

PLANNING FOR GEOTHERMAL DEVELOPMENT IN HAWAII

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ABSTRACT

In 1976 the University of Hawaii completed a successful exploratory geothermal well on the Big Island of Hawaii. The well has raised hopes for a viable alternate energy source to reduce the State's high dependence on imported petroleum. A Development Group was organized to install a wellhead generator to demonstrate the feasibility of utilizing geothermal energy from a volcanically active area. The State is also planning for geothermal development through scenario development, identification of constraints and barriers, resource assessment and non-electric applications.

Introduction

Over 90 percent of all Hawaii's energy comes from oil, most of which is from foreign sources. The current oil consumption is approximately 110,000 barrels per day at a cost to the State of over half a billion dollars annually. Furthermore, any shortage in petroleum products has a more adverse effect on Hawaii than on the mainland United States.

In light of this near-total dependence on a single source of energy, the State Department of Planning and Economic Development (DPED) formulated energy policies and programs (Ref. 1, 2 and 3) in 1974-1975. The objectives are to achieve energy self-sufficiency through conservation and the development of new, indigenous and renewable energy resources.

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Geothermal Drilling in Hawaii

Geothermal drilling in Hawaii started in the early 1960's on the Big Island. Four wells drilled in the Puna region to relatively shallow depths were unsuccessful in locating a useful geothermal resource. In 1973 a fifth scientific research hole was drilled near Halemaumau Crater to a depth of 4,140 feet. Although the maximum temperature reached was only 279°F (137°C), at bottom hole (just below sea level) a high gradient of temperature increase with depth gave promise of a potential geothermal reservoir.

The sixth hole, designated as well HGP-A, was drilled to a depth of 6,140 feet by the University of Hawaii's Hawaii Geothermal Project (HGP) and was completed in April of 1976 (Ref. 4). This well was very successful in terms of fluid and temperature and has raised hopes for a viable alternative to the more conventional energy resources. The bottom hole temperature is 676°F (358°C) and the steam quality 62%. Furthermore, Dr. Charles Helsley, Director of the Hawaii Institute of Geophysics, has estimated that the Kapoho Geothermal Reservoir where HGP-A is located may have a capacity of 500 MW for 100 years (Ref. 5). Well flow tests have shown improved output with usage and a potential output of over 3.5 MW at 150 lbs. wellhead pressure and 302 F (150°C).

Work in Progress

A. Wellhead Generator Proof of Feasibility Project.

After the successful testing of HGP-A, a Development Group was organized in the beginning of 1977. It consists of the State of Hawaii's Department of Planning and Economic Development (DPED), University of Hawaii's Hawaii Geothermal Project (HGP) and County of Hawaii. The local

utilities, Hawaiian Electric Company in Honolulu and Hawaii Electric Light Company in Hilo, are also participating in an advisory capacity. The Development Group applied to the U.S. Department of Energy (DOE) for funding. To date, DOE has in principle agreed to fund the project and has budgeted \$1.4 million in FY 1978 for the project, with \$1.3 million programmed for FY 1979.

The proposed project will construct a 5 MW nominal size condensing generator system with full environmental controls. The design and construction phases of the project will take approximately two years. Since HGP-A is situated in a volcanically active area, a risk assessment for siting a power plant at such a site will be conducted and possible means of minimizing risks will be evaluated and may be adopted.

After the plant is completed, the generator system will be run for two years. During the operational phase, environmental and reservoir data will be collected for evaluation. Economic data will also be obtained to assess the feasibility of a small electric generator system.

The State of Hawaii, through DPED, will provide \$400,000 for the project and DPED's objectives are:

1. To follow the Governor's Directive to encourage the rapid development of geothermal energy to increase the State's energy self-sufficiency.
2. To encourage economic development associated with geothermal energy including both electric and non-electric uses through proof of feasibility, e.g., on-line electricity.
3. To demonstrate the capability of the resource, thereby accelerating resource development by the private sector.
4. To provide reservoir assessment information as well as rift zone operation experience.
5. To build on the highly successful research of the University of Hawaii.
6. To provide inputs for State and County energy planning.

In addition to the \$400,000, DPED has also:

1. Provided \$38,000 to prepare the proposal for the power-generation system.
2. Provided personnel support.
3. Purchased the land where the power station will be situated.
4. Applied for the Special Use Permit to permit the construction and operation of a power plant on land zoned for agriculture.
5. Prepared an Environmental Impact Statement and submitted it to the State Environmental Quality Commission for the Governor's acceptance.

B. Visitor Center.

The County of Hawaii will provide \$100,000 for the project and will play an active role in designing the Visitor's Center at the project site. The University of Hawaii will carry out reservoir assessment based on project data collected on the well operation. The Hawaiian Electric Company and its subsidiary on the Big Island, the Hawaii Electric Light Company, have contributed a full-time senior engineer for technical advice to the project. The utility has also agreed to operate and maintain the plant and to purchase 2 MW of power on a continuous basis and up to 5 MW under certain conditions.

C. Regional Operations Research for Geothermal Resources in California and Hawaii.

The State of Hawaii has joined DOE and the State of California in funding this project to accelerate the actual commercial utilization of geothermal energy by means of a planned time sequence for bringing power on-line or other non-electric uses. The project will provide site-specific scenarios for the development and commercial utilization of geothermal resources in California and Hawaii, identify the specific actions needed by all involved parties for realization of the potential of the scenarios and implement a regional monitor to track progress toward materialization of the scenarios.

This project is of great importance to the State since it will identify potential barriers for rapid development of geothermal resources and recommend specific actions to remove these barriers. Some of these barriers may be:

1. HGP-A is the only successful geothermal well in the State. There is a lack of resource identification and reservoir assessments for the rest of the State.

2. The greatest potential for electric generation is likely to be on the Big Island, but the need for electricity is in Honolulu on the island of Oahu. The islands are separated by deep channels and power transmission between islands is not economically feasible at present.

3. Risks associated with volcanically active areas and the length of time necessary to satisfy environmental and legal requirements result in reluctance on the part of capital investors.

D. State Planning.

DPED will continue its effort to develop geothermal resources in the State by:

1. Resource Assessment Program - The State has proposed a budget of \$500,000 in fiscal year 1978-79 for a geophysics reconnaissance survey and geophysics reservoir definition surveys (seismic, geochemical, electrical, magnetotelluric, etc.). Proposals have also been submitted to both DOE and the U.S. Geological Survey (USGS), particularly for low temperature resource identification by the University of Hawaii.

2. Non-electric or Direct Use Program - The State has proposed a budget of \$350,000 in fiscal year 1978-79 for R&D programs in non-electric applications such as health spas, processing steam for sugar, fruit or fruit juice processing, aquaculture, etc. Puna Sugar Company of the Big Island was successful in obtaining a grant in 1978 to study the feasibility of utilizing geothermal steam in processing cane sugar. If the study proves to be feasible, then a proposal for a demonstration project will be prepared for Federal, State and private funding.

3. Continuous Monitoring Program - In the State Energy Resources Coordinator's 1977 Annual Report, by the year 2000, geothermal energy is forecasted to contribute up to 7% of the total energy consumed in the State (Ref. 6). Table 1 shows an optimistic timetable and cost schedule for geothermal development. However, if any of the barriers identified previously is removed or enhanced, it will greatly influence the realization of geothermal development in Hawaii. Therefore, a system to monitor progress is vital to future planning.

References

1. Dept. of Planning and Economic Development, "State of Hawaii Energy Policies Plan - General Plan Revision Program," 1974.
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3. Robert M. Kamins and Eugene M. Grabbe "State Policy Consideration for Geothermal Development in Hawaii," April 1975.
4. University of Hawaii, Hawaii Geothermal Project Reports, 1973-1977.
5. Charles E. Helsley, "Geothermal Potential for Hawaii In Light of HGP-A," Geothermal Resources Council, Transactions Vol. 1, May 1977.
6. Department of Planning and Economic Development, "Energy Resources Coordinator's 1977 Annual Report," State of Hawaii, February 1978.

Table 1 - Optimistic Timetable and Cost Schedule (1978 Dollar)
Geothermal Energy Development

Activities	1985	1990	1995	2000	
	Status and Capital Investment				
Geophysics Reconnaissance Survey	Completed \$100,000	—	—	—	
Geophysics Reservoir Definition Survey (Seismic, Geochemical, Electrical, Magneto- telluric, etc.)	Completed \$1,040,000	—	—	—	
Exploratory Drilling (Minimum 3 wells per site, well testing program)	12 wells drilled and tested \$20,000,000	12 wells drilled and tested \$20,000,000	12 wells drilled and tested \$20,000,000	3 wells drilled and tested \$5,000,000	
Electric Power Generation for Utilities (Development Drilling, Steam Gathering System and Power Plant Construction) \$950/KW	23 MW on Big Island \$21,850,000	30 MW on Oahu, 15 MW on Maui \$42,750,000	55 MW on Big Island \$52,250,000	110 MW on Big Island (assuming trans- mission between islands is feasible \$104,500,000	
Electric Power Generation for New Indus- tries (Manganese Nodule, Aluminum, etc.) \$950/KW	—	110 MW on Big Island	—	110 MW on Big Island	
Non-Electric Applications (Spas, Sugar Processing Steam, Fruit Processing, Aqua- culture, etc.)	147,200 MBTU/ yr—\$2,800,000	294,000 MBTU/ yr—\$5,600,000	294,400 MBTU/ yr—\$5,600,000	294,400 MBTU/ yr—\$5,600,000	
TOTAL	Electric	23 MW	155 MW	55 MW	220 MW
	Non-Electric	147,200 MBTU/ yr	294,400 MBTU/ yr	294,400 MBTU/ yr	294,400 MBTU/ yr
CUMULATIVE TOTAL	Electric	23 MW	178 MW	233 MW	453 MW
	Non-Electric	147,200 MBTU/ yr	441,600 MBTU/ yr	736,000 MBTU/ yr	1,030,400 MBTU/ yr