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**PROSPECTS FOR
GEOTHERMAL COMMERCIALIZATION IN
THE LUMBER INDUSTRY**

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INTRODUCTION

This is one of four reports on studies conducted by the Earl Warren Legal Institute on the prospects for commercialization of geothermal energy in selected industries, including greenhousing, potato and onion processing, and certain segments of the lumber and chemical processing industries.¹ These particular industries were selected for study from a number of possibilities suggested in the Institute's earlier survey of existing and potential users,² and from a review of existing engineering and economic feasibility work undertaken by others. Our objective in these studies has been to identify and analyze specific legal, economic, and institutional barriers to the direct use of geothermal energy as perceived by firms representing each of the industries selected. The results reported here are based upon extensive personal interviews conducted systematically with substantial numbers of decision-makers representing varied segments of each industry studied.

We focused in this study upon a number of areas considered directly relevant to a particular lumber firm's decision to use or not to use geothermal energy for its commercial needs. These areas include: 1) Current fuel uses and problems, and future fuel concerns; 2) Firm decision-making processes, including managerial and financing conventions; 3) Perceived commercial potential for geothermal energy in the industry and mechanisms for stimulating interest; 4) The

1. See also: Prospects for Geothermal Commercialization in the Chemical Industry; Prospects for Geothermal Commercialization in the Greenhouse Industry; Prospects for Geothermal Commercialization in the Potato and Onion Industry. Earl Warren Legal Institute, 1979-80. In addition to these industry reports, the Institute intends to publish a fifth report synthesizing the results of its work and analyzing its overall implications for government policy.
2. See: Second Interim Report on Legal and Institutional Considerations in the Commercialization of Geothermal Resources for Direct Uses, February 22, 1979.

potential institutional framework for user involvement in geothermal development; and 5) The role that government might most effectively play in stimulating user development.

We hope that this report will present a useful description of the lumber industry's approach to the possibility of geothermal use, the major factors likely to influence individual decisions in this area, and suggestions to guide both the government and the private developer in encouraging rational development of geothermal resources.

I. SELECTION OF FIRMS FOR IN-DEPTH SURVEY

The selection of firms for interviews was determined in part by two controlling facts in the lumber industry. First, in the western United States lumber milling and wood products manufacturing are heavily concentrated in Washington, Oregon and California. With one exception, therefore, we focused our efforts on those states. Second, since raw material supply basically determines plant location, we decided to concentrate on those companies with existing plants located on or near a resource, on the assumption that relocation to take advantage of a resource elsewhere was extremely unlikely. We did, however, want to talk to a few companies not located on a resource to test this hypothesis. In addition, we focused our efforts on companies engaged in kiln drying of lumber since this process commonly uses steam for drying and requires temperatures within the range of low and moderate temperature resources. We included, however, firms which also produce veneers and plywoods, since both processes can utilize steam at temperatures between 150° and 550°F. We largely eliminated the pulp and paper sector of the industry, both because it is being studied by others and because we believed it would make our own study more manageable.

We began our selection process with the "1978 Directory of Forest Products Industry" which lists all wood harvesting companies in the United States. From this Directory, we selected our target states of California, Idaho, Oregon and Washington. We then divided the companies into five categories which would represent a mix of size and organizational structures as follows: A) single sawmill companies located on or near a geothermal resource sight and producing 25 million board feet (MBF) per year or less (13 firms); B) single sawmill companies located on or near a geothermal resource producing more than 25 MBF per year (14 firms); C) multi-sawmill companies owning at least one sawmill on or near a

resource (32 firms); D) large multi-sawmill companies not owning a sawmill on a resource site (19 firms); and E) companies owning veneer or plywood mills on or near a resource (14 firms).

We initially contacted 32 firms by telephone for a preliminary survey. Some of these contacts were not followed up because of scheduling conflicts. Others were not interested in talking further or were not interesting to us because they were not processing lumber in a way that could utilize geothermal energy. We finally selected thirteen firms for in-depth interviews: two from category A; two from category B; seven from category C; and two from category D. Two of the C category firms were also in category E. Those firms are described below in detail.

II. BACKGROUND ON THE INDUSTRY

In 1978, 38 billion board feet of lumber were produced in the U.S., of which 63% came from the west. The four largest companies produced 19% of the lumber in 1977, the top eight companies 29%, and the top twenty companies 46%.

The average sawmill in the United States produces approximately 4-6 million board feet of lumber annually. The top four companies had 141 mills which produced an average of 50 million board feet of lumber. In 1972 there were 9,074 mills in the United States owned by 7,664 companies. Of these, 1,790 of the mills were in the western United States.

There are 170 mills in the U.S. producing more than 50 million board feet per year of which 81% are in the west. These large mills account for half the output of the west. The average mill in the west produces approximately 18 million board feet per year.

Production has remained relatively stable for the past two decades. In 1955, 37.4 billion board feet of lumber were produced as compared with 38 billion board feet in 1978. The U.S. is both an importer and an exporter of lumber. In 1978 the U.S. exported 1.7 billion board feet largely to Canada, Japan, Australia, Italy, West Germany, Mexico and Saudi Arabia. The U.S. imported 11.5 billion board feet in 1978, mostly from Canada. Canada both exports to and imports from the U.S. as a consequence of geographical location and cost advantages.

The U.S. is the second largest lumber producing country in the world and in exporting is surpassed only by Canada, The U.S.S.R., and Sweden. Exports have nearly doubled while imports have more than doubled since 1965. However, most of that growth occurred during the period 1965-72.

Softwood production accounted for more than 80% of total lumber production in 1978. About 70% of all softwood is produced in the western states and about

25% in the south. Very little hardwood is produced in the west. In 1978, softwood lumber consumption was 40.5 billion board feet of which 25% was supplied by imports, largely from Canada. Industry estimates of softwood lumber use by consuming industries are: residential building, 44%; other new construction, 16%; repairs and remodelling, 21%; and materials handling (pallets and crates), 10%. Major uses of hardwood lumber are, materials handling, hardwood floors, furniture and railroad ties.

In recent years lumber prices have risen dramatically. Between 1965 and 1972 the prices rose nearly 75%, but during the next six years they rose nearly two and a half times.

There were 175,000 people employed in the lumber industry in 1978, of which 158,000 were production workers. The average hourly earnings for production workers was \$5.83.

The value of shipments in 1978 was 11.8 billion dollars which represents an 85% increase over 1972. The value added for 1978 was 5.8 billion dollars and is an 85% increase over 1972.

Company diversification by adding new product lines or merging with firms producing other products is increasing. The consolidations have grouped lumber, plywood, particle board, pulp and paper, and other wood product facilities into integrated complexes which produce a variety of products and utilize the raw material more completely. Chips produced from secondary manufacture and lower quality roundwood have become products of considerable importance. The value of shipments of wood chips more than doubled between 1972 and 1976, rising from 505 million dollars to 1.1 billion dollars.

The west has been the fastest growing market for lumber. This has been due, in part to increased home building. Historically, 20-25% of the housing

units have been in the west. However, this rate rose to 27% in 1977 and to 29% in 1978. Capacity utilization in 1977-78 by western U.S. lumber industry was 92%.

Although 1977 was a near record year for housing, in that year 16 sawmills closed in the western states. Most closures were due primarily to inflation and investments required to bring mills up to environmental standards.

The Department of Commerce estimates that lumber production should reach around 40 billion board feet by 1983 assuming an annual growth rate of 1%. Lumber output is largely dependent on residential construction, which is forecast at 1.85 million units in 1983. This is 3.1% below the 1978 rate and only 8.8% above 1979. Other types of construction are expected to show only moderate growth during the next five years. Wood consuming industries, such as pallets and furniture, also expect moderate growth.

In 1972 there were 121 companies owning 232 plywood and veneer plants in the U.S. The four largest companies produced 37% of the softwood plywood and veneer; the eight largest 50%, the 20 largest 67%. In 1972 the average plant produced 124 million square feet annually. Of the plywood and veneer plants, 72% are in the western states.

Softwood plywood production has grown 7% during the past 5 years which is largely due to inflation. There is considerable competition among various wood panel products (lumber sheathing, plywood, and particle board). The demand for softwood plywood is largely a function of this substitution and residential housing construction. As with other lumber products, the availability of timber lands is also an important factor. The U.S. Department of Commerce forecasts the productive capacity of softwood plywood in 1983 at 22.5 billion square feet or 7% higher than existing capacity of 21 billion square feet. Total 1983 softwood plywood output should reach approximately 21 billion square feet.

III. THE FIRMS SURVEYED

A. STATEMENT ON CONFIDENTIALITY OF INDUSTRY INTERVIEW DATA

In the course of its study of potential geothermal users, the Earl Warren Legal Institute conducted personal interviews with representatives of over 50 firms in four selected industries.³ During our initial contacts with these representatives, many expressed strong reluctance to be interviewed regarding company activities because of concerns over disclosure of business information which they or others in their companies might consider proprietary or otherwise confidential. Accordingly, in order to obtain the cooperation necessary to accomplish its task, the Institute assured each respondent that information regarded by the company as confidential would be respected as such by Institute staff members.

In many instances, interviewees prefaced the actual interview with a blanket request for confidentiality. In other instances, respondents indicated during the course of the interview that particular information was confidential and/or proprietary. In all cases, the Institute staff accepted such requests for confidentiality without reservation.

Because so many respondents expressed concern over confidentiality, and because of the difficulty of separating responses on the wide range of topics covered into confidential and non-confidential categories, we decided to eliminate specific attribution in our published reports analyzing the interview data collected. All information is accordingly attributed to interviewees and companies by a fictitious reference, rather than by actual names. In this way, we have been able

3. See Introduction, page iii.

to include in the reports all substantive information in which the public has a legitimate interest, while honoring the respondent firms' expectations of confidentiality and preserving the integrity of representations made on behalf of the Earl Warren Legal Institute.

B. FIRM BACKGROUND

The following tables are a convenient reference for basic data on the companies in our survey. Table 1 lists firms alphabetically and Table 2 lists firms by size. Clarification of some categories of information may be helpful. The determination of firm size was based on lumber production figures. Companies producing less than 75 million board feet per year were designated small; between 90 and 500 million board feet, medium, and over 500 million board feet, large. Three of the categories on Table 1 - Age of Plant, Stated Role in Innovation, and Stated Growth Philosophy - describe the subjective responses of lumber producers to our questions. The remaining categories are explained in the notes accompanying the tables.

Table 1
FIRM BACKGROUND

FIRM	SIZE	PLANT LOCATIONS	ROLE IN INNOVATION	GROWTH
Acme Lumber Company	small	California	L	N
Best Lumber, Inc.	small	California	L	N
Cooper Lumber Company	small	Oregon	F	N
Dependable Lumber, Inc.	medium	Oregon	L	F
Earnest Timber Company	small	Oregon	L	N
Friendly Wood Products	medium	California Pennsylvania	L	N
Good Wood Products	large	California, South, Northwest, East	F	F
High Grade Lumber Corp.	large	Northwest South Midwest	n/a	F
Industrious Lumber	medium	Oregon Washington Canada	L	K
Just Lumber	large	Northwest Midwest South Canada	A	K
Keen Timber Products	medium	Montana Oregon Idaho	F	N
Leading Lumber Co.	large	Northwest Midwest South	F	F
Mammoth Forest Products	large	California Northwest South East Outside U.S.	F	F

Key: Stated Role in Innovation

F = forefront
A = average
L = let others do it
n/a = no answer

Stated Growth Philosophy

F = faster than industry
K = keep up with industry
S = slower than industry
N = no growth (status quo)

Table 2
COMPANIES BY SIZE

Companies	No. of Wood Product Plant Sites	Lumber Production	Plywood, Veneer Production 3/8" basis	Particle Board 3/4" basis	No. of Employees	Net Earnings
<u>LARGE</u>						
Leading Lumber Co.	32	3,384 MM bd ft ¹	2,698 MM sq ft ¹	415 MM sq ft ¹	46,040 ²	\$371,000,000 ³
Mammoth Forest Products	58	1,417 MM bd ft	4,604 MM sq ft	496 MM sq ft	40,000 ²	\$302,000,000 ³
Good Wood Products	40	774 MM bd ft	1,846 MM sq ft	227 MM sq ft	43,000 ²	\$168,600,000 ³
Just Lumber	29	788 MM bd ft	1,525 MM sq ft	149 MM sq ft	35,704 ²	\$132,800,000 ³
High Grade Lumber Corp.	15	590 MM bd ft	437 MM sq ft	66 MM sq ft	10,350 ²	\$64,162,000 ³
<u>MEDIUM</u>						
Industrious Lumber	4	379 MM bd ft	164 MM sq ft	n/a	3-4,000	\$17,311,000
Keen Timber Products	6	144 MM bd ft	288 MM sq ft	n/a	753	---
Dependable Lumber, Inc.	2	132 MM bd ft	93 MM sq ft	n/a	994	\$9,789,000
Friendly Wood Products	2	90 MM bd ft	n/a	30 MM sq ft	550	---
<u>SMALL</u>						
Cooper Lumber Company	1	72-73 MM bd ft	n/a	n/a	155	---
Earnest Timber Company	1	48 MM bd ft	n/a	n/a	250	---
Best Lumber, Inc.	1	17-20 MM bd ft	n/a	n/a	50	---
Acme Lumber Company	1	8 MM bd ft	n/a	n/a	45	---

1. Sales; 2. Includes employees not involved in lumber; 3. Includes earnings from operations other than wood products.

n/a = not applicable

C. DESCRIPTION OF FIRMS

A. Acme Lumber Company Location: Northern California

The Acme Lumber Company is a closely held, family-owned corporation. The major stockholders are the son, who operates the company, and his father.

Acme owns a sawmill and a planing mill. Both operate eight hours a day, five days a week. The sawmill runs ten months a year, while the planing mill runs approximately eleven months, and together employ 45 people including loggers. Production is eight million board feet of lumber per year. The company participates in a federal program designed to ensure the survival of small lumber companies by allocating them a percentage of the national forest timber yield.

Acme's physical plant has undergone renovation since its construction in 1938. Except for the lack of a dry kiln and facilities for sawmill wood waste disposal, the plant is fairly up-to-date. The level of production has been more or less constant over the past fifteen years, due to a lack of additional timber supply. The operator sees the industry as tending toward increased concentration, modernization and elimination of small sawmills. The company, in his opinion, is too small to be innovative.

We interviewed the operator of Acme and his wife.

B. Best Lumber, Inc.
Location: Northern California

Best Lumber is a family-owned corporation, operating a single plant which the family has owned since 1968. Production is between 17 and 20 million board feet per year; the company actually logs approximately 17 million board feet, with the remainder purchased from other loggers. Best Lumber employs 50 people. Operations run eight hours a day, five days a week, with a two to three week shutdown at Christmas for vacation and maintenance.

In the last few years, the company has switched from two shifts daily to one shift, due to a decline in raw material supply. No future growth in output is anticipated, but the quality of production is expected to improve. As a small company, Best's attitude toward innovation is "let others do it."

The interview was conducted with the vice president of Best Lumber, who is the son of the owners. He is approximately 25 years old and grew up in the business.

C. Cooper Lumber Company
Location: Southern Oregon

Cooper Lumber is a closely held corporation whose five shareholders are all members of a single family. In addition to its sawmill in southern Oregon, the company operates a frozen food storage facility and owns a livestock ranch. The sawmill produced between 72 and 73 million board feet in 1978. For the past ten years, production has ranged between 66 and 77 million board feet annually. There are 155 employees.

The company sawmill and planing mill are operated 16 to 18 hours per day, five days per week, 12 months per year, and are closed only for a week around the Fourth of July. The work force currently consists of 153 employees, but the installation of a new computerized planing mill will reduce this number by 30 in the near future. The company installed a new sawmill approximately 12 years ago.

Cooper Lumber expects to grow by modernizing and maximizing the value of its output, not by increasing production. It has developed a computerized grading machine and considers itself innovative. A Portland consulting firm is retained to advise on new technology. In the opinion of our respondent, the company has the most modern facilities on the west coast.

We interviewed the executive vice president and general manager at the firm's office in Oregon. He has spent 21 of his 50 years in the lumber business with Cooper Lumber.

D. Dependable Lumber, Inc.
Location: Central Oregon

Dependable Lumber is a publicly-owned forest products company, with 1978 sales of \$96,664,000. In addition to logging and producing lumber and plywood at two sites in central Oregon, the company owns 231,000 acres of timber.

The lumber division employs 548 people in its logging operations and two sawmills. Production in 1978 was more than 132 million board feet of lumber. This represents a decline from the 1977 production level, primarily due to the installation of new equipment.

The plywood division had 222 employees in 1978, and produced 93 million square feet of plywood. This was also down from the previous years production because of a lengthy shutdown for plant modernization.

A third division of the company produces millwork and molding products. Production in 1978 was 15 million board feet of cut stock and 9 million board feet of molding. The division employs 224 people.

Dependable Lumber operates all its plants with two shifts, 16 hours a day, five days a week, for 49 weeks per year; however, the drying kilns operate continuously.

The company has grown 50% in the past ten years. Recent technological improvements, including sophisticated computer-controlled equipment, make the company mills very modern. The company prefers to see others demonstrate the viability of new technology before acquiring it for its own plants, however.

At Dependable our respondent was the president and chief executive officer, who has also been a director of the company for the past five years. He and other members of his family are substantial shareholders.

E. Earnest Timber Company
Location: Central Oregon

Earnest Timber Company is a closely held, family-owned corporation, with its operations in a town founded by the company in 1939. Earnest employs approximately 250 people, including 53 loggers, 158 mill workers, and 25 supervisors. Logs are obtained from the company's own land and from U.S. Forest Service bid sales. Production is approximately 48 million board feet per year. The plant operates 16 hours a day, five days per week, 50 weeks per year, while the dry kilns operates continuously except for a 10-day maintenance period. A new sawmill was added this year, making the plant very up-to-date.

From the plant's construction in 1939 until 1968, annual production was approximately 40 million board feet. The addition of new equipment in 1968 increased production capacity to its present 50 million board feet, and production since 1968 has remained generally constant. Most of the company's technological innovations come from others in the industry.

At Earnest Timber we interviewed the president and major shareholder. He is a fourth generation lumberman, whose father started the operations in Oregon.

F. Friendly Wood Products
Location: Northern California
Pennsylvania

Friendly Wood Products is a family-owned corporation with two plants, one in northern California producing lumber and particle board, the other in Pennsylvania producing hardwood lumber. The California plant employs 450 people and produces 75 million board feet of lumber and 30 million square feet of 3/4" particle board annually. The Pennsylvania plant employs 100 and produces 15 million board feet of lumber per year.

The California plant was built in 1945 and is currently undergoing a major renovation. A fuel dryer which will allow the company to use wood waste more efficiently is being added. The plant's lumber mill operates 16 hours a day, five days a week; the particle board plant operates 24 hours a day, five days a week. Both are closed two weeks in August and one week at Christmas for vacation and repair.

The company has grown gradually over the past 15 years, mainly in increased automation, rather than increased production. Growth is now starting to level off. As a small company, Friendly is a follower rather than an innovator. It probably would not have started drying its fuel if it had not learned that major firms in the industry were doing it.

We interviewed the vice president for administration of Friendly Wood Products. Prior to his present position, which he has held for four years, he was a personnel manager in another firm in the lumber industry.

G. Good Wood Products
Locations: Northwest
California
South
East

Good Wood Products is the domestic wood products division of Good International Corporation, a public corporation with net sales of \$3.36 billion in 1978. The corporate interests include timberlands, building materials, paper, and paper packaging in the U.S. and Canada. The company owns or controls 3,407,000 acres of timberland. Good International Corporation employed 43,000 people in 1978.

Good Wood Products operates plants at forty locations throughout the U.S., including thirteen softwood plywood plants, three softwood veneer plants, nine softwood sawmills, ten softwood stud facilities, four particle board plants, three hardboard plants, three prefinished hardwood panel plants, one hardwood veneer plant, and one wood chip export facility. In 1978, total production was 774 million board feet of lumber, 1,846 million square feet of plywood, 227 million square feet of particle board, and 371 million square feet of hardboard.

The western division of Good Wood Products has approximately 4,000 employees at eleven plants located in California, Oregon, and Washington. These include both sawmills and veneer and plywood plants.

The plants generally operate five or more days per week with a two week annual shutdown for maintenance. The dry kilns operate around the clock, except for the two week shutdown. Although most of the western plants are old, they have been renovated to keep them very up-to-date. Overall, output has grown at a rate faster than the industry average. The company considers itself to be in the forefront of innovation, with a large R&D department developing new products.

At Good Wood Products, we spoke with the general manager of the western softwood, plywood and lumber manufacturing division of the company. He has been with the company 20 years, and in the lumber industry 30 years. In addition, we interviewed the energy manager of Good International.

H. High Grade Lumber Corporation
Location: Northwest
South
Midwest

High Grade Lumber is a large publicly owned corporation with 1978 net sales of \$688,424,000. In addition to wood products, it produces pulp and paperboard, printing and business papers, packaging, and consumer products. At the end of 1978, High Grade employed 10,350 people and owned 1.3 million acres of timberland.

The wood products division operates 15 plants, including eleven sawmills which produced 590 million board feet in 1978, three plywood plants which produced 437 million square feet, and one particle board plant which produced 66 million square feet. Most of the plants are located in the northwest.

The sawmills operate two shifts, five days per week, although the dry kilns in these plants operate 24 hours per day. The plywood plants operate three shifts, five days per week. The particle board plant operates three shifts, seven days per week.

The company plans to invest \$600 million in plant modernization and power generation projects between 1978 and 1982. A \$70 million wood-fired boiler is to be completed at one sawmill by 1981. A six million dollar project will expand a plywood plant by 35%. The company is trying to grow faster than the industry, and thus improve its marketing position. It considers itself an innovative organization.

Our respondent at High Grade Lumber was the corporate energy coordinator, who is both a Ph.D. in chemical engineering and an M.B.A., and is involved in energy planning at both the corporate and the division levels.

I. Industrious Lumber
Locations: Oregon
Washington
Canada.

Industrious Lumber is a publicly-owned corporation with 2,600 shareholders. Between 3,000 and 4,000 people are employed at the company's four wood products plants. In 1978 the sawmill and veneer manufacturing plant in Oregon produced 127 million board feet of lumber and 88 million square feet of plywood veneer while employing 420 people. The company's Washington plant employed 200 people to produce 87 million board feet of lumber and 76 million square feet of specialty plywood. Two additional sawmills are located in Canada. The sawmills operate on a two-shift basis; the veneer plant operates three shifts daily. All plants run five days per week.

The company has sought gradual growth in the past five to fifteen years. The company seeks to grow by becoming more efficient and productive, not by expanding existing plants or building new ones. Industrious does not develop its own technical processes, but is interested in innovations developed by others.

The vice president for operation (chief operations officer) talked with us at Industrious Lumber. Prior to his arrival at Industrious Lumber a year ago, he managed the western mills for another large company. He started in the lumber industry as a machinery salesman after receiving a degree in engineering.

J. Just Lumber Products
Locations: Northwest
Midwest
South
Canada

Just Lumber is a public corporation that manufactures paper, packaging materials, and office products, as well as wood products and other building materials. The corporation as a whole had 52,646 shareholders in 1978, over 35,000 employees, sales of over \$2.5 billion and net income of over 130 million. It owned over 2.7 million acres of timberland.

The wood products divisions has 19 sawmills, 19 plywood and veneer plants, a particle board plant, a fiberboard plant, and a hardboard plant. Production in 1978 was 788 million board feet of fiberboard, 1,525 million square feet of plywood and veneer (3/8" basis), 149 million square feet of particle board, 488 million square feet of fiberboard, and 81 million square feet of hardboard. The sawmills operate one or two shifts per day, five days per week; the plywood mills operate three shifts, seven days a week. Maintenance goes on continually, but major renovations take place at Christmas and Fourth of July.

The company has increased production slightly in the last ten years. The respondent indicated the company does not wish to be number one, but does wish to be an aggressive number two.⁴ A Newsweek comparison with other companies placed Just Lumber at the bottom in terms of R&D budget. The interviewee thought this inaccurate and told us that the company is at the forefront of composite can development and was the first to test a fluidized bed combuster for wood waste.

Our interviewee began his career with Just Lumber in 1974 as head of the energy conservation department and has continued as director since the department

⁴. In fact, among the companies interviewed, it is the #4 company in net sales.

became the corporate energy department. He has a background in engineering and retired from the Navy at the age of 55 in order to pursue an executive career.

K. Keen Lumber Products

Location: Oregon
Idaho
Montana

Keen Timber Products is a closely held, family-owned corporation founded by a former executive in one of the largest timber products companies in the U.S. Production is approximately 144 million board feet of plywood (3/8" basis) per year, and the company employs 753 people.

The company's two sawmills in Montana produce stud lumber which is air dried. Three Oregon plants manufacture plywood. The mill in Idaho has dry kilns, two of which were added in 1978. The kilns and boiler operate continuously, except for four days of maintenance every three months.

The company has tripled its assets and sales over the past seven years. The coming three years will be used to consolidate recent expansion; no growth is anticipated. The company developed a plywood and rim burner and its own system for plywood manufacturing, and it considers itself in the forefront of innovation.

At Keen Timber Products we spoke with the project manager. Previous to joining the company four years ago, he was an electrical contractor and an engineer with Portland General Electric. A follow-up telephone interview was conducted with the vice president of finance.

L. Leading Lumber Company

Locations: Northwest
South
Midwest

Leading Lumber Company is a large public corporation with approximately 46,000 employees in its wood products, pulp and paper, and packaging materials operations. Its 1978 net earnings were \$371,000,000. The corporation owns 2.8 million acres of timberlands in the northwest and south.

Approximately 32 sawmills and wood products plants are located in the northwest, south and midwest. The sawmills typically operate two or three shifts per day, five days per week, 12 months per year. Production in 1978 was more than 3,000 million board feet of lumber, about 2,700 million square feet of plywood, and about 400 million square feet of particle board.

Leading Lumber has grown steadily in the last 15 years, mostly through acquisition, and intends to continue this growth. The company devotes considerable resources to research and is a leader in the industry in technological innovation.

We interviewed the manager of the energy planning group, who has held that position since the group was created in 1975.

M. Mammoth Forest Products

Location: Northwest
South
California
East
International

Mammoth is a publicly-owned corporation with net earnings of \$302 million in 1978. It produces pulp, paper, and chemicals in addition to lumber and building materials, and employs 40,000 people in its operations world-wide. The company owns 400,000 acres of timberland in north America.

Mammoth operates 41 sawmills and 47 plywood and specialty plants (hardwood, particle board, etc.) located mainly in the South, and Northwest. Total production in 1978 was 1,417 million board feet of lumber, 4,604 million square feet of plywood and veneer and 496 million square feet of particle board. Sawmills typically operate one or two shifts daily, five or six days each week, year-round. Dry kilns at both the sawmills and plywood plants run 24 hours per day, year-round.

The company has attempted to double sales over the last five years and has succeeded. Mammoth is taking part in the industry move toward the south; it is buying additional southern timberland and will move its headquarters in the near future.

Our interview was conducted with the senior economist for government affairs. His function is to analyse legislation and to recommend policy on government programs. His previous position with the company was as plywood buyer in the import division. The vice president for government affairs, an attorney, also participated briefly in the interview.

IV. ANALYSIS OF THE SURVEY DATA

A. FUEL

In order to realistically assess commercialization opportunities in the lumber industry, we examined current patterns of fuel usage for which geothermal energy might substitute. Relevant inquiries began with the types of fuel used and the terms upon which they are purchased. We then sought to determine the ratio between energy costs and total production costs, and the degree of concern felt by firms regarding anticipated price increases for current energy resources, since this information indicates the weight likely to be placed upon geothermal's potential advantage as a cheaper energy source. Apart from on-going cost considerations, we also examined the firms' ability to tolerate fuel supply interruptions and the precautions considered necessary to prevent this, in order to determine the importance of reliability as a factor influencing the decision whether to employ geothermal resources.

1. FUEL SOURCES, USES, AND COSTS

Fuel supply costs and terms vary among companies and among plants within multiplant companies. Seven companies provided estimates of their fuel costs as a percentage of total lumber production costs; the results are as follows:

5% and below	(A,E,H,I,K,L ⁵)
5% to 10%	(C)

While we do not have data from the remaining companies, the fact that those who gave estimates include the full range of sizes and locations suggests that the ratio of fuel costs to total costs will be similar for other firms.

5. Leading Lumber also provided the following figures for wood products other than lumber: veneer/plywood 10%, pulp and paper 10%, paneling 20-25%.

An important use of energy in the lumber industry is to generate steam for drying lumber and for processing veneers and other wood products. The fuels used for generating steam are, in order of increasing importance: oil, natural gas, and wood wastes. Wood wastes, which include bark, twigs and mill wastes, can also be sold or used in the manufacture of paper and particle board, but they have become of major significance as fuel in the lumber industry in recent years; every firm in our sample is now using or has plans to use wood wastes for at least part of their steam generation fuel needs.

For some firms, however, the use of wood wastes may effectively be precluded by air quality standards which cannot be met without installation of expensive pollution control equipment that then makes a waste burning project uneconomical. In some cases, such as that described by Good Lumber, this may only prevent total energy self-sufficiency. Good recently installed a drum dryer to increase efficiency of the waste fuel it burns to generate steam for its dry kiln. The company would now like to install a high pressure boiler and a 5,000 kw generator in order to serve its electric needs as well, but expects that such additional burning will violate air quality standards and thus require installation of pollution control equipment which cannot be justified by returns on the project. In other circumstance, like those of Industrious Lumber, air quality standards may eliminate wood waste burning altogether. Industrious has been unable to meet pollution control standards economically in a Washington plant and consequently must continue to burn expensive fuel oil where wood waste would otherwise be much cheaper.

Larger firms may be able to offset the economic burdens of expensive pollution control equipment through savings achieved by supplying their own very substantial electricity needs. For smaller firms, however, the only way to spread the costs is to generate power on a scale larger than internal needs demand and

then to sell the excess. In this context, the experience with self-generation of two small firms is worthy of note.

Since the electricity needs of Best and Cooper were insufficient in themselves to justify the cost of installing generating equipment, each company tried to negotiate for the sale of excess power to the local electric utility. Best found that the price offered by Pacific Gas and Electric was too low to support its self-generation and consequently dropped the whole project.

Cooper Lumber was also offered a price for excess power which was too low to make the project viable. It then proposed selling the entire electricity production to Pacific Power and Light and buying back its own needs. The utility refused this arrangement because it questioned the reliability of a power supply based on a single generator, but indicated that it would reconsider if Cooper would install and operate two generators. Rather than installing a second generator, Cooper is now attempting to arrange the sale of excess power from its single generator to the Bonneville Power Administration, the public power agency for the Pacific Northwest. Another problem for Cooper has been the cost of a back-up system. Pacific Power and Light set a standby charge of \$8,000 to \$9,000 per month, in addition to the cost of any electricity actually used.

In combination, the problems described above indicate that to the degree that pollution control difficulties and public utility resistance to an economically viable sale of excess electricity inhibit lumber companies' use of wood waste, they may be open to other alternatives such as geothermal.

2. FUEL SUPPLY INTERRUPTIONS

Interruptions of supply of either steam for drying or electricity for powering equipment are a problem in the lumber industry only insofar as they

cause lost production; there is no danger of damage to materials or equipment. As one respondent from a large company put it: "Shutdown is not disastrous, but you don't like to do it." In order to minimize production losses, most firms plan periodic shutdown time (usually around Christmas and/or the Fourth of July) during which maintenance, repair and renovation take place.

No firm has a back-up system for steam used in kiln drying. Since steam is most commonly produced by burning wood waste, the abundant supply of waste and the relatively simple equipment involved make back-up unnecessary. However, eight firms (D,E,G,H,I,J,L,and M) which burn wood waste to produce electricity generally consider a back-up system essential, both because electricity needs are more important to overall production and because equipment breakdown is more common.

Of the companies surveyed, only six stated that they had experienced fuel-related interruptions recently, and all but one of these involved outages of purchased electricity or electricity generating equipment problems.

3. FUTURE FUEL SUPPLY CONCERNS

As one indicator of possible future activities, the firms were asked what type of energy problems they anticipated in coming years. Since all companies saw increased use of wood waste as a dominant trend in the industry, many focused on the difficulties associated with that use.

Leading Lumber noted that because lumber will increasingly be obtained from second-growth trees which produce less waste, wood wastes are not likely to provide a total alternative to other fuels in the long run. This assessment is supported by the fact that the availability of waste also varies with the age of plant equipment and the products produced. The new computer-controlled

saws maximize output from each log and leave significantly less waste than older equipment. In addition, plywood and veneer plants produce much less waste than do saw or planing mills; this segment of the industry will probably never be able to meet its needs primarily from wood wastes.

At the same time, environmental protection laws are an immediate obstacle to increased use of wood waste. Seven companies (D,F,H,I,K,L,M) mentioned air pollution standards as a major impediment to expanding the use of wastes as fuel or as a consideration in locating new plants.

In the short-run, the rising costs of gas and electricity and the possibility of fuel shortages are causing concern among most lumber operators. Ten firms expressed immediate concern about rising costs, and eight about availability. These concerns were shown by all types of firms; neither size nor plant location appeared to be relevant variables. A strong desire for energy independence to overcome these difficulties was expressed. However, this must be interpreted in light of availability of wood waste. In order to achieve a measure of energy independence, lumber firms will be willing to use internal resources and may be willing to absorb higher short-run costs in exchange for longer-run security. However, there is no indication that many firms, especially the smaller ones, would seek out an energy resource outside the industry simply in order to become energy self-sufficient. This is likely to mean that an alternative such as geothermal energy will get serious consideration only where wood wastes are not available or where the environmental problems associated with waste use are insurmountable.

B. FIRM DECISION-MAKING

1. MANAGERIAL STRUCTURE AND DECISION-MAKING

To assist in focusing possible policy initiatives, we sought to determine what levels and which members of a firm play important roles in decisions affecting energy use. For this purpose, various inquiries were directed to the organizational structure and decision-making process of the lumber companies studied.

Managerial Structure

The firms surveyed are all corporations, but they include a full range of sizes. The smallest company, Acme Lumber, employs 45 workers and produces approximately eight million board feet of lumber per year, while the largest company, Leading Lumber Corporation, employs 46,000 people and produces 3,384 million board feet of lumber, as well as many other wood products such as plywood, particle board, veneer, and pulp and paper products. The organizational structures of the firms reflect the diversity in size, as summarized below:

<u>Firm Structure</u>				
<u>Owner/ Operator</u>	<u>Family Controlled</u>	<u>Two Tiered</u>	<u>Three Tiered</u>	<u>Four Tiered</u>
A	C	D	G	J
B	E	I	H	
	F	K	L	
			M	

The five smallest companies (A,B,C,E,F) are all family-owned businesses with simple management structures. All of these firms have a single plant, with the exception of F, which has two. Acme and Best are owner-operated and controlled. Cooper, Earnest, and Friendly are formally controlled by Boards of Directors, but are dominated by the operating owners.

Three of the companies are small multiplant firms with two-tiered managerial structures (D,I,K). Each of these firms has a management headquarters and operates between three to six plants. Dependable and Keen have planning groups at headquarters, and Keen also has a planning group at each plant, as well as energy managers at both levels. Industrious Company indicated that planning was done at headquarters through regular meetings of top-level corporate management.

The remaining five companies are large multiplant firms (G,H,J,L,M) which include three of the largest forest products producers in the United States. Just Lumber has a four-tiered managerial structure (headquarters, group, division, and plant), while the other four have three tiers (headquarters, division or region, and plant). Four of the large firms (G,H,J,L) have energy managers with responsibility for conservation and in some instances, for keeping up with new energy technology, evaluating energy-related investments and auditing energy use and costs at the plant level.

Of the firms surveyed, Just Lumber has the most elaborate system for energy analysis. A corporate energy department was established in response to the Arab oil boycott; currently its concerns include conservation, analysis of energy-related legislation and regulations, and long-range energy planning. The firm's paper group has a special energy coordinator and each paper mill has a full-time energy manager. The lumber group which is less energy intensive has a part-time energy staff at the group level.

Decision-Making Process

With the firm structures as a background, the process by which decisions regarding the use of geothermal energy would be made by the lumber companies was explored. Particular attention was paid to who would play the key roles in initiating geothermal proposals, as well as who would make important recommendations and where final responsibility for decision-making would lie. As

a means of exploring this process, five different projects were suggested: opening a new plant, finding a plant location, expanding an existing plant, retrofitting an existing plant, and using a new energy source - and respondents were asked at which corporate level final decisions on these projects would be made. The responses are detailed below:

Corporate Level of Final Decision

PROJECT	HQ	Div.	PLANT	OWNER/OPERATOR	BD. OF DIR.
Open new plant	D,G,H, I,J,K,L	---	---	A,B	C,D,E,I,H,L J=\$2.5 mil + up
Locate new plant	D,G,H J,K,L	---	---	A,B	C,D,E,J,H,L J=\$2.5 mil + up
Expand existing plant	D,H,I,K,L J=\$250,000 + up	G,H,L	L	A,B	C,D,E,F,H,L J=\$2.5 mil + up
Retrofit existing plant	D,H,I,K,L J=\$250,000 + up	G,H,L	L	A,B	J=\$2.5 mil + up
Use new energy resource	D,H,I,K,L	H	---	A,B	C,E,F J=\$2.5 mil + up

The majority of firms considered all of the suggested projects to be major ones requiring top-level approval. However, three companies (H,J,L) indicated that the dollar amount involved would determine where the decision would be made, and another (G) said that expansion and retrofitting could be decided at the division level.

Although responsibility for decisions appears to be heavily weighted toward the top, many respondents indicated that the process was fairly complex in firms with multilevel management. In such firms, a new project develops through a political process which involves all levels. As one respondent described it, no project will get off the ground if plant and division management oppose it. The conversion to use of wood waste for fuel was a case in point. Although decisions were made at the headquarters level, plant management, which is very production-oriented, saw the new technology as a

threat to output, and was reluctant to use it. It was necessary to find an enlightened regional manager to try it first, and then, when all went well, others were willing to follow.

Respondents were also asked to pinpoint the specific people who would be important in decisions involving geothermal use in particular plants. Once again, project initiation and the most important recommendations would generally be concentrated at the headquarters level. Four companies (B,F,J,L) give plant managers responsibility for initiating projects and making important recommendations, but various headquarters personnel, particularly engineering staff and energy managers, were likely to be important as well. Three companies (C,F,I) reported that they often hire outside consultants, primarily engineering firms, to advise them on technology and energy matters, and their recommendations would be most important. In addition, the company presidents, executive committees and R&D staff were mentioned as important by at least one company each.

2. INVESTMENT PROJECT APPRAISAL

In addition to exploring the managerial structure of the firms in the sample, the procedures for appraising investment projects was also examined. The theoretical literature on project appraisal contains a number of investment criteria of varying sophistication. Since the criteria can lead to different conclusions when applied to the same project, it is necessary to know which criterion a firm actually employs. The firms were asked what financial criteria they employ for "normal" non-energy-related projects, and whether the criteria differ according to the nature of the project - e.g., replacing equipment at an existing plant, expanding production capacity at an existing plant, or opening an entirely new plant. With one exception, the

respondents indicated that the criteria employed would not differ among these types of investment projects. Earnest Lumber stated that it did not employ any specific financial criteria for investment project appraisal, and B,D and H did not respond to the question. The responses of the other firms are as follows:

Investment Project Appraisal

Payback Period

A: 5-10 years
C: 3-5 years
F: 10 years
I*: 2 years on replacement investments
4 years on large new projects

Return on Investment or Discounted Cash Flow

G: 30% after-tax ROI
I*: DCF with 20-25% discount rate
J: DCF with 12% discount rate
K: 25% after-tax ROI
L: DCF with 10-20% discount rate
M: DCF, discount rate not specified

*two criteria are employed

It can be seen that, although four small or medium firms employ the payback period criterion, the larger firms all employ the return on investment or discounted cash flow criterion. The hurdle rates range from 10% to 30% after taxes, although here there is no obvious correlation with firm size.

To determine if the appraisal of a geothermal energy investment project presented a different kind of investment decision to lumber companies, they were asked if they would employ either a different type of financial criterion or a different hurdle rate in evaluating such a project. Responses to this question showed distinct differences. Two firms (G and K) would use the same criterion and hurdle rate as for a non-geothermal project. Two firms (L and M), both large, would probably employ a higher discount rate, incorporating

risk premium, because they regard geothermal as somewhat risky. Six firms (C,E,F,H,I and J), mainly small and medium-sized, implied that they might evaluate an energy-saving investment project more leniently; in particular, Just Lumber reported that given a choice between a project that would increase production and one that would reduce energy use, it would select the latter, even if it offered a return of two percentage points less than the production-increasing project.

C. COMMERCIALIZATION POTENTIAL FOR GEOTHERMAL ENERGY

Dissemination of information on geothermal energy technology, costs, and uses, is obviously essential to commercial development of the resource. The Institute's survey accordingly attempted to determine how much is now known about geothermal potential in the lumber industry, what information would be most useful to encourage future use, and where financial assistance and technical information might most effectively be made available to the industry as a whole.

1. KNOWLEDGE OF GEOTHERMAL

Respondents had some general knowledge of geothermal energy as an energy source and most had heard of geothermal electricity generation at The Geysers. However, only those located near active resource areas, such as Boise and Klamath Falls, had any awareness of existing direct uses. For example, the family which owns Cooper Lumber heats its home in Klamath Falls, Oregon with geothermal energy and is aware that a local hospital and the Oregon Institute of Technology also use it for space heating. This company also uses 65-70°F water from a well on company property for its lumber processes and hopes to drill soon for hotter water.

Several firms had given some thought to using geothermal energy in the lumber business. The respondent from High Grade had visited a New Zealand saw-mill which is the only substantial commercial application of geothermal energy in the forest products industry. One of the largest firms, Leading Lumber Corporation, has been involved in drilling for geothermal energy in the Klamath Falls area, but has not found a suitable resource. Another large firm, Just Lumber, developed a seedling greenhouse using geothermal heat, but frankly admitted it was largely for public relations purposes. Two firms have leased geothermal exploration rights on their property to an oil company, one reserving to itself all water under 300⁰ F. Another firm in the same area is watching this project, and indicates that if the oil company finds a useful resource, it may grant exploration rights as well.

After explaining the nature of geothermal heat to those not already informed, the respondents were asked to suggest possible uses for geothermal in the industry. Among the uses mentioned were: heating kilns for lumber drying; space heat; preheating kiln boiler water; drying veneers; heating for the plywood gluing process; and drying wood chips. However, enthusiasm about the actual future of geothermal energy in the lumber industry was limited. Of the nine firms commenting on this issue, three (D,E,I) thought it would never be an important resource. High Grade Lumber thought geothermal might eventually be of regional importance, and Keen Lumber and Cooper Corporation thought it might be a factor in the next five years. Two of the largest firms, Leading Lumber and Just Lumber, estimated that it might become a useful resource in five to twenty years. Good Lumber predicted no importance for 40-60 years. There was a general perception that there would be significant difficulties associated with geothermal use in the lumber industry.

2. FACTORS INFLUENCING THE DECISION TO EMPLOY GEOTHERMAL RESOURCES

In order to probe for any basic resistance to the use of geothermal energy, the respondents were asked to identify specific problems which they could foresee in using geothermal energy in their operations. Three major problems were mentioned. In order of importance, they are: a) Availability of the resource; b) Cost of using the resource; c) Reliability of the resource. The full range of responses and order of priorities were as follows:

Problem	Most Important	Very Important	Important	TOTAL
Availability	4	-	2	6
Cost	2	1	2	5
Reliability	3	-	-	3
Uncertain technology	-	2	1	3
Lack of information	-	-	2	2
Drilling risk	-	-	1	1
Corrosion	-	-	1	1
Environmental risk	-	-	1	1

a. Availability of the resource near existing plants or raw material supply. Plant location in the lumber industry is almost wholly determined by the location of timber supply. Transportation costs preclude operating far from the raw material supply. This was made clear by the eight respondents who answered inquiries about determinants of plant siting, and although four companies (G,H,J and L) indicated that energy supply was also an important plant siting factor, two (I and K) thought it unimportant, and none suggested that it would override considerations of timber supply. The frequency and importance of siting factors mentioned were as follows:

Factor	Most Important	Very Important	Important	TOTAL	Not Important
Raw material supply	8	-	-	8	-
Transportation	-	4	-	4	-
Water supply	-	3	2	5	-
Energy supply	-	3	1	4	2
Labor supply	-	1	1	2	1
Existing ambient air quality	-	1	-	1	-

Because of this dependence on timber supply, four of the five firms (G,J,K,L and M) planning new plants in the next 15 years will follow the general trend in the industry and locate in the south, where timber is most abundant. Timber supply dependence also contributes, along with high construction costs, to a reluctance to relocate existing facilities. No firm would consider relocating existing plants to take advantage of geothermal energy.

When questioned about new plants, only two firms expressed interest in locating new plants near geothermal resources. Even among those firms which mentioned energy costs as important siting considerations, only Leading Lumber, the largest and most experimental company in the sample, and Keen Lumber would consider exploring for geothermal resources outside of existing plant locations. On the whole, expansion is achieved by large companies buying up smaller ones to avoid the costs of new plant construction, and there is little prospect that other firms would weigh the availability of geothermal resources heavily in choosing a site for a new plant.

b. The cost of using the resource. Only two interviewees had any realistic idea of the costs of developing or using geothermal energy in the lumber industry. However, for many firms the existence of a plentiful and cheap alternative to conventional fuels in the form of wood waste makes considerations of a relatively untried and unfamiliar resource such as geothermal energy less attractive, regardless of costs. It may be worth remembering that use of wood waste is not without cost complications, especially for the small companies. Environmental regulations on allowable particulate emissions may require the installation of scrubbers, which would be a very big expense. At least one company (F) indicated that it could not afford such additional equipment. An additional consideration is that the industry is constantly developing new and possible more valuable uses for wood residues. Several firms

suggested that if that trend continues, other energy sources could become competitive with the use of wood wastes for fuel in the long-run.

c. The reliability of the resource. The danger of reservoir or temperature fluctuation was of considerable concern to a number of the firms surveyed. The interviewee from Industrious Lumber, for example, was particularly skeptical about the reliability of geothermal energy because he had used it many years ago to heat his home and recalled that efficiency of the supply for existing users was reduced when new users tapped the resource. Others without direct experience were nonetheless generally concerned about having a reasonably consistent supply of energy.

In order to probe further the manner in which cost and reliability factors will be assessed in the lumber industry, the respondents were asked to assume the availability of a resource near their plant which was being offered for their use, and then to rate a series of decision factors which might influence their decision whether or not to accept the offer. The following table represents the number of respondents who rated each decision factor:

Number of Firms Rating Alternative Decision Factors

Factor	Most Important	Very Important	Important	TOTAL	Not Important
Reliability	5	1	6	12	-
Cost (as compared to alternatives)	3	-	-	3	-
Capital cost	1	7	-	8	-
Operating cost	1	3	-	4	-
Compatibility with existing equipment	1	1	-	2	1
Previous commercial viability	1	1	-	2	-
Ease of maintenance	-	1	-	1	-
Familiar technology	-	1	-	1	2
Availability of a long-term supply	-	-	1	1	1

The responses reinforce the conclusion that reliability and cost are likely to be of paramount importance in the decision to employ geothermal energy.

Three firms indicated they would compute the total cost of using geothermal and make a decision based on a comparison with other fuel sources. Others would look at capital and operating costs separately. While seven companies view capital cost as very important, only one thinks of it as the most important factor. This supports earlier comments about the desire for energy independence; namely, that while cost is very important, some leeway is possible in projects that increase energy independence. The importance of reliability is consistent with this view.

The ratings indicate that capital costs are slightly more important to the firms than operating costs. In order to test whether firms do in fact regard these costs differently, the following hypothetical question was asked: given the choice between two projects, both with the same total annual cost, but with one (Project "A") having a higher annualized capital cost and a lower operating cost than the other (Project "B"), would you be indifferent between the two or prefer one over the other?

Of the seven companies responding to this question, three were indifferent between the two projects. Cooper Lumber views capital and operating cost as interrelated. Industrious Lumber would be indifferent as long as its ability to borrow was not impaired by a high capital cost project. Just Lumber indicated it would work out a twenty-year return for both projects and pick the project that had the greatest return.

Three firms preferred Project "A" - high capital/low operating cost (E, G, K). Keen Timber Products mentioned its concern about the effects of inflation on operating costs.

Only Leading Lumber would prefer Project "B" - low capital/high operating costs, because it prefers projects which do not have high fixed costs.

In order to gain a similar understanding of the importance of reliability as a decision factor, we decided to test whether the reliability of an energy supply represents a separate dimension of preference from cost. The companies were asked whether the costs of frequent temporary shutdowns would simply be factored in with other operating costs, or would be evaluated separately in considering an investment in an energy resource. Eight companies responded to this question. Five firms (C,E,G,I,K) would factor shutdowns into cost. Two companies, Friendly Wood Products and Leading Lumber would treat shutdowns separately. Since in the town where the Friendly plant is located, everyone works at the mill, any shutdown would have strong repercussions in the community and so must be considered separately. For Just Lumber, it would depend on how frequent and temporary the anticipated shutdowns were.

These results do not indicate a strong trend in the lumber industry sample to consider either operating cost, capital cost or reliability as a separate dimension of preference. A few firms do consider one of these factors separately, but this appears to be a function of their individual situation. None of the other factors indicated in the table on page 39 seemed to represent separate dimensions of preference.

3. FINANCING A GEOTHERMAL INVESTMENT PROJECT

In order to ascertain the importance of financing mechanisms for project appraisal a brief examination of how firms might expect to finance a geothermal investment project was conducted. Respondents were asked to suppose a suitable geothermal resource was discovered in the vicinity of a company plant and that they had accepted a supplier's offer to provide geothermal fluids. They were then asked how would they finance the retrofit of the plant

to utilize the geothermal energy and if this financing arrangement differs from that used to finance a similar investment project not involving a new type of energy. All of the firms which responded indicated that they would finance the geothermal project in the same manner as any "normal" non-energy project. As for the type of financing, five firms (C,E,F,I and L) - mainly small or medium-sized firms - indicated a strong preference for financing the project internally. Firm C, a small firm, would never borrow because of the experience of the owner's family during the depression, and firm F considers borrowing too expensive. The other three would borrow if necessary, but prefer not to. The other large firms responding to the question (G,J and K) would select some mix of internal funds and long-term debt. Firms J and K also expressed a strong interest in financing the project through tax-exempt municipal revenue bonds, if this method became available.

When asked how the firms might finance the front-end costs of resource development, most firms indicated they would use the same mechanisms as for retrofitting a plant. However, Leading Lumber said that it would seek to enter into a joint venture in which a geothermal developer put up the capital for the front-end costs.

4. GENERAL SOURCES OF INFORMATION ON TECHNOLOGY

The discussion above has focused on what lumber respondents know or need to know about geothermal energy if they are seriously to consider using it in their operations. This section examines the sources normally relied upon by industry members to obtain needed information on new technology in general and on energy in particular.

According to those interviewed, there are four major sources of technical information in this industry: others in the industry, trade associations,

company research and development, and equipment supply companies. For information on alternative energy a number of respondents added outside consultants to that list.

a. Other industry members. Ten of the thirteen companies interviewed indicated that other industry members were primary resources on new technology. There appears to be constant communication among industry members. Especially among the small and medium-sized companies, technical exchanges at industry meetings and visits to other plants are frequent. The respondent from Friendly Lumber, a medium-sized firm, told us that the president of the firm spends a large part of his time attending industry meetings and making contacts with other lumber producers in order to keep up on new developments. This same company embarked on a major and expensive fuel drying project to increase energy efficiency in part because Leading Lumber Company had successfully pioneered the process.

b. Trade associations. Seven companies mentioned trade association meetings as useful information sources. Several small companies in particular suggested that the annual sawmill clinic sponsored by Forest Industries Magazine attracted widespread industry participation, and one respondent indicated that the National Forest Products Association, which holds an annual convention, is the number one organization in the industry and could play a significant role in information dissemination. The Western Wood Products Association, which focuses primarily on grading of lumber, was mentioned by one respondent as the top trade association on the west coast. Seven companies also indicated that trade association publications are significant sources of information, especially on new technology. One respondent reports that because he is continually searching for innovative techniques he always looks through

most trade publications and would have read an article on geothermal energy simply because it is new to him.

c. Company research and development. Six companies felt that their own research and development contributed significantly to new technology. Five of these were large companies, and one a small multiplant company owned by a former large company executive. The large companies appeared to rely more exclusively on their own R&D and seem to be a primary resource for the smaller companies. The only small company which relied to any degree on its own R&D was Keen Lumber, which was also unusual in seeing itself as innovative and one of the most modern plants on the west coast.

d. Equipment supply companies. Four firms suggested that equipment supply companies play a role in spreading technology in the industry. Sales representatives call upon lumber mill operators, and equipment companies have demonstration shows which are attended by both large and small lumber company representatives.

In general, the firms would expect to obtain information on alternate energy sources in the same ways as they get other technical information. The larger companies rely on their own research staffs, while the smaller ones look to others in the industry and to trade associations. However, four firms, two small and two large, also indicated they would use outside consulting firms for alternative energy inquiries.

One clear fact emerging from the survey is that the frequent and fruitful communication among industry members means that the introduction of a new technology in one place has rapid impact elsewhere. This has important implications for geothermal development. While there is no existing full scale

use of geothermal direct heat in the U.S. lumber industry, this is an important industry in which a demonstration project would be likely to get widespread attention. One caveat, however, is necessary. The smaller companies are sometimes wary of large company developments because they consider themselves to be in a different league. They are more likely to be influenced by moderate-scale projects which they feel they could realistically implement.

D. POTENTIAL INSTITUTIONAL FRAMEWORK

Most of the inquiries directed to lumber firms related to their potential roles as end-users of geothermal energy. However, in many cases geothermal use may depend on institutional arrangements between end-users and other entities contemplating resource development and/or distribution. To determine the need for such institutional arrangements, and to identify structures which might be acceptable to firms in the lumber industry, the following questions were asked:

- 1) To what extent and under what conditions would the firms be willing to undertake resource development for their own use?
- 2) Would they require full control over a geothermal source, or would they be willing to purchase geothermal heat supplied through a distribution system?
- 3) Would firms which controlled a resource be willing to act as suppliers of excess heat to other end-users?

1. PARTICIPATION IN RESOURCE DEVELOPMENT

One possible development arrangement would be for an industrial or commercial end-user to initiate and carry out development of a resource for its own use, either alone or with partners. Accordingly, the respondents were

asked to comment on their firms' willingness to participate in various stages of geothermal development -- from lease acquisition, to basic exploration, to production well development at a proven geothermal field. Firms indicating an interest in any of these development phases were asked whether they would expect to act alone or in joint ventures with other parties, such as resource companies, other end-users, or outside investors. Their responses are summarized as follows:

Willingness to Become Involved in Resource Development

Willing to consider development of proven resource only,	C,E,G,I,L
Interested only in proven resource on own land.	E,I
Willing to consider basic exploration	J,K
Not willing to consider development.	H
No response	A,B,D,F,M

Only one firm foreclosed any possibility of participating at the development stage. The others would entertain the possibility of limited participation: most would consider only field development of a proven resource, not basic exploration.

Earnest Timber and Industrious Lumber would limit such efforts to development of a proven resource on their own land. High Grade would appraise the value of a resource on its own land as a matter of prudent management, but would leave development to others familiar with drilling technology. Cooper Lumber would consider acquiring a geothermal lease on adjacent land, but only if a resource had been proven.

In terms of institutional arrangements, only Good Wood and Industrious would prefer to carry out resource development alone. Leading Lumber (which drilled unsuccessfully near Klamath Falls) would limit further efforts to substantially proven resources, under partnership arrangements with a resource developer who would provide most of the financing. Similarly, Keen Lumber would participate only in a joint venture with a partner able to provide capital and/or geothermal development experience.

One possible model for joint development arrangements on timberland with geothermal promise is illustrated by an existing agreement between Dependable Lumber and Union Oil Company. The agreement gives Union the right to explore for electric quality resources on Dependable's land, and commits Union to spend at least \$200,000 in this effort during a two-year period. Union has an option to lease and to develop a resource above 300°F for power generation, but Dependable is entitled to access to all of Union's test data, and has full rights to exploit any discovered resource below 300°F.

Earnest Timber, which owns lands adjacent to those covered by the Dependable/Union agreement, is awaiting the results of that agreement before deciding whether to grant exploration rights on its own land.

2. NEED FOR CONTROL OVER SUPPLY

An alternative to user participation at the development stage would be an arrangement under which the user has no development or production functions, but merely purchases geothermal heat from an independent supplier, in the same way that it purchases other types of energy.

An important determinant of the feasibility of a retail distribution structure in the lumber industry is the extent of the firms' perceived need

for control over a geothermal energy source. Accordingly, we asked whether the respondent firms would be willing to tie into a geothermal distribution system controlled by others. The responses are summarized below:

Need for Control Over Resource

Would need to be sole user	F
Willing to hook up to a distribution system	C,D,G,H,I,J,K,L
No response	A,B,E,M

Of the firms responding to this question, only Friendly would insist on sole control of the resource, consistent with its stated desire for energy self-sufficiency. All of the others would be willing to be served by a distribution system. Indeed, a majority of the firms would clearly prefer to tie into an existing geothermal distribution system because they have little real interest in exploring for or developing an energy source which they perceive as unfamiliar, unproven and risky. Leading Lumber did, however, explicitly condition its willingness to tie in on assurances of a reliable supplier; Just Lumber would accept distribution from an independent supplier, but its first preference would be to control the resource in order to guard against price escalation.

3. WILLINGNESS TO ACT AS SUPPLIERS

Even where a firm's primary interest in geothermal is to meet its process needs, both internal economic considerations and broader policy objectives may be served by the distribution of excess fluids or spent heat to downstream users. Downstream distribution by the primary user would be a means to recoup a portion of high front-end development costs. From a policy perspective, the general disinclination of many industrial and commercial users to

engage in resource development, and the possibility of premature disposal of useable fluids, suggests that distribution systems will be required to encourage maximum beneficial use of the resource.

In order to assess the potential role of primary users as resource distributors, we asked whether firms which might control a geothermal resource would be interested in extending their activities to include sales of surplus heat to other end-users. Sales to one or two nearby plants or to a municipality were suggested as one level of activity; initiating the creation of a heating district or an industrial park was offered as another possibility. Whatever their anticipated level of involvement, firms were asked how the prospect of public utility regulation would affect their interest in distributing excess heat, and whether they would consider distribution if such activities were likely to subject them to such regulation.

Willingness to Act as Suppliers

Willing to supply one or two other companies	B,C,F,I,J,K,L
Willing to consider setting up heating district or industrial park	C,I,K,L
No response	A,D,E,G,H,M

Would Still be Interested if Subject to Regulation as a Public Utility?

Yes	C
No	B,D,F,I,L

All of the firms responding to this question would be interested in selling surplus heat to one or two other companies, although Best Lumber and Just Lumber expressed some hesitations about "getting into the energy business."

Some firms would consider sale to a municipality or even establishing a heating district or creating a geothermal industrial park, given an adequate supply of geothermal fluids and a favorable economic evaluation. But Keen and Leading Lumber also had reservations about participating in this type of supply arrangement, even though Leading has a real estate division involved in large development.

The firms' generally positive responses to the possibility of distribution shifted dramatically when the respondents were confronted with the prospect that public utility regulation might be imposed as a result of such activities: almost none of the firms would be willing to consider distribution under such circumstances.

E. THE ROLE OF GOVERNMENT

1. EVALUATING EXISTING PROGRAMS

Awareness of Programs. When asked if they were aware of existing government programs to promote the commercialization of geothermal energy, six firms out of the eleven who answered knew nothing about this kind of government activity. Although two firms knew of tax incentives to promote alternative energy, neither had ever connected these to geothermal energy. Five firms were aware that tax incentives for alternative energy sources applied to geothermal, and three looked favorably upon them. Three firms were aware of the Geothermal Loan Guarantee Program, but only Cooper Lumber approved of it. Leading Lumber, which was considering applying for a PON, was the only firm which knew of government supported demonstration projects.

Demonstration Projects. In order to evaluate whether government-funded demonstration projects would be effective in promoting the development of

geothermal energy, the interviewees were asked if such projects had any credibility with them, or if they would require demonstration wholly in the private sector. Almost all respondents would trust such projects to some degree; three without qualification and seven with somewhat less faith than privately-developed projects. Only one firm, Dependable, rejected government projects as completely unreliable.

The sentiment that government ought to stay out of the commercialization business altogether was expressed directly at various points in the interviews by five respondents (D,E,F,K,M); Dependable Lumber reflected the views of others with its contention that market forces would develop geothermal energy when and if it is economical to do so.

The opposition to government involvement in energy development may stem from the fact that the lumber industry has been adversely affected to one degree or another by air pollution regulation and government protection of timber. However, at least one respondent, Leading Lumber, felt the government was neither doing enough to promote geothermal nor doing the right things. The tax incentives are small and unexciting in his view, and government development of technology is of little value, because geothermal heat is not difficult to use once it is found. He felt the most important thing the government could do was to locate resources and then let industry take care of the rest, although he would like to participate in a cost-shared demonstration project.

2. RECOMMENDATIONS FOR FUTURE PROGRAMS

To assess the types of programs which lumber industry respondents would view as helpful in commercializing geothermal energy, fifteen

different possibilities were presented and values were assigned to each. The following table shows how the firms ranked each program:

Evaluation of Suggested Government Programs

Program	Important	Not Important	Opposed
Tax credits	8	2	1
Resource identification	4	-	3
Information dissemination:			
Resources	4	-	-
Technology	2	-	-
Demonstration projects (PON)	4	-	1
Cost-share industry R&D	3	-	1
Accelerated depreciation	2	1	1
Feasibility studies (PRDA)	3	-	1
Resource development	2	-	2
Direct subsidy	1	1	4
Loan forgiven if unsuccessful	1	-	2
Subsidy to loan if successful	1	1	-
Do nothing	2	-	-

Clearly, more people favored tax credits than any other program. However, when those favoring resource identification and information dissemination on resources are combined,⁶ there seems to be nearly equal interest in this approach. The importance of resource identification to the respondents was demonstrated by further questioning.

When asked directly where the government should concentrate funds, the majority focused on resource identification and development. Eight firms favored this approach. Dependable Lumber, however, qualified the answer by stating that the government should identify and develop resources only on its own land, because private capital will develop private resources when it is economical to do so. Three firms felt that if funds were limited, they should go to finance technical research and development. Cooper Lumber specifically suggested

6. Although the total number of positive responses in these categories is eight, in fact, this represents the responses of only six different firms. Two firms chose both categories as important.

that technical R&D was too expensive for the industry to undertake alone. Good Wood felt there was not enough information about geothermal use and its costs.⁷ Firms B,C and I felt tax incentives would best accelerate private development.

Federal vs. State Programs. Only seven firms responded to inquiries as to whether state or federal government administered programs were preferable. Five of these felt there was no substantial difference between the two. One company spokesman indicated, however, that states, which have stronger universities and better technical people might be better equipped to participate in commercialization, and another firm felt that federal funding was generally more reliable.

7. Note that firm D named both resource identification and development, and technical research and development as important.

V. CONCLUSIONS

A. FUEL

- The generation of steam for drying lumber and processing veneers is the main process in which low and moderate temperature geothermal energy can substitute for existing fuels in the sector of the lumber industry studied. The fuels currently used for this process are oil, natural gas, and wood waste.
- Fuel costs for drying lumber and processing veneers average between 5 and 10% of total costs.
- Wood waste is the most important fuel used for steam generation, and its use is increasing. The advantage of wood waste is that it is an internal fuel source which is presently in abundant supply. In the short run it will prevent many lumber producers from considering geothermal as an alternative.
- However, there are several problems that make the use of wood waste less attractive, particularly to small and medium-sized firms. Increased burning of wood waste would in some instances require the installation of expensive pollution control equipment, which would make the use of wastes uneconomic. Therefore, for some the most efficient and only economic use of waste is for co-generation of process steam and electricity, with the

sale of excess electricity. At present, electric utilities are generally either reluctant to purchase excess power or are offering prices which make production uneconomic. Although provisions of the National Energy Act are designed to mitigate this problem, it is unclear how long it will take to implement these provisions or whether price questions can ultimately be settled satisfactorily. These problems may make some firms more receptive to geothermal energy if it can be made available to them.

- There may be more extensive long-run problems with the use of wood waste for fuel. The newest computer-controlled saws are designed to limit waste, and the younger trees being logged more and more frequently also leave less waste. Additionally, as new products are developed, what is currently waste may be more valuable as a raw material. In anticipation of reduced waste availability at least one progressive company is looking for alternative fuels, and others may be persuaded to do so as well.
- While lumber companies back up their electricity supply, they do not have back-up systems for the steam used for kiln drying. If a back-up were required for geothermal used for process steam, this would increase costs and depart from the convention.
- Rising costs and concerns about availability of gas and electricity are causing many firms to consider alternatives, but wood waste is by far the preferred alternative because of its immediate availability.

B. DECISION MAKING

- The small companies with one or two plants are often family businesses where considerations of geothermal energy as a fuel source will involve relatively uncomplicated owner/operator decisions.
- In firms with three or more plants, investment projects involving the use of geothermal energy will be considered major and will require top management approval. However, they will involve the participation of plant and division level management as well. This often requires a process of persuasion, since lower level management tends to be production-oriented and thus resistant to technological changes perceived as risky.
- Plant managers play a significant role in initiating and making recommendations on technical innovation, and outside consultants are not uncommonly hired to keep abreast of new developments.
- In evaluating ordinary investment projects, the small and medium-sized firms tend to use a payback period criterion of between 2-10 years. The larger firms, on the other hand, use a return on investment or discounted cash flow criterion with hurdle rates of from 10% to 30%.
- There is some difference in the criteria firms would use for a geothermal investment project. Larger firms are more likely to employ higher discount rates to incorporate a risk premium,

whereas the small and medium-sized firms might evaluate the investment more leniently if it promised lower energy costs and greater energy independence.

C. COMMERCIALIZATION POTENTIAL FOR GEOTHERMAL ENERGY

1. ATTITUDE TOWARD GEOTHERMAL

- Only those lumber producers located near commercially exploited low-temperature resources are aware of geothermal potential for use in wood processing.
- Enthusiasm about the future of geothermal energy in the lumber industry is limited. This is undoubtedly due to the existence of wood waste as a much more accessible alternative.

2. ANTICIPATED PROBLEMS

- Availability of the resource in the right location was the foremost concern. No firm indicated a willingness to relocate in order to take advantage of a geothermal resource, and only two large firms would consider geothermal potential when choosing a location for a new plant. Plant location is determined almost entirely by availability of raw material supply. In addition, the high cost of construction inclines the industry to buy existing plant facilities rather than to construct new ones. Therefore, geothermal use will largely depend on discovery of resources near existing plants.

- Many lumber producers perceive the cost of developing and using geothermal as much greater than the cost of using wood waste. Since few have actual cost data for comparison, this may be a misconception, particularly for the smaller firms which have difficulty meeting pollution control restrictions on burning wastes.
- Resource reliability is an important concern of at least half the companies. Lumber producers are used to a reasonably consistent supply of energy and perceive geothermal as potentially unreliable. Since they do not have back-up for lower temperature steam uses, this becomes a serious consideration.
- No firm mentioned the regulatory environment as a potential problem in using geothermal energy. This may reflect lack of specific knowledge rather than informed opinion.

3. FINANCING

- There does not seem to be a strong trend in the lumber industry to consider operating costs or capital costs as separate dimensions of investment appraisal.
- All lumber firms indicated that geothermal project investments would be financed like any other investment project. The smaller and medium-sized firms prefer internal financing. The larger firms prefer a combination of internal funds and long-term debt.

- All but one company would finance the front-end costs of resource development as they would other investments. The exception was the largest firm which would look for a joint venture with a developer putting up the front-end costs.

4. INFORMATION NETWORKS

- Other industry members are the most common sources of technical information for lumber producers. This is an industry where a demonstration project in the right company would be looked at with great interest. A small or medium-sized firm would be most effective, because it is the smaller firms that are less likely to be capable of taking full advantage of the wood waste alternative. In addition, the smaller companies pay the most attention to other lumber firms' technological activities because they have little R&D capability of their own, and since they sometimes consider the activities of the largest companies to be irrelevant to the scale of their own operations, a smaller scale demonstration project is likely to be most convincing.
- Trade associations also attract the particular attention of small and medium-sized lumber producers. The annual sawmill clinic sponsored by Forest Industries Magazine seems to be well attended.
- Company research and development is the primary technical resource of large companies.

- Equipment supply companies are moderately popular sources of technology for all sized firms.

D. POTENTIAL INSTITUTIONAL FRAMEWORK

- Most lumber producers would consider only very limited participation in the development of a geothermal resource. They are not interested in doing basic exploration and would, for the most part, only consider field development of a proven resource.
- The large majority of lumber companies prefer to tie into an existing distribution system, if they are going to use geothermal energy at all. Only one firm we spoke with would insist upon sole control of a resource.
- If lumber companies were to have sole control over a resource, most would be willing to supply surplus heat to one or two nearby companies and a few would consider setting up heating districts or industrial parks if there was adequate supply and favorable economics.
- The prospect of regulation as a public utility would discourage almost all lumber companies from distribution activities.

E. THE ROLE OF GOVERNMENT

- About half of the firms in our survey knew nothing about existing government programs to promote geothermal development. Consequently, if the government is to provide meaningful assistance

to the lumber industry, high priority must be given to disseminating available information to industry members who might benefit from the substantial efforts already under way by DOE.

- Lumber producers perceive a primary need for information on resources and technology. If funds are limited, however, resource identification and development is seen as the most important role of government.
- There is considerable hostility to government involvement in the private sector among lumber producers. Nonetheless, almost all of those surveyed give some credibility to government demonstration projects and about one-third thought such projects would be important for commercialization. The same proportion of respondents strongly opposed direct subsidies to lumber producers for geothermal development. For maximum impact in this industry, DOE efforts must take account of this ambivalence toward government and tailor programs to suit these attitudes.
- If lumber producers were to participate in government programs, most would have no strong preference as to whether the state or federal government administered the programs.

Appendix A

IV.A. Fuel

1. Fuel Sources, Uses, and Costs

a. Fuel uses and sources

Power equipment

(A,B,C,F,K)

Rely solely on purchased electricity. C will meet its electricity needs by self generation when the installation of a generator is completed.

(D,E,G,H,I,J,L,M)

Rely on a mixture of purchased and self-generated electricity. E also powers some equipment with steam.

Steam¹ (for drying lumber, processing veneers, and/or generating electricity.)

(B,H,I,J,L)

Oil. B is currently converting to wood wastes.

(D,G,H,J,K,L,M)

Natural gas

(C,D,E,F,G,H,I
J,K,L,M)

Wood waste. C uses water from a geothermal well at 65-70°F in making steam.

b. Costs of fuel for specific companies by type of fuel.

<u>Company Electricity</u>	<u>Price</u>	<u>Comments</u>
Acme	\$0.034/kwh	
Best	\$30,000/year	
Cooper	\$240-276,000/year	Pays residential rates for uninterruptable service.
Dependable	\$250,000/year	Cost for one of the companies divisions.
Earnest	\$48,000/year	Uninterruptable service.
Friendly	\$500,000/year	Uninterruptable service.
Keen	\$0.019/kwh	Price for Oregon plants only, uninterruptable service.
*The remaining firms did not provide this information		

1. Overlap occurs in the following table because multiplant companies may use different fuels in different plants and because some companies have inadequate wood wastes to meet their total needs.

A.1. b.
(continued)

<u>Company</u>	<u>Price</u>	<u>Comments</u>
<u>Gas and Oil</u>		
Best	\$50,000/year	For diesel fuel (approximately \$0.40/gal)
Dependable	\$800,000/year	For natural gas, at one division only. Interruptable supply.
Industrious	\$0.40/gal	Diesel fuel
Industrious	\$0.321/gal	Propane
Keen	\$0.28/therm	For natural gas at Oregon plants only, interruptable supply.
*Firms G,H,J,L and M did not provide cost figures.		

2. Fuel Supply Interruptions and Back-up Arrangements

a. Comments

- (A) Has only experienced short term interruptions of electricity due to downed transmission line. Has no back-up.
- (B) Did not mention any interruptions, but is considering installing a back-up generator because of a preference for continuous operation.
- (C) Did not mention any interruptions, but will purchase back-up electricity service when its own generator becomes operational.
- (D,E,F) D suffered an interruption in electricity service when its generator disintegrated. E has experienced short term electricity interruptions. F mentioned no interruptions, utilities provide back-up electricity service for all three firms. D and E also purchase interruption insurance.
- (G) Mentioned occasional electricity outages. Would rent a portable boiler if their present wood fired boiler broke. Electricity back-up is provided by a utility.
- (J) No interruptions were mentioned. Back-up arrangements vary with each plant, no general rule.

A.2. a. (K)
(continued)

Mentioned a 10% cut-back in electricity due to drought conditions. The firm responded by disconnecting pollution control devices to operate a more energy efficient plant. No back-up was mentioned.

(L)

Has had interruptions in natural gas service in both the southeast and the northeast. Uses oil as a back-up.

(H,I,M)

Did not mention electricity interruptions or back-up.

3. Future Fuel Supply Concerns

a. Concerns associated with the increasing use of wood wastes.

(D,F,H,I,K,L,M)

Are concerned that environmental protection laws will restrict the use of wood wastes. L also mentioned possible problems with wood waste supply because of increased use of second growth trees and more efficient milling equipment.

b. Short term concerns

(B,C,E,J,M)

Rising energy costs

(H,I,K)

Long term energy availability

(A,D,F,G,L)

Both cost and availability

c. Future changes in fuel use expected?

(B,C,D,E,F,G,H,
I,J,K,L,M)

Will rely more heavily on wood waste. E,G, and L mentioned greater conservation efforts as well.

Appendix B

B. Firm Decision Making

1. Managerial Structure and Decision Making

a. Firm Structure

<u>Owner/ Operator</u>	<u>Family Controlled</u>	<u>Two Tiered</u>	<u>Three Tiered</u>	<u>Four Tiered</u>
A	C	D	G	J
B	E	I	H	
	F	K	L	
			M	

b. Do you have a planning group or energy manager and at what level?

	<u>HQ</u>	<u>Div.</u>	<u>Plant</u>
<u>Planning</u>	D,K,L	H	K
<u>Energy</u>	G,H,J,K,L	J	J,K

c. At what level are decisions made on opening a new plant, locating a new plant, expansion or retrofit of an existing plant and use of a new energy resource?

<u>Project</u>	<u>HQ</u>	<u>Div.</u>	<u>Plant</u>	<u>Owner/Oper.</u>	<u>Bd. of Directors</u>
Open New Plant	D,G,H,I,J,K	-	-	A,B	C,D,E,I,H,L J=\$2.5 mil + up
Locate New Plant	D,G,H,J,K,L	-	-	A,B	C,D,E,J,H,L J=\$2.5 mil + up
Expand Existing Plant	D,H,I,K,L J=\$250,000 + up	G,H L	L	A,B	C,D,E,F,H,L J=\$2.5 mil + up
Retrofit Existing Plant	D,H,I,K,L J=\$250,000 + up	G,H L	L	A,B	J=\$2.5 mil + up
Use New Energy Source	D,H,I,K,L	H	-	A,B	C,E,F J=\$2.5 mil + up

- d. Who might be involved in initiating or making important recommendations on a proposal to use geothermal?

(A,E,H,K)

No answer

<u>Level</u>	<u>Position</u>	<u>Initiates</u>	<u>Recommends</u>	<u>Final</u>
<u>HQ</u>	Energy Manager	C,J	C,J	-
	President	C	C,F	-
	Board of Directors	-	-	C,D,F,J
	Outside Consultant	-	C,F,I	-
	Engineering Department	-	K	-
	R & D Staff	D	-	-
<u>Div.</u>	Head	J	J	G
	Operations Manager	-	G	-
<u>Plant</u>	Manager	B,F,J,L	B,J	-
	Planning Group	G	-	-
	Engineering	K	-	-

B. 2. Investment Project Appraisal

a. Hurdle rates for evaluating 'normal' investment projects

Payback period

A: 5-10 years
C: 3-5 years
F: 10 years
I*: 2 years on replacement investment
4 years on large new projects

Return on investment or discounted cash flow

G: 30% after tax ROI
I*: DCF with 20-25% discount rate
J: DCF with 12% discount rate
K: 25% after tax ROI
L: DCF with 10-20% discount rate
M: DCF, discount rate not specified

*Two criteria are employed.

b. Hurdle rate and criterion for a hypothetical geothermal project.

(G,K)	Same criterion and hurdle rate
(L,M)	Higher discount rate because geothermal is somewhat risky.
(C,E,F,H,I,J)	Implied a more lenient evaluation of energy saving projects.

Appendix C

C. Commercialization Potential for Geothermal Energy

1. Knowledge of Geothermal Energy

a. Know of potential as a source of energy?

Yes A,B,C,D,E,F,G,H,I,J,K,L

No answer M

b. Have heard of commercial applications?

Yes All but F and M

(C,E) Located in Klamath Falls. C uses geothermal to heat home and both know of OIT and hospital use for space heating.

(L) Been involved in trying to develop for lumber use.

(D,K) Sold geothermal lease rights to Union Oil. D reserved right to water under 300°F.

(G,H) The Geysers

(J) Company has geothermal seedling greenhouse.

c. Have seen cost figures for geothermal exploration, drilling or installation?

(C) Very involved in geothermal development in Klamath Falls.

(J) Has small greenhouse operation for public relation purposes.

(L) Has explored and drilled in Klamath Falls area but has found nothing.

d. Ever considered using geothermal energy?

Yes C,D,J,L

No A,B,E,F,G,H,I,K

(C) Several members of Board use for home heating and hope to use in business.

- C.1. d. (L) Will use it if they can find it.
(continued)
- e. What are possible uses for geothermal energy in lumber businesses?
(A,B,D,E,I,K,L)	Lumber drying
(C,K,L)	Steam heat
(G)	Boosting starting temperatures for boiler water.
(K,L)	Veneer drying and plywood gluing.
- f. When, if ever, will geothermal energy be an important resource in the lumber industry?
(C,K)	In five years
(L)	5-20 years
(J)	10-20 years
(F)	40-60 years
(H)	Only of regional importance
(A,F)	Too little information to say
(D,E,I,J)	Never
(B,M)	No response

2. Factors Influencing the Decision to Employ Geothermal Resources

- a. What problems are anticipated in using geothermal energy in your business?
(A,B,C,H,K)	Cost
(D,E,G,H,K,L)	Availability of resource
(C,F,I)	Reliability
(A)	Drilling risk
(G)	Water quality (corrosion)
(A,H)	Lack of information
(H)	Environmental risk
(J,M)	No response

C.2. a.
(continued)

<u>Problem</u>	<u>SMI*</u>	<u>VI*</u>	<u>I*</u>	<u>Total</u>
Availability of Resource	4		2	6
Cost	2	1	2	5
Reliability	3			3
Uncertain Technology		2	1	3
Lack of Information			2	2
Drilling Risk			1	1
Corrosion			1	1
Environmental Risk			1	1

*SMI = Single Most Important; VI = Very Important; I = Important.

b. Willing to relocate existing facilities to take advantage or geo-thermal energy?

Yes	None
No	A,B,C,D,E,F,G,H,I,K,L
No response	J,M

c. Willing to locate a new plant near a resource?

Yes	G,K,L
No	A,B,C,D,E,F,G,H
No response	K,M

d. Future plant plans?

Plan to open new plants within next one to five years. G, L, and M are locating new plants in the south where more timber is available. K plans to locate in geothermal Idaho or Montana, and would locate near a resource if feasible.

C.2. e. What factors are important in choosing a plant site?

<u>Factor</u>	<u>SMI*</u>	<u>VI*</u>	<u>I*</u>	<u>NI*</u>
Raw material supply	8			
Transportation		4		
Water supply		3	2	
Energy supply		3	1	2
Labor supply		1	1	1
Existing ambient air quality		1		

*SMI = Single Most Important; VI = Very Important; I = Important
NI = Not Important

f. Assuming a geothermal resource is available, which factors influence a decision whether or not to use?

<u>Factor</u>	<u>SMI*</u>	<u>VI*</u>	<u>I*</u>	<u>NI*</u>
Reliability	5	1	6	0
Cost (as compared to alternatives)	3	0	0	0
Capital cost	1	7	0	0
Operating cost	1	3	0	0
Compatibility with existing equipment	1	1	0	0
Previous commercial viability	1	1	0	1
Ease of maintenance	0	1	0	0
Familiar technology	0	1	0	2
Availability of long-term supply contract	0	0	1	1

*SMI = Single Most Important; VI = Very Important; I = Important
NI = Not Important

- C.2. g. Considering two projects with the same annualized costs, "A" - high capital/low operating costs, and "B" - low capital/high operating, which would be preferred?

(C,I,J) Indifferent. C saw capital cost and operating cost as interrelated; I was only concerned with not impairing ability to borrow; J would simply work out 20-year return on both and choose greatest return.

(E,K,G) Project "A"

(L) Project "B"

(A,B,D,F,H,J,M) No response

- h. If you would experience periodic, temporary shutdowns, would you factor it into costs or account for it separately?

(C,E,G,I,K) Factor into costs

(F,L) Consider separately. F said entire town depends on continuous operation, J said it depends on frequency.

3. Financing a Geothermal Investment

a. Financing a Geothermal Investment

Internal funds:

(C,E,F,I,L) C said they would never borrow because of the owner's family's experience during the depression. F would not borrow because of the expense. F, I, and L would borrow if necessary, but prefer not to.

Combination of internal funds and long-term debt:

(G,J,K) G indicated the mix between internal funds, long-term debt, and short-term debt would depend on its financial condition at the time of the decision. J and K expressed strong interest in financing with tax-exempt municipal revenue bonds.

C.3. b. Financing resource development

(C,E,F,G,J,K,L)

All firms indicated they would use the same financing method as for a plant retrofit. L, however, would try to enter into a joint venture in which the geothermal developer put up the capital for the front-end costs.

4. General Sources of Information on Technology

a. Most important sources of information on new technology.

(A,B,C,D,E,F,G,H,I,M)

Others in the industry. Company F's president spends a large portion of his time contacting others for new developments, and started fuel drying because firm L did it.

(A,C,E,F,G,H,J)

Trade associations. A mentioned Forest Products Magazine. F said trade magazines are a good place for government "propaganda" because they are at least skimmed by most in the industry. Also suggested National Forest Products Association as influential.

(G,H,J,K,L,M)

Company R&D. Firm G concentrates on product concepts. K was first to test fluidized combustion to ignite wood waste and reduce pollution. M says engineering staff is most important innovator in company.

(D,G,I,J)

Equipment suppliers. I says the best developments are by machinery people.

(C)

Outside consultants.

(B)

Universities. B says they help with insect problems after forest fires.

b. If looking for alternative energy, where do you make first inquiries?

(D,F,G,H)

Others in industry.

(D,G,H)

Trade associations.

(G,H,J,K,L,M)

Company R&D

C.4. b. (B,C,J,L)
(continued)

Outside consultants. B used CH₂M
Hill Engineering Consultants in Redding
on co-generation project. C is planning
to drill for hot water to heat its
offices.

(I)

Govermemnt

(I)

Universities.

Appendix D

D. Potential Institutional Framework

1. Willing to Become Involved in Resource Development?

Willing to consider development if proven resource only C,E,G,I,L

Interested only in proven resource on own land E,I

Willing to consider basic exploration J,K

Not willing to consider development H

No response A,B,D,F,M

2. Prefer to Develop alone or with others

Alone G,I

Joint venture with developer K,L

3. Need to Control Resource?

Would need to be sole user F

Willing to hook up to a distribution system. C,D,G,H,I,J,K,L

No response A,B,E,M

4. Willing to Supply Others?

One or two other companies B,C,F,I,J,K,L

Heating district or industrial park C,I,K,L

No response A,D,E,G,H,M

5. Still interested in supplying if regulated as public utility?

Yes C

No B,D,F,I,L

Appendix E

E. The Role of Government

1. Evaluating Existing Programs

a. Aware of Government Programs?

Yes	C, F, J, L, M
No	A, B, E, H, I, K. <u>A</u> and <u>H</u> knew of tax incentives for alternative energy but didn't know that they apply to geothermal.

b. Rating of Existing Programs

GLGP

favorable	C
unfavorable	J, L

PON/PRDA

favorable	L
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Tax Incentives

favorable	B, E, G, H, I, J
unfavorable	D, L, M (<u>L</u> said tax incentives are unexciting. Government should be identifying resources and industry will do the rest. He did say his firm would like to participate in PON program.)

c. Government Demonstration Projects Credible?

Yes	A, B, C, E, F, G, H, I, K, L (A, C, E, F, G, H, I) had less faith than in privately developed projects.
No	D

E.2. Recommendations for Future Programs

a. What should government do?

Program	Important	Not Important	Opposed
Tax credits	(A,C,D,E,G,H,I,J)	(K,L)	(L)
Resource identification	(F,I,J,L)	-	
Information dissemination:			
1. Resources	(A,J,K,L)	-	-
2. Technology	(A,H)	-	-
Demonstration projects (PON)	(C,G,K,L)	-	(A)
Cost share industry R&D	(C,G,J)	-	(A)
Accelerated depreciation	(C,I)	(L)	(A)
Feasibility studies (PRDA)	(C,E,G)	-	(A)
Resource development	(J,K)	-	(G,D)
Direct subsidy	(G)	(C)	(E,H,I,K)
Loan forgiven if unsuccessful	(G)	-	(E,D)
Subsidy to loan if successful	(G)	(E)	-
Do nothing	(D,M)	-	-

b. If funds limited, where should they be concentrated?

(A,D,F,H,I,J,K,L)

Resource identification and development. D thought this should be limited to resources on government land.

(C,D,G)

Finance technical R&D. C thought this too expensive for private industry.

(G)

Disseminate information on use and costs.

(B,C,I)

Tax incentives.

c. Prefer federal or state programs?

(C,D,E,G,L)

No difference

(H)

Some states have strong universities and better technical people.

(J)

Has more confidence in federal funding.