DOE/NBM--3012267

DE83 012267

REPORT
OF THE
ENERGY RESEARCH ADVISORY BOARD
DIRECT HEAT SUBPANEL
OF THE
GEOTHERMAL PANEL

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

MASTER

MP

NOTICE

PORTIONS OF THIS REPORT ARE ILLEGIBLE.

It has been reproduced from the best available copy to permit the broadest possible availability.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

November 1980

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

REPORT
OF THE
ENERGY RESEARCH ADVISORY BOARD
DIRECT HEAT SUBPANEL
OF THE
GEOTHERMAL PANEL

November 1980

Department of Energy
Washington, D.C. 20585

December 11, 1980

The Honorable Ruth M. Davis
Assistant Secretary for
Resource Applications
US Department of Energy
Washington, D.C. 20585

Dear Dr. Davis:

I am pleased to transmit to you the review of the Department of Energy's Direct Heat Program which was prepared by the Geothermal Panel of the Energy Research Advisory Board. This report was approved by the Board at its meeting on November 7, 1980.

The Geothermal Panel has agreed that Federal support for direct heat hydrothermal applications is necessary and warranted. Furthermore, the Panel recommends that the Direct Heat Program continue to be funded at its current level pending the results of a Department sponsored market penetration study which should determine what level of Federal support is required to ensure the appropriate utilization of this promising resource.

The Board would appreciate any comments you have on this report and would be happy to provide any additional specific information you may desire.

Sincerely,

Solomon J. Buchsbaum
Chairman
Energy Research Advisory Board

Department of Energy
Washington, D.C. 20585

JUL 28 1980

Dr. Solomon J. Buchsbaum
Executive Vice President
Customer Systems
Bell Laboratories
Crawford Corner Road
Holmdel, New Jersey 07733

Dear Dr. Buchsbaum:

I am pleased to transmit to you the Geothermal Panel's Review of the Department of Energy's Direct Heat program. At the February meeting of the Energy Research Advisory Board, Vicki Tschinkel, vice chairman of the Geothermal Panel, recommended that additional information on the goals of the program be obtained before completion of the report. At the request of the department's program manager, this was delayed until now.

On May 22, the Direct Heat Subpanel met to assess the available information and the current status of the program. Their report was presented, amended and endorsed at the May 23 public meeting of the Geothermal Panel.

The program is at a crossroads now. The elements of the program are well conceived and we recommend that it be continued at the current basic level pending results of a market penetration study which should determine what level of federal support is warranted to ensure the appropriate utilization of this promising resource.

Sincerely,

Carl Savit

CS/VT

Enclosure

cc: Tom Kuehn
Geothermal Panel

1. BACKGROUND

The Nation's hydrothermal resources represent an energy asset free of foreign control or interference. If all of the hydrothermal resources identified in the United States Geological Survey's Circular 790 (1980) were utilized, the total energy available at the wellhead from resources above 190°F would be 2500 quads (technically recoverable), which is equivalent to 450 billion barrels of oil--more than 16 times the known oil reserves of the United States. Thirty-eight states have so far been identified as having hydrothermal resource potential (above 100°F), including the Gulf Coast and the Eastern Seaboard (see figure 1). The economics of developing the lower temperature resources is still under investigation.

At the present time, the generation of electrical power and hydrothermal resources is economical above about 400°F, but technology under development may extend the economic limit down to 300°F and probably beyond. Thus, resources below 300°F are available for direct use (non-electric) applications. The number of geothermal reservoirs below 300°F far exceeds those above 300°F, and their geographical distribution is greater. Thus, the number of market opportunities is large.

The market potential for geothermal energy in industrial applications has been established using the listing of Standard Industrial Classifications (S.I.C.) and selecting those S.I.C. categories having processes operating in the temperature range of 100°F to 400°F. The present use and future growth of these industries are shown in figures 2 and 3. (Note: 1000×10^{12} BTU/year = 1 quad). Space heating and cooling is not included in these figures. However, a significant percentage of the U.S. population lives and works within a few tens of miles of known and potential hydrothermal resources.

One major advantage in using moderate to low-temperature resources is that the environmental impact is relatively low. Dissolved solids are generally below 4000 ppm and visual and noise impact is minimal once drilling is complete.

2. BARRIERS

Despite the potential of hydrothermal resources for direct heat applications, very little utilization (about 0.01 quads) has occurred because of several barriers to commercial development.

Lack of confirmed reservoirs is, perhaps, the major barrier. Confirmation of reservoirs by drilling is costly, and the risk of drilling an unproductive well is high. Developers of high temperature reservoirs for electrical power generation facilities are generally large, well capitalized companies that can finance

reservoir confirmation by spreading the cost and risk over many projects. However, such companies are not interested in direct heat applications because of their relatively small scale (low present value of profit). On the other hand, potential users are most interested in direct heat applications, but cannot spread the risk and cost over many sites. Hence, they rely on small resource developers that find the scale of direct heat applications projects attractive. However, these exist in such small numbers, and are so under-capitalized, that little reservoir confirmation drilling has occurred.

Lack of an established industry does not only apply to resource development. There is a general lack of a viable supporting industry, including financing, equipment manufacturing and sales, facility development and utility distribution.

Limited technical data is available on base economics and system operation of direct heat applications. These data are required to establish confidence in the profitability and reliability of direct heat systems.

Policy and regulatory confusion has hindered development. Because of limited experience with hydrothermal direct heat applications and their social and environmental impact at federal, state, and local levels, permitting delays and regulatory confusion are common.

3. PRESENT FEDERAL PROGRAM

The program established by DOE to deal with the identified barriers contains seven major program elements. These are shown in matrix form in figure 4, along with the barriers they address, and are summarized as follows:

Market development includes both an assessment of the market potential and information dissemination to potential users.

State planning and development enlists the cooperation of individual states on planning and implementing development within their borders.

Reservoir confirmation fosters the identification and confirmatory drilling of hydrothermal reservoirs.

Technology demonstrations provide the needed economic and operational data through demonstration projects.

Environmental assessment provides both an assessment of potential environmental impacts of hydrothermal resources and technical assistance in their mitigation.

Policy and regulatory issues assessment includes both a provision for interagency cooperation in streamlining the leasing and permitting process and support for establishment of appropriate state and local policy.

Progress monitoring establishes industry activity levels and the success of federal support.

The Panel agrees that the above elements are the correct ones and observes that this program appears to be well established at this time. For example, cooperative resource assessment efforts have been established in 28 of 38 states in which resource potential has been identified. Cooperative planning for development is taking place in 15 of these states. Technical assistance to potential users is available in 22 states. A total of 23 direct heat demonstration projects have been started. A market penetration analysis has begun.

The current funding level for this program in FY 80 is about \$31 million.

4. MISSING INFORMATION

While the resource base and the market for hydrothermal resources are both large, the degree to which this market may be penetrated and the opportunity for federal support to accelerate this penetration are missing pieces of information at this time. The level and quality of efforts currently being directed by DOE/DGE to provide this missing information both appear to be appropriate and needed. A report providing a market penetration analysis will be issued in September 1980, and will permit scoping the optimum size of the direct heat hydrothermal program.

5. CONCLUSIONS AND RECOMMENDATIONS

The Geothermal Panel makes the following conclusions and recommendations:

- A) Both the market for direct heat hydrothermal applications and the resource base are large and indicate that federal support is necessary and warranted. The optimum level of federal support is not yet known and cannot be determined quantitatively until the missing information described above is delivered.
- B) The FY 80 level of funding is adequate to support preliminary development of hydrothermal resources for direct heat application programs, pending completion of the market penetration analysis. The Panel would recommend an expanded federal level of funding if the result of this analysis is positive.

- C) Any significant reduction in the present level of effort would cause DOE to make priority decisions which might cause cancellation of key activities. This would be unfortunate. In particular the carefully integrated cooperative of industrial, state, and federal agencies and the thrust they have generated should be preserved. Further, any reductions would make it difficult to implement an expanded program if such a conclusion is warranted by the market penetration analysis. Accordingly, the Panel recommends against any erosion of the current funding base.
- D) Water source heat pumps can be used in a heating mode to extract heat from normal ground water in winter and can be used in an air conditioning mode to return heat to the ground in the summer. These processes are applicable to every state in the Union at a substantial advantage over air source heat pumps.

Although we did not study the subject in depth, we observe that, at present, the water source heat pump program is splintered between three parts of DOE (Solar, Conservation, and Geothermal). Because of the national importance of this program, we recommend that it be unified under the leadership of one program office in DOE.

The Panel plans a further study of the relevance of utilizing heat pumps to expand the use of low temperature geothermal resources and make recommendations thereon to the Energy Research Advisory Board.

Figure 1 Known and potential hydrothermal resources

PROCESS HEAT ENERGY USE
FOR TOP 20 INDUSTRIES *

	<u>10¹² BTU/YEAR</u>
1980 TOP 20 INDUSTRY LIST	1941
GROWTH 1980 - 1985	364
GROWTH 1985 - 1990	433
GROWTH 1990 - 2000	1124

* FOR TEMPERATURE $\leq$ 400°F

TOP 20 INDUSTRY PROCESS
HEAT ENERGY USERS

<u>INDUSTRIES</u>	<u>1975 TOTAL PROCESS HEAT * 10¹² BTU/YEAR</u>	<u>NUMBER OF FACILITIES</u>
PULP & PAPER PRODUCTS	975	774
INDUSTRIAL INORGANIC CHEMICALS, M.E.C.	113	384
PAVING MIXTURES & BLOCKS	93	969
ALKALIES & CHLORINE	88.5	48
ORGANIC FIBERS, NONCELLULOSIC	75.4	35
FINISHING PLANTS, SYNTHETICS	74.3	258
BEET SUGAR	61.8	61
SULFUR FRASCH MINING	60	23
SOFTWOOD VENEER & PLYWOOD	57.8	232
HARDWOOD VENEER & PLYWOOD	50.6	367
MEATPACKING PLANTS & PREPARED MEATS	45.4	3782
FINISHING PLANTS, COTTON	42.1	196
CYCLIC CRUDES & INTERMEDIATES	38.5	174
CANE SUGAR REFINING	31.2	33
INDUSTRIAL ORGANIC CHEMICALS, M.E.C	27	519
CELLULOSIC MAN-MADE FIBERS	23.5	18
CORRUGATED & SOLID FIBER BOXES	21.6	1271
DISTILLED LIQUOR, EXCEPT BRANDY	21.4	121
GYPSON PRODUCTS	21.2	114
PHARMACEUTICAL PREPARATIONS	<u>19.9</u>	<u>765</u>
TOTAL	<u>1941.2</u>	<u>10,144</u>

*FOR TEMPERATURE $\leq 400^{\circ}\text{F}$

Program Development Matrix

<div>Barriers →</div> <div>Program Elements</div>	Lack of confirmed reservoirs	Lack of an established industry	Limited technical data	Policy and regulatory confusion	Environmental impact uncertainties
Market Development		XX	X		
State Planning and Development	X	XX	X	XX	X
Reservoir Confirmation	XX	XX	XX		X
Technology Demonstrations		XX	XX	X	X
Environmental Assessment		X	X	XX	XX
Policy and Regulatory Issues Assessment		X		XX	X
Progress Monitoring	X	X	X	X	X

XX Primary Impact

X Secondary Impact

INEL-A-14 928

Figure 4. Program development matrix

GEOTHERMAL PANEL
OF THE
ENERGY RESEARCH ADVISORY BOARD

Carl H. Savit, Chairman*
Senior Vice President, Technology
Western Geophysical Company
Houston, TX

Jack McNamara
Law Offices
Los Angeles, CA

Joseph Aidlin
(Magma power Company)
Los Angeles, CA

Carel Otte
Geothermal Division
Union Oil Company of California
Los Angeles, CA

David Butler
Chevron, Inc.
San Francisco, CA

Richard Pool
Kaiser Aluminum & Chemical Corp.
Oakland, CA

William M. Dolan
Manager, Geothermal Branch
Amax Exploration Inc.
Wheat Ridge, CO

Robert Rex
President
Republic Geothermal Inc.
Santa Fe Springs, CA

Lois Ewen
Coronado, CA

Vasel W. Roberts
Program Manager, Geothermal Power System
Electric Power Research Institute
Palo Alto, CA

Herbert Hunt
Eugene Water and Electric Board
Eugene, OR

Victoria J. Tschinkel*
Assistant Secretary
Department of Environmental Regulation
Tallahassee, FL

George Keller
Department of Physics
Colorado School of Mines
Golden, CO

Stanley H. Ward
Department of Geology & Geophysics
University of Utah
Salt Lake City, UT

John Lund
Geo-Heat Utilization Center
Oregon Institute of Technology
Klamath Falls, OR

*ERAB Members