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**REPORT OF THE
ENERGY RESEARCH ADVISORY BOARD
ON HOT DRY ROCK**

**Prepared by
The Hot Dry Rock Study Group**

May 1, 1980

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Department of Energy
Washington, D.C. 20585

MAY 23 1980

The Honorable Ruth M. Davis
Assistant Secretary for Resource Applications
Department of Energy
1000 Independence Avenue, S.W.
Washington, D. C. 20585

Dear Dr. Davis: *Ruth*

I am pleased to transmit herewith the Report of the Energy Research Advisory Board (ERAB) on the Hot Dry Rock Program of the Division of Geothermal Energy.

The Hot Dry Rock Study Group reached the following conclusions:

- 1) The program's level of success is sufficient to continue the project at the Fenton Hill site; and
- 2) the next site chosen for demonstration of the concept must be higher temperature and closer to the surface in order to demonstrate the economic feasibility of the concept in the near term. The next site should not be opened until this feasibility is established.

This Report was approved by the Energy Research Advisory Board at its meeting on May 1, 1980.

Sincerely,

Solomon J. Buchsbaum
Chairman
Energy Research Advisory Board

HOT DRY ROCK (GEOTHERMAL) PROGRAM

Meeting in Denver on April 3, 1980

Introduction

The Hot Dry Rock (HDR) Study Group was established as an ad hoc group to review the Department of Energy's HDR program. It is separate from the Geothermal Panel of the Energy Research Advisory Board, although some members of the Panel are on the Study Group. The membership of the Study Group is shown on Exhibit 1. The Study Group received information describing the HDR program by letter of March 13, 1980 from R.S.H. Toms, Executive Assistant to the Director of Geothermal Energy/DOE. Subsequently, the Study Group met on April 3, 1980 in Denver, Colorado at the offices of the Western Geophysical Company and received an extensive briefing on results to date and plans for the future. Most of the briefing was done by members of the Los Alamos National Scientific Laboratory (LASL).

Attendance at the meeting is shown on Exhibit 2. W.M. Dolan served as secretary for the meeting and his summary of items discussed is on file in the ERAB offices.

Terms of Reference for the Denver Meeting

The first item of business was to agree on the following terms of reference for the meeting:

1. Determine the level of success of the recent Hot Dry Rock experiments conducted by LASL.
2. Determine the necessity of thermal stress cracking to the HDR concept.
3. What is the economic feasibility of the HDR concept?
4. Are goals and objectives clear and reasonable?
5. Is the pace of the program at proper level?
6. Have the major elements of the program been in appropriate balance to date?
7. Is the program properly integrated with other related programs; e.g., Sandia's high temperature instrument development?

Comments on Terms of Reference

1. The Study Group believes that the level of success has been good. The investigators have been able to set up a Fenton Hill Phase 1 fracture system having about 45,000 sq. meters of surface area at a depth of 3 kilometers and at a temperature of around 185°C. Several runs have been made, one as long as 75 days, and thermal energy was extracted at a rate of 3 to 5 megawatts. Furthermore, there was very little loss of circulating water from the system, less than 2 percent, and the dissolved solids in the circulating water were less than 2000 ppm.
2. It was reported that thermal stress cracking was not necessary to develop a fracture system but, to the extent that it does happen, it provides a bonus by reducing the impedance of the fracture system to water flow and increasing surface area.
3. At present the economic feasibility of the HDR concept is not too attractive. Crude calculations suggest approximately \$3,000 per kilowatt of installed capacity, which is roughly three times the cost of building conventional power plants. However, the technology is in its infancy and there are possibilities of reducing costs by finding locations having higher thermal gradients and by reducing drilling and other operating costs.
4. The Study Group was in accord with the objectives of the Phase 2 program at Fenton Hill; namely, that a 20 to 50 megawatt thermal system be constructed (in fact, construction has already started) at a depth of around 4 kilometers at temperatures of 250 to 275°C. This much larger system will provide confirmation of the Phase 1 data and better economic information. This objective is a logical extension of work done to date.

However, the Study Group is not in favor of selecting Site 2 in a low temperature gradient area as originally proposed. The selection of Site 2 should be aimed at shallow depths and high temperatures to maximize the competitive position of the HDR concept relative to other sources of energy. It was suggested that Site 2 might be inside the Valles Caldera and if the exploratory well does not find hot dry rock it might support a hot wet system in the overall geothermal program of DOE. The Study Group opposes opening a second site at this time.

It was also suggested that the HDR program be on the lookout for wells of opportunity; i.e., wells drilled by other groups that unexpectedly find hot dry rock.

5. The pace of the program appears to be approximately correct. There were no obvious areas identified where an acceleration could help. In fact, the Study Group cautioned against force feeding the program with money.
6. At this time the balance of the major program elements appear to be appropriate. Eighty-six percent of the effort is devoted to the Fenton Hill development and 14 percent to the assessment of the potential application of the HDR concept.

While the Study Group does not recommend a change in balance at this time, it does wish to point out that, as soon as the economics of the process are better defined, there will be a critical need for better information on the extent of reservoirs of various depths and temperatures. Their location relative to population concentration is also important, especially if efficient use is to be made of low temperature energy that would not be practical for electric power generation and for residual low temperature energy from power plants.

The investigating team is well aware of this need and plans to work closely with the USGS on resource assessment.

7. As to the question of appropriate amounts of liaison with other laboratories and agencies, it appears to the Study Group that the situation is improving. In the early stages the HDR staff had to establish some level of self-sufficiency in instrumentation and drilling technology. However, there is a broad and accelerating program of development in these areas taking place in Sandia which should reduce the need for LASL to do all of this type of development. It is not clear that LASL is drawing on Sandia's services as fast as it should.

General Comments

A number of the members of the Study Group opined that the HDR program now has a good team in place. The experience gained over the past few years has equipped the team to carry out the objectives of the program from here on with considerable expertise.

An in-depth economic study of the HDR concept is underway with Bechtel as the prime contractor. The study is expected to take two years. The Study Group considers this to be a very important project, especially with respect to item 6 discussed above.

The Study Group was advised of a change in the method of managing the Los Alamos National Scientific Laboratory. A matrix management system has been installed. It is believed that this will alleviate our concern that too many scientists were being attached to an individual project with too little flexibility of reassigning them to other projects as the need for their particular specialties varied with time.

There was some discussion of the need for the HDR program to include a demonstration of a system that would include building and operating an electric power plant. Although technically this should not be necessary it was recognized that utilities might insist on such a demonstration before committing large sums of money to build commercial plants. The Study Group feels that this problem will need further consideration, but not until HDR economics are on a firmer and more attractive basis.

Finally, it is evident that the basic economic merit of this source of energy depends on a large number of variables and, at this stage of development, it is not possible to ascertain the extent to which the HDR will find its place as an economic source of energy. However, the Study Group believes that the program for the next few years is properly set up to obtain the data necessary for a rational evaluation.

Eric Reichl - Chairman
Dayton Clewell - Chairman pro tem

HOT DRY ROCK STUDY GROUP
OF THE
ENERGY RESEARCH ADVISORY BOARD

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List of Attendees at Study Group
Meeting in Denver, Colorado
April 3, 1980

Dayton Clewell	-	ERAB
William Dolan	-	Panel
George Keller	-	Panel
Carel Otte	-	Panel
Carl Savit	-	ERAB
Bennie DiBona	-	DOE
Ronald Toms	-	DOE
Robert Weinraub	-	DOE
Lawrence Germain	-	LASL
Porter Grace	-	LASL
Grant Heiken	-	LASL
Jefferson Tester	-	LASL