SERI/TP-215-2220
UC Category: 61a
DE84013030

Fuelwood Procurement for an Industrial Power Plant: A Case Study of Dow Corning's Program

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August 1984

Presented at the Industrial Wood Energy Forum '83, Nashville, Tennessee, Sept. 19-21, 1983, sponsored by the Forest Products Research Society. Requested for the joint Council on Forest Engineering/International Union of Forestry Research Organizations (Division 3) 1984 Symposium, Orono, Maine, Aug. 12-14, 1984; presented by Charles T. Bond, Dow Corning Corporation

Work conducted under Task No. 1035.50
WPA No. 350

Paper prepared under Task No. 1430.36

Solar Energy Research Institute
A Division of Midwest Research Institute

1617 Cole Boulevard
Golden, Colorado 80401

Prepared for the
U.S. Department of Energy
Contract No. DE-AC02-83CH10093

Printed in the United States of America
Available from:
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161
Price:
Microfiche A01
Printed Copy A02

NOTICE

FUELWOOD PROCUREMENT FOR AN INDUSTRIAL POWER PLANT: A CASE STUDY OF DOW CORNING'S PROGRAM[1]

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Abstract.--Dow Corning Corporation has developed effective procedures for meeting the fuelwood requirements of a 22.4-megawatt steam and electricity cogenerating power plant. The fuelwood procurement program of Dow Corning's Natural Resources Department involves special arrangements with private landowners, logging and hauling producers, and waste wood suppliers. The program's success is attributable to a favorable location, adequate allowance for advance planning, effective public relations, and flexible management. The program is significant because it demonstrates that industrial fuelwood requirements can be met and that improved production from nonindustrial private forests can be relied upon as a major source of fuelwood.

INTRODUCTION

Two major obstacles confront industrial plants considering using wood as a fuel: assurance of a reliable fuelwood supply and handling of the fuel at the plant site. Dow Corning Corporation is one of the first firms outside the forest products industry to produce energy from wood for large-scale industrial application. In a two-year cost-sharing agreement with SERI's former Industrial Applications and Analysis Branch, Dow Corning was to address problems of fuelwood procurement and handling by

1. Collecting data on test storage of local whole-tree-harvested chips and

2. Reporting on experience gained in planning and developing operational systems for fuelwood procurement, storage, and handling.

This paper reports only on Dow Corning's experience in planning and developing a fuelwood procurement program for the 22.4-megawatt steam and electricity cogenerating (SECO) plant at their facilities in Midland, Michigan.

FUELWOOD REQUIREMENTS

Dow Corning Corporation, an industrial manufacturer of silicone products, replaced two oil-fired boilers for process steam and heat with a wood-fired plant which was started up during the fourth quarter of 1982. The plant consists of a nominal 275,000 pounds per hour (pph) spreader-stoker boiler and a condensing turbine. The unit is designed to burn wood with gas or oil in a 9:1 ratio (by Btu) 11 months of the year. The admixture of natural gas or fuel oil promotes boiler operating stability (i.e., temperature and pressure) for efficient and smooth operation of the turbine. One month per year of down time is planned for inspection and maintenance as required by state law. The annual fuelwood requirements are approximately 165,000 dry tons, which amounts to about 15,000 dry tons of wood per month (±20% depending on the load and season).

The fuel handling and combustion systems of the plant are designed to operate with the variations in particle size and moisture content characteristic of wood fuels. The preferable particle size is a 1-inch chip having typical dimensions of about 1 by 1 by 3/8 inch. However, fuelwood ranging in size from that of sawdust and smaller fine material to a 2-inch cube can be accommodated. The plant is equipped with a wood hog to reduce oversized pieces. The boiler can handle a fuelwood mix containing as much as 20% fines (by dry weight). The boiler is designed for a wood moisture content of 40% (wet basis), but 50% moisture wood, such as is generally characteristic of fresh field-harvested chips, is acceptable.

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[1]Paper presented at the COFE/IUFRO$_3$ 1984 Symposium, Orono, Maine, USA, 12-14 August.

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Requirements of industrial revenue bonds used to finance the plant dictate the types and sources of fuelwood. Seventy five percent (by dry weight) of the fuelwood must originate from noncommercial, or residue, sources. Forest-derived material from tops and limbs, standing dead trees, and noncommercial species are included, as well as mill residues and urban wood wastes.

Contaminants in the wood fuel are of concern for their effect on equipment and as occupational safety or environmental hazards. Major types of contamination to be avoided are (1) hazardous chemicals, such as the chlorinated hydrocarbons and heavy metals in preservatives and pesticides; (2) demolition rubble, such as glass, brick, stone, concrete, and metal; and (3) miscellaneous contaminants, such as asbestos and other types of insulating materials. With the exception of contaminated wood from forest areas recently treated with pesticides, including herbicides, the major potential wood sources with unacceptable contaminants are urban wood wastes. Limited quantities of mineral soil from field chipping operations are expected.

A limited area is available at the plant site for fuelwood handling and storage. The area designated for open storage of fuelwood can contain a pile of wood about 35 feet high extending over approximately 4 acres, as shown in figure 1. This amounts to a 30-day supply. It is imperative, therefore, that fuelwood be available and deliverable throughout the year without major disruptions.

RESOURCE EVALUATION

Construction of the SECO plant followed several years of investigation, evaluation, and planning. Critical questions involved the availability of wood resources. An internal study team was created early in 1977 to study the feasibility of using wood for fuel, addressing such questions as

- How much wood is there?
- Who owns the wood?
- How available is the wood?
- Who would produce the wood?
- How much competition is there for this resource?

The study team, initially comprised of a manager of engineering support, a utilities specialist, and an accountant, selected a forestry consulting firm to perform resource evaluation studies. A professional forester was hired to help direct and interpret the findings of the resource studies. Specifically, the forestry firm was to

1. Evaluate the economics of using Michigan's wood resources to meet Dow Corning's energy requirements,

2. Identify the wood procurement sources and procedures offering the most dependable long-term wood supplies at a reasonable cost, and

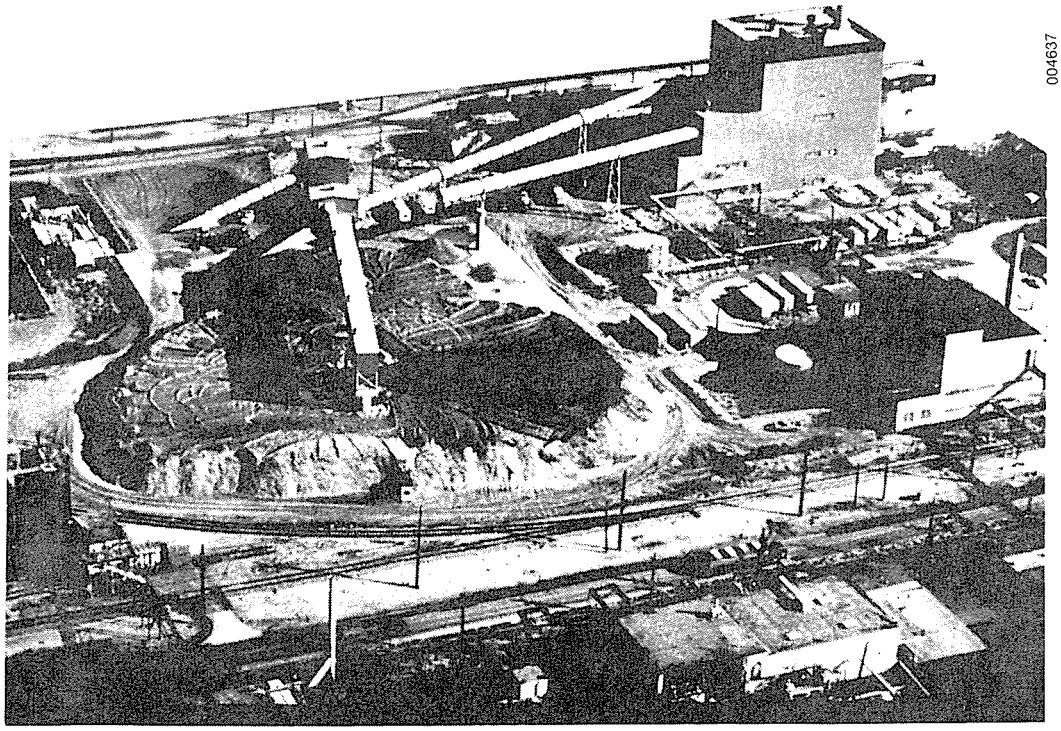

Figure 1.--Dow Corning's SECO power plant and the wood fuel storage pile.

3. Recommend a specific wood procurement system.

In a series of three reports, the forestry consulting firm presented their findings and recommendations. The Phase I report indicated that wood would be economical in comparison with fossil fuels (i.e., gas, oil, and coal). The Phase II report concluded that the potential supply of wood fuel material within a 75-mile radius of Midland is more than adequate to provide almost any desired mix of forest, urban, and industrially derived fuelwood in the quantity required by Dow Corning. The report recommends that

- Dow Corning need not purchase forest land or directly hire timber harvesters,
- Chips should be acquired through purchase contracts with independent producers,
- Brokers should be used to collect urban and industrial wood residues,
- Procurement efforts should be concentrated within 50 to 75 miles west and north of Dow Corning,
- Delivery of wood fuel should be by truck, and
- Prices paid for wood fuel should be based on dry tons.

The Phase III report identified and evaluated wood producers, forest products mills, and large forest landholdings within the procurement area.

The conclusions and recommendations of the forestry firm were supported by forest resource data and analyses presented in several federal and state government reports (Blyth and Hahn 1977, Chase et al. 1970, Manthy et al. 1973, Wood Energy Task Force 1981). Data were compiled on commercial forest land (by ownership and forest type), growing stock volume, net annual growth, timber products removals, logging residues, standing tree residues (i.e., rough, rotten, cull, small, and salvageable dead trees), and mill residues for counties within a 75-mile radius of the Midland plant site. Figures 2, 3, and 4 show pie graphs of commercial forest land ownership, annual forest growth versus removals, and mill residues, respectively.

Despite the limitations and uncertainties of available resource data, the potential fuelwood supply appeared to be adequate in terms of both the physical supply and competition for the resource. Annual forest growth exceeds removals by a wide margin, and the standing tree residue portion of the forest alone contains over 100 times Dow Corning's annual wood requirement. While there are about 80 sawmills of various sizes in Dow Corning's procurement area, the procurement of mill residues and lower-value forest material (e.g., pulpwood) for the SECO plant would offer little competition with major pulpwood purchasers in the Lower Peninsula of Michigan (fig. 5). The predominance of forest land to the north and west

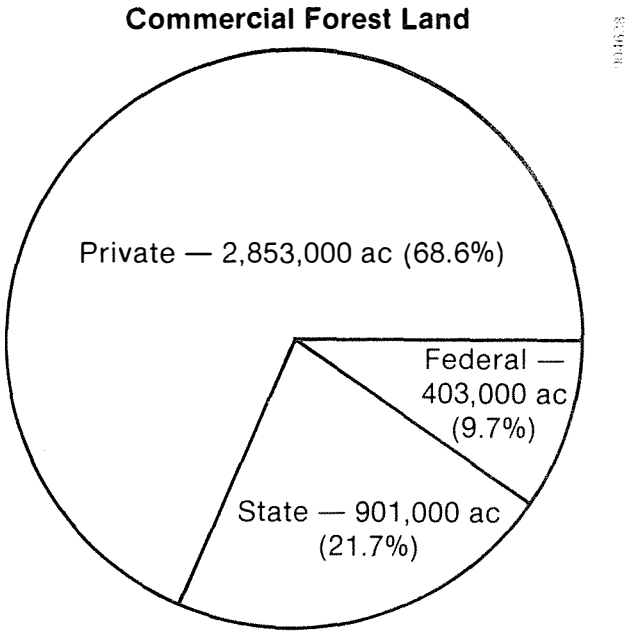

Figure 2.--Ownership of commercial forest land for counties within a 75-mile radius of Midland, Michigan.

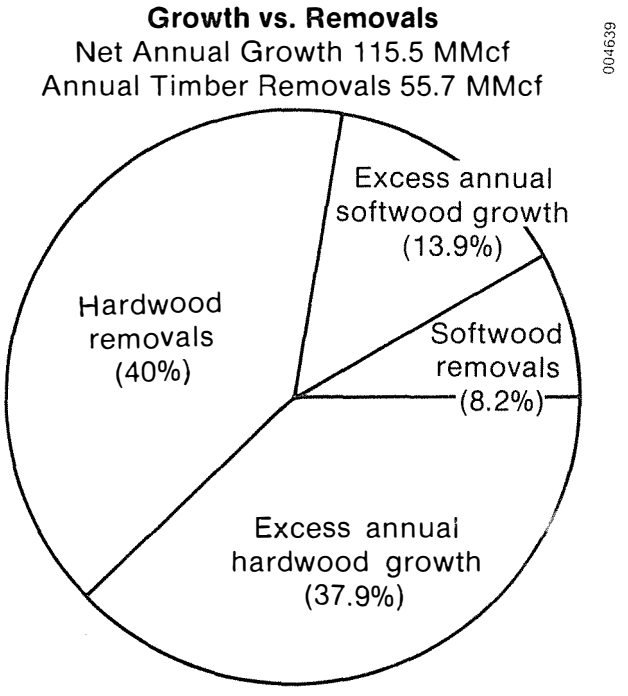

Figure 3.--Annual forest growth versus removals for counties within a 75-mile radius of Midland, Michigan.

of Midland (fig. 6) directed the focus of procurement planning to that area.

The forest stands in the vicinity of Midland consist of natural mixed hardwoods (e.g., aspen, maple, oak, and birch) and planted pines (e.g., red, Scotch, white and jack). In general, the hardwood stands became established following abandonment of agriculture during the 1930's. Much of the forest growth is underutilized and underproductive. Aspen stands, which regenerate from sucker sprouts, are typically clearcut. The pine plantations and hardwood stands are typically managed for pole and sawtimber production, as appropriate, by thinning. Though steep terrain is unusual in the area, site conditions that affect harvesting are soil texture and wetness, which vary spatially and temporally. Low and/or wet areas are, therefore, most accessible during the winter and summer months when the ground is frozen or dry.

FUELWOOD PROCUREMENT PROGRAM

Procedures for wood procurement are well established within the forest products industry. Utility companies and nonforest industrial firms considering the use of wood for fuel are often deterred by the apparent lack of a suitable infrastructure for continuous, long-term (e.g., 20 to 30 years) provision of wood at reliably constant prices. General guidelines for industrial fuelwood procurement are described by Harris and Helms (1981). The program developed by Dow

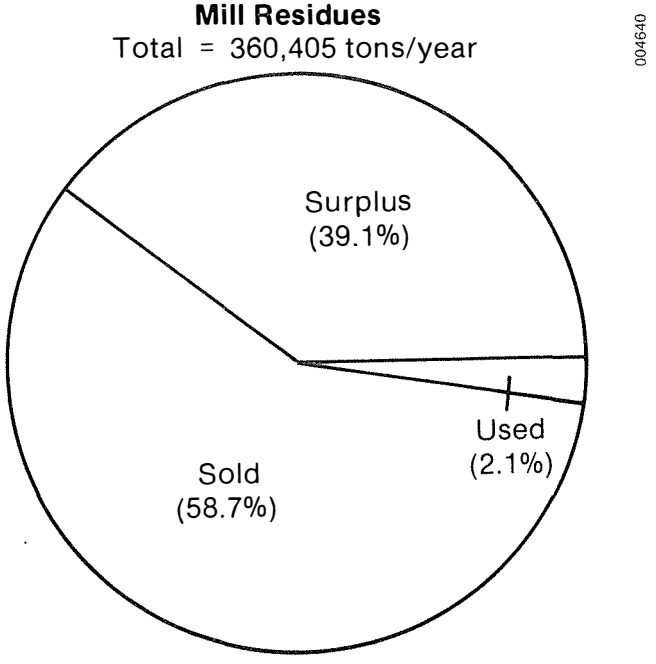

Figure 4.--Annual generation of saw mill residues for counties within a 75-mile radius of Midland, Michigan.

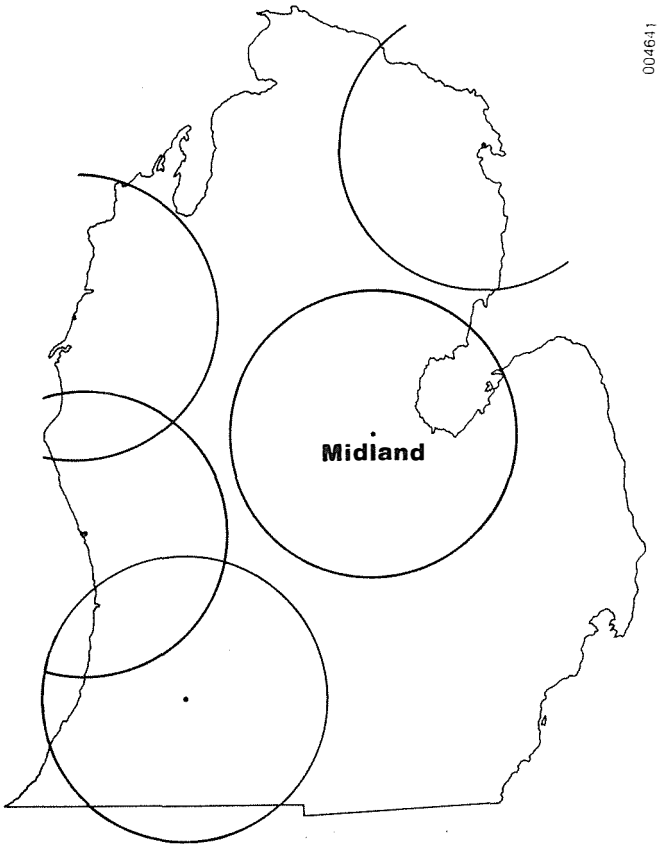

Figure 5.--Circles of 50-mile radius from Midland and from the locations of major pulpwood purchasers in the Lower Peninsula of Michigan.

Corning Corporation is offered here as an example of how, under a particular set of circumstances, it can be done.

The fuelwood procurement program for the SECO plant, in the form that it became established and operational, involves special arrangements with private landowners, logging and hauling producers, and waste wood suppliers--all managed by a small staff of natural resources and procurement professionals. The structure and procedures of the program were developed from investigations and plans over a 5-year period.

In addition to study and planning, effective communications with the public were highly instrumental to the development and success of the program. For example, audio-visual presentations were developed by Dow Corning's public relations department, in conjunction with natural resources and engineering staffs, to explain the power plant project within the context of sound natural resources management. By the time of plant start-up, nearly 200 presentations to about 10,000 people had been made. All inquiries and requests for informational presentations were honored.

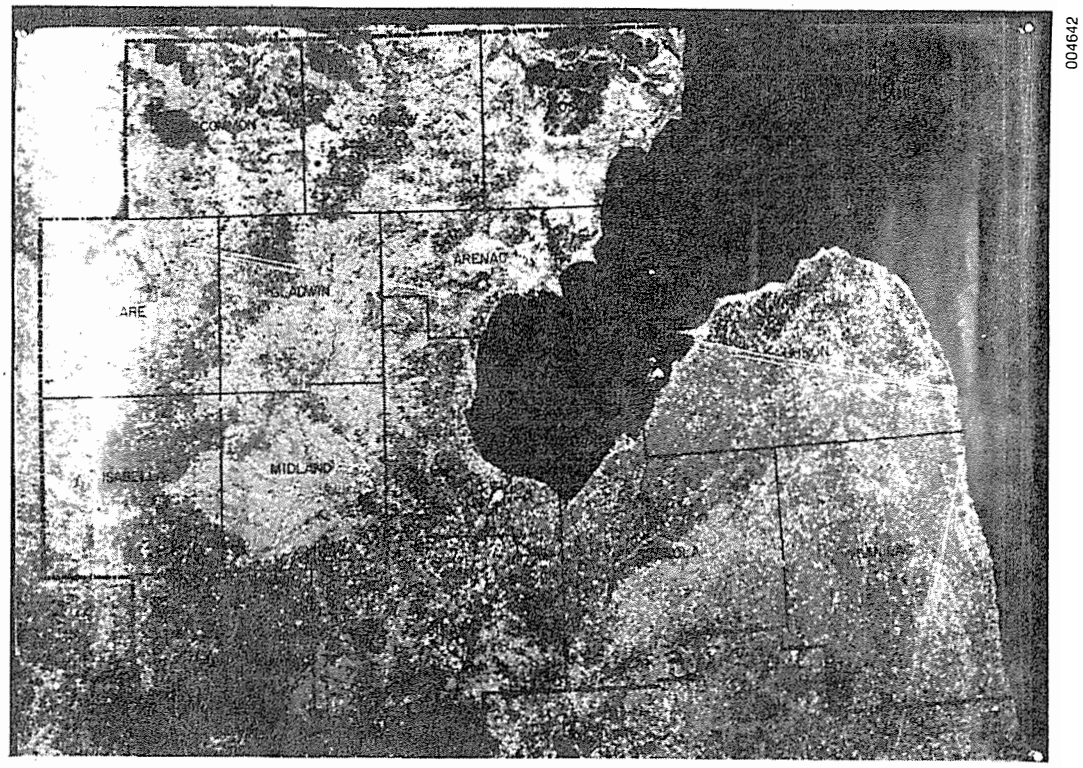

Figure 6.--Satellite image reproduction showing the occurrence of forest land to the north and west of Midland, Michigan, and agricultural land to the south and east.

Private Forest Landowners

The procurement program came to focus on private landowners as an alternative to initial plans for long-term contracts with state and federal land-managing agencies. Responses to a questionnaire sent to selected landowners in 1977, and subsequent contacts and discussion, revealed much interest in forest management, particularly for wildlife habitat improvement. The variety of landowner objectives and the need for individualized attention to ensure proper forest management induced Dow Corning to gradually enlarge the natural resources staff to include wildlife biologists and a field ecologist, as well as additional foresters.

The program with landowners involves land management guidance and assistance before money is exchanged for wood, excluding sawlogs. When a landowner contacts Dow Corning, a meeting is arranged with an appropriate staffperson of the Natural Resources Department to discuss the landowner's goals and how forest management practices can be applied. If in the judgement of the natural resources staff the landowner's tract of timber is suitable for Dow Corning's purposes and the landowner genuinely intends to manage it, an inventory is conducted and a management plan is prepared.

The management plan incorporates the landowner's goals within a framework of sound timber management, wildlife management, and soil conservation practices. The landowner's tract is characterized in terms of soils, vegetation, timber, and wildlife habitat using maps, tables, and descriptions. Management prescriptions include a harvest map and schedule, recommendations for locating access roads, and additional information as necessary for more specific landowner goals such as ruffed grouse management, turkey management, pine plantation thinnings, or special recreational needs.

The immediate intent of a management plan is to facilitate communication and understanding of natural resources management by the landowner. It is provided to the landowner without necessitating any obligation to Dow Corning. Upon negotiation of one or more contracts for Dow Corning to purchase pulpwood from the landowner, the plan provides prescriptions for harvesting that are understood and assumed by both parties. To ensure compliance with the plan, Dow Corning provides assistance by designating sale areas, marking trees to be removed or left, and locating access routes and landings. The plan's specifications are reviewed with the producer before harvesting and are also used as a basis for subsequent periodic inspections of the job.

Logging and Hauling Producers

The forestry consulting firm and the state department of natural resources developed lists of potential chip-harvesting producers for Dow Corning. Dow Corning selected 15 local producers and sent invitations to bid on contracts to harvest and haul Dow Corning stumpage (purchased from private landowners). The bid invitation package included (1) bid instructions and a bid form, (2) a sample contract, (3) general criteria for stumpage to be provided, (4) a form for information on the producer, and (5) a description of Dow Corning's safety requirements. Of the 15 producers contacted, 6 responded and 3 were selected.

This bid approach allowed the producers to specify their preferences for operating locations and tonnages of wood chips to be delivered. A major reason for bidding rather than specifying delivered chip prices was that the operators know best the economics of their own operations. To alleviate concerns about blind bidding on Dow Corning stumpage, criteria for the stumpage to be provided were established. Since the producer contracts are to be effective for a period of 3 years, the bid form and contracts incorporate provisions for adjusting the payment rates per dry ton or per dry ton mile in response to unforeseen escalation of fuel, labor, or other costs. The producers are paid on a dry ton equivalent basis to encourage practices which promote delivery of wood with a low moisture content.

Waste Wood Suppliers

As mentioned previously, a rather large number of sawmills operate in the Dow Corning procurement area producing substantial quantities of residues requiring disposal. Waste wood suppliers (currently mostly sawmills) were selected on the basis of sawmill size, quantity of residues available, and delivered price. Because the production of sawn wood products varies with demand, Dow Corning's contracts allow for 15% to 20% variation in dry tons delivered. Prices paid for mill residues are based on dry tons and a maximum permissible moisture content to encourage handling practices that minimize moisture content. The total amount of sawdust used is restricted by the capacity of the power plant and its wood handling systems to tolerate fine wood particles.

CONCLUSIONS

Dow Corning's industrial fuelwood supply is not absolutely secure in terms of sources and costs for the lifetime of the plant. However, contracts are now in effect with suppliers and landowners for the next 2 to 4 years. What is more significant is that flexible, responsive, and effective procedures are now established that should serve to maintain a continuous supply of fuelwood at reasonable costs in a dynamic market situation.

The apparent success of Dow Corning's fuelwood procurement program is attributable to several factors, not the least of which is a favorable location. Other factors are (1) the questioning and open-minded attitude of Dow Corning's management, (2) adequate allowance of time and expenses for planning, (3) implementation of effective public communication practices, and (4) incorporation of the expertise of natural resources professionals throughout planning and implementation of the project. Continued success of the fuelwood procurement program depends on maintaining an innovative and questioning approach in response to dynamic wood market conditions.

Dow Corning's fuelwood procurement program provides an example of how a nonforest industrial firm can ensure a reliable supply of substantial quantities of fuelwood in a manner that is complementary to the requirements and operations of the forest products industry. It also provides an example of how to facilitate productive management of nonindustrial private forest lands, a question which is often described as the major challenge to forestry in the United States for meeting future wood supply requirements (FPRS 1979, USDA Forest Service 1982).

RECOMMENDATIONS

During the first year of operation of Dow Corning's power plant, a need to improve control of fuelwood moisture content became apparent. Several mechanisms were identified (and are still being refined) which are summarized below as recommendations for industrial firms starting up wood-burning power projects.

- Wood purchases should be based on actual weight, including the moisture content, rather than on a dry weight equivalent--because the latter does not reflect differences of net energy value with moisture content.
- Evaluations of fuelwood resources in planning should also be based on the net energy, or usable Btu, values using relationships between costs and moisture content such as the ones illustrated in figure 7.
- Incentives and disincentives can be used to encourage delivery of low-moisture-content wood.
- Quick and accurate moisture content sampling procedures are needed for receiving and paying for delivered loads of fuelwood.
- The use of sawdust may need to be restricted and carefully controlled because of its tendency to absorb and retain moisture.
- Whole-tree-chipping operations can be planned and scheduled to minimize wood moisture content by considering species, time of year, and site conditions. In

addition, allowing a period of several weeks to elapse between the severing and chipping operations of a harvest reduces wood moisture content by transpirational drying when foliage is present.

General recommendations, drawn from the Dow Corning experience, for planning and developing an industrial fuelwood procurement program are summarized as follows.

- Publicize wood fuel needs early in project development so all sources can be identified.
- Develop an effective, comprehensive public communications program.
- Begin procurement planning and actual procurement as early as possible.
- Use bids in conjunction with specifications instead of fixed rates of payment in formulating arrangements with producers and suppliers.

Finally, two general recommendations are offered, based on Dow Corning's experience, regarding information that would be helpful to those considering industrial wood energy systems.

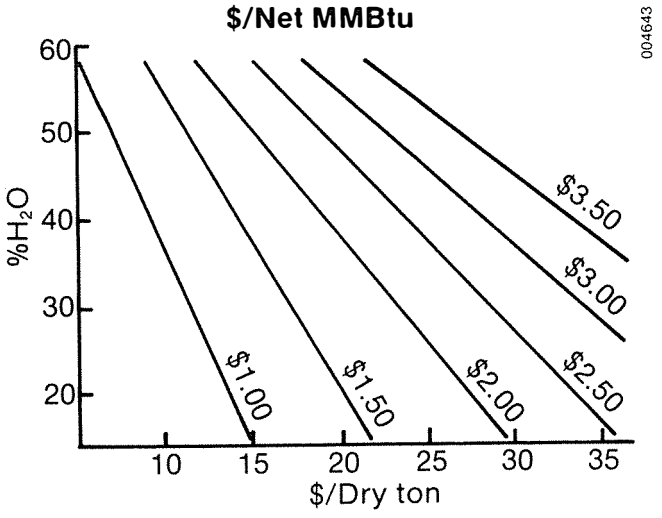

Figure 7.--Relationships between actual energy costs versus dry weight costs of fuelwood as influenced by moisture content.

- Reliable information and data are needed on the total biomass from any given forest and on the material available as wastes from wood utilization and disposal.
- Some central source of information on fuelwood resources, wood fuel characteristics, and energy conversion systems is also needed.

ACKNOWLEDGEMENT

Partial support for this project was provided by the Biomass Energy Technology Division of the U.S. Department of Energy under prime contract number DE-AC02-83CH10093.

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