BY THE COMPTROLLER GENERAL

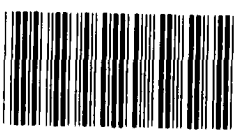
Report To The Congress

OF THE UNITED STATES

The Nation's Unused Wood Offers Vast Potential Energy And Product Benefits

The Forest Service and the Department of Energy need to place higher priority on encouraging the use of wood residues as an energy source and as a substitute for more energy-intensive materials in manufacturing. Despite their recognized potential, immense quantities of wood residues--decaying logging residues and dead trees, unused wood-processing residues and vast, untapped acreages of small, defective, and other lower value trees--are wasted each year.

GAO's recommendations to encourage better use of wood residues do not necessarily entail any major increases in Federal expenditures. Where found cost-effective, use of wood heating or power systems would actually reduce funding requirements. Other actions, such as adoption or modification of Federal forest management programs and policies, might yield benefits in excess of any additional costs.



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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

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To the President of the Senate and the
Speaker of the House of Representatives

This report illustrates that immense quantities of wood, which might be used as fuel or products, are wasted each year and that Federal policies are contributing to this lost potential. We have studied these policies, and offer recommendations to five different Federal agencies to help eliminate this waste of valuable wood resources.

We are sending copies of the report to the Secretaries of Agriculture, Defense and Energy, the Administrators of the Environmental Protection Agency and the General Services Administration, and the Director of the Office of Management and Budget.

Comptroller General
of the United States

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

THE NATION'S UNUSED WOOD OFFERS VAST POTENTIAL ENERGY AND PRODUCT BENEFITS

D I G E S T

BACKGROUND

Immense quantities of wood residues--estimated by the Forest Service at 600 million dry tons each year--are wasted in the U.S. in the form of decaying logging residues and dead trees, unused wood processing residues, and large, untapped acreages of small, defective, and other lower value trees. (See p. 1.)

Wood residues could be an important energy source. The Forest Service estimates that, within 10 years, about half of the available residues could be recovered economically, increasing wood's contribution to 8 percent of the Nation's energy budget. (See p. 1.)

Residues are also suitable for making lumber and plywood, as well as reconstituted wood products such as pulp, paper, and particleboard. Wood products can substitute for other materials, such as aluminum and steel, which are far more energy-intensive. Some officials believe that increased substitution of wood products offers even greater potential benefits than alternative use of wood to produce energy. (See pp. 2 and 3.)

MAJOR BARRIERS TO RESIDUE USE

GAO identified numerous factors standing in the way of greater use of wood residues for energy and products. While there are regional differences, GAO found four barriers which appear to have a significant effect on residue use nationwide. These barriers are

- --inadequate data on the volume, location, accessibility, and availability of forest residues;
- --lack of economical and effective equipment for harvesting and transporting residues;
- --lack of investment capital needed for harvesting and using residues; and

--limited awareness and acceptance of wood energy and product technology among industrial firms, utilities, and State and local bodies. (See p. 22.)

Other obstacles may serve to discourage or prevent residue use in some areas around the country. They pertain to

--Federal forest management policies and programs,

--utility practices and regulations, and

--environmental concerns related to greater use of residues. (See p. 58.)

DETAILED EXAMINATION OF ACTUAL POTENTIAL IS NEEDED

While the Forest Service and Department of Energy have an interest in greater residue use, they have made little progress in developing a national wood residue plan. The agencies need to expedite development of a comprehensive, well coordinated plan for using residues for both energy and products. (See pp. 76-78.)

Initially, the agencies should direct their attention to regional variations by making a number of assessments in selected locations around the country which appear to offer significant opportunities for greater residue use. (See p. 78.)

These residue assessments should be made in areas adjacent to a particular site where potential end-use facilities for wood residues exist and/or could be developed. Such operating areas should be defined in terms of key factors such as topographical features, transportation corridors, economic hauling distances, and landowner attitudes. The mere existence of residues in a given area may mean little if landowners are unwilling to make them available. (See p. 79.)

GAO believes the Forest Service should take the lead in accomplishing the needed assessments. The Department of Energy should be an active participant in the studies, but the assessments must deal more with resource management problems than end-use technology questions. Given the

current preponderance of resource issues, Forest Service lead responsibility is essential. (See p. 81.)

Concurrent with accomplishing the residue assessments, the Forest Service, Department of Energy and some other Federal agencies can initiate several actions to stimulate greater residue use. (See p. 81.)

RECOMMENDATIONS

To The Secretary Of Agriculture And The Secretary Of Energy

To more fully evaluate potential barriers to wood residue use and how these barriers vary by locations, and to begin development of a comprehensive national plan for realizing the vast potential of wood residues for producing energy and products, the Secretaries should conduct a cooperative program of assessments in at least six locations around the country. Based on the results of these assessments, the Secretaries should present to the Congress within 2 years a national wood residues plan, including proposed residue use goals and recommendations for legislation or other actions to overcome barriers to such goals.

The Secretaries should also work jointly to develop standardized methods for evaluating the costs and benefits of using wood fuels in Federal facilities, including allowance for forest management benefits, and submit these methods to the Office of Management and Budget within 6 months for dissemination to the executive branch to assure consistency in life-cycle energy evaluation. (See pp. 84-86.)

The Secretaries should also establish programs which encourage both the use of wood fuels and the development of residue-handling equipment. (See p. 85.)

To The Administrator, Environmental Protection Agency

To help promote wood residue use in locations where current air pollution regulations preclude such facilities, GAO believes that policies and procedures must (1) recognize emission trade-offs

resulting from reduced burning of residues in the woods or in other locations and increased burning at proposed wood energy facilities, and (2) allow such trade-offs to be considered in deciding whether a wood-burning facility may be constructed and what type of pollution control equipment will be required. GAO recommends that the Administrator request legislation to amend the Clean Air Act to allow full recognition of such trade-offs. The Administrator should also encourage the States to modify their policies where needed to recognize such trade-offs. (See p. 87.)

To The Secretary Of Defense And The Administrator of General Services

GAO recommends that the Secretary of Defense and the Administrator of General Services provide a major stimulus for wider wood residue use through both facilities conversion and procurement policies. (See p. 87.)

Matters For Consideration By The Congress

GAO's recommendations call for carefully coordinated interagency actions to plan, fund and implement local wood residue assessments in each of the Nation's major forested regions and to develop subsequent proposals for a national wood residues plan. Effective participation by both the Department of Agriculture and Department of Energy is essential to the success of these actions. GAO believes the Congress should consider the adequacy of participation and degree of cooperation and coordination displayed by the Departments in the course of reviewing their future appropriations requests. (See p. 88.)

AGENCY COMMENTS

GAO sent a draft of this report to the Departments of Agriculture, Energy and Defense, the General Services Administration, and the Environmental Protection Agency. The Environmental Protection Agency did not provide comments on the report. All the other agencies provided written comments. (See appendixes.)

The Department of Agriculture said the report could provide "an impetus for greater and more

effective use of unutilized wood fiber." The Department said the Forest Service would assume the lead agency role in planning and conducting local wood residue assessments and the results of the assessments would be incorporated into subsequent proposals for a national wood residues plan. (See p. 89.)

Overall, the Department of Energy agreed that wood residues should play an important part in achieving the national energy goals. (See p. 91.)

Other comments by the Departments of Energy and Defense and the General Services Administration supported some GAO recommendations and disagreed with other recommendations. (See pp. 89-93.)

CONTENTS

ABBREVIATIONS

BLM	Bureau of Land Management
DOD	Department of Defense
DOE	Department of Energy
EPA	Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
GAO	General Accounting Office
GSA	General Services Administration
PURPA	Public Utility Regulatory Policies Act of 1978 (92 stat. 3117)
SERI	Solar Energy Research Institute
S&PF	State and Private Forestry Division, U.S. Forest Service

GLOSSARY

biomass	The total quantity of a living organism, such as a tree.
broadcast burning	Intentional burning in which a fire is allowed to spread over a specified area to dispose of the logging residues.
British thermal unit	The amount of heat energy necessary to raise the temperature of 1 pound of water by 1 degree Fahrenheit.
clearcutting	A harvest method whereby all trees in a specified area are cut.
concentration or sorting yard	An area to which wood removed from adjacent harvest areas is taken to be sorted and sold for its best use.
ethanol	Ethyl alcohol. Commonly called grain alcohol.
gasohol	By strict definition, a mixture of 90 percent unleaded gasoline and 10 percent nonpetroleum based ethanol. In general, however, any blend of unleaded gasoline and a nonpetroleum based alcohol.
hardwoods	Trees that are usually broad-leaved and annually shed their leaves.
megawatt	One million watts of electricity or 1,000 kilowatts.
methanol	Methyl alcohol. Commonly called wood alcohol.
pole timber	Live trees of commercial species having diameters of at least 5 inches but less than 9 inches (softwoods) or 11 inches (hardwoods) measured at a point 4-1/2 feet above the ground, and having good form and vigor.

reconstituted wood products	Products such as pulp, paper, paperboard, and particleboard formed from wood fibers or particles.
roundwood products	Logs, bolts, or other round sections cut from trees for industrial or consumer use.
saplings	Live trees of commercial species between 1 inch and 5 inches in diameter measured at a point 4-1/2 feet above the ground, and having good form and vigor.
scaling	The process which involves measuring and making visual observations to estimate the merchantable volume of wood in a log.
softwoods	Trees that are usually evergreen having needles or scale-like leaves.
wheeling	The process of using the electrical transmission facilities of one entity to move power owned by another entity.
wood gasification	A modified wood pyrolysis process which yields primarily a combustible gas.
wood pyrolysis	High-temperature heating of wood with controlled amounts of air to produce gases, an oil, and charcoal.

CHAPTER 1

INTRODUCTION

Wood is a material resource of great importance to the American economy. Its importance derives from its abundance throughout much of the Nation, its versatility as a source of energy and numerous products, the relative energy efficiency of its processing, and, above all, its renewability. Wood is by far the Nation's most important renewable material.

THE VAST POTENTIAL OF WOOD RESIDUES

In recent years interest has grown regarding the unused portions of the Nation's wood resources. These portions--the wood residues--take several forms, including (1) branches, tops, stumps, roots, defective main stems, and other remnants of commercial tree species left behind after logging, (2) low-value species, defective trees, and smaller trees and shrubs not considered desirable for commercial harvesting, (3) unharvested dead timber, (4) unused bark, slabs, edgings, sawdust, and other by-products of wood processing, and (5) unused material from urban tree removals, building construction and demolition, and other urban wood wastes.

It is generally agreed that residues offer a vast potential for increasing the amount of wood fiber available for energy products. Although it lacks detailed inventory data for the various types of wood residues, the Forest Service has estimated that about 600 million dry tons of unused residues are available annually, excluding stumps and roots. If this amount of residues could be used for energy, it could add 10.2 quadrillion Btu's (QUADs) to the Nation's current wood energy use of 1.5 QUADs. This could increase wood's share of the 79-QUAD national energy budget from 1.9 percent to 14.8 percent and reduce daily oil imports by about 4.7 million barrels (59 percent).

The Forest Service estimates that, within 10 years, about half of the available residues could be recovered economically, increasing wood's contribution to 8 percent of the Nation's energy budget. By some other estimates, wood could eventually provide up to 20 percent of our energy needs through careful and intensive forest management and residue harvesting.

Because estimates are based on inadequate residue inventory data, we endorse no specific estimate of wood's potential share of the national energy budget. We are convinced, however, that the potential of wood is significant enough to warrant further detailed analyses of barriers to increased residue use beginning with this report.

Residues as sources of energy

Wood residues are a source of industrial and utility fuels, home heating fuels, and energy chemicals. Residues are used in a variety of forms, including chunks or chips of wood in its basic state; briquettes and pellets of densified wood materials; wood pyrolysis products, such as charcoal and combustible gas; and wood-based alcohols, such as methanol and ethanol.

The technology for burning wood and densified wood to heat industrial and utility boilers is proven. Indeed, wood was the dominant source of fuel for American industry until the mid-1800s, when cheap and plentiful sources of coal and oil were discovered. However, aside from the forest products industry, which supplies about 45 percent of its energy needs by burning residues, industrial firms are generally not aware of the potential of wood combustion. Similarly, utilities have made little use of wood to generate electricity, with only 5 to 10 wood-burning utility plants operating nationwide.

Despite limited use of wood fuels outside the forest products industry, there are some recent signs of change. For example, in the South a number of firms in the textile and masonry products industries have begun using wood as costs of some alternative fuels have skyrocketed. Also, at least a few utilities are planning or considering use of wood fuel either alone or in combination with other fuels in new and existing power facilities.

Interest in wood for home heating has increased dramatically since oil and natural gas costs began to climb. Here again, suitable wood combustion equipment is readily available, although improvements in burning efficiency and air pollution characteristics of some equipment may be needed. Nationally, an estimated 7.5 million homes use wood for all or part of their heating needs.

Most of the interest in wood as a source of energy chemicals has centered on production of methanol and ethanol for use in making gasohol. In contrast to use of wood in industry and home heating, technological advancements are needed to improve the economics of converting wood to these alcohols. Despite the current technology limitations, one forest products firm in the State of Washington is producing ethanol for sale to gasohol dealers.

Residues as sources of wood products

Some wood residues are of sufficient size and quality to be made into lumber and plywood, while others may be used to

produce reconstituted wood products such as pulp, paper, and paperboard. Facilities which use some residues to produce these types of products are numerous. Residues may also be converted into newer types of reconstituted wood products which can replace lumber, plywood, and other materials in construction applications. However, only a few facilities for producing these newer products have been constructed since their development in the mid-1970s.

Using residues for products can extend the Nation's wood supply and thereby help moderate potential increases in product prices. At the same time residue use can contribute to energy conservation, since the energy efficiency of wood products is generally much greater than that of competing materials. Some Forest Service and forestry association officials believe that increased substitution of wood products for competitive materials offers greater potential energy savings than using wood to produce energy.

Residues as sources of chemicals

Wood residues could be an increasingly important source of chemicals in the future. At present wood-based chemicals yield common products, such as turpentine, rayon, and cellophane. While almost any organic chemical could be derived from wood, current economics favor petroleum feedstocks for producing most of these chemicals. However, as petroleum supplies diminish and chemical conversion processes for wood are improved, wood residues may assume an expanded role as a chemical feedstock.

RESIDUE POTENTIAL NOT REALIZED

Despite the vast national potential of wood residues for producing energy and products, little of this potential has been realized. As indicated earlier, significant use of residues occurs only in meeting the energy needs of the forest products industry, in supplying fuel for home heating, and in producing particleboard and pulp, paper, and paperboard products. As a result, immense quantities of wood residues remain unused in the United States each year.

The Federal Government has a major role in production and use of wood resources. It owns over one-fifth of the Nation's commercial forest land containing more than half of the commercial softwood most widely used for products, such as lumber, plywood, pulp, paper and particleboard, and for energy. The Forest Service is responsible for Federal leadership in ensuring beneficial use of wood resources from Federal forests and for assisting

State, local, and private landowners in managing their lands to meet national demands for wood materials. As such, the agency is keenly interested in using the millions of tons of wood residues available in the United States each year.

Over the last decade the Forest Service, State and local governments, and private industry have increasingly discussed opportunities for utilizing wood residues and how the enormous potential of this resource might be realized. However, widespread interest and discussion have not resulted in a comprehensive national plan for increased wood residue use. In 1971 the Forest Service initiated a "close timber utilization study" aimed at developing a plan for greater use of logging residues and dead timber in National Forests. While the study led the Forest Service to change some timber sale provisions, which in some cases could result in removing more wood from harvest areas, it failed to produce any overall plan for substantially increasing use of wood residues. Although the Forest Service's longstanding interest in using more residues has been joined in recent years by the Department of Energy's (DOE) desire to realize the energy potential of wood, the agencies have yet to develop a comprehensive wood residue plan.

Both Forest Service and DOE efforts to develop an effective national plan for increased wood residue use have been handicapped by inadequate funds and staffing. The agencies have been unable and/or unwilling to make significant progress on wood residue use. However, we believe that a more important factor stalling progress toward a national wood residue plan is the agencies' failure to adequately recognize and allow for wide regional variations in residue opportunities, problems inhibiting greater use, and alternative solutions. These variations arise from broad geographical differences in (1) quantity, accessibility, and types of residues, (2) ownership of residues and forest lands, (3) the overall economics of residue removal and use, (4) costs of alternative energy sources and competing products, and (5) other factors, such as State and Federal programs and regulations. The Forest Service and DOE have attempted to initiate a national wood residue plan without obtaining adequate data on these regional differences.

In our opinion, reliable information on regional variations in factors affecting wood residue use is an important prerequisite of developing a comprehensive national residue plan. In making this review we were careful to obtain data from various regions and to highlight regional differences whenever possible. Thus, while taking a national perspective, this report also represents an initial step in evaluating factors affecting use of wood residues on a regional basis.

We hope it will serve as a catalyst for more in-depth, local residue assessments, in various regions of the country which we believe are necessary to develop an effective national plan for increasing residue use.

There are a number of economic, technological, and ecological barriers which must be analyzed to determine how much of the undoubtedly large physical resource represented by wood residues can be usefully used by American society. In the mineral world, a distinction is always maintained between generally available mineral "resources" and that portion of them known as mineral "reserves" which may, at any given time, be economically recoverable. In the same vein, it has yet to be determined what portion of wood residues resources might be convertible to actual reserves for either energy or wood product purposes.

SCOPE, OBJECTIVES, AND METHODOLOGY OF REVIEW

Recognizing the strong geographical linkage of factors affecting residue use, we designed our review to incorporate most of the States having significant forest resources. This included work in the following regions: the Pacific Coast, the Rocky Mountains, the Great Lakes, the South, and New England. In each region we sought information on the potential for residue use, the current level of use and its impacts, the factors or barriers limiting greater use, and the alternatives available to reduce the barriers.

In most of these regions we talked with officials of the Forest Service, the Department of Energy (DOE), State forestry agencies, and State energy agencies; with representatives of forest products firms, electric utilities, and other private firms either involved in supplying or using residues, or in a position to do so; and with consulting engineers or university and private researchers. In some regions we also contacted representatives of the Department of Defense (DOD), the Environmental Protection Agency (EPA), the Bureau of Land Management (BLM), the Tennessee Valley Authority, the Bonneville Power Administration, State environmental agencies, and State public utilities commissions. Headquarters officials of the Forest Service, DOE, Federal Energy Regulatory Commission, EPA, DOD, and General Services Administration (GSA) were also contacted.

We reviewed applicable documents in the Federal, State, and private sectors, including various studies and research papers, and current and proposed statutes, regulations, procedures, and guidelines.

The following chapters present the results of our review by focusing on

--the impacts of failure to use residues,

--the most significant barriers to greater residue use,

--additional obstacles to increased use of residues,

--the need for more attention to regional variations and better organization of Federal resources to facilitate development of a comprehensive national wood residue plan, and

--conclusions and recommendations for Federal agency actions.

CHAPTER 2

EFFECTS OF FAILURE TO USE WOOD RESIDUES

Failure to use wood residues for energy and products results in several major detrimental effects. While these effects are national in scope, their significance varies among the different regions of the country. For ease of discussion the various effects may be considered under four categories:

--Waste of the resource.

--Impact on national energy goals.

--Effect on timber supplies and product prices.

--Impact on management of forest lands.

WASTE OF THE RESOURCE

The most glaring effect of failure to use wood residues is the waste of a valuable national resource. Every year vast quantities of this resource are lost when unwanted processing residues are burned or buried in landfills, when dead timber rots in the woods, and when trees and portions of trees left after logging either rot, or are burned or chopped up and ground into the soil. Even greater amounts of the residue resource are locked up in growing stands of low-value species in overcrowded thickets of small trees and shrubs, and in logging residues and dead trees located in areas where decomposition is extremely slow. The potential of these residues remains neglected year after year.

The Forest Service estimates that about 600 million dry tons of unused wood residues are available annually, excluding stumps and roots. Table 1 shows the major components of the Forest Service estimate.

Table 1

Forest Service Estimate of
Unused Wood Available Annually

	Millions of dry tons
Excess growth and smaller trees	215
Logging residues	160
Rough, rotten, and dead trees	115
Wood processing residues	20
Residues from land clearing	20
Urban wood residues	70
Total	600

To better understand the significance of such a vast amount of residues, it is helpful to consider each of the separate components and how its occurrence varies regionally.

Excess growth and smaller trees

Over a third of the Forest Service estimate, 215 million tons, is made up of types of trees for which annual growth far exceeds commercial harvesting. These residues are predominantly the low-value species and smaller trees, which are generally less desirable than the alternative sources of wood available in a given area. Every forested region of the country contains large quantities of these untapped resources.

The vast majority of the unused low-value species and smaller trees are classified as poletimber and saplings with diameters of less than 9 inches for softwoods, or 11 inches for hardwoods. Preliminary Forest Service data show that about 53 percent of the Nation's commercial timber acreage is made up primarily of such small trees. In the Great Lakes region, almost three-fourths of the commercial timberland consists of small-diameter stands, while in both the South and New England regions these stands amount to about 61 percent of commercial timberlands. Meanwhile, in the Rocky Mountain and Pacific Coast regions, where larger tree species predominate, small-diameter stands make up only 29 and 30 percent of commercial timberlands, respectively.

Not only do small-diameter trees predominate on large portions of the Nation's commercial timberland, but often they exist in excessively thick clusters. For example, more than half of the commercial forest land in Maine and New Hampshire is overstocked, and unable to achieve optimum growth rates because of too many small trees.

Logging residues

The Forest Service estimate includes 160 million dry tons of above ground logging residues--branches, foliage, and portions of the main stem of trees felled and left behind after logging. The amount and characteristics of residues left on logging sites varies greatly, both within and between the major forested regions of the Nation.

On a site-by-site basis the largest concentrations of logging residues occur in some parts of the Pacific Coast and Rocky Mountain regions. Studies indicate that in the Douglas fir areas of western Oregon and western Washington residues on Federal forest lands may range from 50 to more than 250 tons an acre. On many sites in this area the residues are made up of large logs and other portions of defective old-growth trees. (See picture 1.) Virtually all these residues could be used for energy or reconstituted wood products. Also, as discussed in a previous report on Federal forest lands, some of these residues are suitable for making plywood and lumber. 1/

Our previous report also noted that residue amounts on Forest Service logging sites in western Montana were estimated to average more than 100 tons per acre. It was also estimated that 90 percent of this material was 4 inches or more in diameter at the small end. Forest service officials said that residues of this size were suitable for lumber, reconstituted wood products or pulp chips, depending on their quality.

Officials contacted in other regions said that amounts of residue left on logging sites in their areas were generally much smaller than those in the Pacific Coast and Rocky Mountain regions. While several factors may cause this difference, officials cited absence of large, highly defective old-growth trees and generally widespread processing plants using wood chips as two major reasons for smaller residue volumes. An

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1/"Increased Use of Felled Wood Would Help Meet Timber Demand and Reduce Environmental Damage in Federal Forests," B-125053, July 30, 1973.

(Forest Service photo)

LARGE LOGS AND PORTIONS OF OLD-GROWTH TREES LEFT AFTER LOGGING ON A TIMBER SALE AREA IN THE PACIFIC NORTHWEST.

exception occurs in areas such as portions of the Appalachian Mountains, where nearby processing facilities are limited and steep slopes complicate harvesting. Officials said that substantial amounts of residues are left on logging sites in these areas.

The Forest Service estimate of 160 million dry tons of available logging residues is based on amounts of residues created annually. It does not consider the inventory of logging residues which have accumulated where decomposition is slow, primarily in the Pacific Coast and Rocky Mountain regions. While inventory data has not been compiled, it is recognized that huge quantities of residue from past logging operations remain unused in these regions.

Rough, rotten and dead trees

The Forest Service estimate of unused wood residues available annually include 115 million dry tons of rough, rotten, and dead trees. Rough and rotten trees are live trees which

are considered unsuitable for producing saw logs because of their poor form or deteriorated condition. They are particularly prevalent in some areas of the country. For example, many New England stands have been harvested by periodically removing only the most marketable wood, leaving residual stands which contain an increasing percentage of rough and rotten trees. Timber stands in some parts of the region are clogged with these poor quality trees. In a 1972 survey the Forest Service estimated that in Vermont nearly half of all trees over 1 inch in diameter are rough or rotten. Many stands in Maine have up to a third of their timber volume in such trees. While these trees are considered poor quality for production of many forest products, they are a fine source of energy and reconstituted wood products.

Dead trees result from natural causes, such as fire, insects, disease, and storm damage. If salvaged before they decay, these trees are not only usable for energy, but are also good or better than some live trees for making lumber, plywood, and reconstituted wood products.

While mortality amounts vary by region, dead trees are a substantial source of wood residues in all parts of the country. According to preliminary Forest Service data, the amount of wood contained in trees which died during 1976 equaled over 31 percent of the total volume harvested as roundwood products on the Nation's commercial timberlands that year.

Annual mortality amounts are greatest in Oregon and Washington. Other western States such as California, Idaho, Montana also experience huge volumes of mortality each year. When combined with the generally slow decay rates in western forests, annual mortality results in huge stockpiles of dead wood. In 1977 the Forest Service estimated that between 210 and 280 million dry tons of dead wood had accumulated in the northern Rocky Mountain States of Idaho, Montana, and Wyoming.

States in other regions such as Michigan and Maine also experience large amounts of mortality each year. While total mortality amounts in the Great Lakes and New England regions are smaller than in western regions, they are extremely significant when compared with regional harvest levels. For 1976, Great Lakes region mortality amounted to about 83 percent of the volume harvested for roundwood products, while in New England mortality equaled about 64 percent of the region's roundwood harvest. Unlike the West, in these and other regions dead trees are subject to fairly rapid decay, which prevents any buildup of residue volumes. Rapid decay also necessitates timely salvage of dead material before it loses too much of its wood fiber content.

Processing residues

The Forest Service estimate includes 20 million dry tons of unused wood processing residues generated by sawmills, plywood mills, and other primary wood processing plants. These residues are in excess of those used by these facilities to generate process heat and electricity and also exclude those used as wood chips for making pulp and paper and reconstituted wood products, or as sawdust and bark for such purposes as landscaping.

Forest Service data indicates that substantial amounts of unused primary processing residues occur in all regions of the country, with the South accounting for about 39 percent of these residues. These residues are typically disposed of by burning or burying in landfills. They are, however, the most economically available of all residues, and the amount disposed of in this way is declining rapidly.

Residues from land clearing

Residues created by land clearing operations are a potentially large source of unused wood in some geographic areas. The Forest Service estimates that about 20 million dry tons of these residues could be available annually.

Residues from land clearing could be significant sources of wood for energy and products in such areas as southern New England (Connecticut, Rhode Island, and Massachusetts). The Forest Service estimates that in that area more than 85 percent of all timber removal from commercial forest lands results from land clearing and other nontimber production activities. According to the Forest Service, more than half of the timber removed is unused.

Urban residues

The remainder of the unused wood residues projected by the Forest Service--about 70 million dry tons--consists of residues from urban tree removals, building construction and demolition, and other urban wood sources. Data on the volumes of urban wood residues by region is unavailable, but it appears that volumes should vary with the size of the urban population in a given area.

IMPACT ON NATIONAL ENERGY GOALS

In April 1977 President Carter introduced a national energy program designed to reduce America's dependence on costly

foreign oil. This led to passage of five acts dealing with national energy policy (PL 95-617-621) on October 15, 1978, which according to the Secretary of Energy established a policy framework for decreasing oil imports. The Secretary said that two key elements of the energy policy were to

--replace oil and gas with abundant domestic fuels in industry and electric utilities, and

--build a base for developing solar and renewable energy sources.

The Nation's wood residues, being both abundant and renewable, could play a significant role in reducing dependence on foreign energy sources. For example, if the estimated 600 million dry tons of residues available annually were added to the wood currently used to produce energy, wood could meet over 14 percent of national energy needs and cut current U.S. oil imports in half. In addition, the huge stockpiles of unused western logging residues and dead and dying timber not included in the Forest Service estimate could meet another large increment of U.S. energy needs each year until depleted. This could help ease the short-term energy situation pending research and development of longer term energy technologies.

One attactive attribute of wood compared to other fuels is that it is available in quantity in many locations--including areas heavily dependent on petroleum and natural gas, such as New England and California. Wood-using facilities strategically located adjacent to local wood supplies could offset use of these fossil fuels in dependent areas as further discussed in chapter 3. Table 2 compares the heating value of wood with other fuels.

Using wood residues for products may also help conserve U.S. energy supplies, since these products can be substituted for more energy-intensive items made from such materials as steel and aluminum. One study, which considered extraction, processing, and transportation to consumers, found that steel floor joists require 50 times as much energy as comparable wood joists. 1/ The study found that aluminum framings for

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1/Report of Panel II, Structural Purposes, Committee on Renewable Resources for Industrial Materials, National Academy of Sciences/National Research Council, Renewable Resources for Structural and Architectural Purposes, 1976.

exterior walls and brick siding require 20 and 25 times as much energy, respectively, as their wood counterparts. Some Forest Service and forestry association officials believe that increased substitution of wood products for competitive materials offers even greater potential energy savings than using wood to produce energy.

Despite the stimulus provided by the legislation dealing with energy policy and the availability of proven wood burning technology, a number of factors combine to limit wood energy developments as discussed in subsequent chapters of this report. As a result, most wood residues remain unused and their vast energy potential untapped. Progress toward achievement of national energy goals suffers accordingly.

Table 2

Comparison of Heating Values of Wood and Other Fuels

Type of fuel	Weight of fuel needed to equal the heating value of one barrel of fuel oil a/ (pounds)
Bituminous coal	456
Sub-bituminous coal	507
Lignite coal	580
Dry wood	582-841 b/

a/Based on a 42-gallon barrel of No. 6 heavy fuel oil (2.7 percent sulfur).

b/Depends on species.

Source: Adapted from "Wood Fuels--How Do They Stack Up?", Forest Products Research Society Proceedings Number P-76-14, November 1976.

EFFECT ON TIMBER SUPPLIES AND WOOD PRODUCT PRICES

Timber supplies and product prices are of far-reaching significance to the economy, since forest products make up nearly one-fifth of all industrial raw materials consumed in the United States. 1/ The demand for timber was strong during the last decade, and studies have projected that, while demand for timber will continue to grow, commensurate expansion of timber supplies may be difficult. The Forest Service outlook is for increasing supply problems and substantial price jumps for all timber products.

Price increases for timber products historically have exceeded the general inflation rate. The Council on Wage and Price Stability reported that prices for all wood products rose by 10.4 percent annually between 1970 and 1976, compared to an average increase of only 6 percent a year for non-farm sector prices in general. Price increases for softwood lumber and plywood were even more dramatic, averaging 14 percent a year. Continued escalation of softwood lumber and plywood prices may severely impact housing and other types of construction, which use large quantities of these materials.

Greater use of wood residues for products could help extend timber supplies and moderate increases in product prices. Proven technology is available to convert residues to competitively priced reconstituted wood products, which can replace lumber, plywood, and other timber products in many applications. However, a number of factors currently inhibit widespread adoption of this residue use technology. (See chapters 3 and 4.)

IMPACT ON MANAGEMENT OF FOREST LANDS

Small quantities of forest residues -- logging residues, dead timber, and low-value trees--have little adverse impact on forest land. In fact, such quantities can be beneficial, serving as sources of seed, shade, and moisture for new trees and habitat for wildlife and, as they decay, adding nutrients to the soil. However, the large volumes of forest residues occurring on the Nation's forests create severe problems for landowners in managing their forest lands.

1/ The Outlook for Timber in the United States, Department of Agriculture, Forest Service, October 1973.

In the West, logging residues and dead timber cause a number of management problems which appear more sizeable on public lands; whereas in the East, low-value stands create substantial problems on public and private forests alike. The problems that forest residues create include (1) adverse effects of treating residues, (2) fire hazards, (3) loss of forest productivity, (4) wildlife impacts, and (5) forest aesthetics.

Adverse effects from treating residues

Forest residues are frequently disposed of or otherwise treated to reduce forest fire hazards and to improve access to harvest areas for reforesting, thinning, and other management activities. Residue treatment is common on many National Forests and other Federal forest lands, and is often employed on State and private lands as well. However, as discussed in our earlier report 1/, residue treatment on lands of some large private companies is less common because fewer logging residues are left on their lands after harvesting. Although the presence of younger, more healthy trees on private lands is a contributing factor, the companies are generally able to use more logging residues from their land because they consider the forest management benefits that would accrue to them from greater removal. This concept is further discussed in chapter 4 (p. 61).

The practice of treating logging residues varies geographically, but the decision on whether the residues will be treated and how it will be done is generally based on the amount of residues left after harvesting. If large volumes are left, the residues are usually treated by fire or through a combination of mechanical methods and fire. If lesser amounts are involved, the material may be crushed or chipped with heavy equipment and left to decay.

In parts of the West, for example, large volumes of logging residues are left in clearcut areas after harvest of large, mature, and over-mature timber. In some cases, the residues are treated in place through a practice commonly called broadcast burning. This is an intentional burning of the residues, in which fire is set to spread over all the harvest area. In another treatment approach used on many harvest areas, the largest pieces of residues are first moved into large piles with the equipment used for

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1/"Increased Use of Felled Wood Would Help Meet Timber Demand and Reduce Environmental Damage in Federal Forests," B-125053, July 30, 1973.

harvesting the merchantable logs. This practice is commonly called yarding or piling of unmerchantable material. (See picture 2). The piles are then often burned and the rest of the harvest area may also be broadcast burned to eliminate the remaining logging residues.

Burning residues creates its own problems. First, it can represent a significant forest fire hazard. During broadcast burning, burning of piled logging residues, or burning of other forest residues, the fires occasionally escape and spread to adjacent stands. These forest fires damage the timber resource and may also damage other resources, such as wildlife and watersheds.

For example, in one western region, 13 of the 17 large forest fires (over 100 acres burned) which occurred during the first 9 months of 1979 were caused by fires escaping from controlled burning of logging residues. One of these fires burned over 3,000 acres destroying timber with an estimated value of $4.5 million. An additional $2 million was spent in suppressing the fire. Another example involved the escape of an early-1980 controlled fire in the Forest Service's Eastern Region. Intended to burn logging residues in preparation for replanting and to develop habitat for an endangered bird species, the fire consumed about 25,000 acres of brush and timberland, killing one person and destroying over 40 homes and buildings.

Forest Service officials in the Pacific Southwestern region said that in recent years they have been able to contain escaped residue treatment fires before they became larger. However, they noted that large and destructive fires occurred in earlier years, and that the potential for such fires always exists when burning residues.

A second problem arising from burning logging residues is the adverse impact on air quality. Residue burning releases large quantities of particulate matter, degrading the aesthetic quality of the air through reduced visibility and offensive odors. Also, researchers are now concerned about potential health problems from such burning since suspected carcinogens have been found in the smoke.

Increased removal of logging residues in lieu of burning may become necessary to comply with air quality standards. Rules are currently being promulgated by EPA that could limit burning of logging residues in rural areas.

(Photo courtesy of Rocket Research Company)

LOGGING RESIDUES PILED IN A PORTION OF A FOREST SERVICE TIMBER HARVEST AREA IN THE PACIFIC NORTHWEST REGION.

A final problem with residue treatment is its expense. While the costs of treating logging residues vary from area to area, Forest Service officials told us that costs can be substantial. Although specific cost data is not routinely compiled, a Forest Service estimate showed that at least $120 million was spent in 1978 for residue treatment on National Forests. The highest costs are incurred in the West because of the larger volumes of logging residues. In one western Forest Service region, officials estimated that it costs an average of $900 per acre to yard or pile unmerchantable material in the major timber producing section of the region, and that this practice is employed on about 90 percent of all clearcut timber sales there. Using these estimates, the region would have spent about $37 million in fiscal year 1979 for yarding or piling unmerchantable material on clearcut timber sales in that part of the region alone. The region would have incurred other costs for broadcast burning some of the harvest areas and treating residues in other areas.

Fire hazards

If logging residues are not treated or if dead trees accumulate on forest lands, they can cause severe fire hazards. The damage caused by a forest fire and the cost to suppress it can be significantly affected by the amount of such residues in the path of the fire. Considerably more damage and greater costs can be incurred in areas where large volumes of such residues are present.

For example, in September 1967 a forest fire in Idaho advanced 16 miles in 9 hours, claimed 2 lives, threatened several communities, and destroyed more than 50,000 acres of valuable timber and watershed. A mobilized force of several thousand men, combined with favorable weather, were finally able to control the fire. The intensity of the fire and the difficulty of controlling it were attributed largely to dead wood that had accumulated over the years from insect-and disease-killed trees in the area.

In another example, the momentum of a 7,700-acre fire in a National Forest in Oregon in 1973 was attributed to untreated logging residues. A 1977 Forest Service report for the region in which Oregon is located stated that an estimated one-half of the region's fire protection and suppression costs of $40 million were due to untreated logging residues and other accumulated dead wood.

The Forest Service has reported that stepped-up efforts to increase residue use could greatly reduce associated fire hazards.

Loss of forest productivity

Forest residues can cause a loss of forest productivity by hindering rapid reforestation after logging and by tying up land that could be devoted to faster growing, more valuable trees.

Logging residues can delay reforestation by hindering the seeding or planting of an area. The degree of hindrance depends on such factors as the amount and distribution of the residues, steepness of slope, and the extent to which the residues have been treated.

The logging residues occupy surface area, making it unavailable for seeding or planting. The surface occupied may be a large part of the total on some old-growth stands or may be a minor part after close utilization of healthy young growth. Even when residues are treated to reduce fire hazards and ease replanting, significant areas may remain unavailable for planting because no treatment method eliminates all residues. One report co-authored by a Forest Service researcher stated that perhaps 10 percent of the harvest area in the South was unavailable for planting even after the area had been treated.

Treatment of logging residues is necessary in some cases before tree planting can be accomplished. When burning of the residues is the recommended treatment method, planting delays may occur because the burning cannot always be done the same season that the logging is completed. For example, burning can be done only when certain climatic and other conditions can be met. In some areas, burning days may be severely limited in the spring because of the rapid transition from snowpack to severe forest fire weather. In addition, fall burning can be limited because of early rains. Smoke management restrictions can further limit burning. Therefore, several years may pass before an area can be burned and planted.

Overall productivity of the Nation's forests--especially in the East and the Pacific Coast region--is severly reduced because vast acreages of forest lands are stocked with inferior tree species or low quality trees, whose annual growth represents little volume or value. These lands are capable of producing much more. This would, however, require (1) cutting out poor-quality trees to improve growing conditions for the remaining potentially commercial trees or (2) clearing the land, planting it with desirable tree species, and then managing the new stand of timber.

As an example of the significance of the low-value tree problem, invasion of southern pinelands by unwanted hardwoods is considered by many forest managers in the South to be one of their major forest management problems. The invasion problem occurs over most of the 73 million acres of southern pinelands, and the hardwoods are conservatively estimated to have a volume of over 1 billion dry tons. The hardwoods are slow growers because the sites are not right for them, and they are often scarred, crooked, or otherwise defective. They occupy space better suited for the pine and are a detriment to the pine's growth. Clearcutting of hardwoods, followed by planting with pine, would make the land much more productive.

Another example of loss of productivity involves more than half the commercial forest land in Maine and New Hampshire, which is overstocked and unable to achieve optimum growth rates because of too many small trees. A 1979 forest industry report noted that hardwood stands in Maine experience "slow net growth, characteristic of the existing overstocked, low quality stand condition which has resulted from a lack of markets for low grade material." The report concluded that forest productivity in Maine could be improved by thinning these stands, and that energy uses may offer a market for the low-quality material removed.

Wildlife impacts

Forest residues in the form of low-value timber stands also create problems for wildlife. Many of these stands are overstocked with trees, which limits the growth of plants and shrubs on the forest floor. Various forms of wildlife need this growth for food and shelter. Thus, the stands need openings to allow sunlight to penetrate and thereby stimulate forest floor growth. Selective harvesting of the overstocked trees could create such openings.

Forest aesthetics

In many cases the residues left on timber harvest areas after logging can have a negative and long-lasting effect on the visual qualities of the forest landscape. Many people consider logging residues an aesthetically unpleasant contrast to the natural environment. In some parts of the country, where decomposition is slow, the disorderly appearance of the residues may persist for many years before the material deteriorates or is camouflaged by new vegetation. Reducing the amount of logging residues through improved utilization could improve the aesthetics of harvest areas.

CHAPTER 3

LACK OF INVENTORY DATA, HANDLING EQUIPMENT, INVESTMENT CAPITAL, AND ACCEPTED TECHNOLOGY OFFER MOST SIGNIFICANT BARRIERS TO RESIDUE USE

During our review we identified numerous barriers or potential barriers to greater use of wood residues for energy and products. While the nature, extent, and significance of many of these barriers differ among the various regions of the country, we identified four barriers which transcend regional boundaries and appear to have a significant effect on residue use nation-wide. These barriers are

- --inadequate data on the volume, location, accessibility, and availability of forest residues;
- --lack of economical and effective equipment for harvesting and transporting residues;
- --lack of investment capital needed for harvesting and using residues; and
- --limited awareness and acceptance of wood energy and product technology among industrial firms, utilities, and State and local bodies.

Reducing these barriers through more concerted efforts at the Federal level offers perhaps the most clearcut opportunity to stimulate greater use of wood residues for energy and products.

INADEQUATE DATA ON FOREST RESIDUES

Widespread interest in forest residues is a fairly recent development, having its origin primarily in the higher energy costs of the last decade. Before that, forest residues were deemed to have little or no value and were not adequately considered in assessing the Nation's wood resources. As a result, adequate inventory data on forest residues was never obtained. Despite the growing importance of residues, this condition persists.

Wood resource inventories are primarily a Forest Service responsibility. Under existing law the Forest Service conducts ongoing surveys of all Federal, State, county,

municipal, and private forest lands. The forest surveys employ statistical methods to estimate the wood resource based on measurement of sample plots.

Numerous Federal, State, and private officials have concluded that the forest surveys do not provide adequate data on forest residues. Shortcomings in the surveys frequently cited were that they do not (1) measure the total biomass in a tree, (2) include all trees and woody shrubs, (3) cover all forest land, (4) adequately measure logging residues and dead timber, (5) provide data for geographical units below the county level, and (6) indicate the accessibility and availability of forest residues.

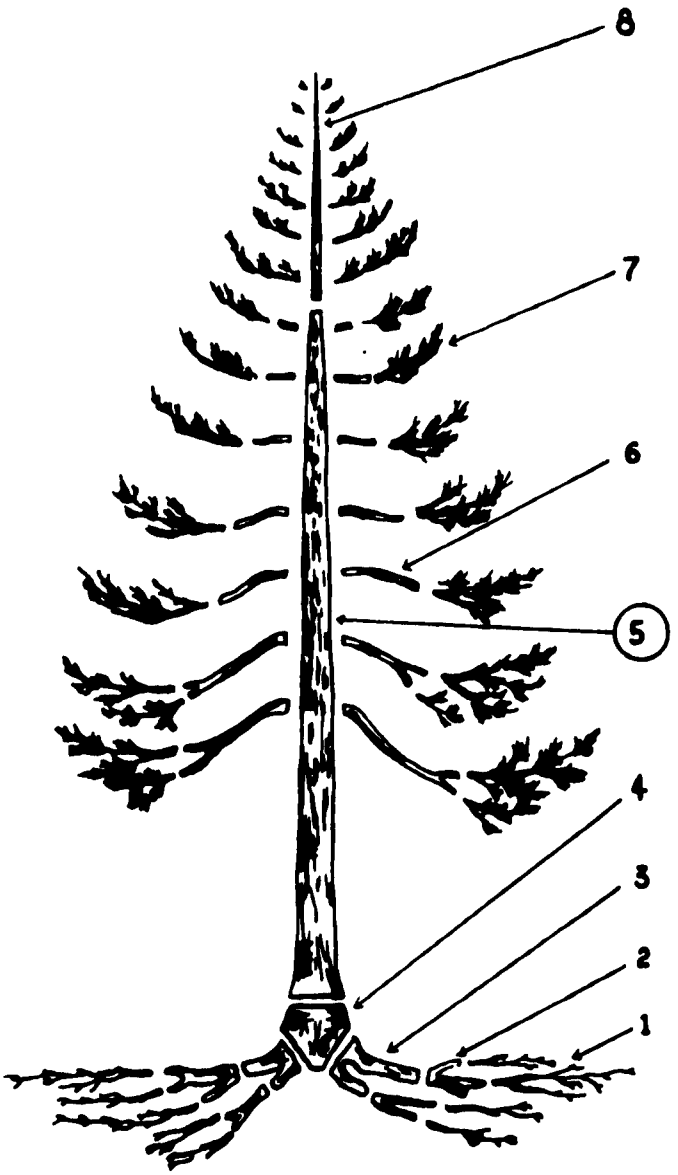
Total tree biomass not measured

Perhaps the foremost criticism of the forest survey process is its failure to measure the total biomass of a tree. The survey focuses only on what has historically been the "merchantable" portion of the tree--the main stem from above the stump to a minimum 4-inch-diameter top (or to where the main stem breaks into limbs). The merchantable stem of a typical softwood tree is shown in figure 1, along with the "nonmerchantable" roots, stump, side branches, top, and foliage, which are excluded from forest survey measurement.

Reliable data on the relationship of merchantable and nonmerchantable portions of trees of all species and sizes is not available. However, rough estimates indicate that the nonmerchantable portions of a tree such as the one shown in figure 1 may account for 30 percent or more of its total biomass. These portions are just as useful as the merchantable stem for producing energy or reconstituted wood products and represent a significant omission in forest survey projections of the wood resource.

Not all trees and woody shrubs measured

In addition to measuring only a portion of a tree's total biomass, the forest survey is also selective in terms of the types of trees and shrubs measured. First, it generally excludes all woody plants or shrubs which either lack a well-defined central stem or fail to reach more than 12 feet in height at maturity. Second, it overlooks all trees which are not considered to be of commercial species suitable for industrial wood products. Finally, it does not measure trees of commercial species which are less than 5 inches in diameter.



1 Roots less than 1 inch in diameter
2 Roots 1-4 inches in diameter
3 Roots larger than 4 inches
4 Stump
5 Merchantable stem (4-inch top diameter)
6 Branches larger than 1 inch
7 Branches smaller than 1 inch
8 Unmerchantable stem

FIGURE 1. COMPONENTS OF A TYPICAL SOFTWOOD TREE. (ADAPTED FROM WOOD WASTE FOR ENERGY STUDY, STATE OF WASHINGTON, DEPARTMENT OF NATURAL RESOURCES, 1978, p. 58.)

The above factors may result in sizeable quantities of residues being omitted from the forest survey projections for a given geographic region. For example, millions of tons of brushy mesquite and chaparral trees in Texas and California are not included. Likewise, while the survey indicates that over 57 million acres of commercial forest land in the South are stocked predominantly with commercial trees less than 5 inches in diameter, the volume of wood in these smaller trees is unmeasured.

Not all forest lands covered

Forest Service statistics for 1977 show that of the more than 740 million acres of U.S. land area classified as forest land, the agency considers only abut 488 million acres (65.9 percent) as commercial forest land for inclusion in the forest survey process. Of the remaining forest land the Forest Service excludes about 24 million acres because they are public lands withdrawn from timber utilization by statute or administrative regulation or are under study for possible wilderness designation. Another 23 million acres in the interior of Alaska are considered too inaccessible for commercial harvesting, and the remainder, some 205 million acres (28 percent) of U.S. forest land, are excluded as unproductive.

Unproductive forest land is defined as land which is incapable of producing at least 20 cubic feet of industrial wood per acre per year. Industrial wood means all roundwood products except roundwood used for fuel. This definition excludes some lands which produce large volumes of wood each year, but not of a type which is traditionally considered suitable for removal as industrial wood. However, such non-industrial wood can be used in production of energy and reconstituted wood products.

As a result of the rather arbitrary 20-cubic-foot standard and the roundwood product standard, the wood resources on more than a quarter of the Nation's forest land are unmeasured. Most of this land is located in the West, with nearly every western State accounting for several million acres. While growth of trees suitable for industrial wood is less on these lands, they may still offer an important source of wood for energy or reconstituted wood products.

Logging residues and dead timber not adequately measured

The forest surveys do not adequately measure either residues left after logging or dead timber on unlogged areas. In some regions of the country, these two categories of residues

represent the best opportunities to obtain concentrated volumes of wood for energy and products.

The forest survey only provides an estimate of logging residues created in a given State during the year in which the survey is taken. It does not indicate the total volume of residues which remain on harvest areas in the State at a given time. In many areas where decomposition is slow, an important statistic is how much unused logging residue has built up over the years. The forest survey does not address this critical question. In addition to this major defect, the logging residue estimate derived from the forest survey represents only those residues from the merchantable main stem portion of the tree, and also excludes all residues from rough and rotten trees, tree species considered noncommercial, and trees less than 5 inches in diameter. These excluded portions can account for the majority of the residue volume on some harvested areas.

For dead timber, Forest Service researchers themselves note that forest survey inventories are fragmented and inconsistent. The survey measures "salvable" dead trees, which are considered currently or potentially merchantable by regional standards. In the northern Rocky Mountain area the Forest Service arbitrarily defines salvable dead trees as dead trees of commercial species, 11 inches or more in diameter, at least 25-percent sound, and containing at least one merchantable 16-foot log. Such definitions may exclude vast amounts of dead timber. For example, researchers estimate that the forest survey projection of salvable dead timber in the northern Rocky Mountain region may represent only one-third to one-fourth the total volume of dead wood in that area.

Data below county level not provided

Yet another criticism of the forest survey data on wood residues is that it cannot be broken down into useful geographical units or groupings. Survey data is available only for an entire State, or for a county within a State. This presents problems for those who would like to use survey data to assess the residues available in part of a county or in an area which may include portions of more than one county. Forest boundaries, topography, transportation corridors between forest and potential residue markets, and other variables dictate the need for resource data covering geographical areas that seldom follow county lines.

The usefulness of countywide data may also vary among States because of the differing sizes of counties. For example, several Oregon counties have more than four times the total area and forest area of the largest and most forested counties in Vermont.

Residue accessibility and availability not indicated

A final shortcoming of the forest survey data is that it indicates neither the accessibility nor availability of forest residues. Accessibility relates to the potential ease with which the residues can be harvested and removed. Survey data sheds no light on questions such as:

--Are the logging residues in a given area distributed randomly over each logging site, or have they already been concentrated in large piles near the access roads?

--How much of the dead timber in a given area can be reached by existing road systems?

--Is the terrain in a given area gentle enough for harvesting stands of low value species using whole-tree chippers and chip vans?

Availability of forest residues hinges on ownership of the forest lands and the owner's willingness to sell wood materials. The need for data on availability of residues is more serious on private lands, particularly those of smaller, nonindustrial landowners. In 1977 the Southern Regional Working Conference on forest research concluded that refining the inventory data to show volumes actually available on private land is the highest priority resource appraisal need.

Vermont offers a good example of the availability problem. Some 77,300 landowners hold about 90 percent of the State's commercial forest land, averaging about 52 acres each. Studies indicate that some of these owners are adamantly opposed to any harvesting on their land. Others may lack initial capital for selective harvesting to upgrade their timber stands, or may be unwilling to invest their capital when part of the economic return will not be realized for many years. Meanwhile, other owners may have definite plans to harvest all or part of their forest land within the next few years.

Failure to consider the attitudes and intentions of private landowners makes forest survey data of limited use in assessing residue availability. In a current draft report we note that lack of such information also prevents Federal programs for stimulating harvesting of nonindustrial land from being directed to those most likely to use them.

Limited steps to upgrade survey data

The Forest Service has recognized the shortcomings of its forest survey data in light of the growing interest in the

various types of forest residues, and is taking some tentative steps to expand the survey from its narrow focus on merchantable material to a wider view of the wood resource. However, these steps are limited and are not guided by an overall plan for comprehensive improvement of forest survey data on residues.

The forest surveys are the responsibility of seven regional forest and range experiment stations. In the absence of a national plan for improving survey data on residues, each experiment station is deciding what steps it will take, if any. For example, one station responsible for surveying seven States in the South has funded research at universities which should result in total tree biomass tables for several Southern tree species by the end of 1980. The station hopes to begin using this data in its 1981 surveys, and station officials believe this will allow them to make "ballpark" projections of timber inventories on a total-tree basis (excluding root systems). Another experiment station responsible for surveys in Pacific Coast States is taking a different approach by planning to obtain data for noncommercial forest lands in California. Station officials believe this represents the most pressing need to upgrade survey data. Meanwhile, they stated that, in light of current efforts, it will be many years before they will be able to project commercial timber inventories on a total biomass basis.

While some experiment stations have taken limited steps to upgrade survey data on wood residues, the Forest Service has made little or no effort to address survey shortcomings on a national basis. The agency has not evaluated the feasibility of expanding its nationwide resource projections to include total tree biomass, noncommercial tree species, commercially unproductive lands, trees less than 5 inches in diameter, all logging residues, and all dead timber. It has not considered the feasibility of subdividing county projections, particularly those for large counties, into logical units based on wood-using facilities and/or population centers, transportation corridors, geographical features, or other factors. A Forest Service headquarters inventory official told us that inventory data below the county level is "site-specific" and, along with data on accessibility and availability of resources, should be obtained by consultants rather than by the forest survey.

In sharp contrast to the inventory official's comment on obtaining resource availability data, two experiment stations view this alternative more favoraly. One station has initiated a program to contact owners of forest survey sample plots to determine their intentions concerning management of their land and sale of timber. Officials of the second station said they were waiting to see how useful the results of this new effort are before deciding whether to make such

studies themselves. The contrast between experiment station interest in availability data and the views of the headquarters official points up the lack of an agency-wide plan for improving forest survey data.

LACK OF ECONOMICAL AND EFFECTIVE EQUIPMENT FOR HARVESTING AND TRANSPORTING RESIDUES

A major barrier to using forest residues for energy and products is the relatively high cost of harvesting and transporting the small, scattered, or low-value timber that comprises these residues. Various types of logging equipment are available for harvesting forest residues. Most of this equipment is, however, designed for piece-by-piece harvesting of the larger and/or more valuable trees found in conventional timber sale areas. As a result, the equipment cannot, under a variety of conditions, be used to harvest forest residues economically. Although new technology is evolving for harvesting forest residues, it is developing slowly. The slow rate may, in part, be due to limited Federal efforts to develop new equipment and to restrictive Federal patent policies.

Equipment available or under development

The slope of the ground is a major factor governing the type of equipment used for harvesting timber. (See figure 2). On gentle slopes ground-traversing equipment can be used, whereas on steep slopes sophisticated cable systems are needed.

On flat ground or gentle slopes, loggers typically use mobile mechanical tree fellers to shear off small and modest-sized trees. They use hand-operated equipment, such as chain saws, to fell the larger trees. Once felled, the trees are dragged singly or in bunches to an area called a landing. Equipment used to perform this function includes rubber-tired skidders and tracked vehicles. The logs at the landing are then loaded onto a truck or chipped by a chipping machine and the chips blown into a van. (See figure 3.)

On steeper slopes, where ground equipment cannot operate efficiently or safely, diesel-powered cable systems may be used to transport the logs to the landing. A cable is stretched between two points and the logs then dragged or carried along the cableway. Two main types of cable logging systems are high-lead and skyline, as shown in figure 2. Transporting the logs to a landing by a cable system is generally two to five times more expensive than ground skidding.

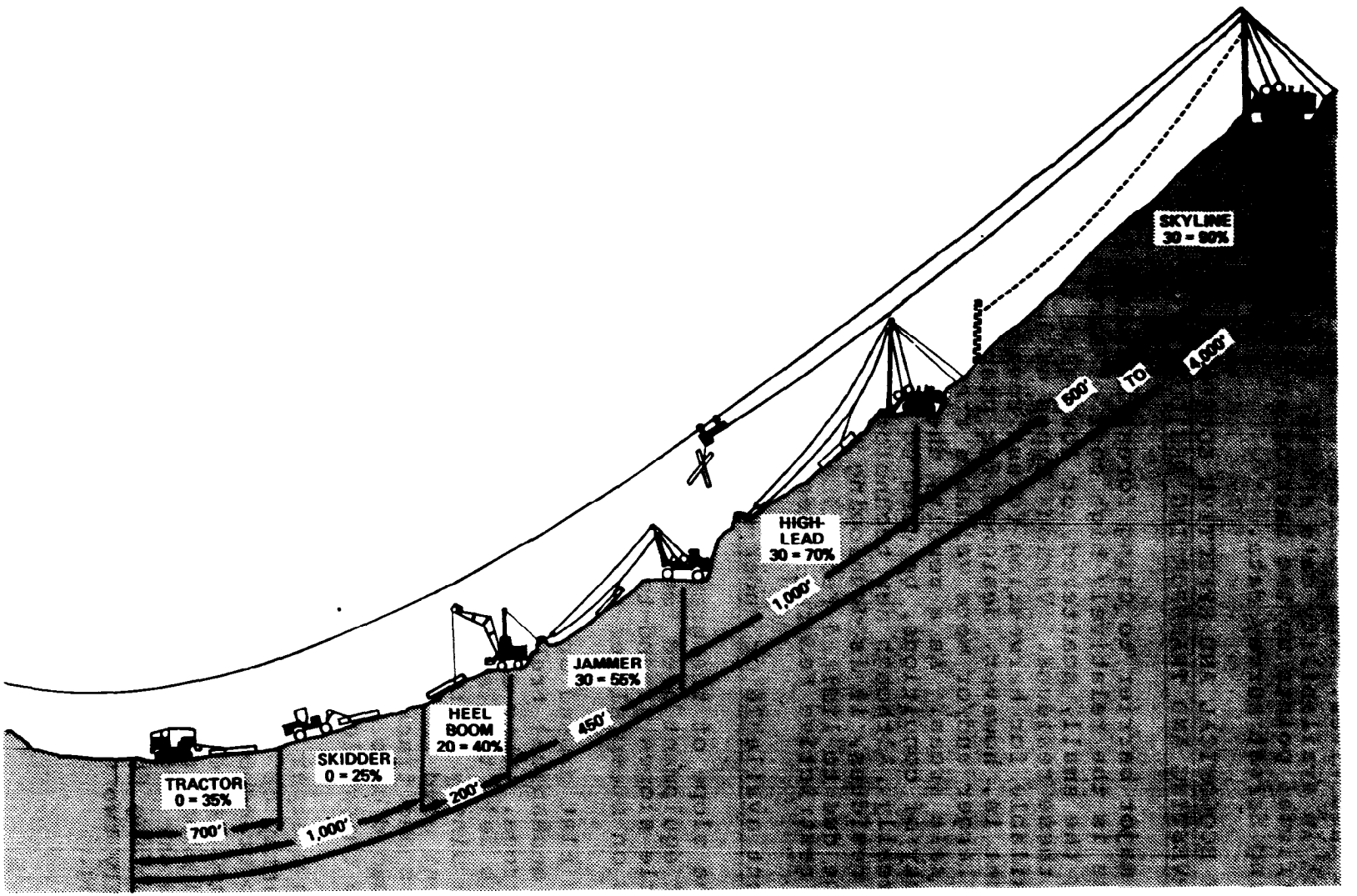


Figure 2. Common timber harvesting equipment. (Adapted from figure provided by the Forest Service)

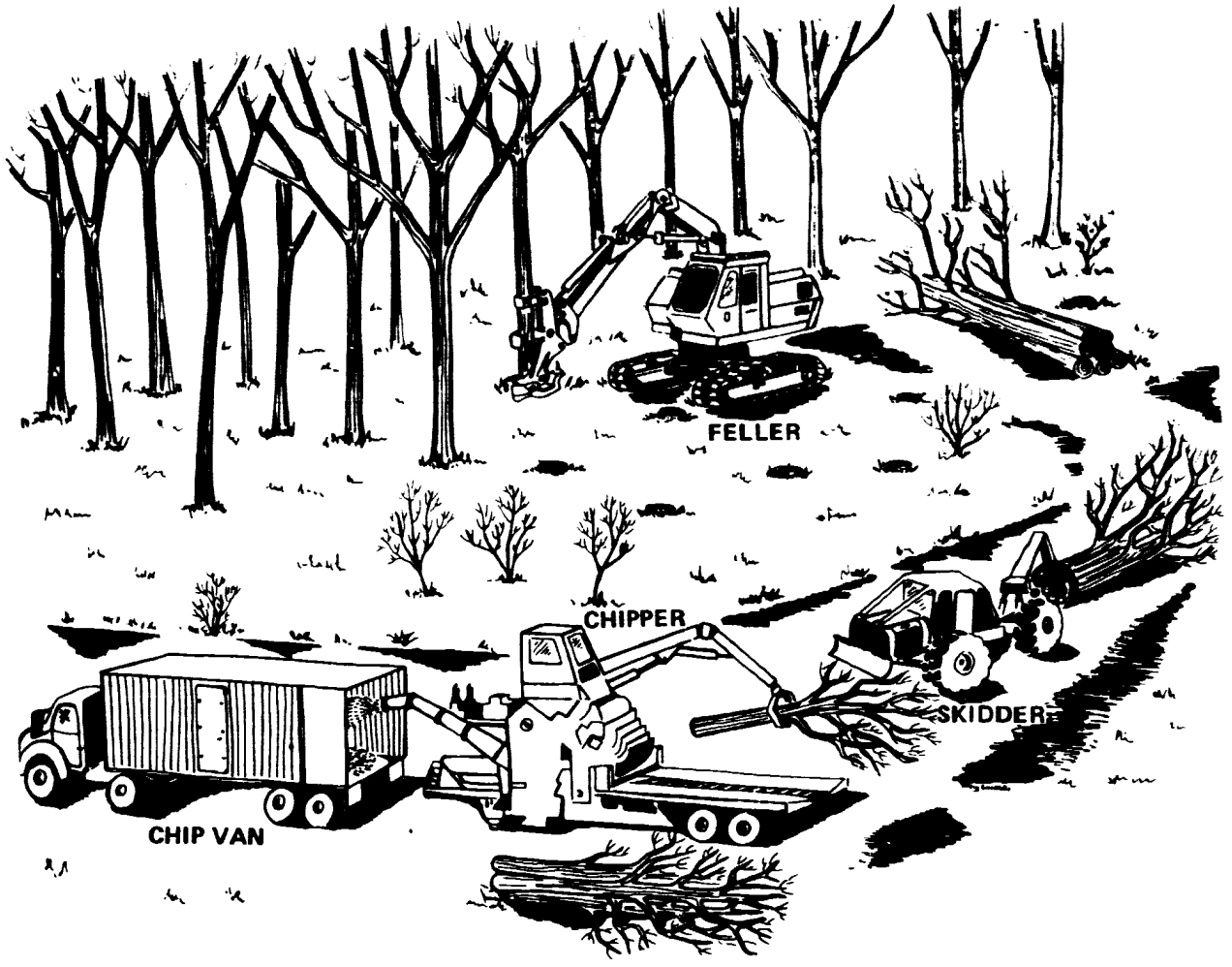


FIGURE 3. TYPICAL EQUIPMENT FOR HARVESTING FOREST RESIDUES ON GENTLE TERRAIN. (FIGURE PROVIDED BY THE FOREST SERVICE)

Some new types of equipment are being developed that could be used for harvesting forest residues. For example, a mobile machine is being developed that fells small trees, pulls the trees into chipping blades, and blows the chips into a companion vehicle following behind. (See figure 4.) The machine is designed to operate on gentle slopes and would eliminate the need for piece-by-piece handling of logging residues or small standing trees. Other pieces of equipment being developed include another type of mobile chipper, and cable systems designed to more economically yard small logs.

Limited Federal efforts to develop, demonstrate, and assist commercialization of new equipment

Development and commercialization of new harvesting and transportation equipment has progressed slowly. Even successful efforts to develop equipment take considerable time. For example, when field demonstrations are completed prior to commercialization of the mobile chipper discussed above, about 5 years will have elapsed since Forest Service researchers showed it to be a feasible concept.

Many Federal, State, and private officials we visited said that a greater effort is needed by the Federal Government to develop and demonstrate new residue harvesting and transportation equipment. Some indicated that this could best be accomplished in cooperation with private industry. They said that, although new technology is being developed, a faster rate is needed in view of the importance of wood as a potential energy source. They cited development and demonstration of equipment capable of economically cutting trees and transporting logs and other pieces of wood on steep slopes as a major need. We also believe that the Forest Service could assist in commercialization of equipment developed under an accelerated cooperative development program.

The Forest Service is the major Federal agency involved in developing and demonstrating forest residue harvesting and transportation equipment. The Forest Service conducts this work through two equipment development centers and some of its experiment stations under the research program. Forest Service budget data shows that it is using only a small percentage of its research and development budget to develop and demonstrate equipment for harvesting and transporting forest residues. In fiscal year 1980, the agency allocated only $345,000 out of the development centers' total budget of $3 million for forest residue purposes. Likewise, it allocated only $2.4 million out of its $108.8 million research budget for research relating to residue harvesting and transportation.

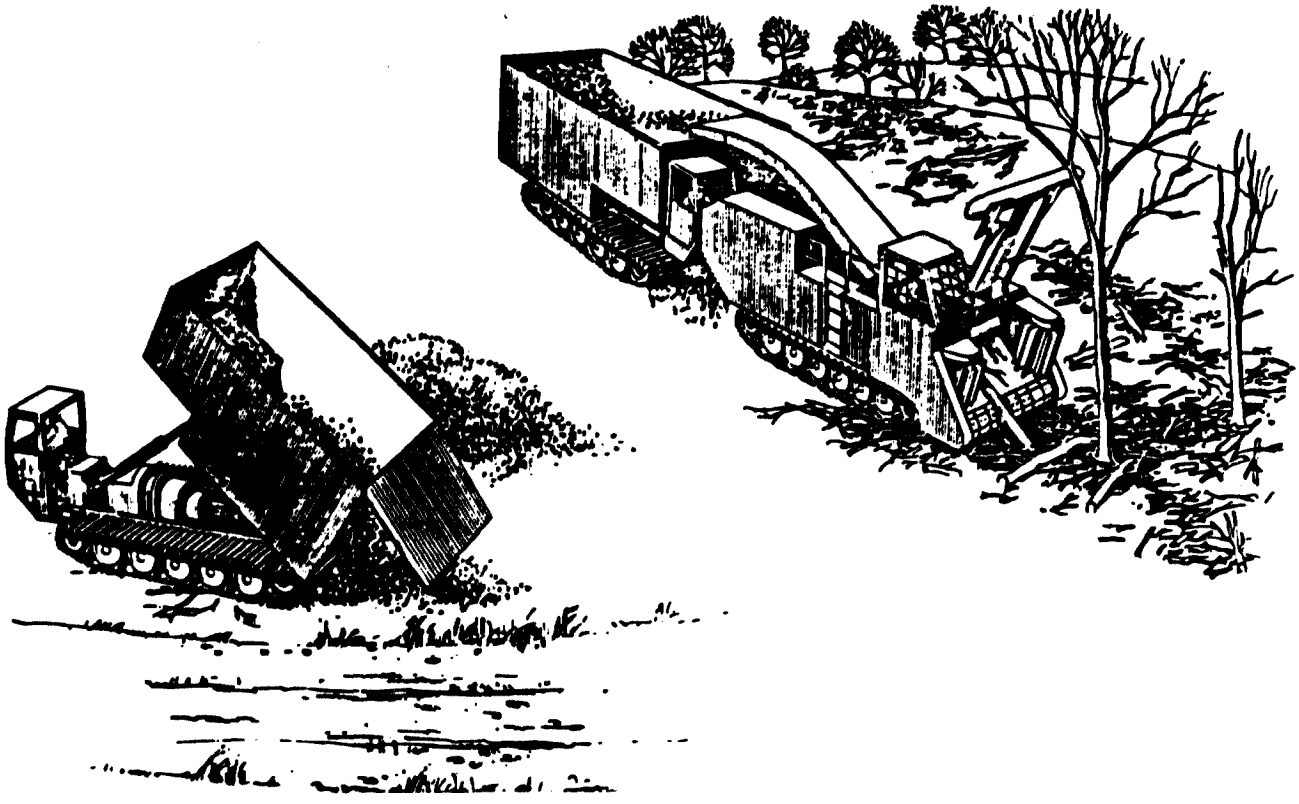


Figure 4. Mobile chipper converts residues to chips and companion chip forwarders deposit them in roadside inventory piles. (Figure provided by the Forest Service.)

Although improved residue-handling equipment may be vital to greater use of wood residues for energy, the Department of Energy has provided only negligible support for development of such equipment. Despite its multi-billion dollar budget, we noted only one instance in which DOE provided such support--in the amount of $230,000--as part of a cooperative effort involving the Forest Service and several private companies to develop one piece of equipment.

Some Forest Service officials told us that additional funds should be provided to expand development and demonstration relating to residue harvesting and transportion problems and that additional appropriations may be needed for this purpose. For example, the principal researcher involved in developing and demonstrating the mobile harvesting, chipping, and

transportation equipment shown in figure 4 said that major technology advances are needed and that this could best be accomplished by creating several teams of engineers and materials experts. He suggested that each team would look at equipment problems in a given area of the country and establish clearly and narrowly defined goals for solving the problems. An equipment concept would be developed and the concept tested through a laboratory bench model, with the results being used to conceive a prototype. The Forest Service and possibly other Federal agencies would enter into a cooperative agreement with an equipment manufacturer and potential users of the equipment and all three would contribute capital to cover the design, manufacture, and field trials of the equipment. The researcher said that this approach was used for the development of the mobile harvesting, chipping, and transportation equipment.

We believe implementing such an approach could require substantial increases in the funds allocated and personnel assigned to develop and demonstrate harvesting and transportation equipment for forest residues. Since improved equipment may hold the key to major increases in the use of wood residues for energy and products, increased investments appear to be warranted. The Forest Service, as lead agency in equipment development, should intensify its efforts to encourage private investment in development of residue harvesting and transportation equipment, and where necessary, provide additional funds by allocating a larger share of its research and equipment development and test program budgets for this purpose.

In addition, because of DOE's responsibility for accelerating the use of alternative energy forms, it should cooperate with the Forest Service in developing and demonstrating equipment and, when needed, provide the Forest Service with funds. Such an approach relating to the Nation's helium resources was recommened in our report to the Congress entitled, "Unique Helium Resources Are Wasting: A New Conservation Policy Is Needed" (EMD-78-98, March 7, 1979). The report recommended that the Congress establish a new financial plan under which conservation expenses associated with storing helium for energy technology purposes would be funded by DOE appropriations.

In addition to pursuing an expanded and accelerated equipment development program, we believe the Forest Service could assist in the commercialization of equipment developed under the program and could encourage private sector cooperation by granting either title to the invention patents or an exclusive license for further development of the equipment to a private firm when needed to achieve commercialization. Forest Service officials believe, however, that current

law would prevent them from granting exclusive licenses to encourage rapid commercialization of equipment developed under an expanded program.

In testimony before the Senate Committee on the Judiciary in commenting on Senate Bill 414 which was introduced to establish, among other things, a consistent patent policy concerning inventions developed with Federal assistance, we stated that Federal patent policies are often too restrictive in the granting of titles or exclusive licenses and that, as a result, the commercial development of some inventions has been slowed or not accomplished at all. To stimulate commercial development, we supported the bill which would have established uniform procedures under which certain organizations could obtain title to inventions developed through Federally-supported research and which would have established uniform authority to grant exclusive licenses of Federally-owned inventions with a provision of "march-in-rights." The "march-in-rights" provision would assure that if a firm was not diligently pursuing commercialization the license could be withdrawn and assigned elsewhere.

We believe the Forest Service should request the necessary legislation which would authorize the agency to grant title to invention patents or exclusive licenses whenever this is clearly needed to encourage full commercial development by cooperators.

LACK OF INVESTMENT CAPITAL FOR HARVESTING AND USING RESIDUES

The investment capital required to harvest and use residues offers another major barrier to greater residue use. The equipment needed for harvesting and transporting forest residues is expensive. Similarly, the equipment or facilities used for burning wood residues as a fuel or for manufacturing reconstituted wood products represent sizeable investments. Because of such high capital requirements, some companies and individuals have not purchased harvesting and transporting equipment or have not converted to wood energy or wood products facilities. In a related problem the owners of woodlots have been unable or reluctant to invest in upgrading and managing their forest lands. They cited lack of capital or incentives to do so as the primary cause. These problems are further discussed in the following sections.

Lack of capital may limit investments in wood residue harvesting and transportation systems

Equipment for harvesting and transporting forest residues is expensive to buy. This high capital cost appears to limit investments in or use of such equipment for forest residues.

A system suitable for felling, bunching, chipping, and delivering forest residues may require investments of $500,000 or more. Cable systems for steep slopes usually require even larger investments. The mobile harvester and chipper under development (see figure 4, p. 33) is estimated to cost $470,000, including its companion equipment.

Some forest managers told us that such high costs are deterring investments in or the use of equipment for harvesting and transporting forest residues. For example, Forest Service field managers in the South told us that the largest volumes of logging residues on their lands occur in the Appalachian Mountains. Some of the officials said that since the Appalachians are an economically depressed area, many loggers do not have the financial resources to purchase residue-handling equipment and financial institutions are unwilling to loan funds to them. Similarly, even when a logger can finance the purchase of residue harvesting equipment, he may choose to buy equipment to harvest merchantable timber rather than residues. The logger may believe that he can realize a higher return if he uses his equipment for harvesting merchantable timber. For example, a timberharvesting specialist in the West said that logging contractors interested in purchasing forest residue harvesting equipment generally decide that the equipment investment is too high in relation to the low value of the product and seek other, less risky logging activities.

To make investments in forest residues equipment more attractive, the State of Georgia Forestry Commission has proposed an amendment to the Energy Tax Act of 1978 (P.L. 95-618) to allow tax credits for logging contractors who invest in equipment to collect, harvest, and deliver forest residues for energy. The State of Georgia Forestry Commission adopted a resolution calling for an amendment to the act, which currently allows such credits only for companies investing in facilities using alternative energy sources. In adopting the resolution, the commission reported that an incentive for contractors to purchase residue harvesting equipment is vital to the success of wood as an alternative energy source.

Other suggestions to lessen the financial burden include (1) making low-cost loans for purchasing equipment and (2) developing less costly equipment through an expanded development and demonstration program at the Federal level.

Lack of capital may limit investments in wood energy and wood products facilities

Even when equipment is available to harvest and transport residues, either a wood energy or wood products facility must

be available to use the residues. Both types of facilities are expensive and require considerable capital to construct. These high capital requirements have slowed the pace of building wood energy and wood product facilities.

Wood energy facilities

Equipment that burns wood as a fuel includes many different kinds and sizes. Some systems are used for direct heating or drying, whereas others are used to heat water to steam in a boiler. The steam produced may be used for such purposes as heating, drying, or producing electricity.

The investment capital required for a wood-fueled system is generally about three to four times that of a comparable oil or gas system. The extensive fuel preparation and handling system required for solid fuels, such as wood and coal, as compared to liquid and gaseous fuels, accounts for much of this cost difference. A wood-fueled system will, however, generally cost no more than a comparable coal system.

The costs of wood-burning systems vary considerably depending on the size of the system and its components, but even small systems are expensive. For example, a system with a small boiler (producing 10,000 pounds of steam an hour) would generally cost in excess of $500,000. On the other end of the scale, a system with large boilers (producing 500,000 pounds of steam an hour) would generally cost more than $30 million.

Adding a turbine generator to a wood-fueled system to produce electricity increases the cost. A system capable of producing 55 megawatts of electricity is estimated to cost $55 million. A 55-megawatt plant is considered the practical size limit because of the logistics and economics of handling wood fuel. Such a plant can consume up to 95 tons of wood an hour, depending on the moisture content of the wood. In addition, wood fuels generally must be transported to an electric powerplant by truck as opposed to other fuels, such as coal and oil, which may be carried by train, ship, or pipeline. As a result, a wood-fueled system may not enjoy the economies of scale that can be realized by building larger facilities using other fuels, such as coal-fired power plants which are capable of producing up to 1,000 megawatts. A State of California study concluded, however, that several small wood-fueled plants strategically located to use local wood residues could compare favorably in cost with a large, coal-fired facility.

Alternative fuel systems may be added to wood-fired facilities as a hedge against potential disruptions in the wood supply. Designing a system to include alternative fuel capability does, however, increase the cost of the facility. For example, a facilitiy designed to burn both wood and coal would need more expensive air pollution abatement equipment in many areas because of the high sulfur emissions produced by combustion of coal.

Many companies consider the high capital costs of wood energy systems and the difficulty of obtaining financing for such systems as a major barrier against converting to wood fuel. For example, a State of Michigan survey showed that many wood products companies could not afford to convert to wood fuel because of the capital outlay required. A State official involved with the survey said that lack of capital is an especially significant problem for medium- and small-sized companies.

In another example a study by a New England college concluded that lack of available capital is a major constraint to converting to wood-fueled boilers in that region. The study noted that banks hesitate to make loans for wood-boiler conversion and deal only with companies that have proven financial stability and can afford a loan with a short-term payback. We contacted two wood products firms in the New England area that had plans to convert to wood-fueled systems and found that both were having difficulty obtaining financing.

High capital requirements may prevent many companies or institutions from converting to wood fuels, in particular smaller entities which may lack adequate investment capital. However, some smaller entities are fortunate enough to obtain investment capital under favorable financing arrangements. Illustrating the latter, a small university in the South is converting its natural gas heating and cooling system to wood fuel, with a Federal grant funding most of the cost. Another example is a small, municipally owned electric company in New England which is planning to fund a wood-fueled electric plant by issuing bonds authorized by city voters.

As these examples show, some financial incentives currently exist that can encourage the use of wood fuel. The Energy Tax Act of 1978 provides one such incentive: a 10-percent investment tax credit for businesses investing in facilities which use a fuel other than oil or gas. Publicly owned utilities have an incentive to build wood-fired electric plants because they can finance construction by issuing tax-

exempt revenue bonds. Thus, they generally pay lower rates of interest than a private utility or company that borrows from a financial institution or issues taxable bonds. Finally, Federal grants provide incentives for conversion to wood fuels. Federal grants may be obtained if wood energy facilities are intended to result in energy conservation at institutions or if their construction will increase employment and development in urban areas.

While some incentives are available for converting to wood-fueled facilities, Federal, State, and private officials or representatives to whom we talked believed that current incentives were too small or had only limited application. The officials made several proposals on how the Federal Government, and in some cases State governments, could assist in reducing the the high capital costs. One tax-related proposal suggested that taxing bodies at the Federal and State level allow wood-fueled equipment to be depreciated over a shorter time. A shorter depreciation period would reduce the amount of taxes paid during the first years of the investment. Another tax proposal would increase the 10-percent Federal investment tax credit for alternative fuels. Suggested amounts for the increased credit varied, some recommendations being as high as 50 percent. Some suggested that those States with income taxes also allow an investment tax credit.

Outside the tax-related areas, one proposal recommended that Federal and State governments make long-term, low-interest loans available on a wide-scale basis to companies or institutions for financing conversions to wood fuel. Under a similar proposal the Federal Government would insure or guarantee loans that financial institutions make for such conversions. Finally it was suggested that the Federal Government or State governments make grants available on an expanded basis to companies and institutions. Grants were considered to be most appropriate for entities that are not subject to income taxes and which, therefore, would not be eligible for benefits from tax credits or other tax incentives.

Wood products facilities

Wood residues can be used for manufacturing many reconstituted wood products that can compete with traditional timber products. The processes used to manufacture the products primarily include chipping or flaking the residues, adding resins and wax, and then forming the mixture into sheets under intense heat and pressure. The products include COM-PLY lumber (see p. 52), which equals or exceeds the performance of sawn lumber, and particleboard roof decking (see p. 53), which

can be substituted for steel decking normally used in commercial buildings.

Larger capital investments may be required for facilities producing reconstituted wood products than for those producing traditional wood products. More processing is required to convert residues into a product than to saw logs into lumber or to peel logs and laminate the peeled wood to make plywood. Complex and expensive equipment is needed to convert the residues to particles, to align and orient the particles, and to glue and form the particles into a product. Likewise, newer processes may initially have higher capital costs because of the technological problems that are usually met. As an example of cost differences, the estimated cost of a typical factory for manufacturing COM-PLY lumber is more than $17 million, which a Forest Service research official estimated to be several million dollars more than for a comparable mill producing sawn lumber. He said, however, that the higher capital costs would be offset by lower costs for the wood raw materials and by less waste in the process.

The greater cost of facilities producing reconstituted wood products is apparently one reason why the forest products industry has been slow in building such facilities even though it appears residue-based products can compete with traditional products in terms of quality and price. For example, the project leader for developing COM-PLY lumber said that company representatives cited the high factory capital cost as a major reason why they had not taken any action on this new product line.

We visited one company that was interested in manufacturing COM-PLY lumber, and the owner confirmed that high capital costs are a major consideration in his decision on whether to build a COM-PLY plant. In addition, he said that, since the plant would be the first commercial plant of its kind, banks are willing to loan construction funds only through a lien on his existing sawmill. This would limit his line of credit needed for sawmill operations. High capital costs, combined with these unsatisfactory financing terms, have made the owner reluctant to build the plant. At the time of our visit, he had not decided whether to go ahead with construction.

Federal, State, and private officials we talked to made several proposals to help firms overcome the high capital costs of new wood products facilities which closely paralleled those of proposed wood energy facilities (see p. 39). Low-interest, long-term Government loans or Government-backed loans were most often cited as the preferred course of action.

Lack of capital and incentives may limit management and upgrading of small woodlots

Privately owned forest land other than forest industry land comprises the largest portion of the Nation's commercial forest land, referred to in Table 1 as nonindustrial land. The major portion of the nonindustrial land is in small ownerships averaging about 75 acres, with the majority located in the eastern half of the country. These small woodlots generally contain low-value trees; if properly managed they could produce much more.

Table 3

Ownership of Commercial Timberland
January 1977

Owner	Million Acres	Percentage
Public	137	28
Industry	68	14
Nonindustrial	283	58
	488	100

Source: U.S. Forest Service.

About 4 millions people own the nonindustrial private forest land. These owners represent a variety of backgrounds and financial makeups. Some are farmers and others include housewives, doctors, lawyers, and other occupations, or retirees. Many of the owners in this diverse group either do not have the financial resources to invest in managing their forests for timber production or do not have any incentive to do so. The cost for management practices such as planting or thinning are considered to be expensive to some because they have limited capital available. Others have the financial resources to manage their forest land, but choose not to for reasons such as better opportunities to use their funds elsewhere, lack of understanding about the forest's potential for production, or a preference for alternative uses of their land.

The Federal Government, as well as some State governments and private companies, has programs to increase the productivity of nonindustrial private forest lands. The Forestry Incentives Program is a major Federal program of this type. The

current program was established in fiscal year 1975 and provides Federal funds for cost-sharing with nonindustrial owners for tree planting and timber stand improvement work. As of September 30, 1979, Federal cost-sharing payments of about $45 million had been made to increase timber production on 1.25 million acres of private forest land. However, this acreage represents less than 1 percent of the total nonindustrial private forest lands.

Another program, the Rural Forestry Assistance Program, provides Federal funds to State forestry agencies to assist them in giving technical advice to nonindustrial private forest owners. In fiscal year 1979 about $3.6 million in Federal funds were provided for reforestation and timber stand improvement on about 168,000 acres, and for harvesting 186 million cubic feet of wood. An additional $4 million was spent under this program to improve the utilization of wood on forest lands in general and in manufacturing facilities.

The 96th Congress considered a bill that would have provided additional funds for cost-sharing and providing technical advice. Senate bill 1775 was introduced in September 1979. It would have provided up to $100 million annually for Federal cost-shares to nonindustrial forest landowners for forest improvement practices to increase the production of wood for energy. Also, the bill would have authorized grants to State forestry agencies for additional foresters to provide technical assistance to forest landowners in producing wood for energy.

Despite numerous Government and privately sponsored programs, there has not been a substantial increase in timber productivity on nonindustrial private forest lands. The causes of program failure were analyzed in our draft report entitled "New Means of Analysis Required for Policy Decisions Affecting Private Forestry Sector," (EMD-81-18, December 31, 1980). The report discusses potential changes in Federal tax policy and landowner assistance efforts to make them more responsive to actual wood production potential on the nonindustrial lands.

LIMITED AWARENESS AND ACCEPTANCE OF WOOD ENERGY AND PRODUCT TECHNOLOGY

Many officials said that lack of awareness and acceptance of wood energy and product technology on the part of industry, utilities, and State and local bodies is a major barrier, if not the major barrier, to more widespread use of wood residues.

Although wood was once the dominant fuel in America, today's industrial firms, utilities, and State and local bodies are generally not aware of wood energy technologies. Increased awareness will not suffice, however, because potential users are unwilling to accept such technologies as viable alternatives to more common fuel systems without demonstration of their benefits and reliability. In addition, forest products industry awareness and acceptance of some newer technologies involving reconstituted wood products has been slow in coming.

Wood energy technology

Outside the forest products industry--and to some extent even within the industry--knowledge of wood energy technology is limited. In a recent wood energy overview, the Georgia Institute of Technology identified lack of knowledge about available wood energy equipment and its costs, reliability, and risks as the primary barrier to widespread use of wood fuel. The institute concluded that "the industrial sector will be slow to accept wood systems if they aren't assured of a reliable and economically feasible technology."

Officials of the California energy commission said that attitudes of industries, utilities, and governmental bodies were perhaps the greatest barrier to increased use of wood and other biomass. They characterized the prevailing attitude in the State as "inertia," or resistance to changing from familiar liquid and gaseous fuels to solid fuels, such as wood. They said that many potential wood users consider wood energy technologies to be unproven and high-risk investments. To overcome industry inertia, in September 1979 the California Legislature established a $10 million revolving fund to help finance energy production demonstrations using forestry and agricultural residues. California officials hope that the fund will result in enough examples of successful residue energy facilities to reduce the risk as perceived by potential wood users in the State.

While the State of California is active in this area, many officials stressed the need for greater Federal efforts to demonstrate and promote wood energy technologies. Such efforts are needed to stimulate more widespread awareness and acceptance among industry, utilities, and State and local bodies of technologies that have already been proven in forest products industry applications. Such proven technologies generally involve direct firing of boilers using wood pieces or chips, sawdust, and bark. Efforts are also needed to increase awareness and acceptance of emerging technologies, such as burning of densified wood materials or products of wood

pyrolysis and gasification. While most of these emerging technologies have been successfully employed in pilot plant operations or in full-scale operations at a few sites, their adaptability to varying requirements of potential users must be shown.

Our review showed that Federal efforts to support demonstration of wood energy technologies among industry, utilities, and State and local bodies are minimal. Meanwhile, capital improvement programs for Federal facilities, while offering a potentially important vehicle for demonstrating wood energy technologies, are not being used for this purpose. Finally, we found that Federal efforts to promote wood energy technology by disseminating educational materials and providing technical assistance are limited.

Federal support of demonstrations at industrial, utility, and State and local facilities is minimal

The Department of Energy is responsible for implementing Federal energy policies aimed at replacing oil and gas with abundant domestic fuels and building a base for developing renewable energy sources. The Forest Service is responsible for ensuring a high-level output of wood resources from Federal forests and promoting output of wood resources from other forest lands. As such, both agencies have a major stake in demonstrating and promoting use of wood energy technology which can create a market for unused wood residues. However, despite this mutual interest the two agencies' total funding for wood-burning demonstration projects at industrial, utility, and State and local facilities was only about $1.5 million in fiscal year 1980. In comparison to the respective DOE and Forest Service overall 1980 research, development, and demonstration budgets of $3.8 billion and $108.8 million, funding for such wood-burning demonstrations seems minimal.

We could identify only five instances nationally in which DOE or the Forest Service provided funds during fiscal year 1980 to help plan or implement demonstration of wood burning technology at industrial, utility, or State and local facilities. Two of these involve demonstration of wood-fueled heating systems at a State hospital in Georgia and at a State prison facility in Colorado. The other projects involve (1) a proposed cogeneration facility to produce process heat for a Wyoming wood products firm as well as electricity for the local community, (2) a wood-fired utility generating plant in Vermont, and (3) a feasibility study for a geothermal-wood electrical generating plant in California.

The California study involves the bulk of of the Federal demonstration funds--nearly $1 million from DOE and $300,000 from the Forest Service. The proposed project offers a unique combination of low-temperature geothermal steam and wood residue fuel to power a 55-megawatt generating plant. The plant would use geothermal steam to dry the residues, which in turn would be burned to raise the temperature of the steam for efficient electricity generation. The State would use most of the plant's output to help meet the energy needs of its water-pumping facilities and the remainder would be reserved for local communities. A regional Forest Service official said the project is extremely important because it could demonstrate the feasibility of the geothermal-wood concept and possibly pave the way for developing the many low-temperature geothermal sites in the West. He noted that a large percentage of these sites are located in or adjacent to forested areas where wood residues are available.

Despite the potential importance of the California geothermal-wood project, both the number and scope of demonstration projects involving DOE or Forest Service funds appear inadequate to effectively increase awareness and acceptance of wood energy technology among industry, utilities, and State and local bodies.

Federal capital improvement programs do not aid demonstration of wood energy technology

Federal agencies, through capital improvement programs for their facilities, can play an important role in demonstrating use of wood energy technologies to private concerns and State and local bodies. Many heating plants or powerplants at Federal facilities could have the potential to use wood or wood-derived fuels for all or part of their energy needs. Many are located in or adjacent to areas where vast quantities of unused wood residues exist. However, we found that capital improvement programs at four agencies contacted--the Department of Defense, the Department of Energy, the Forest Service, and the General Services Administration--have done little to demonstrate wood energy technologies. While the four agencies have over 6,000 installations throughout the country, many with their own heating/powerplants, only one of these was using wood fuel at the time of our review and only four more were scheduled for conversion to wood fuels.

Although the agencies have established policies which call for conversion of their heating/power facilities from oil and natural gas to alternative energy sources, in most cases

coal is the only alternate energy source given serious consideration. Wood fuels are seldom given adequate evaluation in planning capital investments for these facilities. The following discussion of wood energy planning and utilization at each agency demonstrates the need for standard methods to evaluate wood energy use in Federal heating/powerplants.

Department of Defense--The Department of Defense (DOD) is the largest single energy consumer in the Nation, maintaining over 4,000 installations comprising more than 300,000 buildings. Many of these facilities have heating/powerplants and are located in regions of the country where forest resources and wood residues are plentiful. As a result DOD is perhaps the Federal Government's best vehicle for testing and demonstrating wood energy technologies.

The Office of the Deputy Assistant Secretary of Defense for Energy, Environment, and Safety has overall responsibility for DOD's energy policy. The Office has established a defense energy program policy which sets goals for improving energy efficiency, reducing dependence on critical fuels, and increasing use of alternative energy resources. Alternative energy resources covered by the policy include coal, geothermal resources, solar and wind energy, and biomass fuels, such as wood. The short-run goals for DOD installations emphasize conversion to solid fuels and mention both coal and biomass. However, GAO found that in implementing this policy the military services are predominantly looking to coal and giving little serious consideration to wood fuels. Evaluation of the potential for using wood fuels has been made at only a few of the more than 4,000 DOD installations. In some cases even when wood fuels have been evaluated, such evaluations have been limited and/or little action has resulted. These problems are discussed below.

--In implementing DOD energy policy the Air Force has specified that all new facilities under its heating plant conversion/construction program will be designed with coal as the primary fuel. Only one Air Force installation utilizes wood fuel and thorough evaluation of wood fuel potentials has been made at only six other installations. These evaluations were made under a 1978 study of the feasibility of using trees grown on Air Force installations to replace fossil fuels currently being used to heat the installations. The study included an evaluation of the heating plant modifications required to convert to wood fuel. Focusing on six installations which encompassed 94 percent of all forest lands under Air Force management,

the study showed that four of these installations could meet a significant portion of their energy needs by using their supplies of nonmerchantable wood. One installation has the potential for supplying all of its own heating energy needs plus those of a nearby base. The study concluded that harvesting this wood for fuel would be consistent with forest management practices designed to optimize the production of merchantable timber, improve wildlife habitat, and protect the environment. The study found that one of the six installations has a central heating system which could be adapted to burn wood fuel by installing a boiler with wood-firing capability. The other installations, which have dispersed heating systems, could be converted to wood fuel by either installing central heating plants with wood-fired boilers or by installing wood pyrolysis units to produce liquid and gaseous fuels suitable for the existing heating systems. The study concluded that the technical feasibility of the pyrolysis units needed further demonstration. As of March 1980 more than 1-1/2 years had elapsed since the study was completed, but no positive steps had been taken toward demonstration of wood energy technologies or realization of wood energy opportunities at any of the six installations.

--Prior to 1960, Navy installations used coal extensively and the Navy is now encouraging a return to coal to combat rising costs of oil and natural gas. As of our review, no Navy installations were using wood fuel for their heating/powerplants, although one installation was scheduled for conversion to wood in fiscal year 1982. While a Navy facilities official told us that fuel conversion studies incorporate wood and other biomass fuels as well as coal, our review of a conversion study at one facility, the Puget Sound Naval Shipyard in Bremerton, Washington, revealed a failure to give serious consideration to wood.

A shipyard official said that the Puget Sound Naval Shipyard is the largest energy-consuming Federal facility in the Northwest. With an average oil consumption of about 200,000 barrels a year, the facility could afford an excellent opportunity to demonstrate wood energy technology while helping reduce oil imports. It is also located adjacent to an area having extensive forest resources and wood-processing facilities. In December 1979 the Naval Facilities Engineering Command completed a feasibility study on a capital

improvement project to replace the shipyard's oil-fired central heating system. The study concluded that a coal-fired central heating plant should be constructed and that future capability to burn both wood wastes and refuse-derived fuel should be provided. Although the possible use of wood was mentioned in the study report, our review of the report and our discussions with project officials showed that no serious consideration was given to wood residues as a primary fuel. Failure to evaluate wood fuels in depth is particularly questionable in light of the shipyard's unique situation discussed above.

--An Army facilities official said that the Army is oriented mainly to coal conversion, but also considers biomass fuels. At the time of our review 24 Army installations were using coal, while none were using wood fuels. Also, potential fuel conversion opportunities at 44 installations identified by the Army included only four instances involving wood or combined wood and coal systems. Construction funds had been approved for two of these wood-related projects.

Department of Energy--As the lead Federal agency for energy policy matters, DOE is responsible for stimulating development and demonstration and use of technologies based on renewable energy sources. A DOE facilities official told us that agency policy is aimed at conversion of its largest heating/powerplants to alternative fuels. At the time of our review DOE was involved in conversion studies at 18 such facilities from among its more than 800 installations. The official said that while the studies consider all potential alternative fuels, coal is generally the most economical choice.

We reviewed the results of one study which considered the feasibility of using pelletized wood as an alternative fuel supply at a DOE Facility in Richland, Washington. The study was prompted largely by concern over potential uses for 1.5 million acres of dead timber located in a nearby area of the State of Oregon. The study, dated October 1979, concluded that the cost of pelletizing and delivering the wood exceeded the delivered cost of coal, making use of wood fuel uneconomical. The study indicated, however, that wood pellet and coal prices should be monitored and the option of firing wood pellets be revived if a change in cost dictated an economic advantage. Based on these conclusions DOE-Richland decided against using wood fuel. The study's conclusions were based solely on the economics involved for DOE's facility, and did

not consider the benefits which could accrue on thousands of acres of Forest Service lands, where dead trees represent a severe fire hazard. Similarly, the study did not consider the potential value of wood burning as a demonstration project to increase confidence in alternative fuel technologies.

Forest Service--In overseeing the protection and development of the National Forest System and State and private woodlands, the Forest Service has numerous responsibilities important to wood utilization. In recent years the agency has recognized a need for a national wood utilization program to improve forest land management through the commercial use of wood for pulp and paper, reconstituted wood products, and energy. It has assisted some wood-burning demonstration projects in the private and State and local governmental sectors and has an overall policy to consider wood as one alternative for fuel conversion at its own installations, which total some 20,000 buildings. However, at the time of our review no Forest Service installations were using wood for primary heating, although the agency planned to use wood to heat a laboratory in Kentucky.

A Forest Service facilities official indicated that many of the agency's structures are relatively small (7,000-8,000 square feet) and that converting such buildings to solid fuel heating systems is capital intensive. He said that the Forest Service will not make fuel conversions unless they are cost effective over a reasonable payback period. In determining cost effectiveness the Forest Service considers only the direct benefits to the facility. It does not consider potential forest management benefits or the value of a conversion in demonstrating wood fuel technology and thereby stimulating greater awareness and acceptance of wood fuels in furtherance of agency goals for improving wood utilization.

General Services Administration--The General Services Administration (GSA) controls nearly 10,000 buildings, many with their own heating and/or power systems. GSA buildings are located in every region of the country with extensive forest resources. While GSA Policy calls for consideration of all alternative fuels for conversion of its heating/power facilities, most conversions are to coal. GSA facilities officials told us that wood is considered a very minor fuel and they were not aware of any facilities for which potential wood use had been studied in detail. As of our review no GSA facility was using wood to meet even part of its energy needs.

The large number of buildings operated by the above agencies should present many opportunities for conversion to wood fuels.

A canvass of facilities located in forested regions of the country is needed to identify wood conversion opportunities. Also, the Forest Service and DOE need to develop standardized methods for evaluating wood energy use governmentwide to assure consistency in life-cycle energy evaluation when considering conversion.

Federal promotion of wood energy technology is limited

Federal action to promote wood energy technology among industry, utilities, and State and local bodies occurs more frequently than Federal support of demonstration projects in these sectors. Yet overall Federal efforts to promote technology by disseminating education materials and providing technical advice are limited; in some regions of the Nation they appear insignificant in relation to widespread promotional needs and opportunities.

DOE's efforts to promote use of wood for energy are primarily carried out through contract with private energy research bodies. Staff at DOE regional offices also provide some promotional services, but since the regions have no budget for such wood energy functions, their promotional efforts are sporadic and extremely limited.

The main thrust of DOE's contracted promotional work involves a small program that the Solar Energy Research Institute (SERI) in Golden, Colorado, started in December 1978. The planned approach of the SERI wood residue commercialization program is to conduct informational seminars in several regions of the country and to develop technical publications that might assist industrial firms to convert to wood energy. A program official said that the program's limited funding--around $130,000 a year--restricts it to offering general advice at seminars and providing publications rather than giving specific technical assistance to individual firms that might be interested in wood. The official estimated that through January 1980 the Federal Government had spent no more than $1 million on all its outreach programs to promote wood residues for energy, and said that much larger expenditures would be needed to accelerate conversion to wood fuels.

The Forest Service, through its State and Private Forestry (S&PF) Division, carries out most other Federal efforts to promote use of wood fuel by industry, utilities, and State and local bodies. Other Forest Service personnel under the National Forest System may reply to requests for limited advice or available data, but only S&PF staff engage in direct promotional activities.

Our review showed that S&PF promotional activities in the wood energy area are quite limited in all regions of the country. Only in one region, the South, is an S&PF staff member assigned to promoting wood energy full time. Even though the staff member is available full time, his outreach efforts are modest compared to the widespread promotional needs and opportunities in the 13-State region he must cover.

Promotional activities in other regions are even less imposing. In a 20-State area covering the northeastern part of the country, no staff member was assigned specifically to wood energy promotion at the time of our review. Promotion in that area is generally limited to providing educational materials to State forest management agencies. In the large western area covering 17 States, S&PF personnel were available at a few widely dispersed locations to answer requests for information or advice, but again no staff was assigned full-time to wood energy responsibilities. The Forest Service is considering funding at least one full time position for wood energy activities in the western area, and an S&PF official in California told us such full time promotion is badly needed to help overcome bias against wood fuel.

Wood product technology

Some officials believe that wider use of wood products in place of more energy-intensive materials represents wood's greatest potential contribution to achieving national energy goals. Reconstituted wood products made from residues offer not only significant energy savings over non-wood competitors, but can play an important role in extending timber supplies and moderating price increases, thereby increasing the attractiveness of all wood products relative to alternative materials. However, despite their potential value, the forest products industry has been slow to embrace commercial production of some residue-based products which employ new technologies developed through Forest Service research. Officials responsible for developing these technologies said that a major part of the problem is inadequate promotion. They believe that greater Federal promotion is needed to increase industry knowledge and acceptance of newer products made from residues. In addition to greater promotion, we identified a need for the Federal Government to use other means to stimulate rapid commercial production of residue-based products derived through Federal research. The Government could take action to assure maximum flexibility in its patent policies and to establish procurement policies and practices which might help accelerate commercialization of such products.

Federal promotion is minimal

Federal actions to promote reconstituted wood product technologies developed through Forest Service research have been minimal. The inadequacy of such actions is apparent in the case of two newer products, COM-PLY lumber and particleboard roof decking.

Researchers at the Forest Service's Southeastern Forest Experiment Station in Georgia developed COM-PLY (or composite) materials in the mid-1970s to be used interchangeably with conventional lumber and plywood. They designed these materials specifically to tap unused wood supplies, such as processing residues, logging residues, and particularly unused timber in the vast hardwood forests of the East and South. COM-PLY lumber represents a more efficient way to utilize timber. In conventional sawing some of the strongest, stiffest wood from the outer portions of a log are wasted as slabs and edgings, while weaker, more defective wood from the center becomes lumber. In COM-PLY lumber production, however, the strong outer portions of the log are used for facing strips while the inner log is ground up to make a particleboard core. The facing strips are then sandwiched around the core material and the entire unit is bonded together to form lumber as shown in figure 5.

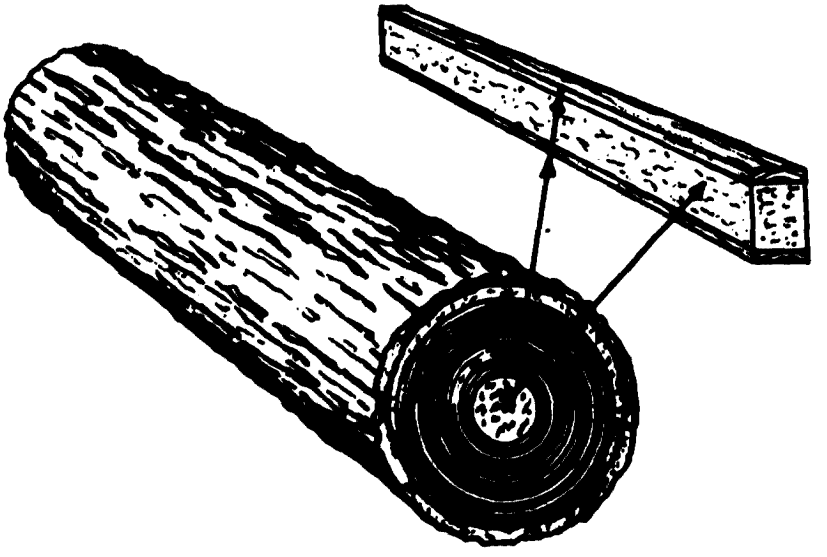


FIGURE 5. THE COMPLY CONCEPT. OUTER LOG PORTIONS ARE USED AS FACING STRIPS AND INNER PORTIONS FORM A PARTICLEBOARD CORE.

Compared to conventional lumber, COM-PLY lumber is uniformly stronger, stiffer, and straighter. A study also showed that COM-PLY can be cost competitive with conventional lumber and offer an acceptable rate of return on investment. However, commercial production of COM-PLY lumber has yet to be realized. As of March 1980 only one forest products firm was seriously evaluating possible production of COM-PLY lumber, but it had not reached a decision on whether to go ahead with plant development.

The head research official responsible for developing COM-PLY lumber said that a much greater promotional effort is needed to spur commercial development. He said this effort should include informational seminars and direct technical assistance to interested firms. He indicated that he is the only one available for such activities and only on a limited basis because of ongoing research responsibilities.

Another example of a reconstituted wood product technology yet to be adopted by industry is heavy-duty structural particleboard, which can be used for roof decking in industrial and commercial buildings. An appealing aspect of this residue-based product is its ability to substitute directly for more energy-intensive, ribbed-steel roof decking. Particleboard roof decking, as developed by a university researcher under contract to the Forest Service's Forest Products Laboratory, is designed specifically to employ unutilized, low-value hardwoods found throughout the eastern United States. Studies have shown that it is as strong as ribbed-steel decking and is cost competitive. The studies concluded that a market exists for particleboard roof decking and that it can be produced profitably.

The university researcher who designed particleboard roof decking said that the product has yet to be adopted by industry in the 2 years since he developed it. He said that particleboard roof decking has excellent potential but needs to be promoted effectively throughout the forest products industry. He said that only 10 percent of his time is available to promote it and that the Forest Products Laboratory has done little to promote it beyond publishing research results.

More aggressive Forest Service actions to disseminate information and provide technical assistance in promoting residue-based products developed under its research program are clearly called for. At the same time the Forest Service and other Federal agencies have additional measures at their disposal that could hasten commercial development of such products. These additional measures involve Federal patent and procurement policies.

Additional means of stimulating commercialization have not been used

The Forest Service and other Federal agencies have not employed patent or procurement policies as means of stimulating more rapid commercialization of wood residue products. With the proper authority, the Forest Service could help stimulate commercialization of a technology developed through its research program by allowing a private firm to have an exclusive interest in commercial development of the process while the Government retains title to the patent. We advocated such exclusive licensing in our May 1979 testimony on a bill before the Senate Committee on the Judiciary with provision of "march-in rights" to assure that if the firm is not diligently pursuing commercialization the license could be withdrawn and assigned elsewhere.

According to the Forest Service, amendment of current law is necessary to use the exclusive licensing approach to maximize the incentive for private firms to begin commercial production of residue-based products. We believe the agency needs to request amending legislation and take any other actions needed to adopt policies which can stimulate commercialization when private development would otherwise be delayed.

Federal procurement policies can have a significant impact on commercialization of new products. If a new product has an opportunity to obtain a share of the sizeable market represented by Federal purchases, its viability is greatly enhanced. Federal consideration of wood residue products could help assure prospective manufacturers of an initial market and thereby help stimulate commercialization.

We found that Federal procurement policies do not give sufficient attention to residue-based wood products. Such policies generally require that energy conservation be considered in making procurement decisions, and note that products made with recycled materials are often adequate for Federal needs. However, "recycled materials" do not include reconstituted wood products, and the advantage of these residue-based wood products in comparison to more energy-intensive competitors is not mentioned. An official of the Office of Federal Procurement Policy said that, under the existing policies, it is unlikely that procurement personnel would consider the degree of energy intensity of product manufacture in making purchasing decisions.

Federal procurement policies could help stimulate commercialization of new residue-based wood products by recognizing the energy savings and other benefits to the Nation which would accrue from using such products, and considering

them as viable alternatives for all Federal construction and related applications when suitable performance criteria can be met. In making cost comparisons, the procuring agency could consider not only delivered cost of alternative products, but also any differences in costs of using them or in related facilities' costs during the life of each product. An example of such differences involves the straightness of COM-PLY lumber in comparison to standard lumber. Builders testing COM-PLY lumber said it resulted in fewer wasted boards and made assembly of wall panels and surfacing and hanging cabinets easier. Another example involves the additional insulation provided by particleboard roof decking versus steel decking and the potential differences in costs of heating over the life of the structure.

CONCLUSIONS

Nationwide, the most significant barriers to greater residue use appear to lie in four problem areas:

--Lack of data on the supply of the various types of residues and their location, accessibility, and availability.

--Lack of equipment to economically harvest and transport residues under the widely varying conditions present in the Nation's forest lands.

--Lack of investment capital needed for harvesting and using residues.

--Limited awareness and acceptance among industrial firms, utilities, and State and local bodies of both proven and emerging technologies for producing energy and products from wood residues.

More concerted Federal efforts are needed to help reduce these barriers to increased use of wood residues.

National inventories of wood residues projected from samples made by Forest Service researchers provide inadequate data on forest residues. Among the shortcomings of these forest surveys are their failure to measure total tree biomass, to include all trees and forest lands, to adequately measure logging residues and dead trees, and to indicate accessibility and availability of forest residues. The Forest Service is taking a few tentative steps aimed at measuring total tree biomass, but it lacks any overall

plan for upgrading its ability to measure and characterize the Nation's residue biomass.

Equipment is not available to economically harvest and transport differing sizes and shapes of residues, distributed in a range of concentrations over a wide variety of forest terrains. Development of new technology to meet these requirements is progressing very slowly, severely limiting the opportunities to obtain residues at competitive costs for production of energy and products. Forest Service and DOE funding for equipment development has been limited and Forest Service patent policies do not appear flexible enough to assist commercialization of equipment developed under an expanded and accelerated program.

The lack of investment capital needed for residue harvesting and processing is another barrier to greater residue use. The equipment needed for harvesting and transporting forest residues is expensive and, similarly, the equipment and facilities used for burning wood residues as a fuel or for manufacturing reconstituted wood products require sizeable investments. In a related problem, the cost to manage and upgrade woodlots may be more than the landowner can afford or is willing to invest. Government-sponsored programs that provide incentives to make investments in harvesting and using residues more attractive have not been successful in substantially increasing timber production on these woodlots.

Despite common industrial use of wood fuels in the United States during the 19th century, American industrial firms, utilities, and State and local bodies are generally unaware of proven and emerging wood energy technologies, and are unwilling to accept such technologies without thorough demonstration of their benefits. At the same time the forest products industry has been slow to adopt some important new technologies for producing reconstituted wood products from residues. Federal efforts to overcome these barriers have been minimal. Only a handful of wood fuel demonstrations at private firms or State and local facilities have been implemented or planned using DOE or Forest Service funds. Potential demonstrations at Federal facilities may be foregone because Federal agencies' capital improvement programs do not give adequate consideration to wood fuels. Federal efforts to promote use of

wood energy and reconstituted wood product technologies are limited, and lack of staffing means that technical assistance to individual firms interested in residue technologies is unavailable.

CHAPTER 4

ADDITIONAL OBSTACLES TO RESIDUE USE

Even if the major barriers discussed in chapter 3 are overcome, additional obstacles to widespread residue use will still remain. These obstacles involve

--Federal forest management policies and programs,

--utility practices and regulations, and

--environmental concerns related to greater use of residues.

These obstacles, either separately or in combination, can be a major factor in discouraging or preventing residue use in some regions or localized areas around the country.

FEDERAL FOREST MANAGEMENT POLICIES AND PROGRAMS

The policies and programs of the principal forest management agency, the Forest Service, may serve as obstacles to greater use of forest residues for energy or products. Under current policies and programs, the agency determines the selling price of Federal timber without fully considering the various economic and environmental benefits that could be realized if more forest residues were removed and delivered to a point of use. Likewise, the Forest Service has not fully evaluatd or implemented new policies and programs that could lead to greater utilization. Several of these policies or programs were recommended for evaluation or implementation as early as 1972 when a Forest Service committee reported the results of its 7-month study on improving timber utilization.

The Forest Service potentially could facilitate greater residue use by such options as

--considering forest management benefits in determining timber sale prices,

--establishing a service contract program for logging and delivering residues to a Government-operated concentration or sorting site,

--using long-term contracts to guarantee a supply of residues to a user,

--using tree measurement sale methods in western forests to stimulate removal of more residues, and

--preserving piled logging residues for future use.

Forest management benefits not considered in selling price

Several economic and environmental benefits can accrue to the forest landowner if greater volumes of logging residues are removed from harvest areas (see ch. 2). Purchasers of Federal timber are interested primarily in converting standing trees into merchantable logs and are not directly concerned with the land management aspects facing the landowner. They may expect to do some routine cleanup work, but the broad responsibility for residue management and planning is generally regarded as being a landowner's concern. However, if the Forest Service were to compensate the purchaser for the work required to remove and transport the residues to a point of use, he could economically remove greater volumes of residues. In the process, economic and environmental benefits equal to or greater than the cost of the added incentives potentially could accrue to the landowner. The Forest Service could compensate the purchaser by modifying timber sale procedures to include a cost allowance when determining the fair market value of the timber or to give a credit in lieu of payment for the timber included in the regular sale.

Cost allowance for removal

The Forest Service makes timber appraisals to insure that it does not sell commercial timber for less than the fair market value. The fair market value is a residual value which is determined by subtracting allowances for the estimated costs of removing and processing the timber and for normal profit and risk margins from the projected selling value of the products normally manufactured from the timber. The Forest Service then sells the appraised timber through a public auction to the highest bidder, with the fair market value usually being the minimum acceptable bid.

The Forest Service policy concerning the types and amounts of acceptable cost allowances used in determining the fair market value of Federal timber limits the financial incentives that the agency can provide to a timber purchaser for removal of residues. Forest Service policy states that as a general rule the fair market value of a "tract" of timber

will not be reduced to obtain utilization of noncommerical tree species or sizes or classes of material. Some Forest Service field managers told us that the policy is too restrictive in this regard and may need to be modified or clarified to consider the full benefits of greater residue removal in the timber appraisal. They stated that, under such a modified policy, allowances could be made in the appraisal for the estimated cost of removing and delivering residues to a point of use in any amount up to the value of associated land management benefits accruing to the Government. One of our previous reports 1/ discussed such an approach and recommended that the Forest Service establish some means to recognize in the contracting process the various economic and environmental benefits that the Government could realize through increased use of logging residues. In our opinion, that recommendation remains valid and is even more appropriate today in light of changes in the Nation's energy situation since our 1973 report.

Some private timber companies have established means for recognizing in their accounting systems the value of forest management benefits realized from increased use of logging residues. One company representative told us that his company was removing logging residues from its own lands that it normally leaves on Forest Service timber sale areas and that these residues were being used in a company processing facility for the manufacture of a reconstituted wood product. The representative stated that benefits such as reduced forest fire hazards and more rapid reforestation make it economical to remove greater volumes of wood from its own forest land.

Credit to the purchaser

Another option that the Forest Service could use to recognize economic and land management benefits would be to give a credit to the purchaser if he removes the residues to a point of use. Such an approach would provide an incentive similar to a cost allowance, but the credit would not be a factor in determining the fair market value.

The fair market value would be determined as though the residues were to be left in the sale area and no cost allowance would be given for residue removal in the appraisal.

1/ "Increased Use of Felled Wood Would Help Meet Timber Demand and Reduce Environmental Damage in Federal Forests," B-125053, July 30, 1973.

However, if the purchaser subsequently removes the residues to a point in use, he would receive a credit reflecting the removal cost. The purchaser could use this credit as an offset against the amount owed the Government for merchantable timber removed on the sale or on future sales. No credit would be appropriate if the purchaser chose not to remove the residues.

As with cost allowances, some Forest Service Field managers believe that improved utilization could result from such purchaser credits. The recently enacted Wood Residue Utilization Act of 1980 (P.L. 96-554) will provide credits under a pilot program. To receive the credits the purchaser has to remove the residues to a point of use. The law prohibits using credits on those sales where removing the residues would cost more than their value as fuel or wood products, except where removal is necessary for fire prevention, site preparation, wildlife habitat improvement, or other land management purposes.

Service contract program not established

The Forest Service could establish a service contract program to obtain greater utilization of forest residues. Under such a program a timber stand would be logged under a contract in which the Government would retain ownership of the logs. This contrasts with normal timber sale procedures, in which the purchaser buys the standing timber and assumes ownership of the logs when cut and removed. With a service contract the Forest Service would pay a logging operator to harvest the timber and deliver the logs to a site where they would be sold by the Government.

A number of Forest Service field managers told us that a service contract would be very useful to them in getting greater utilization of forest residues in certain situations. They said that the most appropriate use would be for harvesting low-value or non-merchantable stands that timber purchasers would not normally be interested in buying. Such stands need to be clearcut or thinned to improve the growth rate and quality of wood on the site. Millions of acres of such land exist in many parts of the country.

As an example of a service contract approach the Forest Service potentially could use, the State of Vermont has initiated a program to harvest residue timber on some of its lands. Vermont authorized State funds, which it deposited in a revolving fund, to contract for harvesting low-value hardwood trees or rough, rotten, and dead trees from

overstocked stands. The logs are delivered to State-operated concentration yards, where they are sold for firewood and the receipts deposited in the revolving fund for awarding new contracts. According to a State official, the service contract program has made wood available that would normally be wasted and at the same time is improving the capability of State lands to grow higher quality wood more rapidly. He said that sales revenue has been sufficient to pay for most of the program costs.

Forest Service officials told us that, while they believe that prior legislation authorizes them to enter into such service contracts for harvesting timber under certain circumstances, funds are not available to establish such a program. The Wood Residue Utilization Act of 1980 authorizes funds for harvesting residues when the timber value in a sale area is insufficient to allow a purchaser credit for residue removal. The act authorizes funds for establishing and operating wood concentration or distribution centers as the delivery point for residues. Some Forest Service officials said that such centers could be used to sort the logs and other residues based on their best use, and potentially an overall higher price could be obtained for them.

Long-term contracts guaranteeing a residue supply not used

Uncertainty over whether an uninterrupted wood supply will be available for long periods of time is frequently cited by representatives of utilities, industrial firms, and others as a barrier to using wood fuels. Substantial capital is required to build or convert a plant to use wood residues. As an example, estimated construction costs for a 25-megawatt, wood-fueled powerplant range as high as $56 million. A representative of a public utility that is studying the feasibility of a wood-fueled powerplant told us that utilities are reluctant to commit such large amounts of capital unless wood supplies can be assured for at least 15 to 20 years. A representative from a private utility that is planning to build a wood-fueled powerplant said that a contract guaranteeing a long-term supply of wood is essential for obtaining a construction loan at a favorable rate of interest.

Although ample residue supplies may be available in a given area, competing residue uses could develop in the area, thereby curtailing future residue availability for producing energy. For example, a 1978 study concluded that

large quantities of a particular tree species in northern Minnesota would be available for producing electricity since such trees had little value for making wood products. However, at present several particleboard plants are being built in the area to use this species.

Similarly, market fluctuations can have a big impact on residue availability. When lumber and plywood demand drop, such as during the 1978-1980 slump in home construction, logging and mill activity decreases and fewer residues are available. Pulp and paper mills rely on such residues for much of their raw material, and are highly competitive for wood wastes during such a downturn. This competition for limited residues places a burden on other residue uses, especially energy. Although such problems are generally short-lived, recurring fluctuations in the market cause utilities and other potential users of wood residues concern over the stability of supply.

We noted that the State of Michigan has recently entered into a long-term agreement with an electric cooperative guaranteeing a supply of forest residues from State lands. The cooperative plans to build a 25-megawatt, wood-fueled powerplant, and the forest residues from the State would provide part of the needed fuel. The contract runs 10 years, and under its terms the State will annually make available to the cooperative a minimum specified volume of residues from its lands. The forest residues will consist of logging residues from commercial harvesting operations and low-value or non-merchantable trees from selective or clearcutting operations. The State expects the benefits from residue use to include increased growth and quality of wood on poorly stocked or overstocked lands and improved habitat for wildlife.

In many parts of the country, the Forest Service is a principal forest landowner. In those areas where substantial volumes of logging residues or other forest residues are available, the Federal Government could enter into long-term commitments to supply portions of such residues as an incentive for constructing new wood-burning facilities or modifying existing facilities to use wood.

The concept of a long-term contract to supply forest residues from State or Federal lands evokes mixed reactions. The pulp and paper industry generally opposes such contracts, as it feels that overpromoting residues for energy uses could affect the supplies it needs for pulp purposes. Some Forest Service officials favor long-term contracts, whereas others oppose them. Those in favor see such contracts as an

opportunity to get greater volumes of residues used. Those opposed generally felt that at some point in the future a better use for the residues could develop; however, if the residues were committed to energy uses under a long-term contract, they would be unavailable for this better use.

While a better use for residues potentially could develop at some point in the future, the Nation's immediate energy problems are sizeable and could become more serious in the years ahead. In view of the significance of these problems, failure to promote the use of residues for energy because a better use may later develop seems imprudent. In addition, entering a contract for 15 to 20 years, when needed to help assure payback of investment in a wood energy facility, would not permanently remove Forest Service options. At the end of the contract period, residue supplies could be diverted to any higher value use that may have developed. If the Forest Service is seriously interested in alleviating energy shortages, it could adopt a more flexible policy to allow using long-term contracts for supplying forest residues in any location where such agreements are deemed necessary to achieve greater residue use.

It appears that the Forest Service has authority to use such agreements. If the agency determines that any legal obstacles exist, it should bring this to the attention of the Congress.

Tree measurement sale method not used in western forests

The Federal Government uses two basic methods for selling its timber. Under the tree measurement method the purchaser agrees to pay a specific amount for the timber in a sale area based on an estimate of the merchantable volume of wood in the standing trees. Under the log measurement method the purchaser agrees to pay for logs taken from a sale area on the basis of scaling--an estimate of the merchantable volume of wood in each log he removes. Some field managers believe that the tree measurement method increases the amount of timber removed from a sale area.

The Forest Service has used the tree measurement method for many years in its eastern and southern regions. However, it has made only limited use of the tree measurement method in its western regions. Conversely, the Department of the Interior's Bureau of Land Management (BLM) uses tree measurement for all of its sales on western forest lands.

In mid-1973 the Forest Service proposed a timetable to gradually increase the volume of timber sold by tree measurement from 5 percent to 90 percent by the end of 1980. However, the Forest Service abandoned the timetable because the Senate Appropriations Committee expressed concerns and because funding for converting to tree measurement sales was uncertain. Currently only about 15 percent of the Forest Service's sales are by the tree measurement method, and these sales are virtually all in the eastern and southern regions. While Forest Service officials still believe that converting to the tree measurement method is desirable, no plan or timetable exists for such conversion. In an earlier report we recommended that the Forest Service provide funds for a test sale program to compare the costs and effectiveness of the tree measurement and log measurement sale methods, but no action has been taken on our recommendation. 1/

The Forest Service believes that the log measurement method results in larger volumes of wood being left in a sale area. Forest Service officials stated that one problem with this method is that the timber purchaser generally pays an average price per unit of wood for all timber species included in the sale. Although the higher quality logs are worth much more than the average while the lower quality logs are worth much less than the average, the purchaser pays the same price per unit volume for all logs. This provides an incentive to remove the high-quality logs and, if possible, leave the low-quality logs as residue. Officials stated that, conversely, under a tree measurement sale the purchaser has an incentive to remove more material, since he pays one overall price for the timber and may remove as much wood as he desires without paying for each log. BLM officials had similar views on the potential advantage of tree measurement sales over log measurement sales with respect to improved utilization.

In addition to improved utilization, Forest Service and BLM officials said that the tree measurement method should decrease manpower requirements and the overall costs of timber sales. They said that while costs to prepare a tree measurement sale would be greater, the reduction in administrative costs due to the elimination of scaling should more than offset the increases. Likewise, some said that the tree measurement method takes away any incentive for a purchaser

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1/ "Forest Service Efforts to Change Timber Sale Payment Method", RED-75-396, July 16, 1975.

to avoid paying for his logs by bypassing a scaling station. The Forest Service conceded that the tree measurement method may not be as accurate as the log measurement method, especially in timber having a high defect rate, but felt that errors in volume estimates would not be great and would tend to balance out over time.

Timber industry representatives did not necessarily share the same views as the Forest Service and BLM on the advantages of the tree measurement method. They questioned whether the tree measurement method could be extended to sales of defective, old-growth trees, which constitute a large part of the Forest Service's timber holdings in the western regions. They stated that changing the measurement method could bring about large financial risks to both the Government and the purchaser because of the difficulty of estimating usable volume in old-growth stands. They stated that if the Forest Service substantially overestimates the volume in such sales, the purchaser could suffer a large loss. The industry representatives said that to minimize his risk the purchaser would need to make his own estimates of the volume, and the amount he bids for the Forest Service sale would reflect the cost of this fieldwork. The industry representatives added that no conclusive evidence exists that tree measurement sales will actually cost the Forest Service less to administer than log measurement sales, nor that they will result in better utilization.

While Forest Service and BLM officials generally agreed that the tree measurement method had several advantages, they said that data supporting their contentions was not readily available. They said that studies had not been conducted that either proved or disproved the advantage. BLM officials in Oregon said that, even though they have used the tree measurement method extensively on old-growth timber on their lands, they did not have data to support their general observations about the advantages of tree measurement.

Conceptually, we believe that the tree measurement method offers net benefits over the log measurement method. BLM has used the tree measurement method on old-growth timber in the West for several years, apparently without experiencing any major problems of the type mentioned by industry officials. The Forest Service needs to request funds from the Congress and take any other actions necessary to (1) demonstrate that it too can administer a successful tree measurement sale program in western forests and (2) move rapidly to convert to the tree measurement method in its western regions.

Preserving piled logging residues not always considered

As mentioned on pp. 16 & 17, logging residues are being yarded and piled on many Forest Service timber sales in the West. The timber purchaser has the option of removing this piled material at no charge or minimal charge, but frequently leaves it. If the purchaser does not remove the material, the Forest Service may allow another logging operator or the public to remove all or part of the pile. Often, however, the purchaser does not remove the piled residues, and the Forest Service later burns them.

Some Forest Service officials said that they burn the piles because they are a potential forest fire hazard, especially when sale areas are broadcast burned to prepare the site for reforestation. Although they could preserve the piled residues indefinitely, the officials did not foresee a use developing for the material in the near future.

In contrast, one of the five Forest Service regions involved in extensive piling of residues has taken steps to preserve some of the piles because of their potential use in the future. The Regional Forester for the Pacific Southwest region issued instructions in June 1979 to each national forest supervisor to limit disposal of the piles by burning on their forest and to store the material on site when possible. In his instructions, the Regional Forester stated that the piles are a potential source of energy and could become an attractive source of readily available energy wood. Regional officials said that they can minimize the fire hazard from the piled residues by separating them from other residues left on the sale area. This may be done by placing piles in log loading areas along the road, or in nearby areas.

Since preserving piled residues appears to be a viable option in the Pacific Southwest region, such a practice may have application in the other regions. These regions need to evaluate the desirability of preserving the piled residues on their lands. If the evaluations indicate that preserving piled residues has merit, then field instructions should be issued specifying under which conditions the practice is appropriate.

UTILITY PRACTICES AND REGULATIONS

Problems caused by practices of electric utilities and by Federal and State utility regulations have been an

obstacle to using wood residues for industrial cogeneration, or combined production of electricity and other forms of energy. Forest products firms seeking to use more of their wood residues for cogeneration and to sell the excess electricity to utilities or other users or transfer it to their own facilities at other locations have often been thwarted. Passage of the Public Utility Regulatory Policies Act of 1978 (92 stat. 3117) (PURPA) and promulgation of Federal regulations under the act may help reduce some of these problems and thereby stimulate wood-fired cogeneration in the forest products industry as well as in other industries. However, the States and utilities not under State regulatory authority still must interpret the Federal regulations and put them into effect. Results of this implementation by each State and by each utility exempted from State regulation will determine how effectively obstacles to wood-fired cogeneration are removed.

Obstacles to cogeneration

Prior to the enactment of the Public Utility Regulatory Policies Act of 1978, a cogenerator seeking to establish interconnected operations with a utility faced three major obstacles. First, under Federal and State utility regulations a utility was not generally required to purchase the cogenerator's electric output or, if the utility chose to make such purchases, to pay an appropriate price. Second, some utilities charged discriminatorily high rates for making backup service available to a cogenerator in case it experiences a disruption in its own electrical generation. Third, a cogenerator which provided electricity to a utility's grid ran the risk of being considered an electric utility itself, and thus being subjected to State and Federal regulation. Additional problems arose if the local utility did not want to purchase any power and the cogenerator wished to sell power to another utility or industrial firm or tansfer it to its own facilities elsewhere. The local utility had no obligation to transfer the power over its transmission lines ("wheel" the power) and deliver it to these potential users. PURPA includes provisions which are designed to remove the first three obstacles and to partially address the wheeling problem.

PURPA requires the Federal Energy Regulatory Commission (FERC) to prescribe rules to encourage cogeneration, including rules requiring electric utilities to purchase power from and sell power (including backup power) to cogeneration facilities. PURPA also directs the Commission to assure that utilities purchase and sell such power at rates which are "just and reasonable," "in the public interest," and meet

other specified tests. One such test is that the price not exceed the incremental cost to the utility of alternative electric energy. Nor is it intended, the House Conference Report stated, that a utility's rate payers be required to subsidize cogenerators. PURPA also authorizes FERC to prescribe rules under which cogeneration facilities can be exempted from regulation as a utility, and to issue orders requiring utilities to wheel cogenertors' power to other utilities wishing to purchase it.

On February 25, 1980, the Commission adopted regulations to implement the provisions of PURPA discussed above. The regulations became effective March 20, 1980. Implementation of these rules is reserved to State regulatory authorities and to electric utilities which are not regulated by States and must be completed by March 20, 1981.

Implementation in some States should encourage cogeneration

The States of California, Oregon, and Washington have begun to implement the FERC regulations. In December 1979 the California Public Utilities Commission ordered the State's largest utility to base its cogeneration purchase rates on marginal costs (using an oil-fired, combined-cycle generating plant to determine marginal cost). As a result the utility has proposed rates which are about double the 1979 levels. In Oregon the Public Utility Commissioner has prepared a draft model tariff regarding pricing and conditions of service for cogeneration. Oregon Public Utility Commission officials believe that PURPA and the implementing regulations will create additional generating capacity statewide. On March 8, 1979, the Washington Utilities and Transportation Commission ordered a major utility to inventory all presently used or underused cogeneration sites having untapped power sources of 5 megawatts or more in or near its service area. The commission later directed the other two utilities under its jurisdiction to conduct similar inventories. The commission believes that the combination of these surveys, predicted power shortages in the State, implementing PURPA, and a State bill promoting cogeneration will create significant opportunities for more power production.

Both Washington and Oregon have recently passed State laws promoting cogeneration by small power producers. The laws of both States offer tax incentives to encourage cogeneration, while Oregon's also exempt cogenerators from regulation as utilities and provide for buying and selling cogenerated power.

Some problems may still exist

Although some States appear to be progressing well in implementing the FERC cogeneration rules, the results of implementation by other States and by utilities exempt from State regulation may not be as satisfactory. An FERC official noted that many utilities opposed the cogeneration order and will probably try to delay cogeneration projects and may challenge the order in court. Some utilities are concerned about their lack of power storage capability and whether they have sufficient distribution networks to link potential sources of cogenerated power with potential users. On the other side some cogenerators are still concerned about the power purchase contracts proposed by the utilities. They note that, while the proposed purchase rates may be better, the economic incentives may still be insufficient to warrant full development of a cogenerator's potential for energy production. Finally, a major problem may remain for cogenerators who want to wheel power over local utility transmission lines to other firms or their own remote facilities. The Public Utilities Regulatory Policy Act of 1978 and the FERC regulations provide for wheeling of power for delivery to utilities. They do not cover wheeling to other potential users.

ENVIRONMENTAL CONCERNS

We noted potential obstacles to increased wood residue use involving two areas of environmental concern. Air quality regulations affecting wood energy use currently represent the most significant environmental obstacle. These requirements may make it difficult to construct wood energy plants in certain areas of the country. The impact of residue removal on the nutrient levels of forest soils is another environmental concern. While not considered a significant obstacle to residue use at present, nutrient effects could be a factor in frequent, intensive utilization of certain forest stands.

Air quality regulations

In some parts of the country, air quality regulations may be a significant obstacle to increased use of wood residues in cogeneration facilities and electric powerplants. As with any fuel, combustion of wood in such facilities leads to emission of certain pollutants. In comparing wood with fossil fuels, the two most important air pollutants are sulfur and particulates.

With respect to sulfur emissions, wood fuel offers significant advantages over fossil fuels. Wood contains little sulfur; thus, sulfur emissions from combustion of wood are much lower than from combustion of coal and oil. High sulfur emissions pose significant health hazards and are major obstacles in siting large, coal-fired electric powerplants. Burning mixtures of wood and coal offers a means of reducing sulfur emissions from such facilities.

In contrast to sulfur, particulate emissions from wood burning are higher than from combusion of fossil fuels. Particulates can react with water vapor to form smoke and reduce visibility and thereby adversely impact local aesthetics. They also represent a health hazard, but actual health problems resulting from them are minimal in most areas, since State and Federal standards limit airborne particulates to nonhazardous levels.

Air quality requirements may be an obstacle to use of wood fuels in specific locations. Generally, these potential problem locations involve nonattainment areas and class I areas.

Nonattainment areas

Nonattainment areas are regions whose air contains pollutant concentrations in excess of maximum standards prescribed under the Clean Air Act, as amended, (42 U.S.C. 7401, et seq). Because the current standards are not being met, locating a wood energy facility or any polluting facility in such an area would be difficult. If air pollutant concentrations in a nonattainment area are reduced so that the area comes into compliance, new facilities could be sited as long as they did not interfere with maintenance of the standards.

While a strict interpretation of the Clean Air Act would prevent the siting of all new air polluting facilities in nonattainment areas, in December 1976 EPA announced an offset policy designed to allow such sitings. The policy allows new sources to be located in nonattainment areas as long as, among other things, the new pollutants are more than offset by a reduction in emissions of the same type of pollutants from existing facilities in the same area. However, individual States which have the responsibility to implement Clean Air Act provisions can set stricter new source regulations than those of the Federal Government.

The effect that environmental policies can have on wood-fired plants and cogeneration facilities is illustrated in

a report on issues affecting cogeneration in California, prepared by the staff of the California Energy Commission. The report states that, although a potential of about 1,800 megawatts of cogenerated power has been identified in the State, developing this potential requires resolving several important issues and that perhaps the single most pressing issue is air quality. The report states that, because of the additional fuel required for cogeneration at an existing facility, these facilities will have to conform to air pollution regulations such as the New Source Review rules in force in most California regions. Under these rules new pollution is allowed in nonattainment areas only when an existing pollution source can be decreased by at least an equal amount of the specific pollutants involved. The report notes that such offsets can be difficult to obtain, and that even when they are available a firm might choose to use them to implement higher priority projects, such as increasing the size of its production facilities, rather than adding cogeneration capability.

Class I areas

Class I areas include almost all land within the National Wilderness Perservation and the National Park System. Other lands, most notably certain Native American holdings, have also been designated as class I areas. Standards for locating polluting facilities near such areas are often strict. Even though sizeable quantities of residues may be available near class I areas, it may be impossible to locate wood-fired plants near these areas under existing standards. This obstacle to increased wood residue use looms larger in the West, where much of the forest residue resource is located near class I areas.

More flexible policies may be needed to recognize pollution trade-offs

Disposal of logging residues by burning is routinely employed in many parts of the country, producing large quantities of smoke, which can dramatically affect air quality and visibility in these areas. If wood residues were transported off the site and burned in wood energy facilities, air quality impacts could be reduced, since emissions from open burning are far greater than from burning residues in a furnace to fire a boiler. Recognition of such trade-offs by Federal and State air pollution control authorities could allow construction of wood energy facilities in locations where they would otherwise be prohibited, or could allow a reduction in the pollution control equipment required for such facilities.

EPA officials expressed doubt that these trade-offs could be recognized under provisions of the Clean Air Act. They said that while EPA may consider such trade-offs in facilities siting decisions, it can not consider them in determining required pollution control equipment, since the Act specifies use of best available control technology in all cases. EPA, and State and local pollution control authorities need to adopt more flexible policies to allow recognition of air pollution trade-offs between in-forest residue burning and operation of a wood energy facility using forest residues. EPA should request legislation to amend the Clean Air Act to allow full recognition of such trade-offs.

Soil nutrient impacts

The impact of logging residue removal on the nutrient levels of forest soils is another environmental concern. While not considered a near-term problem, nutrient removal limitations could present an obstacle to long-run intensive utilization on certain forest stands.

The maintenance of soil nutrient levels and productivity of the forest has not been considered a major problem under long cutting cycles because very few nutrients are within the portions of the tree removed through normal logging practice. The nutrients necessary to meet normal growth are derived from annual leaf and needlefall as well as from logging residues. However, research indicates that whole-tree harvesting on short cycles can alter the balance significantly. Since our forests are generally grown on less fertile soils, the cumulative nutrient losses from frequent harvests may not be offset by natural processes.

Officials we contacted do not believe adverse nutrient losses will ever become a significant problem as long as landowners follow sound forest management practices. They stated that vast quantities of wood residues could be harvested without departing from such practices.

CONCLUSIONS

Federal forest management policies and programs, utility practices and regulations, and environmental concerns may represent additional obstacles to increased use of wood residues for energy and products.

The policies and programs of the Forest Service may serve as obstacles to greater use of forest residues. Although the

Government would gain substantial economic and environmental benefits from greater removal of logging residues, the Forest Service has not established a way to determine the value of these benefits and to recognize them when selling timber. Similarly, substantial land management benefits could be realized from harvesting nonmerchantable stands of timber, but the Forest Service has not evaluated the benefits, costs, and actions needed to establish a service contract program to pay for removing the wood to a point of use.

The Forest Service has not entered into contracts for guaranteeing long-term supplies of residues from its lands. The agency has not adopted a flexible policy which allows such contracts when needed to encourage public utilities or private companies to invest in facilities that use wood residues.

Despite the success another Federal agency, the Bureau of Land Management, has had in using the tree measurement sale method in the West, the Forest Service continues to sell nearly all of its western timber by the log measurement method. Conceptually, the tree measurement method should improve wood utilization and lower administrative costs. The Forest Service has not taken the actions necessary to convert to the tree measurement sale method in its western regions while also assuring an effective timber sale program.

A final Forest Service policy which may limit residue use involves the routine burning of piled logging residues by some regions even though the piles could be saved and potentially utilized at some point in the future. The Forest Service has not determined in what situations piled residues can be preserved without creating unacceptable forest management problems nor has it taken appropriate actions to assure that the residues are saved.

Electric utility practices and Federal and State utility regulations may represent obstacles to greater use of residues by industry for cogeneration. Forest products firms seeking to use more of their wood residues for cogeneration and to sell the excess electricity to utilities or other users, or to transfer it to their own facilities at other locations, have often been thwarted. Although the regulations issued under the Public Utility Regulatory Policies Act of 1978 may help reduce this problem, State and nonregulated utility interpretation and implementation of the regulations may continue to limit the development of cogeneration potential.

A final barrier to increased use of wood residues involves two areas of environmental concern. First, Federal,

State, and local air quality regulations may make it difficult to construct wood-fired electric powerplants and cogeneration facilities in some areas. The Environmental Protection Agency believes that an amendment to the Clean Air Act (42 U.S.C. 7401, et seq.) is needed before the agency can adopt flexible procedures to recognize the air pollution savings such plants could produce by reducing in-woods burning and to credit such savings against the emissions from the plant itself. Second, while shortages of soil nutrients could potentially develop from frequent and complete harvesting of trees on particular forest sites, this is not expected to become a significant problem as long as landowners follow sound forest management practices.

CHAPTER 5

MORE ATTENTION TO REGIONAL VARIATIONS AND BETTER ORGANIZATION OF FEDERAL RESOURCES NEEDED

While the potential of wood residues for producing energy and products is vast, the barriers to greater use of residues are many and varied as the preceding chapters indicate. Just as the barriers are numerous, so too are the actions proposed to reduce them. Compounding the situation are wide-ranging differences among regions in types and quantities of residues available, attractive end-use opportunities, significant barriers to use, and proposed solutions. The Department of Energy and the Forest Service have taken some actions aimed at increasing use of wood residues, but have not given adequate attention to these regional variations. In our opinion, the failure to identify and evaluate vital differences between regions and to incorporate them in agency planning is a primary factor preventing development and implementation of a comprehensive national plan for use of wood residues. Another factor which hinders development and implementation of an effective national wood residue plan is lack of a suitable organization of Forest Service and DOE resources for accomplishing the task.

FEDERAL PLANNING FOR WOOD RESIDUES IS INADEQUATE

The Forest Service has long been interested in increasing wood residue (see ch. 1). For nearly a decade the agency has been trying to develop an effective residue utilization program, with little success. The close timber utilization program initiated in 1971 resulted in some tightening of Forest Service standards for material a timber purchaser must remove from a sale area, and provisions for pricing low-value material and for piling residues as incentives for removal, but little else. During this period Forest Service officials discussed several other potential means of increasing residue use, such as service contracts for residue removal, sale of residues from Government-operated concentration yards, and greater use of tree measurement sales. While Forest Service officials said these concepts had merit, they never progressed beyond the talking stage.

In July 1979 the Forest Service carried its initial interest in residue utilization one step further by drafting a general proposal for a national wood energy program. The proposal noted that considerable technical data is available on the management of forests, the harvest and transport of

forest products, and the use of wood for fuel and for less energy-intensive products. The proposal recommended that "a concentrated effort be established to apply the known technology in demonstrations and commercial applications," and also that research efforts be increased to more fully develop and promote the use of wood for energy and energy-saving products. While calling for a more intensive energy program, the proposal did not discuss funding for such a program and also failed to show how its recommendations were to be implemented. As of June 1980 the Forest Service had yet to adopt the program by specifying any funding or implementation plans for it.

In July 1979 the Department of Energy also drafted a proposal for a "wood commercialization" plan aimed at increased use of wood for energy. In September 1979 DOE issued a revised draft of the proposal, but as of October 1980 it had yet to be finalized or approved.

While DOE's proposal incorporates specific funding levels and implementation steps which the Forest Service energy proposal omitted, it falls short of being a comprehensive national plan for wood residues. First, it sets goals for use of wood residues and outlines implementation steps solely in the context of direct energy production. It does not address using wood residues for energy-saving products, which not only can contribute to national energy objectives by replacing more energy-intensive materials, but also help extend timber supplies and moderate potential price increases. Thus, DOE's proposal is too narrowly drawn.

A second shortcoming of DOE's wood commercialization proposal is that its major thrust is to develop "hardware system concepts" which will overcome various barriers to wood use. It is designed to deal primarily with hardware-type solutions for end-use facilities, such as designing wood-burning and pollution control equipment to resolve the specific problems of an industry, locality, or firm. As such the proposal does not adequately address the need to select and implement solutions, on a national or regional basis, from among a multitude of possible actions dealing with complex forest management issues and economic incentives for wood suppliers and wood users.

Another problem is that, while the DOE proposal calls for studies in several locations which could provide some of the regional inputs necessary for development of a comprehensive national wood residues plan, it will not generate such inputs in a timely manner. It does not call for completion of

evaluations at all selected sites until the end of fiscal year 1985. Also, completion of some studies will be delayed since they were to be initiated at the start of fiscal year 1980, while as of October 1980 the proposal had yet to be approved and implemented.

Finally, DOE's wood commercialization proposal falls short of providing for effective involvement of, and coordination with, the Forest Service. Since wood energy development is closely tied to forestry policies and practices and since the forest products sector of the economy affects the availability and economics of wood energy, DOE and the Forest Service obviously have overlapping interests. Any plan for increasing residue use should, therefore, be formulated through joint agency participation and specifically provide for joint implementation and monitoring. In this case DOE structured its wood commercialization proposal independently, although the agency plans to give the Forest Service an opportunity to review and comment on its final draft. Also the DOE proposal provides no significant role for the Forest Service in helping to direct its overall implementation or to monitor its progress.

FEDERAL ACTIONS NEEDED

Chapters 3 and 4 discuss major barriers and other obstacles to greater residue use. For some of these problems a consensus appears to exist on Federal actions needed to help reduce them. In these instances the Forest Service, DOE, and other Federal agencies can begin taking appropriate action with reasonable certainty that such actions will complement any national wood residues plan which may later be developed. However, for most other problems, particularly many of those involving land management practices and economic or marketplace factors, neither the extent of the obstacle in a given region nor the desirability of proposed solutions is sufficiently clearcut to recommend specific Federal actions. Appropriate actions to remove these obstacles should evolve as part of the development and implementation of a comprehensive national plan for wood residues.

More attention to regional variations required

If the Forest Service and DOE are ever to develop a viable national plan for increased use of wood residues, we believe they must begin by giving more attention to wide regional variations in residue quantities and availability, potential uses, barriers to use, and alternative approaches

for overcoming barriers. For example, some approaches may be suitable for stimulating more use of large quantities of softwood logging residues and dead timber on steeply sloped Federal forests in western States where alternative energy costs are relatively low. Meanwhile, other approaches may be necessary to encourage selected harvest and use of overcrowded hardwood stands on moderately sloped forests of private nonindustrial landowners in some northeastern States where alternative energy costs are higher.

Initially the agencies could direct their attention to these regional variations by making a number of assessments in selected locations around the country which appear to offer significant opportunities for greater residue use. These residue assessments, as we view them, would involve the concept of an operating area or zone around or adjacent to a particular site where potential end-use facilities for wood residues exist and/or could be developed. Officials we contacted said that the boundaries of such operating areas might be determined by topographical features, transportation corridors, economic hauling distances, and other factors. Some thought such areas would typically involve distances of 50 to 75 miles around a utilization center, based on today's transportation economics.

In selecting sites for making residue assessments we believe that the Forest Service and DOE should emphasize residue availability of alternative energy sources. The mere existence of residues in a given area may mean little if landowners are unwilling to make them available. In regions where nonindustrial private landowners predominate, it is particularly important that the agencies establish sites for assessments only when they have reasonable assurance that landowners intend to make residues available.

Cost and availability of alternative energy sources should also be a major consideration in selecting assessment sites. We noted that interest in wood energy and movement toward greater use of residues is more pronounced where costs of alternative energy supplies are high relative to the cost of wood residues and where industrial and utility users are dependent on supplies whose long-run availability is uncertain. This is the case in New England, where a regional commission reported that

> "The oil situation presents additional special problems for New England businesses because prices are higher and rising faster here than in any other region of the country. We have no source of supply within the region, so we must rely completely on supply from outside the

area. Unless action is taken, many industries will soon find themselves at a serious competitive disadvantage with industries in other parts of the country."

"New England industries must find creative solutions for problems of rising prices, as well as reduced and uncertain supplies. One that is especially attractive, yet often overlooked, is wood." 1/

However, tempering the enthusiasm for wood energy among that region's industry and utilities is the ready availability of coal at costs competitive with those of residues. Such energy cost and availability relationships will help determine the true extent of opportunities for greater use of wood residues in a given area.

We believe that a minimum of six local assessments are needed at sites in the various forested regions of the country to provide sufficient information on the range and variation of residue opportunities and factors affecting residue use. The assessments should determine residue quantities and availability, potential uses, barriers to use, and alternative actions to reduce barriers. Specific information to be developed through the assessments should include

--the cost of making detailed residue inventories in each assessment area, with projections of costs to make such inventories regionally and nationally;

--the volumes of wood residues that are potentially available in each area and the costs to collect and remove them using conventional equipment;

--the specific needs for improved equipment to lower collection and removal costs;

--the benefits and costs of, and alternative Federal roles in, stimulating greater removal and use of wood residues by (1) modifying or initiating a number of possible forest management policies and programs on Federal, State, and private lands, (2) encouraging private investment in new or modified facilities to use wood residues; and

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1/New England Regional Commission Energy Program Report 79-8, "Why Wood?" An Introduction to the Industrial Use of Wood Fuel."

--the extent of, and alternatives for reducing, additional barriers caused by utility practices and regulations, air pollution regulations, and other factors.

Since we view the residue assessments as an important initial step in developing a national plan to realize the vast potential of wood residues, they need to be completed rapidly. We believe that, within 6 months to a year after initiating this approach, alternative locations should be evaluated and the actual assessment sites selected. Also by this time the need for involvement of Federal agencies other than the Forest Service and DOE during any assessment should be determined and provided for. Further, we believe that within two years following release of this report a proposed national wood residues plan, predicated upon and supported by results of the assessments, should be reported to the Congress. The plan should include proposed residue use goals and recommended actions to overcome barriers to such goals, including any legislative actions needed.

Assessments require better organization of Federal resources

We believe that the Forest Service and DOE must cooperate closely in order to complete the residue assessments in a timely manner. The agencies have not provided for such close cooperation in their existing residue-related proposals (see p. 78).

We also believe that the Forest Service must take the lead role in planning and making the residue assessments. This is not intended to minimize DOE participation in any way, but to recognize that the assessments will involve forest resource management topics more than they will end-use technology questions. As noted earlier, DOE's current wood commercialization program mainly stresses hardware-type solutions for end-use facilities and does not adequately consider forest management issues (see p. 77). In our opinion, analyzing these issues as well as upgrading residue inventory data and analyzing residue-handling equipment problems requires Forest Service expertise and direction.

Another factor which points to the Forest Service as the logical lead agency for planning the residue assessments is the need to carefully select assessment sites on the basis of residue availability. In a current draft report on taxation policy related to timber production we discuss the need for the Forest Service to winnow down the current national estimates of nonindustrial private forest acreage by identifying those private landowners whose objectives support timber

growing. In the process the Forest Service would also be developing data on nonindustrial private landowners who are likely to make wood residues available to potential users. Thus, in regions where nonindustrial private landowners are prevalent, the Forest Service would have already developed critical information needed to help select the most promising sites for making residue assessments. Logically, it should bring such knowledge to bear in leading the selection process.

While the Forest Service seems the logical choice to lead Federal efforts in planning and implementing the assessments, DOE should participate fully in the process. The agencies' staff resources should be allocated accordingly, and mechanisms for close coordination and cooperation among agency staff in joint planning, implementation, and monitoring of the assessment process should be established. Full DOE participation in making the assessments may also require allocation of DOE funds to underwrite a portion of Forest Service activities as lead agency. Use of pass-through funding would be appropriate in this instance.

CHAPTER 6

CONCLUSIONS, RECOMMENDATIONS, AND AGENCY COMMENTS

CONCLUSIONS

The enormous potential of the Nation's wood residues for meeting energy and product needs is well recognized. The Forest Service believes that by 1990 the level of residue use could amount to 25 percent of current oil imports. Some estimates indicate that wood could eventually supply energy equal to 50 percent of current oil import levels. Some officials believe that use of residues to produce products which can substitute for more energy-intensive materials offers even greater energy benefits.

Despite their recognized potential, immense quantities of wood residues are wasted each year in the United States in the form of decaying logging residues and dead trees, unused wood-processing residues, and vast untapped acreages of small, defective, and other lower value trees. This waste of a potentially valuable resource not only has adverse effects on achieving national energy goals and on timber product supplies, but results in severe forest management problems and environmental damage.

While both the Forest Service and the Department of Energy have expressed an interest in greater residue use and have taken some steps in that general direction, progress toward a comprehensive national plan for realizing the potential of residues has been minimal. To begin to take greater advantage of the residue resource, several barriers identified in our review must be overcome. Some of these barriers are widespread, and a consensus exists on Federal actions needed to help reduce them. For a few other barriers, means of reduction have already been successfully implemented on a limited basis and we believe these means should be employed more widely at the Federal level. Several remaining barriers require more detailed analysis before a comprehensive national plan can be formulated with specific residue use goals and specifications to achieve them.

We are making several recommendations for Federal action to reduce residue use barriers. Some of these recommendations entail specific measures to stimulate the greatest residue use in the short run. Other recommendations involve the need for further study and evaluation of barriers to determine specific actions needed and to aid development of a comprehensive national plan for realizing the long-term potential wood residues.

Federal actions to reduce barriers to wood residue use do not necessarily imply any major increase in Federal expenditures. Some actions should require no additional funds, for example giving wood more serious consideration in fuel conversion studies for heating/power systems at Federal facilities. Where found cost-effective, use of wood systems would actually reduce funding requirements. Other actions involving adoption or modification of some Federal forest management programs and policies could involve little or no cost in excess of resulting benefits, such as reduction in residue management costs which now exceed $100 million annually. Revision of patent policies and other actions could stimulate greater private investment in residue-handling equipment and new residue product technologies without increased Federal expenditures. Further, the Forest Service and DOE might reallocate available funds in line with wood residues' potential to make immediate and sizeable contributions toward meeting national and product requirements.

Overall, we believe that the Forest Service and DOE must begin to give greater attention and priority to wood residues in recognition of their vast potential for producing energy and products. We are not making any recommendations to the Congress at this time.

RECOMMENDATIONS

Recommendations to the Secretary of Agriculture and the Secretary of Energy

To more fully evaluate potential barriers to wood residue use and how these barriers vary by locations, and to begin development of a comprehensive national plan for realizing the vast potential of wood residues for producing energy and products, we recommend that the Secretary of Agriculture and the Secretary of Energy:

1. Conduct a cooperative program of assessments in at least six locations around the country. The Secretaries should select the areas they believe hold the most promise for increased use of residues based on (1) estimates of residue availability and cost, and (2) availability of competing energy sources. The assessments should include a detailed inventory of residue quantities and availability and an evaluation of potential residue uses, barriers to use, and proposed solutions. Specific information to be developed through the assessments should include

--the cost of making detailed residue inventories in each assessment area, with projections of costs to make such inventories regionally and nationally;

--the volumes of wood residues that are potentially available in each area and the costs to collect and remove them using conventional equipment;

--the specific needs for improved equipment to lower collection and removal costs;

--the benefits and costs of, and alternative Federal roles in stimulating, greater removal and use of wood residues by (1) modifying or initiating a number of possible forest management policies and programs on Federal, State, and private lands, and (2) encouraging private investment in new or modified facilities to use wood residues; and

--the extent of, and alternatives for reducing, additional barriers to residue use caused by utility practices and regulations, air pollution regulations, and other factors.

We recommend that the Forest Service assume the lead agency role in making the residue assessments, but that Forest Service and DOE staff work closely in joint planning and implementation. We also recommend that DOE provide sufficient funding to allow full implementation of those features of the assessments which relate to energy matters.

2. Present to the Congress within 2 years a national wood residues plan, including proposed residue use goals and recommendations for legislation or other actions to overcome barriers to such goals. It should be supported by data on regional variations developed through the residue assessments.

The Secretary of Agriculture and the Secretary of Energy should also work jointly to:

3. Implement an accelerated program to develop and demonstrate residue-handling equipment in cooperation with private industry.

4. Develop standardized methods for evaluating the costs and benefits of using wood fuels in Federal facilities, including allowance for forest management benefits, and submit these methods to the Office of Management and Budget within 6 months for dissemination to the executive branch to assure consistency in life-cycle energy evaluation.

5. Establish a program to promote use of wood fuels among industry, utilities, and State and local bodies through increased participation in demonstration projects and provision of educational materials and direct technical assistance.

Within their respective Departments, the Secretaries should:

--Convert all Department facilities to wood fuels for all or part of their heating/power needs where life-cycle evaluations show them to be cost-effective.

--Identify and evaluate additional opportunities to demonstrate wood-energy technologies at Department facilities in order to enhance the prospects for future economic feasibility of such technologies.

Recommendations to the Secretary of Agriculture

To further help reduce barriers to increased use of wood residues for energy and products, we recommend that the Secretary of Agriculture:

--Upgrade the forest survey to provide an inventory of the potentially useable biomass of all trees and woody shrubs, logging residues, and dead trees on the nation's commercial forest lands.

--Request legislation which would authorize the Department to grant private firms either title or an exclusive license in residue-handling equipment and reconstituted wood product technologies developed wholly or partly with Federal funds when needed to stimulate commercialization.

--Increase promotion of new reconstituted wood product technologies developed with Federal funds by allocating necessary resources to effectively disseminate information and provide technical assistance to forest products firms.

--Adopt a more flexible policy which allows use of long-term contracts to assure that residues from National Forests will be available on a continuous basis when needed to achieve increased residue use in a given area.

--Demonstrate Forest Service ability to conduct tree measurement sales and convert the agency's western region to the tree measurement basis as rapidly as possible.

--Preserve piled logging residues for potential future use by foregoing burning whenever possible under sound forest management practices.

Recommendation to the Secretary of Defense and the Administrator of General Services

To provide a major stimulus for wider wood residue in the near term in support of national energy goals, and in recognition of the extensive facilities construction, renovation, and management programs of the Department of Defense and the General Services Administration, we recommend that the Secretary of Defense and the Administrator of General Services:

--Assure in implementing existing policies for conversion of their heating/power systems from oil and natural gas to alternative fuels that wood is given equal consideration with coal in forested regions of the country. A canvas of wood conversion opportunities at all such facilities should be made, to later be tested by the standard feasibility evaluation methods developed by the Forest Service and DOE.

--Issue procurement guidelines pointing out that, because of their value in meeting national energy goals, residue-based wood products be carefully considered as alternative materials for all construction and related applications.

Recommendation to the Administrator, Environmental Protection Agency

To help promote wood residue use in locations where current air pollution regulations preclude such facilities, we believe that policies and procedures must (1) recognize emission trade-offs resulting from reduced burning of residues in the woods or in other locations and increased burning at proposed wood energy facilities, and (2) allow such trade-offs to be considered in deciding whether a wood-burning facility may be constructed and what type of pollution control equipment will be required.

The Environmental Protection Agency has indicated that an amendment to the Clean Air Act (42 U.S.C. 7401, et seq.) would be needed to allow the agency to fully consider the trade-offs between reduction of in-woods residue burning and emissions associated with new wood energy facilities using the residues. EPA said that, while it may consider such trade-offs in facilities siting decisions, it can not consider them in determining required pollution control equipment, since the Act specifies use of best available control technology in all cases. We recommend that the Administrator request legislation to amend the Act to allow full recognition of such tradeoffs. The Administrator should also encourage the States to modify their policies where needed to recognize such trade-offs.

Matters for consideration by the Congress

There are two matters we believe the Congress should consider. First, our recommendations call for carefully coordinated interagency actions to plan, fund and implement local wood residue assessments in each of the major forested regions of the country and to develop subsequent proposals for a national wood residues plan. Effective participation by both the Department of Agriculture and Department of Energy is essential to the success of these actions. We believe the Congress should consider the adequacy of participation and degree of cooperation and coordination displayed by the Departments in the course of reviewing their future appropriations requests.

Secondly, EPA chose not to comment on the draft of this report. EPA will be required by law to respond formally to Congress within 60 days of the publication of this report and Congress should review this formal response carefully. Since full consideration of trade-offs might reduce technology requirements and improve the economic feasibility of some wood energy facilities, we believe that the Congress should consider any needed amendments to the Clean Air Act to allow consideration of such trade-offs.

AGENCY COMMENTS AND OUR EVALUATION

We sent a draft of this report to the Departments of Agriculture, Energy, and Defense, the General Services Administration, and the Environmental Protection Agency. EPA chose not to comment on this report. All the other agencies sent comments and their complete responses are included as appendixes. In some cases their responses suggested clarifying language or other minor changes which we have incorporated into the report. The following discussion concerns only the more significant agency comments and our evaluation of them.

Department of Agriculture

The Department of Agriculture viewed our report as "positive" and said it could provide "an impetus for greater and more effective use of unutilized wood fiber." Acting through the Forest Service, the Department said it would assume the lead agency role in planning and conducting local wood residue assessments as recommended by GAO and in incorporating the results of the assessments into subsequent proposals for a national wood residues plan. The Department offered only two comments requiring further clarification. First, concerning our recommendation to preserve piled logging residues for potential future use, the Department said the idea had merit, but noted that the piles have adverse land management effects if preserved very long. Our recommendation states that this should only be done where possible without creating unacceptable forest management problems. The Department's comments indicate that such unacceptable problems will always be present if the piles are preserved beyond the period needed to replant the harvested area (usually, no more than a year or two). We believe that in many cases unacceptable problems can be avoided using techniques, which we mention in the report, already being employed in one Forest Service region. Thus, it may be possible to preserve some piled logging residues for longer periods if necessary to obtain their utilization under cyclical wood residue markets.

In a second area the Department took exception with our statement that the recommendations for Federal action would not necessarily imply any major increase in Federal expenditures, noting that there is at least a trade-off cost of agency resources diverted from other efforts. The Department may have misinterpreted our views. We did not intend to imply that our recommendations could be implemented without any change in expenditure levels or patterns. Rather, as indicated by the examples discussed on page 85, we believe there are a number of cost offsets and other factors which could significantly reduce the overall expenditure levels which might otherwise be anticipated.

Department of Energy

Overall, DOE agreed that wood residues should play an important part in achieving National energy goals, and made several comments on our recommendations for a cooperative Forest Service/DOE program of wood residue assessments. The Department did not comment on any of our other recommendations.

Concerning wood residue assessments, DOE agreed that the Forest Service should lead in their conduct, but did not believe that DOE should assist the Forest Service in funding the assessments. However, it appears that the Department has defined

the assessments to include only biomass inventory aspects rather than the comprehensive surveys of residue inventories, potential uses, utilization barriers, and solutions which we recommended. DOE noted that, aside from residue inventories, the other specific information that we recommended be developed through the assessments--the need for residues handling equipment, the alternative Federal roles in stimulating residue use, and the alternatives for reducing barriers caused by factors such as utility and air pollution regulations--involves energy matters within its lead agency responsibility. DOE said it intends to continue working with the Department of Agriculture and other agencies on these problems, but did not indicate its willingness to undertake these matters as part of the recommended assessments and as a basis for a national wood residue plan.

As noted in our report, we consider the initial wood residue assessments and subsequent development of a proposed national residue plan as vital to realizing more of the untapped potential of wood residues. We believe that DOE should take immediate action to cooperate with the Department of Agriculture in planning, funding, and implementing the comprehensive assessments and national residue plan development process outlined in our recommendations. We are not suggesting that DOE provide funding for aspects of the assessments which are clearly Forest Service responsibilities, such as inventorying the unused wood resource. Rather, we believe the Department should provide sufficient funding to allow full implementation of those features of the assessments which relate to energy matters within its purview.

DOE did not comment on five of our recommendations which call for actions concurrent with the wood residue assessments. These actions involve accelerated development of residue-handling equipment, conversion of Federal facilities to wood fuels, and promotion of wood use in non-Federal facilities. The Department should clarify these matters by providing its specific response to each of our recommendations in its written statements on this report to certain congressional committees as required by section 236 of the Legislative Reorganization Act of 1970.

Finally, in a comment not directed at our recommendations, DOE said it is implementing two proposed plans which include projects aimed at identifying ways to overcome barriers to wood residues use and that our report is incomplete in its description of one of these plans. However, our discussion with department officials confirms that the plans, which were prepared in July and August 1980, are revised versions of earlier proposals covered in our review which have been pending for a considerable period (see p. 77). One official, said the

plans are still considered to be in the rough draft stage, and may not be approved for a long time, if at all. If the Department believes that existing plans are still viable and are important in stimulating wider use of wood for energy, it should take the opportunity during its next appropriations cycle to remedy the current failure to allocate the proposed resources.

The Department of Defense

Regarding our first recommendations dealing with wood fuels, the Department of Defense said that its military departments already give wood equal consideration with coal in fuel conversions studies. We disagree. Although the shortrun goals for DOD installations emphasize conversion to solid fuels, evaluation of the potential for using wood fuels has been made at only a few of the more than 4,000 installations. We found that in implementing this policy the military services are predominantly looking to coal and giving little serious consideration to wood fuels.

For example, as our report noted and DOD's comments confirm, the Air Force requires that coal be the primary fuel in all new and replacement heating plants larger than 50 million BTU's per hour. The Air Force considers wood only as a possible secondary fuel to supplement coal. Similarly, while the Navy states that it is not prudent to rely soley on wood as a source of fuel for Navy shore plants, no such limitation is applied to coal. Finally, while 24 Army installations burn coal and several additional coal conversions are planned, use of wood fuels is planned at only 2 Army installations. We believe that DOD needs to take steps to assure that wood fuel is accorded equal consideration with coal for conversion of heating/powerplants in forested regions.

In commenting on wood fuel potentials, DOD said our report should focus on only 850 of its 4,000 domestic installations which it described as "major defense installations". However, the Department failed to state whether or not it agreed with our recommendation that it make a complete canvass of wood conversion opportunities at facilities in forested regions. For purposes of an initial canvass of conversion opportunities, it may be appropriate for the Department to begin by focusing on its major installations. However, we anticipate that the standard wood fuel evaluation methods to be developed jointly by the Forest Service and DOE will provide more suitable guidance on the size and type of facilities which DOD and other Federal agencies should evaluate for potential conversion opportunities. The Department should clarify this matter by specifying the actions it will take to implement the recommended canvass in its required statements on this report to certain congressional committees as required by section 236 of the Legislative Reorganization Act of 1970.

Concerning residue-based wood products, DOD said that its current policy is to consider such products as alternative materials if they meet performance criteria and are cost competitive. We do not believe that DOE has given sufficient attention to these alternative materials. Therefore, DOD's procurement guidelines need to specifically point out the value of these less energy-intensive products in meeting National energy goals.

Finally, in commenting on the scope of our review, DOD said we failed to contact appropriate offices in the military departments and, as a result, our report does not adequately reflect efforts of the departments to implement energy policy on wood use. In evaluating wood usage within DOD we made several contacts with officials of the military departments, beginning with the designated official for DOD-wide energy technology matters. We contacted all offices and officials to whom we were referred and, as agency comments note, DOD must assume responsibility for designating appropriate contacts. We believe the overall status of wood energy use in the military departments is correctly described in our report. The additional data on wood fuel activities presented in DOD's comments merely provide details of the overall limited program which, as of our review, had not resulted in a single DOD installation using wood to meet ongoing central heating/power-plant requirements.

General Services Administration

The General Services Administration agreed with our recommendations concerning evaluation of wood fuel opportunities and procurement of residue-based wood products. GSA said that it has no objections to giving wood equal consideration with coal in fuel conversions and that a canvass of wood conversion opportunities at buildings located in forested areas would be accomplished during fiscal year 1981. The agency said it would review its procurement guidelines and if necessary issue further guidelines for careful consideration of residue-based wood products and inform all purchasing units to procure such products when life-cycle cost effectiveness and suitable performance criteria are met.

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UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
P.O. Box 2417
Washington, DC 20013

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(TM)
NOV 6 1980

Mr. Henry Eschwege
Director, Community and
Economic Development Division
United States General Accounting Office
Washington, DC 20548

Dear Mr. Eschwege:

The following are USDA Forest Service comments on the draft of your proposed report to the Congress, The Nation's Wasted Wood Offers Vast Energy and Product Benefits.

The draft report is a positive document that can be an impetus for greater and more effective use of unutilized wood fiber. On the whole, we support its message.

Some general comments follow before we address the recommendations:

Use of the term "wasted" in the title and text - This term conjures the image that vast quantities of wood throughout the Nation are wasted. Waste in this context occurs when wood is not properly utilized for its full economic return. This occurs in some harvesting and manufacturing processes. On the other hand, a ridge of trees that has no access or economic transport cannot be viewed as waste. We prefer the term "unutilized". This term includes wood which is wasted, but it also includes all other wood that beckons an opportunity for utilization.

The term "residue" needs definition or replacement. The text uses the term loosely in reference to logging and wood processing and also to dead and living trees. Residue is normally viewed as that which is left over from some other part that is utilized. For logging and milling, butts, chunks, ends, slabs, edges, and the like are considered residues in the wood industry. Standing trees are not residues in this sense. A replacement term that includes both classes is "unutilized wood fiber" or "unutilized wood".

Digest

The draft states "Neither agency has evaluated vital differences between regions in types and quantities of residues and barriers to their efficient consumption". The Forest Service has worked by Region and State in its approach to closer

GAO Note: Page numbers have been changed, where appropriate, to correspond with the page numbers in the final GAO report.

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utilization of the forest resources from the beginning. We know by Region the differences in the resource and the barriers to its use and, to some extent, the best market opportunities. A formal plan for energy development was prepared in Region 4 and plan development in conjunction with DOE's Region 10 is well underway in Region 6. An energy coordinator has been appointed in each Forest Service Regional Office and Research Station.

The last sentence states, "The Forest Service uses surveys to project the nation's forest resources, but these surveys do not yield suitable data on residues potential." This is also discussed in Chapter 3, page 22 of the draft. The forest survey standards are established to meet the needs of the day. Demand for material from tops, limbs, brush, and debris in the past was so slight that the added expense of inventorying this material was not justified. The current interest in unused biomass to satisfy fuel and energy needs has changed the picture. In 1978 the Forest Service assigned a group to review and test formulae available from limited studies to use in compiling biomass volumes from existing inventory data. A compilation of biomass statistics by State will be published about January 1981. Meanwhile, studies, some financed by DOE, are under way to obtain data to refine formulae and estimating procedures. In 3 to 5 years, more detailed biomass data will be published. The data is both costly and time consuming to obtain.

Forest inventory standards have been adjusted to measure all woody material down to 1 inch in diameter. This will account for all but the very smallest and difficult to recover biomass on forest lands. By the end of the decade, we will have an accurate state-by-state assessment of the forest biomass and be in position to track the effect of closer utilization.

Page ii. "While the Forest Service and DOE have an interest in greater residue use, they have made little progress in developing a national wood residue plan." The Forest Service has prepared a publication, "A National Energy Program for Forestry," which is currently at the printers. It will provide a framework on which to develop the suggested plan. One is definitely needed.

Page ii. This page and page 27 of the text discusses the need to inventory the attitude of landowners and the availability of forest biomass. Attitudes tend to shift with time, conditions and land ownership. Such changes are frequent. We feel that long range inventory predictions based on the assumption that present owner willingness to harvest biomass will convey with ownership title are unrealistic.

"Federal actions to reduce barriers to wood residue use do not necessarily imply any major increase in Federal expenditures." We do not agree with this statement. Studies are not made without funds and people to conduct them. At minimum, there is a trade-off to not do something else when there are no additional resources. Further, the Government is not exempt from the same capital requirements as the private sector when decisions are made on installing or converting to wood using energy systems. Page 42 of the draft discusses investment capital barriers.

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Following comments refer to page number in the main body of the report following the Digest:

Page 1. The last paragraph should be updated and revised to read in part as follows:

". . .in 1980, the Forest Service estimated that about 600 million dry tons of unused biomass are available annually, excluding stumps and roots. If this amount of residues could be used for energy, it could add 10.2 quadrillion Btu's (QUAD's) to the Nation's current wood energy use of 1.5 QUAD's. This could increase wood's share of the 79-QUAD national energy budget from 1.9 percent to 12.9 percent and reduce daily oil imports by about 4.7 million barrels (59 percent)." The 10.2 QUAD'S contribution is potential. However, at today's economics, we feel a practical goal by 1990 is a 6.4 QUAD energy contribution from forest biomass.

Page 8. Table 1 should be updated as follows:

Table 1
Forest Service Estimate of Unused Wood
Available Annually

	Millions of Dry Tons
Excess growth and smaller trees	215
Mortality	95
Logging residues	160
Salvable rough, rotten, and dead trees	20
Wood processing residues	20
Residues from land clearing	20
Urban wood Residues	70
Total	600

Page 16. The first paragraph discusses logging residues in parts of the West which are piled or yarded after logging. The report states, "The piles are then often burned and the rest of the harvest area may also be broadcast burned to eliminate the remaining logging residues." The Forest Service has been successful in disposal of these piles in many cases. The piles have been sold for the chip market and also utilized by the public to a large degree for home firewood use.

Page 25. The first paragraph states, "Unproductive forest land is defined as land which is incapable of producing at least 20 cubic feet of industrial wood-per-acre-per-year. . . . However, such nonindustrial wood can be used in production of energy and reconstituted wood products." We agree wood from such lands could be used for energy. It should be recognized, however, that such lands produce less than 20 cubic feet per-acre-per-year because of the harshness of the growing site. To harvest this material in many areas would be equivalent to mining the wood resource. We need a further look at some of these lands in light of the energy wood market potential.

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Pages 54 and 55 first paragraph makes reference "As such, both agencies have a major stake in demonstrating and promoting use of wood energy technology which can create a market for unused wood residues. However, despite mutual interest the two agencies' total funding for wood burning demonstration projects at industrial, utility, and State and local facilities was only about $1.5 million in fiscal year 1980. In comparison to the respective Department of Energy and Forest Service overall research, development, and demonstration budgets of $3.8 billion and $108.8 million, funding for such wood-burning demonstrations seems mimimal." Forest Service research has concentrated its attention on the production and recovery of biomass for wood products including energy. Only one research project (the Koch Burner) funded partially by DOE is involved with combustion. For this reason, little of the Forest Service budget has been assigned to demonstration projects in wood burning. A Forest Service laboratory building completed in 1980 at Berea, Kentucky, will use wood for both heating and cooling. Operation of the equipment will be closely monitored and analyzed for cost effectiveness.

The State and Private Forestry program in cooperation with state forestry organizations has, by way of technical assistance, contributed to a number of wood burning demonstrations. Some examples include retrofit of brick kilns from gas to sawdust in the Carolinas, generation of electricity and retrofit of a hospital in Vermont, conversion of a textile plant from gas to wood in Georgia, and others. Most of these accomplishments occurred with little or no federal funding support. There is considerable opportunity to expand this effort if additional funds were available. The Forest Service has the experience and organization to effectively conduct such a program.

Page 76. First paragraph refers to Congress approving the Wood Residue Utilization Act of 1980. There is no such act. Two similar bills relating to use of wood for energy were introduced in the second session of the 96th Congress. These were H.R. 6755 and S. 1996. The bills are presently being considered for conference after the November election. The act title referred to above is from H.R. 6755.

Page 78. This page begins a discussion on the merits of long-term contracts guaranteeing a residue supply. The Forest Service is not opposed to long-term contracts. Our experience with many such contracts show many problems are attendant with them. Primary problems relate to the obsolescence of the contract as time brings new land management requirements and changing economics. Also, we have seen enthusiasm by proponents for a long-term contract diminish when they understand that stumpage under the contract is subject to periodic rate redetermination.

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Page 65. The last sentence of the first paragraph states the Forest Service has taken no action on a 1975 GAO recommendation to provide funds for a test sale program to compare the costs and effectiveness of the tree measurement and log scale methods. In August 1977, Former Chief McGuire directed a national review of log accountability and scaling practices. This review developed two action items on tree measurement:

1. Clarify national direction on use of tree measurement as a method of sale for National Forest timber.

2. Conduct a national workshop on tree measurement to identify problems and explore opportunities for increasing tree measurement in those situations where tree measurement sales are economically feasible and suitable.

The workshop was held in November 1979, and concluded tree measurement is a valuable and necessary technique with applicability in a variety of forest types Service-wide. Recommendations were made to the Chief. In addition, a task force is currently finalizing a review and action plan which examines the total measurement function of which tree measurement is a part.

Also, as a result of the fiscal year 1980 "Action Plan to Increase Timber Supply Through More Effective Utilization," we are initiating funding in fiscal year 1981 to evaluate utilization differences between tree measurement and scaled sales.

All the above actions are preliminary to implementation of a tree measurement program.

Recommendations - pages 84-88. We have enumerated the recommendations herein for reference purposes.

RECOMMENDATIONS TO THE SECRETARY OF AGRICULTURE AND THE SECRETARY OF ENERGY

1. "That the Secretary of Agriculture and the Secretary of Energy conduct a cooperative program of assessments in at least six locations around the country. The Secretaries should select the areas they believe hold the most promise for increased use of residues based on estimates of residue availability and cost and availability of competing energy sources. The assessments should include a detailed inventory of residue quantities and availability and an evaluation of potential residue uses, barriers to use, and proposed solutions. Specific information to be developed through the assessments should include:

a. —the cost of making detailed residue inventories in each assessment area, with projections of costs to make such inventories regionally and nationally;

b. --the volumes of wood residues that are potentially available in each area and the costs to collect and remove them using conventional equipment;

c. --the specific needs for improved equipment to lower collection and removal costs;

d. --the benefits and costs of, and alternative Federal roles in stimulating greater removal and use of wood residues by (1) modifying or initiating a number of possible forest management policies and programs on Federal, State, and private lands, and (2) encouraging private investment in new or modified facilities to use wood residues; and

e. --the extent of, and alternatives for reducing, additional barriers to residue use caused by utility practices and regulation, air pollution regulations, and other factors."

We concur with this recommendation. We understand the intent is to derive a definitive assessment within six areas that have economical promise. The six areas can be regionally located and could vary geographically by large or small size. For example, the Willamette Valley in Oregon could be one area while a county or community in New England could be another.

This assessment would be a pilot study at the local or regional level. From this, we would determine the feasibility of projecting and/or implementing a national assessment.

2. "We recommend that the Forest Service assume the lead agency role in making the localized assessments, but that Forest Service and DOE staff work closely in joint planning and implementation. We also recommend that DOE provide additional funding to the Forest Service as needed."

We agree the Forest Service should be the lead agency in making the localized assessments. Our decentralized organization and resources are suited very well for this role.

3. "A National wood residues plan, including proposed residue use goals and recommendations for legislation or other actions to overcome barriers to such goals, should be presented to Congress within two years following release of this report. It should be predicated upon and supported by the geographic site-specific assessments needed to understand regional variations in opportunities of residue conversion."

We concur. However, we feel the plan should be supported by the assessment rather than predicated on it. Therefore, the second sentence should read:

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"It should be supported by the geographic site-specific assessments needed to understand regional variations in opportunities of residue conversion."

4. "The Secretary of Agriculture and the Secretary of Energy should also work jointly to:

a. --Implement an accelerated program to develop and demonstrate residue-handling equipment in cooperation with private industry.

b. --Develop standardized methods for evaluating the use of wood energy in facilities, including allowance for benefits for improved forest management, and submit these methods to the Office of Management and Budget within 6 months for dissemination to the Executive Branch to assure consistency in life-cycle energy evaluation.

c. --Establish a program to promote use of wood fuels among industry, utilities, and State and local bodies by providing them with educational materials and direct technical assistance."

We concur and comment as follows:

Recommendation 4a. Development of new equipment is not cheap. A considerable portion of the Forest Service research budget is already directed toward special logging equipment for handling small trees and residues. Equipment Development Centers have tested and modified equipment for slash disposal. These efforts have resulted in some machinery and systems that have improved the economics of harvesting this material. But, progress is not adequate to make forest residues economically competitive with other fuels in most of the country. A much expanded effort is needed now in both harvesting and handling equipment development and testing. This will require increased funding.

4b. The Forest Service is conducting a study of the feasibility of using wood fired furnaces and small boilers in the 0.25-3.0 million Btu/h (output) range. This range encompasses most of the larger buildings or facilities of the agency. It also has wide applicability both in the private and federal sector. The study, known as the "Wood Fired Furnaces and Small Boiler Study," is being conducted by our San Dimas Equipment Development Center.

The Study has two main objectives:

(a) to investigate six potential retrofit projects for conversion to wood energy.

(b) to provide training for in-Service personnel in the area of design operation, economic analysis, and wood energy utilization.

The first objective includes the investigation of several aspects including combining thermal storage with pyrolitic combustion of wood. This approach presently appears to have major benefits of meeting air quality standards, reducing maintenance costs, and improving the utilization of the energy found in wood. A major concern is the cost effectiveness of this approach. Installation costs will be high. The DOE has been advised of this study. They have endorsed the concept as only limited attempts have been made in coupling thermal storage with wood energy and no studies have been made using "clean" wood energy/economics in the range proposed. The study will be completed about May 1981.

The second objective will be accomplished by conducting a seminar/workshop for facility engineers, architects (In-Service designers), and selected personnel from Research, State and Private Forestry. This workshop is tentatively scheduled for May/June 1981.

While the feasibility studies do not attempt to relate benefits of improved forest management to utilization of wood energy, we consider this effort a major step in determining the sensitivity of cost/energy efficiency. This is presently a barrier to increased use of wood biomass in the small commercial/institutional/industrial sector.

5. "Within their respective Departments, the Secretaries should:

a. --Convert all facilities to wood fuels for all or part of their heating/power needs where life-cycle evaluations show them to be cost-effective.

b. --Identify opportunities to demonstrate wood-energy technologies in order to enhance their prospects for future economic feasibility."

We concur. This is currently within the charter of the USDA Energy Survey/Retrofit Program for existing buildings. Present instructions are to investigate opportunities where apparent and prudent but execute only where cost effective.

Additional analysis criteria are being developed through the study being conducted by San Dimas Equipment Development Center. See discussion on "Wood Fired Furnace and Small Boiler Study".

RECOMMENDATIONS TO THE SECRETARY OF AGRICULTURE

6. "To further help reduce barriers to increase use of wood residues for energy and products, the Secretarty of Agriculture should:

a. --Upgrade its forest survey to provide an inventory of the total biomass of all trees and woody shrubs, logging residues, and dead trees on the nation's commercial forest lands.

b. --Utilize flexible patent policies which authorize granting a private firm an exclusive interest in residue-handling equipment and reconstituted wood product technologies developed wholly or partly with Federal funds when needed to stimulate commercialization.

c. --Increase promotion of new reconstituted wood product technologies developed with Federal funds by allocating necessary resources to effectively disseminate information and provide technical assistance to forest products firms.

d. --Adopt a more flexible policy to allow use of long-term contracts for assuring a continuous supply of residues to a user when needed to achieve increased residue use in a given area.

e. --Demonstrate Forest Service ability to conduct tree measurement sales and convert the agency's western regions to the tree measurement basis as rapidly as possible.

f. --Preserve piled logging residues for potential future use by foregoing burning whenever possible without creating unacceptable forest management problems."

We concur with the following comments:

Recommendation 6a should be changed to ". . .provide an inventory of the total biomass of all trees and potentially harvestable woody shrubs, logging residues, and dead trees on the nation's commercial forest lands."

6b. We are constrained by law to give exclusive rights for use of USDA patents. We would support legislative change for a more flexible patent policy.

6c. Demonstrated success of a new reconstituted wood product technology would have more effect with forest products firms than the promotion of the same. We feel the recommendation should be to "Increase demonstration. . ." of such technology rather than to "Increase promotion. . ."

6d. Our comments on long-term contracts were discussed earlier.

6e. Here too, we have discussed tree measurement sales earlier. However, we have no evidence that indicates tree measurement sales result in greater wood utilization on-the-whole than scaled sales.

6f. The preservation of piled logging residues for potential future use has adverse land management effects if the preservation is for very long. Such piles occupy tree growing sites and provide a source of intense fire under wildfire conditions.

We feel the idea has merit, but prefer not to retain or preserve residue piles beyond the period necessary for regeneration of the particular harvested unit. Removal of the material to special concentration areas may be an alternative but a very costly investment.

RECOMMENDATION TO THE SECRETARY OF DEFENSE AND TO THE ADMINISTRATOR, GENERAL SERVICES ADMINISTRATION

7. "To provide a major stimulus for wider wood residue use in the near term in support of national energy goals, and in recognition of the extensive facilities construction, renovation, and management programs of the Department of Defense and the General Services Administration, we recommend that the Secretary of Defense and the Administrator, GSA:

a. --Assure that in implementing existing policies for conversion of heating/power systems for oil and natural gas to alternative fuels at DOD and GSA facilities in forested regions of the country, wood is given equal consideration with coal. A canvas of wood conversion opportunities should be accomplished, to later be tested by the standard feasibility evaluation methods developed by the Forest Service and DOE.

b. --Issue procurement guidelines (1) requiring that, because of their value in meeting national energy goals, residue-based wood products be carefully considered as alternative materials for all construction and related applications and (2) directing all purchasing units to procure such products whenever their cost is equal to or less than competing materials and suitable performance criteria are met. The guidelines should require that, in making cost comparisons, the purchasing units include not only direct acquisition costs, but also related construction costs and life-cycle cost."

In 7b, item (1), we suggest the phrase "residue-based wood products" be changed to read "solid and residue-based wood products". The change would include dimension construction lumber as well as reconstituted products. In item (2), we suggest that a "construction materials" policy be adopted: . . . "to use wood, where appropriate." This has been a Forest Service policy for years and has not caused problems using concrete, steel, and other

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materials in building construction. The key is . . . "where appropriate."

RECOMMENDATION TO THE ADMINISTRATOR, ENVIRONMENTAL PROTECTION AGENCY

8. "To help promote wood residue use for producing energy at powerplants and cogeneration facilities in locations where current Federal and State air pollution regulations would otherwise prohibit such facilities or require expensive pollution control equipment which might prevent their construction, we recommend that the Administrator, Environmental Protection Agency, adopt flexible policies and procedures which recognize emissions trade-offs from reduced burning of residues in the woods or in other locations resulting from proposed wood energy facilities, and allow such trade-offs to be considered in deciding whether a facility may be constructed and what type of pollution control equipment will be required. The Administrator should also encourage the States to modify their policies where needed to recognize such trade-offs."

There is considerable opportunity for onsite direct combustion process/comfort heat. This use would be in a smaller range of appliances than implied in the recommendation. EPA should review the air quality standards for appliances below 10.0 million Btu/h.

We appreciate the opportunity for our staff to meet and talk about the draft with Messrs. John Hadd and Jack Pivowar on October 10.

Sincerely,

for Kenneth L. Rogers

R. MAX PETERSON
Chief

APPENDIX II

ASSISTANT SECRETARY OF DEFENSE

WASHINGTON, D.C. 20301

MANPOWER,
RESERVE AFFAIRS
AND LOGISTICS

8 NOV 1980

Mr. W.H. Sheley, Jr.
Acting Director
Procurement and Systems Acquisition Division
United States General Accounting Office
Washington, D.C. 20548

Dear Mr. Sheley:

This is in response to your letter of September 10, 1980, which requested Department of Defense (DoD) comments on the General Accounting Office (GAO) draft report of September 10, 1980, "The Nation's Wasted Wood Offers Vast Energy and Product Benefits," GAO Code 008420, OSD Case Number 5528.

Our comments are enclosed and address the following:

- GAO representatives did not seek information from the appropriate offices within the military departments,
- Amplification of defense energy policy on the use of wood,
- Expansion and clarification of the efforts of the military departments to use more fully our wood resources,
- Discussion of the recommendations to the Secretary of Defense, and
- Discussion of one recommendation to the Secretary of Agriculture and the Secretary of Energy.

I trust that this information will be helpful in your efforts to finalize the draft report. If we may be of further assistance, please call Edward Dyckman (697-1988) of my staff. Mr. Dyckman is the central point of contact within the Department of Defense for this audit.

Sincerely,

Richard Danzig

Richard Danzig
Principal Deputy Assistant
Secretary of Defense (MRA&L)

Enclosure

Department of Defense Comments on the GAO Draft Report of September 10, 1980, "The Nation's Wasted Wood Offers Vast Energy and Product Benefits" (GAO Code 008420)(OSD Case No. 5528)

GAO representatives did not seek information from the appropriate offices within the military departments.

The paucity of information in the draft report on the efforts of the military departments to implement defense energy policy for wood usage reflects the lack of GAO representatives' consultation with the appropriate offices within the military departments. Each military department has a special assistant for energy matters, as well as an energy office, to manage departmental energy programs and take lead action in designated energy areas of importance to the military departments. We have verified that GAO representatives did not discuss their investigation with either the office of the special assistants for energy or the energy offices of the military departments. As a result, the information in the draft report does not reflect adequately the efforts of the military departments to implement defense energy policy on wood use. The GAO representatives did discuss their investigations with a few field organizations of the military departments, and, as a result, obtained incomplete information concerning DoD efforts to use fully our wood resources. The central point of contact for this study within DoD must assume part of the responsibility for not assuring that the proper GAO-military department communications were initiated. The remaining comments will serve to expand upon and clarify the military department's efforts to implement defense energy policy and to use wood in their fixed facilities.

Amplification of defense energy policy on the use of wood. Defense energy policy, as stated in the draft report, is correct, albeit abbreviated. We have two specific goals that include the use of wood. One is to obtain an increasing percentage of total energy from coal (solid coal, coal liquids, and coal gas), refuse derived fuel, and wood. These increases in percentage of use will be met according to the following timetable:

- 10 percent of the total facility's on-base generation of utility energy by fiscal year 1985,
- 15 percent by 1990,
- 20 percent by 1995, and
- 35 percent by 2000.

The second goal is to obtain an increasing percentage of total installation energy from geothermal and renewable energy sources using the following technology applications: geothermal heating and electric, lowhead hydropower, solar heating and cooling, solar electric, biomass (municipal solid waste, refuse derived fuels, and wood), wind, and ocean thermal. These increases in percentage of usage will be met according to the following timetable:

- 1 percent of the total facility's utility energy by fiscal year 1985,
- 5 percent by 1990,
- 10 percent by 1995, and
- 20 percent by 2000.

The military departments are programming funds to meet these and other defense energy goals. It may be seen that wood use, although an important element within the defense energy program, is only one of several means through which the military departments may meet energy supply goals.

Expansion and clarification of the efforts of the military departments to use more fully our wood resources.

The draft GAO report indicated correctly that the DoD is the largest single energy consumer in the United States. The report goes on to suggest that we have the opportunity to use wood waste at over 5,000 installations. While there are approximately 4,000 defense installations in the United States and 1,600 defense installations overseas, the majority of these are small and remote. For example, many of these installations may be radar sites on one acre of land or less. These small installations cannot be considered viable candidates for wood burning for economic and logistic reasons. Rather than overstate DoD's potential to use wood waste at its 5,000 installations worldwide, we recommend the report focus on our efforts to burn wood at the 850 major defense installations in the United States.

Further considerations on the burning of wood at our major installations include: wood waste availability, economics, and the need for military installations to maintain a duel fuel capability wherever possible. These considerations are described in greater detail in the military department comments that follow.

Department of the Army.

The Army is the lead military department in this energy technology area of wood burning. In February 1974, soon after the OPEC embargo of 1973, a contract was awarded to study the feasibility of meeting energy needs at 24 Army installations through the use of "energy plantations."

The study addressed potential acreage, fast-growing species which could be harvested, rainfall, potential fuel savings, harvesting equipment requirements, environmental problems, and other related factors. Findings indicated that a potential exists to obtain supplemental energy from wood at 15 large Army installations. This study formed the basis for subsequent investigations and project planning.

The Army has been testing sawdust and pelletized wood in equipment ranging from small heating units to large central boiler plants to obtain experience with wood as a major energy source. Particular interest was given to tests of wood pellets in 1979 in a large central plant at Fort Benjamin Harrison, where the boilers and fuel handling equipment were designed to burn coal. Large coal-fired boilers at Rock Island Arsenal were also operated on wood pellets during 1979 and provided additional information. Fort McCoy is successfully using wood as the only source of fuel in a number of smaller boilers designed specifically for this purpose. These tests began in March, 1978, and are being expanded. Results of the operation are being monitored through the Corps of Engineers Construction Engineering Research Laboratory (CERL). Sierra Army Depot has also burned wood pellets successfully in equipment which normally burns coal.

The first new large boiler plant for operation with wood chips was planned in 1978, when a project was included in the proposed FY 1980 military construction program for Red River Army Depot. Congress approved this project. The boilers and fuel handling systems will be capable of operating on wood chips or coal, although it is intended that wood chips be used to the maximum extent available. The wood chips are available in large quantities from waste wood which arrives at the depot in connection with its mission. This plant will replace two existing plants that burn oil and natural gas. Another large project is planned at Fort Stewart, which has a particularly large forested area. We expect Congressional approval in the FY 1981 military construction program. Fort Stewart has a large timber harvest program, and we intend that waste wood and harvesting slash be used for fuel. This plant will also be supplemented with coal. In each location, experiments will permit the Army to identify the maximum available wood which can be used for energy without impacting adversely on other programs, i.e., timber sales and environmental programs.

A number of other studies that CERL and architect engineers are conducting provide valuable information. One study investigated the potential for joint ventures between Army installations and local utility authorities in the field of biomass.

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The Army has begun a major program for conversion from oil and natural gas to solid fuel. The term solid fuel includes coal, wood, refuse, and fuels derived from these sources. The fuel selection is based on availability and economics. We also intend that new or converted plants include sufficient flexibility to operate on more than one fuel wherever warranted. For instance, tests have shown that certain types of coal-fired equipment can burn pelletized wood with minor adjustments. This will permit use of wood, or a mixture of coal and wood, to the extent that wood is available and economical. The boiler plants which are included in the solid fuel conversion program are being prioritized primarily on the basis of oil or natural gas saved per dollar cost for the fuel change modifications. Geographical locations distance from fuel supplies and air pollution abatement criteria are also considered, however.

Direct combustion of wood is not the only area being investigated. Gasification and pyrolytic oils are also being studied. Present information indicates the greatest gain per dollar expended is in the use of direct combustion, however. This approach also permits use of existing technology and earlier attainment of the objective. One disappointing factor has been the cost of wood pellets due to transportation from remote locations. Additional sources of pellets are materializing and costs are expected to decline.

Although a vast potential of wood residues exists, there are practical limitations on harvesting of this as a source of energy. In each case, an optimum compromise must be sought between the use of wood opposed to the use of coal, which is the primary alternate source of solid fuel. The environmental balance must also be observed, since dead trees and forestry wastes can be an important link in the ecological chain, in addition to a source of soil nutrient as they decay. The present planning is to consider the waste from timber harvesting, i.e., tree tops, branches, and other biomass sources to the extent feasible and economical. Saleable timber will not be used for energy unless economics clearly support this action.

In summary, the existence of a vast potential of wood residues which could supplement energy supplies and construction materials has been recognized. The Army has a dynamic program underway to utilize these resources and is prepared to share this information with all interested agencies.

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Department of the Navy

On the use of fuels for shore installations' boiler and power plants, Navy policy is to explore the feasibility of waste wood as a fuel option. For those feasibility studies, both the economics of wood fuel and long term assured availability of wood as a fuel are dominant parameters. In view of Navy readiness needs to assure continued reliable utility plant output, it is not considered prudent to rely solely on wood as a source of fuel for Navy shore plants. The addition of a wood burning capability to an existing or alternate fuel, such as coal, is considered appropriate when economics and availability indicate this to be to the Navy's advantage. The use of waste wood as a boiler plant fuel is also extremely site specific. Therefore, feasibility studies concerned with the use of this fuel are restricted to those geographic areas such as the Northeast and Northwest where wood fuel would be available.

Examples of specific Navy endeavors in the use of waste wood as a fuel are as follows. The Navy fiscal year 1982 Energy Conservation Investment Program (ECIP) includes a project at the Naval Air Station, Brunswick, Maine, to add wood burning capabilities to the station central heating plant. If the Congress authorizes and appropriates this project, the consumption of approximately 50,000 barrels of fuel oil per year at Brunswick could be avoided. In addition, the Navy is seeking a replacement steam plant at the Naval Shipyard, Puget Sound, Washington. While this project presently calls for coal as the primary fuel, ongoing efforts are exploring all fuels, including the capability for a future add-on to burn up to 50 percent of either refuse derived fuel or waste wood. Feasibility studies to involve use of waste wood as a fuel are also presently underway for boiler plants at the Marine Corps Base, Camp Lejuene, North Carolina; the Marine Corps Air Station at Cherry Point, North Carolina; the Naval Submarine Base at Kings Bay, Georgia; and the Naval Weapons Support Center at Crane, Indiana.

The Navy evaluates regularly the energy and cost savings potential of using waste wood as an industrial fuel. The realities of long term availability of wood as a fuel and the existing lack of a dedicated industry to reliably provide such fuels are important factors that must be considered, however. While wood does offer the potential for substitution of fuel oils, its site specific and fragmented supply aspects often prevent its viable competition with coal as an alternate fuel.

APPENDIX II

Department of the Air Force.

Air Force policy is that all new and replacement heating plants greater than 50 million BTU per hour will be designed to burn coal as the primary fuel, and that an alternate fuel be considered such as wood or refuse derived fuel. If it is found to be feasible and economical, the plants will burn coal as well as the alternate fuel, thus providing a dual fuel capability.

Conversion and replacement of existing central heating plants will give the Air Force a larger reduction in natural gas and oil consumption per dollar invested. The installation of a distribution system and conversion of individual units to a central system will cost as much if not more than a central heating plant itself. Therefore, Air Force policy is to convert and replace existing plants before new plants and distribution systems are installed. This policy is in keeping with the intent of the Power Plant and Industrial Fuel Use Act of 1978, (PL 95-620) and Executive Order 12217 of June 15, 1980, to convert large central plants to coal or alternate fuels.

Regarding use of wood, the Air Force burned a pelletized wood fuel at Kingsley Field, Oregon, until the air field was turned over to the local municipality. Wood pellets were also tested at Loring AFB, Maine, in May, 1979. The wood pellets were shipped from Oregon in a covered rail car. The test concluded that to burn wood, a new fuel handling system would be required to prevent losing a considerable amount of fuel due to breakage and spilling. A new system would also correct a dust problem that had the potential to result in an explosion.

The draft GAO report referred to an Air Force study entitled, "Forrestry Lands Allocated for Managing Energy (FLAME)," that the Civil Engineering and Development Center prepared in 1978. The FLAME study was a broad based survey to identify Air Force bases where wood energy conversion warranted the investigation. Of all the bases identified in the study as having a potential to meet their energy needs with wood residue from their own forestry programs, only Arnold Air Force Station had a central heating plant. Arnold was studied subsequently for burning wood, and we concluded that a reliable source of wood was not available in the quantities required annually. Furthermore, the additional manpower, equipment, and storage facilities necessary to burn wood made the effort uneconomical. As a follow-on to the FLAME study, the Air Force has been conducting an in-depth techno-economic analysis of using local forest

resources at the FLAME bases to meet their annual facility energy requirements. This study will be completed in November, 1980, and will identify bases where the biomass energy island concept appears to be most promising. The technical and economic basis for these conclusions will be given.

The Air Force is also engaged in a cooperative effort with the Solar Energy Research Institute (SERI), Department of Energy, to assess advanced small-scale wood energy conversion technologies for potential use at military bases. The Army is cooperating in this study, which will be published as a joint technical report in mid FY 1981. It will provide information to support the planning, programming, and implementation of advanced wood energy technologies for military use and will identify problems requiring resolution before specific technologies can be considereed viable.

Discussion of recommendations to the Secretary of Defense.

The report recommends to the Secretary of Defense that he give wood equal consideration with coal for conversions of heating or power plants from oil and natural gas to alternate fuels at DoD facilities in forested regions of the country. As indicated in the previous comments, the military departments currently give wood equal treatment with coal. On the recommendation to work with the Forest Service and DoE in these efforts, we will continue to do so.

The report recommends to the Secretary of Defense that guidelines be issued to require consideration of residue based wood products as an alternate material for all construction applications. Many residue based wood products are used presently in military construction. Sheathing, underlayment, and siding are some examples where those products are used. Our policy is to consider commercially available products as alternative materials, provided the material meets performance requirements and is cost competitive. When residue wood products meet our construction standards and engineering criteria, and are competitive with competing materials, they are considered and often used.

Discussion of recommendations to the Secretary of Agriculture and the Secretary of Energy.

We support the recommendation to the Secretaries of Agriculture and Energy to develop jointly a comprehensive and coordinated national plan to use wood residues for both energy and products. This plan would include a detailed inventory of residue quantities and availability, and an evaluation of potential residue uses, barriers to use, and proposed solutions.

APPENDIX III

Department of Energy
Washington, D.C. 20585

OCT 24 1980

Mr. J. Dexter Peach, Director
Energy and Minerals Division
U. S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

We appreciate the opportunity to review and comment on the GAO draft report entitled, "The Nation's Wasted Wood Offers Vast Energy and Product Benefits." The Department of Energy (DOE) agrees that increased emphasis on energy derived from nonconventional sources such as biomass, including forestry residue and waste, is important in achieving our national energy goal. DOE agrees that wood residues and wastes are an integral part of an overall wood program and recommends, for the near term, that residues and wastes be a particularly important part of the total wood program.

DOE's Multiyear Plan, draft dated July 1, 1980, and the Wood Commercialization Plan, draft dated August 1980, include many of the projects mentioned in the GAO draft report. These plans focus on developing an inventory of residues and wastes and improving harvesting systems to make maximum use of residues and wastes. Our plans recognize the need and suggest ways to overcome economic, institutional, environmental and technological barriers to the use of wood residues, and we are implementing the projects outlined in these plans. Careful review of the report indicates that it is incomplete in its description of the FY 80 DOE wood commercialization program. For example, the draft report does not mention that the wood program plan encourages information technology transfer to potential end-users to accelerate knowledge about, and utilization of wood or that it advocates the establishment of a reliable supply infrastructure.

We agree that an accurate assessment of all forest biomass, including residues and wastes, is important. We are working with the U. S. Department of Agriculture/U. S. Forest Service to support development of methodology to make complete measurement in order that the Forest Service can fulfill its legislated mandate to assess all merchantable forest resources. We believe that the resources necessary to conduct the program of localized assessments should be provided by the Department of Agriculture and that they should assume the lead responsibility for that activity. However, other areas are considered to be energy matters fully within the lead agency responsibility of the Department of Energy. These include: 1) identifying the specific needs for improving equipment to lower collection and removal costs of wood intended for energy uses; 2) studying alternative Federal roles in stimulating the use of wood as an energy source and in encouraging private investment in facilities to utilize wood energy; and 3) developing alternatives to overcome

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barriers caused by utility practices and regulations, air pollution regulations, and other factors. We intend to continue working with the Department of Agriculture and other agencies to solve these and many other problems inhibiting the large scale use of wood as an energy resource.

DOE shares GAO's concern about environmental impacts of the use of wood residues. The draft report could be criticized by the environmental community because it does not adequately emphasize the potential deleterious effects on the availability and quality of both water and soil that could result from extensive forest residue removal. Increased removal can decrease site productivity due to erosion of nutrients, organic matter, and soil. Energy farming will require substantial land and water resources and will have water and air quality impacts similar to conventional agriculture.

In conclusion, the Department's policies and programs continue to support the utilization of wood residues as an integral part of its wood production program.

We appreciate this opportunity to comment on the draft report, and trust that our comments will be considered in preparing the final report.

Sincerely,

R. Marshall Ryan
Controller

APPENDIX IV

Exhibit

General
Services
Administration Washington, DC 20405

OCT 16 1980

Honorable Elmer B. Staats
Comptroller General of
the United States
General Accounting Office
Washington, DC 20548

OCT 22 8:49

Dear Mr. Staats:

This is in response to a draft of a proposed report of the General Accounting Office (GAO) entitled "The Nation's Wasted Wood Offers Vast Energy and Product Benefits" which was forwarded to the General Services Administration (GSA) for comment.

In reply to specific issues addressed in this report, GSA has no objections to giving wood equal consideration with coal in converting from existing oil or gas heating systems in forested regions of the country. GSA is continually looking for alternative fuel sources which will broaden the supply of fuels which can be utilized and reduce our vulnerability to supply interruptions. Alternative fuels will assist the agency in continuing to provide economical, reliable and efficient service in the management of its property. In the issue of alternative fuels supply, GSA is presently concentrating on converting the large central heating plants and diversifying the types of fuels that can be used at these locations.

A canvass of wood conversion opportunities will be accomplished during fiscal year 1981 for those buildings located in forested areas. When available, the methodology for standardized feasibility evaluations developed by the Forest Service and the Department of Energy will be forwarded to the applicable GSA regional offices to use in evaluating the conversion opportunities that have been identified. A standardized method for evaluation is needed to insure that appropriate fuel escalation, maintenance and operating factors as well as opportunity costs figures are employed consistently throughout the Federal sector.

In the issuing of procurement guidelines which require careful consideration of residue-based wood products as alternative materials for construction and related applications, GSA will review the procurement guidelines to determine that residue-based wood products are not excluded solely because a constituent of the product is made of wood and not because of other overriding reasons.

In the materials used for construction and related applications, one must consider and include the factors of durability, maintainability and limited flammability in evaluating the applicability of using wood.

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When the cost of wood products is equal or less than other competing materials based on life-cycle costing analyses, all other factors being equal, these products will be considered for use in construction materials. After the review of the procurement guidelines is completed, GSA will issue guidelines if necessary for the careful consideration of residue-based wood products in construction and other applications as alternative materials and inform all purchasing units to procure such products when life-cycle cost effectiveness and suitable performance criteria are met.

In a brief overview of the buildings within GSA, less than one-third of the 8,000 buildings operated or leased by GSA are owned by the Federal Government. The vast majority of these buildings are located in urban areas. Because of siting limitations for wood fuel at the buildings as well as the lack of development of the transportation and marketing sectors to supply the wood in a dependable and sufficient manner and to be competitive in price with other fuels, it is doubtful that wood will be utilized in these urban areas. However, GSA does operate about 200 border stations. Because of the nearness to abundant and indigenous wood fuel supplies, some of these border stations may be candidates for further evaluations as well as other selected small buildings located in forested areas.

Sincerely,

R. G. Freeman III
Administrator

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