply problems experienced have been quality-related. Most have occurred when availability restrictions at primary suppliers have caused fuel to be purchased from alternate sources. When fuel is not ″clean″ (i.e. contains foreign objects), the feed systems tend to malfunction. A 2″ x 4″ grate is used to screen materials entering the feed system, but problems still occur. Long, thin pieces of wood and metal objects (bolts and the like) can pass through the grate.

Fuel procurement is a constant concern, especially during the winter. Bedding purchases by the area's chicken producers has an influence on the sawdust market.

Fuel Handling

Longwood owns and operates a tractor-trailer (with two trailers) to assure supplies. Because the college owns the truck, it is not dependent on outside firms for fuel deliveries. The operation of the truck has reduced fuel supply costs. One employee drives the truck. This is a full-time job in winter, but part of his time is available for other duties (including school bus driver for field trips) during the warmer months. The availability of the trailers helps the facility manager to acquire clean fuel, as the trailers can be left with suppliers and loaded directly, avoiding the need for on-ground fuel storage.

A concrete-floored, metal-sided shell building adjacent to the heating plant is used for sawdust storage (Figure C-3). The building has has two entrances, one at floor level and the other about 15 feet above the floor. The upper entrance allows the storage capacity to be more fully utilized. Large sliding garage-type doors can be closed to keep the stored fuel from freezing in winter, by trapping the heat of decomposition. No auxiliary heat is required of fuel storage. On site storage capability is approximately twelve 25-to-30 ton truck loads. During the winter heating season, this is barely enough to get through a weekend.

Fuel handling operations are made more efficient by the fact that the trailers have "live beds" (moving slats which pull the load towards the rear of the bed, where the force of gravity can remove it from the truck.) A small "bobcat" loader moves the fuel to a screening grate in the floor. The fuel moves through the grate to a feeding system utilizing traveling screw augurs, drag chains, and a bucket elevator. This system moves the fuel into hoppers at the mouths of each boiler. The feed system is manufactured by Lambion Corporation.

Air Emissions

The only air pollution control equipment installed specifically for the wood fuel system was a series of rotor lock valves (approximately $1000 each). These were placed on the gravity-feed cyclones which had been installed with the original coal boilers. A blower system removes most of the fly ash from stack gases. There have been no complaints or problems due to air emissions.

Solid Waste

An augur system feeds fly ash into a bin, where it enters a 55 gallon barrel. This barrel needs to be changed approximately once per day per operating boiler, when it is about 3/4 full. During the week previous to September 18, 2620 pounds of ash had been taken to the Prince Edward County landfill. Disposal is routine - no special permit is required.

Costs

The cost of converting the boilers to wood wastes was approximately $230,000 in 1984-85. The 1990 fuel-handling system installation cost was $319,000. The tractor cab and two trailers were purchased for about $60,000 total, in 1986-87. The conversion to wood wastes has not required the addition of any new employees -- except the truck driver.

Piedmont Geriatric Hospital

Heating System

Piedmont Geriatric Hospital maintains a central heating plant, which produces heat energy for space heating, hot water, autoclaves, laundry, and cooking. There are three boiler units in this central plant. The two older units (manufactured in 1945) use coal; they are rated at 12,500 and 15,000 pounds/hour. The third unit is more modern (1987) and smaller (6,900 pounds/hour), a Kewanee fire-tube boiler using a Lambion fuel-handling unit and combustion panel to burn waste wood.

The Kewanee boiler was originally specified to burn coal, sawdust, shavings, and chips. A price adjustment was made to the state because an evaluation showed that sawdust was the only fuel that would work. This unit is generally used only

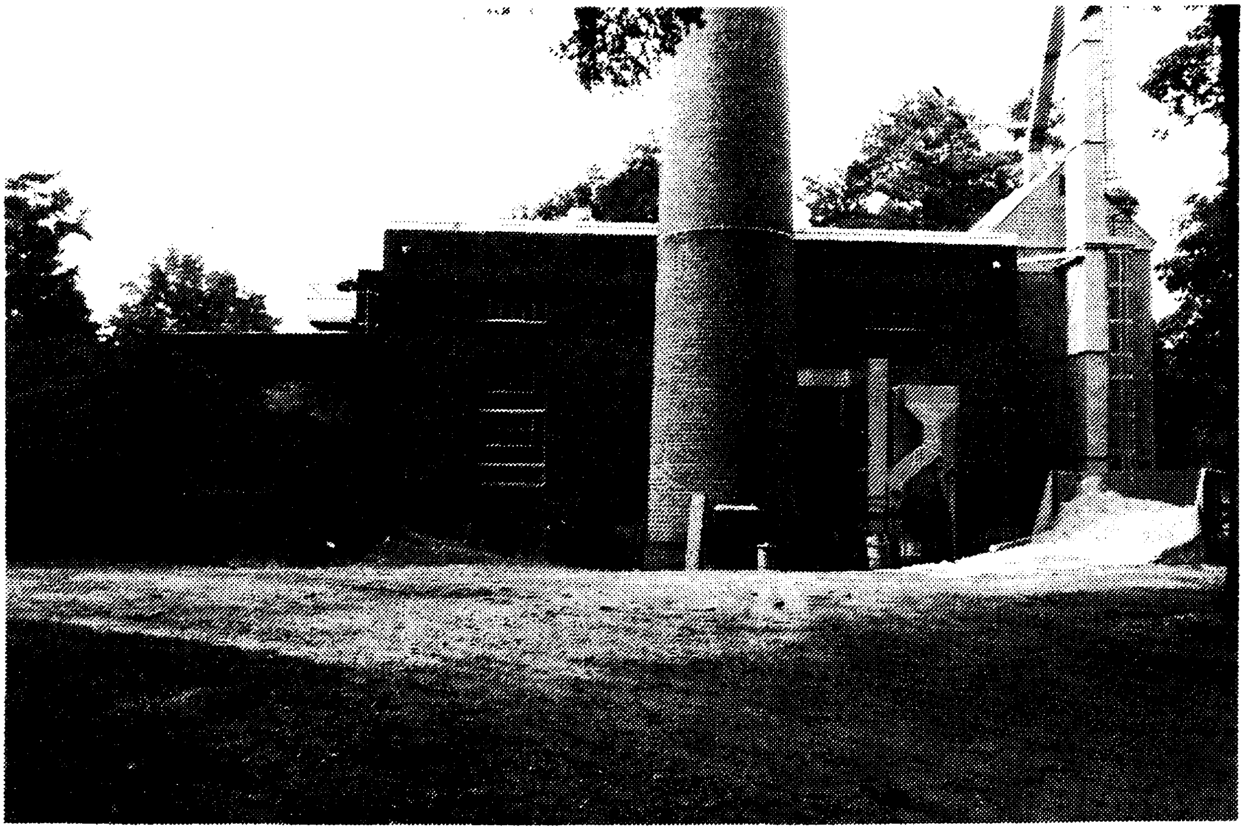

Figure C-4. The heating plant at Piedmont Geriatric Hospital. Coal storage can be seen at the left hand side of the photo. The wood-waste fuel delivery hopper and the fuel storage silo can be seen on the right.

during the warmer months, because stored fuel tends to freeze during winter weather.

The wood-using unit was installed to replace an oil burner (#6 fuel oil). The previous boiler was fairly old and had reached a stage where it was unreliable. When a fuel oil spill contaminated 5-6 miles of an nearby stream, the decision was made to replace oil-fired unit with the wood-burner.

Fuel

The fuel is hardwood sawdust produced from green wood by milling operations. Fuel moisture contents are typically in the range of 40-to-50 percent.

The fuel suppliers use poplar and oak. As in the other facilities, the Kewanee unit handles oak better than poplar. The major problem with poplar is that it burns so rapidly.

Wood fuel purchases range from three 25-to-30 ton truckloads every two weeks, to four or five truckloads per week. Sixty to sixty-five tons of fuel can be stored on site. Fuel cost is $13.00 per ton, delivered. The Piedmont Geriatric Hospital uses the same suppliers as Longwood College.

The primary fuel supply problems have been quality-related. When fuel contains foreign objects, the feed systems tend to malfunction. A 2″ x 4″ grate is used to screen materials entering the feed system, but problems still occur.

The coal is procured by state contract. The most recent coal purchase was from West Virginia.

Fuel Handling

The fuel is delivered in a live-bottom trailer, which moves the material into a hopper (Figure C-4). The material moves through a screen at the bottom of the hopper by gravity into a below-ground enclosed cavity. A screw-auger system at the base of this cavity feeds the material into a bucket elevator, which transports it to the top of a concrete silo and dumps it into the silo. From the silo, the fuel is automatically fed into hoppers at the front of the boiler.

Solid Waste

An automatic system collects fly ash, and places it in 55-gallon drums. The rate of accumulation is very slow (less than 1 drum per week during the busy season). The ash is kept in an exterior storage pile, with no observed harmful effects. Hospital personnel use the ash on lawns, and extra ash is made available to local citizens at no charge. The result is that most of the ash is disposed in this manner, at no cost to the facility.

Air Emissions

The only air pollution equipment installed is a mechanical dust collector. No air pollution problems have ever been reported. There have been no complaints or known problems due to air pollution.

Costs

The capital cost of the wood-burning installation (boiler, fuel storage, and fuel feeding apparatus) was approximately $500,000. The facility manager believes that a comparably sized unit could be obtained from a domestic manufacturer today for far less.

Wood fuel is purchased under contract for $13.00 per ton. The facility manager calculated steam costs for the 1992 fiscal year at $.00195/pound using wood, $.00263/pound using coal.

Maintenance has required a number of minor costs. Whenever possible, the facility manager replaces the Lambion components with domestic components, from a domestic supplier. He recently replaced the metric sprockets in the fuel feeding system for $900. He has had to replace the underfeed screw for a cost of $1800.

Appendix D: Fuel Costs at Longwood College, 1981-1991

The data of Table D-1 demonstrate that fuel cost savings were achieved by substituting hardwood sawdust fuel for fuel oil at Longwood College.

These figures do not include the costs of owning and operating a truck to haul wood waste fuel supplies. A rigorous evaluation of heating costs at Longwood would need to consider that the winters of 1981 and 1982 were among the coldest of the 1981-1991 period, and that additional buildings have been added to the heating system load since 1981.

Capital costs to install the wood heating system were $231,791 to convert two coal boilers to handle wood-waste fuels in 1983, and $319,000 to install a wood-fuel handling system in 1990.

Table D-1. Fuel Costs at Longwood College, 1981-1991.

Year	Gallons Oil	Oil Cost	Tons Wood	Wood Cost	Total Cost
1981	767,216	$553,597			$553,597
1982	653,970	443,820			443,820
1983	315,927	205,353	7,970	$74,911	280,264
1984	363,686	236,396	7,570	120,891	357,287
1985	425,032	309,966	2,591	65,380	375,346
1986	172,966	103,031	10,330	140,516	243,547
1987	325,424	130,115	8,728	109,282	239,397
1988	311,509	126,400	10,133	124,055	250,455
1989	425,835	158,809	8,875	104,319	263,128
1990	510,219	234,188	6,425	74,609	308,797
1991	304,679	155,187	8,559	95,747	250,934

Source: Bill Brown, Supervisor of Buildings and Grounds.

Appendix E: Augusta Correctional Fuel Analyses

The following fuel analyses were performed during boiler efficiency testing at the Augusta facility. The tests were performed after installation, but prior to beginning routine operation of the boilers, in 1987. Fuel analyses were performed on each of three separate wood-waste fuel samples, as received from the mill and on a dry-weight basis. A sample of coal from Augusta's backup fuel supply was also tested.

Table E-1: Results of Augusta Correctional Center Fuel Analysis.

Fuel:	Wood	Wood	Wood	Coal
As received:				
Moisture Content	43.6%	40.8%	40.6%	3.5%
Ash	0.35%	0.36%	0.28%	7.29%
Heat Value (Btu/lb)	4729	4986	5082	13223
Sulfur Content	0.14%	0.18%	0.14%	0.92%
Dry:				
Ash	0.62%	0.61%	0.47%	7.55%
Heat Value (Btu/lb)	8385	8422	8565	13703
Sulfur Content	0.24%	0.30%	0.23%	0.95%