FOREST SERVICE ENERGY RESEARCH OVERVIEW

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The utilization of woody biomass is becoming increasingly important to each of the three major management areas of the Forest Service -- National Forest System, State and Private Forestry, and Research.

The National Forest System has management responsibilities for more than 150 National Forests throughout the country. An important goal of forest managers is multiple use management of these forest to obtain maximum benefits for all U.S. citizens. Timber harvesting and utilization is an important component of this goal, but a profusion of low-value woody biomass on many forests makes this is task more difficult. For instance, low value hardwoods of poor form or from low-value species are difficult to harvest and utilize profitably. Yet, if these cull trees are left on the land, they interfere with the establishment and care of more desireable tree stands. The problems are much the same with softwoods killed by insects and disease in different parts of the country and mortality of trees from natural destruction such as fire, high winds, or even a volcanic eruption as on Mount St. Helens.

The National Forest System has long had a fuelwood use program through which homeowners are issued permits for cutting of firewood to provide fuel for heating their own homes. This has always provided some assistance in removing undesirable material from the forest, but it has become much more significant since the oil crisis of 1973. Firewood gathering is now a major activity on many forests. In the past, most firewood-cutting permits were issued at no costs. However, in 1983, a nominal minimum fee was instituted. Thus, in 1983, there was a slight dropoff from 1982 when nearly 5.6 million tons (4.7 million cords) were removed.

The National Forest System also has demonstration projects with industrial fuelwood users based on innovative timber sales approaches. In one example, removal of firewood from a sawtimber sale earns a timber purchaser credit for cleanup that can be applied toward brush cleanup responsibilities. In California, in preparation for more intensive utilization, a biomass inventory of National Forests is underway.

The State and Private Forestry section of the Forest Service is concerned with assistance to private forest landowners and State and local government organizations. One program, Cooperative Forest Management, has wood energy specialists to assist in setting up local wood energy programs. As a part of this program, a procedure has been developed to provide a relatively fast method for ascertaining the feasibility for an industry to replace a fossil fuel-burning energy system with a woodburning one. The preliminary economic analysis may also be used to compare the economics of alternative systems where no energy system exists. State and Private Forestry also provides management assistance to produce wood for energy on nonindustrial private lands.

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[1]Maintained in cooperation with the University of Wisconsin.

In the third area of emphasis in the Forest Service Research, we have 79 research work units in which some portion of the work is energy related.

These projects involve research in silviculture; forest products utilization; resource evaluation; economics, marketing, and taxation; tree genetics; harvesting and forest engineering; insects and disease; fire behavior; and air quality.

An aspect of silvicultural research that has a heavy energy orientation is mine land restoration and reclamation and mine spoil reclamation. Restoration of strip-mined lands and mine-spoil banks to productivity with tree plantations is important to reduce adverse environmental impacts from coal mining and, possibly, to provide a new source of fuel from the trees that are grown.

Growing trees by intensive culture for energy and other purposes is of interest for many locations, not only mine lands. At Rhinelander, WI, we are cooperating with the Department of Energy in research to produce high yields of tree biomass in short rotations.

In Nevada and Arizona we have projects on pinyon-juniper woodland management and ecology. Pinyon-juniper production for energy and other purposes offers the potential for more effective use of arid lands.

Other silvicultural research projects can provide increased production of wood for energy through improved natural stand management. Such projects are at Provo, UT, Grand Rapids, MN, Columbia, MO, Parsons, WV, Durham, NH, Orono, ME, Warren, PA, Delaware, OH Corvallis OR, Olympia, WA, Wenathchee, WA, Redding, CA, Honolulu, HI, Fort Collins, CO, Laramie, WY, Rapid City, SD, Lincoln, NE, Asheville, NC, Clemson, SC, Gainesville, FL, Charleston, SC, Alexandria, LA, Sewanee, TN, Stoneville, MS, Auburn, AL, and Monticello, AR.

We have wood utilization energy-related research at eight locations. These involve utilization of wood to produce energy, or processing and using wood to conserve energy. Center for this work is the Forest Products Laboratory in Madison, WI.

Our research on conversion of wood to fuels ranges from solid wood fuel to charcoal and fuel alcohol from wood. In 1980, the Forest Products Laboratory be an work on a two-stage hydrolysis process first proposed by the Stora Kopparberg Company in Sweden about 1944. The two-stage process is particularly appropriate for hardwoods, since it facilitates recovering both 5- and 6-carbon sugars from wood particles. Single-stage processes concentrate mainly on 6-carbon sugars, but the 5-carbon sugars are a significant fraction in hardwoods. They may be used as raw materials for valuable chemical products. The use of higher temperature and less processing liquid in the new process requires about 25 percent less capital investment, and energy costs are reduced about 40 percent. The research is now being adapted for design and construction of a pilot plant by the Tennessee Valley Authority.

We are particularly optimistic about research that may lead to fermenting 5-carbon sugars to ethanol. This could bring about a doubling of the ethanol yield by acid hydrolysis of hardwoods that are currently in large surplus in the Eastern United States. Another prospect for increasing the ethanol yield from wood is through research on enzyme hydrolysis.

We have some strong research and development programs to improve the processing of wood to various products. Improvements in processing go

hand in hand with energy conservation. Based on past experience, we can make some big savings in future processing efficiencies. For example, recent Forest Products Laboratory research on press drying of paper has resulted in a new process that can reduce the total energy consumed in making paper from hardwoods by 19 percent.

At the Forest Products Laboratory, renewed emphasis is being given to research on combustion and gasification of wood. Information has been obtained on the kinetics of wood combusted in suspension that may be used to design more efficient wood burning equipment.

Fundamental work on wood combustion is an essential step toward increasing efficiency above the best levels now attainable. We are hopeful that some new research efforts on pyrolysis and gasification of wood will also result in a more favorable position for wood fuel in comparison to gas, oil, and coal.

Because of changed building construction practices as a result of rising energy costs, more building insulation is being used, and air leakage in buildings is greatly reduced. These factors can combine to create moisture problems within walls, floors, and roofs of woodframe homes. Researchers at the Forest Products Laboratory are taking several approaches to insure that moisture accumulation does not become a major problem. A theoretical model, which considers the effect of air leakage, has been developed to analyze moisture movement through walls. Data on seasonal moisture changes in walls have been obtained with field experiments. Manufacturers of siding and insulation materials are using results of these studies in their product application recommendations to builders.

At other research stations, researchers are working on more intensive utilization of local species and evaluating the effects of more intensive removal of biomass from forests on soil nutrients and soil erosion.

Utilization researchers also work on assessment of existing biomass. Traditionally, timber inventories have provided information only on availability of wood for high-value uses such as lumber, veneer, poles and pulpwood, but equations are now being refined to accurately determine total tree biomass from timber inventory data.

Resource evaluation research is concerned with better documentation of the total forest resource. Biomass is included in periodic forest inventories as required by a new Resource Planning Act. A new inventory system is being used in Alaska to survey the natural resources on 32 million acres of the Tanana River Basin in interior Alaska, an area as large as Alabama. The system uses imagery from satellites small- and large-scale aerial photography plots, and a newly developed field plot system.

Economics marketing, and taxation research work projects also include energy-refated research. A maple syrup and wood energy project in Vermont is heavily energy oriented, even in the maple sugar part of the work. Woodfuel is used in evaporators to process the maple syrup.

The Forest Products Laboratory, aided by the University of Wisconsin Survey Laboratory, surveyed U. S. households to learn about residential woodburing and about sources of fuelwood. The found that fuelwood use increased to 42 million cords or 3 to 4 billion cubic feet in 1981. This was one-fourth the amount used for all other wood products. The survey also showed that about one-fourth of all U.S. households

burned wood. Half of all woodburners used fireplaces and burned one-fourth of all fuelwood. The other half of all woodburners burned wood in stoves or furnaces and consumed three-fourths of all fuelwood. Fuelwood cut from woodlands was salvaged mostly from dead or down trees and logging residue. Only 28 percent of the fuelwood came from standing live trees. The estimated value of wood sold commercially to household woodburners was $620 million during 1981.

Genetics can play a major role in the selection of hybrids and superior trees to obtain maximum biomass production along with other desired traits such as disease resistance. Clones of hybrid poplar trees developed at our Northeastern Station are beginning to be used in plantations to produce biomass for energy in the Northern United States.

Harvesting wood for energy has some unique problems. Normally energy wood is lower value wood composed of smaller trees and trees that are defective because of crookedness, decay, or other reasons. Despite the fact that smaller and defective trees are less valuable, they are often more expensive to harvest. Researchers at the Intermountain Station field-tested and evaluated several harvesting systems that handle small trees more efficiently than conventional harvesting. The researchers found that the most effective systems incorporated feller-bunchers, grapple skidders, and whole-tree chippers, with equipment to load skidders and transport logs and chips. The benefits are a clean logging site with no residue, utilization of all material harvested, and recovery of both logs and chips to obtain maximum value. Southern Station research engineers have evaluated several recently developed machines for thinning southern pine forests. The results of these studies provide information on production rates, costs, and physical impacts to the soil and residual trees. Several Southern forest products companies are using the information in trials of plantation thinnings.

Insect and disease research projects provide technology for controlling infestations in tree plantations for energy and other products. Likewise, research to control insects and diseases in natural forests provides the means for conserving trees which would be destroyed and rendered unavailable for energy and other uses.

Fire and atmospheric sciences research is concerned with fire prevention, hazard reduction, and prescribed burning that have energy-related components. Modeling of wildfire behavior and evaluation of particulate emissions from open fires provide basic information that maybe applied to attain greater efficiency in controlled burning of wood. Modeling also provides guidelines on the potential for improving air quality through combustion of wood for fuel rather than through incineration on the forest site.

Continuation of Forest Service projects with energy components will provide solutions to many of the problems and constraints to wider fuelwood production and use. The greatest constraints today are harvesting and transportation costs resistance by traditional wood users to new outlets for raw material, deficient technology to convert to gaseous and liquid fuels, environmental pollution, and lack of infrastructure for handling wood fuels. It will take creativity and imagination to work against these constraints and other adverse economic factors to utilize wood for energy. Our goal is to utilize wood for energy when that is the highest and best use of the resource. Attaining this goal will help to achieve good forest resource management.

Zerbe, John I. Forest Service energy research overview. In: Proceedings of the 5th annual solar and biomass energy workshop (including wind); 1985 April 23-25; Atlanta, GA. [Tipton, GA]: U.S. Department of Agriculture, Science and Education, Southern Agricultural Energy Center. 1985: 31-34