

UNSOLICITED RESEARCH PROPOSAL SUBMITTED TO THE U.S. DEPARTMENT OF ENERGY

Submitting Organization: Research Corporation of the University of Hawaii
Address of Organization: 1110 University Avenue, Room 402
Honolulu, Hawaii 96826
Title of Proposed Project: State of Hawaii Geothermal Commercialization Plan
Amount Requested: \$150,600 Proposed Duration of Project: 12 months
Proposed Starting Date: January 1, 1979

Principal Investigator

Project Manager

Name: Dr. Eugene M. Grabbe

Dr. Bill H. Chen

Title: Manager, Alternate Energy Programs, Geothermal Specialist, DPED
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ENDORSEMENTS

Grant Administrator

Other Endorsement(s)

Approving
Administrative Official

Name: Dr. Richard K.C. Lee

Mr. Gilbert Oshima

Mr. Hideto Kono

Signature

Signature

Signature

Title: Executive Director,
Research Corporation of the
University of Hawaii

Comptroller,
Research Corporation of
the University of Hawaii

Director, Department of
Planning & Economic
Development (DPED)

Date: November 8, 1978

Nov 8, 1978

November 8, 1978

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I. ABSTRACT

In accordance with the U.S. Department of Energy programs, the State of Hawaii Department of Planning and Economic Development proposes a planning project which will develop realistic scenarios for the development and commercialization of geothermal energy resources in Hawaii. The preliminary electric and direct-use scenarios developed by DOE regional contractors, SAI and SDC, will be used as a foundation for further refinement. These realistic scenarios will be developed in conjunction with other State and County agencies, private industry and community groups to insure that the resulting development program will reflect local aspirations. The scenarios will assist in identifying the barriers and time constraints to the aspired development. Mechanisms will be established to review, update and monitor progress. Support to the Pacific Region Team and its Federal Commercialization Plan will be provided.

The results of the proposed project will include lists of recommended State, Federal and local actions to be pursued to realize the goal of early commercialization of geothermal resources in Hawaii. The State Geothermal Advisory Council will provide input in guiding the development of such action plans.

II. INTRODUCTION

Since the State of Hawaii is almost completely dependent on imported petroleum for energy, the government and its citizens have been keenly aware of the need for developing the state's natural energy resources. The fact that the State Legislature appropriated \$200,000 as early as 1972 before the national energy crisis for geothermal development demonstrates the commitment of the State in seeking alternative energy resources. Currently, the per capita State expenditure for energy research and development is the highest in the U.S.

The 1974 Legislature created the position of Energy Resources Coordinator and designated the Director of the Department of Planning and Economic Development to fill this position. Hence, state energy management, policy formulation and planning, conservation, energy research and development support, and commercialization development reside in this key State agency concerned with the planning and economic development. The total number of personnel involved with energy programs averages between 15 and 20.

The Governor has appointed an Advisory Committee for Alternate Energy Development which serves as an umbrella for the various technical and coordinating committees in the State, University of Hawaii and counties, concerned with geothermal, biomass, solar, wind and OTEC resources. A broad based Geothermal Advisory Council, chaired by Dr. Eugene M. Grabbe, principal investigator for this project, includes representatives of State and County governments, University of Hawaii, industry, land owners, utilities and native Hawaiians. The Council will provide input on State geothermal program priorities for this proposed project.

Geothermal exploration was started by the University of Hawaii in 1972 with funding from the State of Hawaii and the National Science Foundation. A well was drilled in the Puna District of the Island of Hawaii in 1976 with funding from the State and DOE. This well, HGP-A, is one of the hottest wells in the world and it has a capacity of producing 3.5 MWe. Currently, a DOE funded Wellhead Generator Feasibility Project will construct and operate for two years a 3MW generator at the HGP-A site to prove the feasibility of utilizing geothermal resources in a volcanic rift zone environment.

The State started its planning for alternate energy in 1974. Reports, such as "State of Hawaii Energy Policies Plan (1974)" and "State Policy Considerations for Geothermal Development in Hawaii (1975)", published by DPED, "Legal and Public Policy Setting for Geothermal Resources Development in Hawaii (1976)" and "An Assessment of Geothermal Development in Puna, Hawaii (1977)", and "Energy Coordinator's Annual Reports (1975, 1976, 1977)" include consideration of the options of the State in geothermal development. However, to plan for rapid commercialization of geothermal resources, further federal support of the effort is needed.

At the recent Pacific Region Regional Coordinating Council meeting, all of the five state representatives from the Pacific Region expressed the importance for each state to plan for its own geothermal commercialization due to the uniqueness of each state's requirement and the difference in stages of development in each of the five states. These individual state commercialization plans are important because they provide the important input to the Federal Commercialization Plan for the Pacific Region. The Regional Coordinating Council provides periodic interchange of information among the states.

IV. OBJECTIVES

The main objective of the State Geothermal Commercialization Plan is to accelerate the utilization of geothermal energy in the State of Hawaii, thus, to reduce the dependence in imported oil for energy. It is proposed that the project will develop, update and refine realistic scenarios for the development and commercial utilization of geothermal energy resources in the State of Hawaii. The scenarios will identify all technical, institutional, environmental, economic and social barriers and constraints to the aspired development, and the type, magnitude, scheduling and estimated cost of Federal, State and local, public, industrial and commercial actions needed now and in the future to remove the barriers identified to ensure achievement of the potential of the State geothermal development scenarios. Mechanisms will be established to review, update and monitor progress. Support will also be provided to Pacific Region Team to integrate the State plan to the Federal Commercialization Plan.

IV. STATEMENT OF WORK

The preliminary work on electric and direct-use geothermal scenarios and identification of barriers by SAI and SDC will be reviewed and utilized. These site-specific electric and direct-use scenarios for Puna will be further refined and updated as a model for future planning in other areas of geothermal potential in Hawaii.

Task 1 Resource Characterization

Currently, there is only one well drilled in Puna and the magnitude of the resource remains to be defined. Based on seismic data, Dr. Charles Helsley, Director of the Hawaii Institute of Geophysics, has estimated that the Puna reservoir may have a capacity of 500 megawatts of electric power.

This task will attempt to identify the necessary steps for positive resource characterization for both electric and direct-use development, which may be used for other sites as well as for Puna. It is not realistic to go beyond five years in defining an action program until Hawaii's geothermal resources are better defined.

In developing the five-year electric scenarios, Tasks 2 to 5 will be performed.

Task 2 Market Analysis - Electric

- a. Public Utilities - Attempts will be made to identify specific steps that can be made to make baseload generation on or near active rift zones acceptable to the local utility.
- b. Industrial Uses - Identify potential industrial power users, such as sugar, manganese nodules and aluminum, and the timing of their needs. Preliminary economic analyses will be performed to assess their feasibility.
- c. Interisland Power Transmission - Preliminary economic analysis of the feasibility of interisland electric transmission and energy transportation systems to bring power to other islands from the Big Island.

Task 3 Technical and Institutional Barriers - Electric

Identify and quantify critical barriers to expediting geothermal development as proposed in the scenarios. For each barrier the following approach will be used:

- a. Problem statement
- b. Objective to be achieved in overcoming the problem
- c. Detailed description of the problem
- d. Priority level
- e. Alternative actions required to achieve objective and tradeoff considerations
- f. Schedule of actions
- g. Estimated cost of actions

Task 4 Federal, State, County and Private Actions - Electric

Identify, describe and show the schedule of specific Federal, State, County and private actions, ongoing and planned to mitigate each barrier identified. Identification and description will include:

- a. Problem statement
- b. Objective to be achieved in overcoming the problem
- c. Detailed description of the problem
- d. Priority level
- e. Alternative actions required to achieve objective and tradeoff considerations
- f. Schedule of actions
- g. Estimated cost of actions

Task 5 Validation of Electric Scenarios

The developed scenarios will be validated by review and evaluation by the State Geothermal Advisory Council and with other key public and private organizations.

In developing the direct-use scenarios, Tasks 6 to 9 will be performed.

Task 6 Market Analysis - Direct-use

Identify potential markets through a carefully planned research and industry user interview program. Cost benefit analysis will be prepared for the most likely, near-term direct uses.

Task 7 Technical and Institutional Barriers - Direct-use

Direct-use barriers will follow the approach format of Task 3.

Task 8 Federal, State, County and Private Actions - Direct-use

Direct-use actions will use the same format as Task 4.

Task 9 Validation of Direct-use Scenarios

Validation of direct-use scenarios will use the same format as Task 5.

Task 10 Integration of Electric and Direct-use Scenarios

A five-year integrated scenario including proposed appropriate public and private actions will be developed with FY80 and FY81 shown in greater detail than later years.

Task 11 Progress Monitoring and Evaluation

Develop, implement and maintain a development progress monitor to determine the status of ongoing and planned public and private actions to achieve the development scenario proposed for the next five years.

Task 12 Report to Pacific Region Team

A monthly status report will be submitted to DOE and a final report summarizing the developed scenarios and Tasks 1 through 11 will be submitted to DOE. The principal investigator or the project manager will also participate in all regional coordinating meetings.

A proposed project schedule for the twelve tasks is given in Table I.

TABLE I. PROJECT SCHEDULE

TASKS	JAN 1979	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1980
1. Resource characterization Electric scenarios	█												
2. Market Analysis	█												
3. Technical & Institutional Barriers			█										
4. Federal, State, County and Private Actions					█								
5. Validation of Scenarios Direct-use Scenarios								█					
6. Market Analysis	█												
7. Technical & Institutional Barriers			█										
8. Federal, State, County and Private Actions					█								
9. Validation of Scenarios								█					
10. Integration of Electric and Direct-use Scenario						█							
11. Progress Monitoring & Evaluation								█					
12. Report to Pacific Region Team	█												

V. MANAGEMENT

Dr. Eugene M. Grabbe, Manager for Alternate Energy Programs in the State Department of Planning and Economic Development (DPED) will be the principal investigator. Dr. Bill H. Chen, Geothermal Specialist of DPED, will be the project manager to oversee the project. Previous Hawaii subcontractors to DOE Regional Contractors, namely Action Resources, Inc., Pacific Analysis and VTN Pacific may be retained for certain specific tasks. Industry and engineering firms such as Dillingham Corporation and R.M. Parsons will be employed to perform market analyses. Information on key project personnel is given in the resumes included in this proposal.

VI. BUDGET

Direct Cost

Principal Investigator (1 man-month)	\$ 3,000
Project Manager (6 man-months)	14,000
Clerical (6 man-months)	<u>6,000</u>

23,000

Fringe Benefits (20% of Direct Cost) 4,600

Consultants (2000 man-hours @ \$55/man-hour) 110,000

Travel

Mainland 6 trips @ \$700/per trip	4,200
Interisland 12 trips @ \$200/per trip	<u>2,400</u>

6,600

Other Direct Costs

Supplies	1,770
Publication	2,000
Communication	<u>1,200</u>

4,970

RCUH Indirect Costs (6.23% of 23,000) 1,430

TOTAL PROJECT BUDGET \$150,600

VII. RELATIONS TO OTHER CURRENT STATE AND FEDERAL PROGRAMS

A number of ongoing resource assessment, technology development and environmental, legal and social programs will have a direct impact on the proposed project.

- a. "Operations Research of Geothermal Resources in California and Hawaii", DOE contract with SAI and "Development of Geothermal Resources in California and Hawaii", DOE contract with SDC. These studies to be completed by the end of calendar year 1978, have developed preliminary electric and non-electric scenarios and identification of barriers for Puna. This proposed State of Hawaii project will further develop, update and refine these scenarios for implementation.
- b. "HGP-A Wellhead Generator Feasibility Project", jointly funded by DOE, State of Hawaii and County of Hawaii, will design, construct and operate for two years a 3 MW generator at the HGP-A site. The project will provide economic, environmental and engineering feasibilities of utilizing geothermal resources in a volcanic rift zone environment.
- c. "Hawaii Geothermal Project Phase IV Program" DOE contract with the University of Hawaii. This study will continue the engineering, geophysical and geochemistry study of the Kapoho (Puna) Geothermal Reservoir to provide information for reservoir characterization.
- d. Hawaii Institute of Geophysics has a contract with DOE and USGS to assess statewide geothermal potentials in Hawaii. This program will provide input for future scenario development.
- e. "Engineering and Economic Analysis of the Feasibility of Utilizing Geothermal Steam in Cane Sugar Processing", a DOE funded project to Puna Sugar Company. This study will provide input to the direct-use scenario.
- f. The National Council of State Legislature has a contract with DOE to initially help legislators in six states to understand geothermal development and to develop necessary rules, regulations and laws to accelerate the geothermal development. Hawaii is one of the six states being chosen.
- g. The energy-intensive and rapidly developing manganese nodule industry, along with Hawaii's role, is being studied. The major funding is State, with small grants from NOAA's University of Hawaii Sea Grant Program and the Office of Marine Minerals.

h. Hawaii Natural Energy Institute has a contract with DOE in conjunction with Lawrence Livermore Laboratory to conduct an Environment Overview of Geothermal Development in Hawaii. This study will provide input to the environmental and social barrier identifications.

i. The State Department of Planning and Economic Development has submitted a preproposal to the Economic Development Agency of the Department of Commerce to study the feasibility of establishing an industrial park at Puna utilizing the geothermal resources. This preproposal has been assigned top priority in receiving funding from the Technical Assistance Program of EDA for the State of Hawaii.

j. "State of Hawaii Integrated Energy Assessment", jointly funded by the State and DOE. This project will utilize the existing State input-output table and adapt it to include new energy technologies (including geothermal), residuals and new industries for Hawaii. A number of scenarios will be developed and assessment made of various combinations of energy demand and supply based on new technologies. The results will provide decision makers with analysis of the impact of, and tradeoffs among, alternate energy sources for planning and policy formulation for developing Hawaii's energy future.

IX. REFERENCES

1. "State of Hawaii Energy Policies Plan", General Plan Revisions Project, DPED, 1974.
2. "State Policy Considerations for Geothermal Development in Hawaii", DPED, 1975.
3. "Alternate Energy Sources for Hawaii - 1975", University of Hawaii and DPED, 1975.
4. "Legal and Public Policy Setting for Geothermal Resource Development in Hawaii", Hawaii Geothermal Project, 1976.
5. "An Assessment of Geothermal Development in Puna, Hawaii", Hawaii Geothermal Project, 1977.
6. "Energy Resources Coordinator 1975 Annual Report", DPED, 1976.
7. "Energy Resources Coordinator 1976 Annual Report", DPED, 1977.
8. "Energy Resources Coordinator 1977 Annual Report", DPED, 1978.
9. "Hawaii Natural Energy Institute Annual Report 1977", University of Hawaii, 1978.

X. RESUMES

THE COMPANY

Action Resources Incorporated (ARI) is an independent professional organization providing problem solving, program development and implementation, and research and analysis services to the public and private sectors in the Pacific basin. Using an interdisciplinary, analytic approach, ARI brings the latest in scientific and technical knowledge to the islands and independent territories of the Pacific in such a manner as to enhance the economic, political and social milieu without destroying what is uniquely known as "the Pacific way."

Incorporated in Hawaii on 15 April 1977, ARI has its principal offices in Suite 442 of the Alexander Young Building, at 1077 Bishop Street in the heart of downtown Honolulu.

THE PEOPLE

ARI's current technical staff of 18 persons includes engineers, mathematicians, attorneys, media specialists, business management specialists, urban transportation planners, solar and geothermal energy specialists, systems analysts, computer programmers and experts in the military sciences. They are supported by an administrative staff of five professionals. The ARI employees are supplemented by a broad range of seven consultants, each of whom is professionally recognized in his own right.

SUMMARY OF PACIFIC ANALYSIS CORPORATION'S
EFFORT IN THE FIELD OF ENERGY

Since 1975, Pacific Analysis Corporation (PAC), has been conducting brief operations research and/or system analysis studies, both funded and non-funded in the field of energy as it relates directly or indirectly to the State of Hawaii. Contractual efforts have been with the State of Hawaii, Office of Naval Research (ONR), Army Corp of Engineers, and Department of Energy through Science Applications, Inc. Ordered in time, these contractual efforts were:

- A Survey of Potential Use of Alternative Energy by the Military in Hawaii; Supported by ONR, 1976;
- An Inventory and Analysis of the Electric Energy Industry in the State of Hawaii; Supported by the Army Corp of Engineers; 1977;
- Development of State of Hawaii's Energy Conservation Plan; Funded by DOE Through the State's Energy Office; 1977;
- Development of an Energy Extention Service Pilot Program for the State of Hawaii; Funded by the State Energy Office; 1977;
- Regional Operations Research for Geothermal Development in Hawaii; Funded by DOE Through Science Applications, Incorporated; 1977-1978.

SPECIFIC EXPERIENCE

Specific experience in operating research and analysis for geothermal energy implementation has been gained during PAC's present subcontracted effort with Science Applications, Inc., of La Jolla, California. Tasks completed and reported include:

- Identification of Permitting and Reporting Action by Federal, State and Local Regulatory Agencies, Including Milestones and Estimated Times;
- Present Utilization of Process Heat and Mechanical Energy in the State of Hawaii;
- Refinement of a Preliminary Scenario for the Construction of an Experimental Wellhead (Electric) Generator at Puna, Hawaii.

The results of the latter task was presented to the Geothermal Resources Council on July 25, 1978.

Presently, a task to develop a Direct Use (of geothermal energy) Overview for the State of Hawaii is being conducted using the approach of, (a) determining available geothermal energy resources, (b) analyzing potential applications for utilizing geothermal energy directly, and (c) identifying potential source-user pair-candidates most likely to attain physical realization/operations with their associated short comings, using technological, economic and environmental causative factors.



Hawaiian Dredging & Construction Company

November 8, 1978

Dr. Eugene M. Grabbe
Center for Science Policy & Technology Assessment
Department of Planning & Economic Development
P.O. Box 2359
Honolulu, Hawaii 96804

Re: Geothermal Planning Proposal

Gentlemen:

I am enclosing a slightly revised version of our "Suggested Procedure to Commercialize Geothermal Energy in Hawaii". This is essentially the same document we transmitted to you informally two weeks ago. As you know we originally conceived of this as a proposal to respond to the Department of Energy PRDA which should be issued in November.

As I indicated, we would agree to operating as a sub-contractor within your planning effort if that is the Department of Energy's wishes. I have worked out a man-power loading diagram which would be appropriate if we were to do this work as an independent study for the Department of Energy. As you can see from this, over half of our work is subcontracted to firms other than Dillingham. In the short time available, I have not had the opportunity to obtain rates for the subcontractors for this particular proposal. If you need a figure to estimate the subcontractors, we would suggest \$40.00 per hour. This number must be confirmed with them.

Hawaiian Dredging & Construction Company

Dr. E. M. Grabbe
November 8, 1978
Page 2 of 2

If our work is to be folded into a larger plan to be conducted by the State of Hawaii then we need your direction whether these subcontractors act as sub-subcontractors to us, or as subcontractors to the Department of Planning and Economic Development. Either arrangement can be worked out.

For Dillingham the rates are as follows:

Program Manager	\$52.00 per hour
Program Director	\$39.00 per hour (HD&C Staff)
Financial Analyst	\$27.00 per hour (Dillingham Corp.)
Clerical	\$14.00 per hour

These rates include overhead, G&A, profit, but do not include Hawaii Gross Income Tax, which we interpret to be not applicable to this contract. These rates have been approved by the Defense Contract Audit Agency for use on an existing Department of Energy contract.

We are including resumes for the following people: Program Manager, Lloyd Jones; Program Staff, Jim Moreau. Also enclosed is a brief write-up of our capabilities in the geothermal area.

Please call if you require any further information.

Very truly yours,

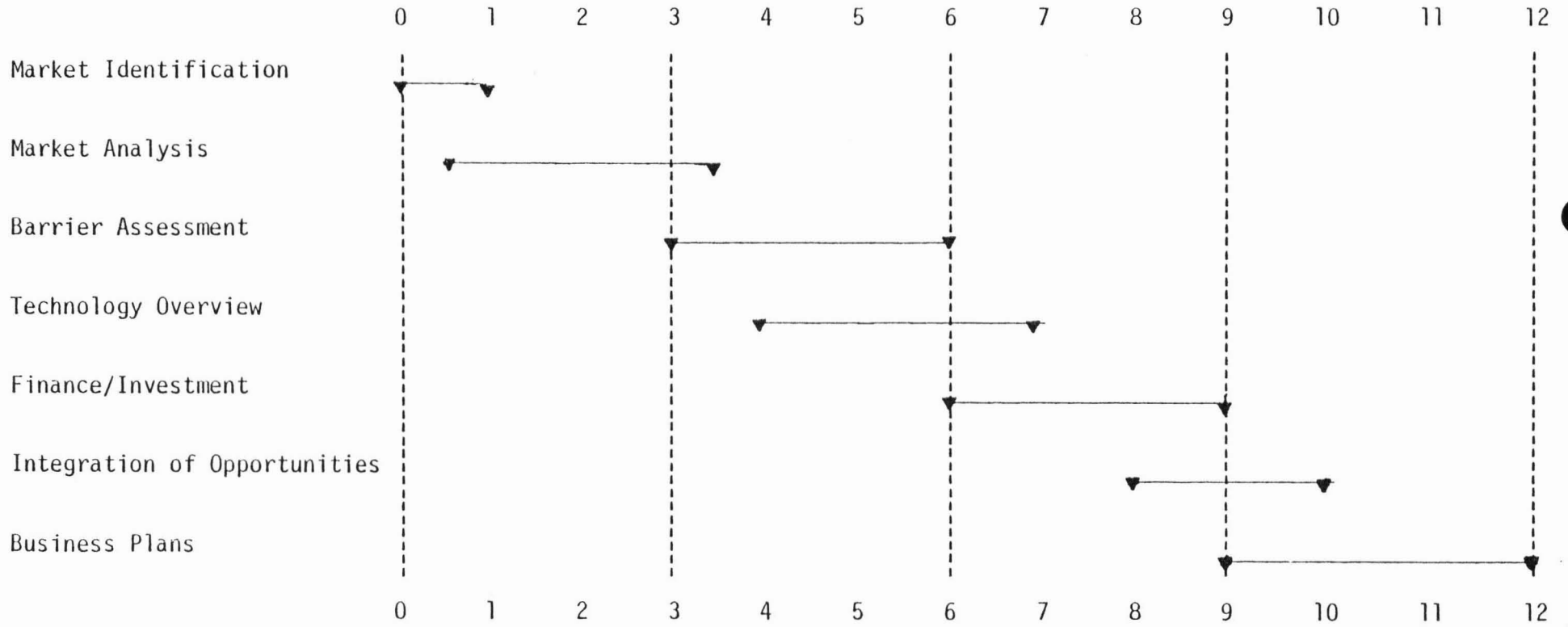


W. Lloyd Jones
Manager, Energy Projects

Enclosures

WLJ:p

WORK FLOW



GEOTHERMAL COMMERCIALIZATION IN HAWAII PROPOSAL

MANPOWER LOADING - MANHOURS

TASKS:

1. Market Identification
2. Market Analysis
3. Barrier Assessment
4. Technology Overview
5. Finance/Investment
6. Integration of Opportunities
7. Business Plans

Time Months	Program Manager L. Jones	J. Moreau and HD&C Staff	Dilco Financial Analyst	Clerical	Merrill, Lynch (Financial)	Carlsmith (Legal)	Parsons Hawaii (Engineering)	Helsey (Resource Asses't.)	Other	Total
1	50	150	20	40	20	10	20	10	-	320
3	100	390	400	40	70	50	200	10	150	1410
3	75	50	50	10	150	250	-	40	75	700
2	50	100	40	10	20	50	150	40	50	510
3	75	50	150	20	250	200	100	10	-	805
2	100	40	100	100	150	100	50	10	-	690
3	50	200	150	150	250	30	200	10	25	1065
	500	980	910	370	910	690	670	170	300	5500

DILLINGHAM UNDERSTANDS AND IS INVOLVED
IN THE GEOTHERMAL PROGRAM

In the three years Dillingham has been following the alternate energy programs in Hawaii, they have become familiar with the goals and programs of the Department of Energy. Dillingham companies have supported many prime contractors on alternate energy programs in their proposals, primarily in ocean thermal.

Dillingham has worked to prepare itself to be a contractor for construction and deployment of OTEC plants, construction of the Honolulu Solid Waste Energy Resource Recovery Facility and the construction associated with the development of geothermal resources in Hawaii.

Dillingham Corporation, a diversified large corporation headquartered in Honolulu, is active in shipping, construction, ship repair, LP Gas distribution, and property management. In the business field pertinent to geothermal, Dillingham is a major factor in the Pacific Basin. Activities on the American continents range from Alaska through Canada and the U.S. Mainland to Panama.

Dillingham's profit making record by itself, in the cost competitive areas of construction and maritime, speaks to the efficiency and on-time delivery record of assigned personnel. Dillingham is fully experienced and qualified to undertake and deliver on world class major contracts, where guaranteed performance and the national reputation is involved.

With 1977 revenues of \$856 Million, Dillingham is prepared to commit the necessary resources together with selected consultants, to deliver a comprehensive study that will more than fulfill the DOE requirement to establish procedures to assure the commercialization of geothermal energy in Hawaii.

A Suggested Procedure
To Commercialize Geothermal Energy
For Hawaii

Introduction:

Recent geothermal development in Hawaii has opened a wide range of opportunities that might flow to Hawaii if the potential of geothermal energy is fully developed. We see these three phases for this development:

- A significant contribution to the energy self-sufficiency on the Big Island
- A significant commercial exploitation of this energy should happen on the Big Island
- This should stimulate the full development of the geothermal resource which could be attractive enough to force the solution to the problems in transporting the energy to Oahu and help alleviate its dependence on imported oil.

To date, efforts have been directed at proving the existence of the geothermal resource and trying to assess what steps need to be taken to harness the contained energy. The path leading to economic payoff from today's starting point is not clearly marked and there is a need for concentrated efforts by industry, government and academia working together to make the geothermal potential an economic reality. Dillingham proposed to mobilize private interest in the state working with the state and county governments and the University of Hawaii to clearly chart a path around the many barriers to the economic exploi-

tation of the extensive resource that is believed to exist underground.

This paper outlines previous work, shows the impact of that work on future geothermal development and recommends the way for the private sector to become involved through a research study proposal to the U.S. Department of Energy. The research study team would evaluate and document how to make commercialization happen in Hawaii at an early date by addressing seven basic tasks, including:

1. Market Identification
2. Market Analysis
3. Barrier Assessment
4. Technology Overview
5. Finance/Investment
6. Integration of Opportunity Issues
7. Business Plans for Investors

Background:

A first step along our geothermal pathway might be to ask ourselves the question: "What is the status of geothermal development in Hawaii?" In response to that question, the following items pertain:

- Drilling for geothermal energy in Hawaii started in the early 1960's on the Big Island. Five unsuccessful wells were drilled. Finally, success came with a sixth hole completed in April, 1976. This well, HGP-A, has the highest recorded temperature of any geothermal well and raises hopes that in Hawaii, geothermal energy will become a viable alternative to fossil fuel energy.

- HGP/DG (Hawaii Geothermal Project/Development Group), a consortium of the State of Hawaii's Department of Planning and Economic Development, the University of Hawaii's Natural Energy Institute, and the County of Hawaii, has been funded for approximately \$6.0 M for the installation of a 3 to 5 MWe wellhead generator. This generator should be in operation by July 1, 1980.
- The University of Hawaii Geophysics Institute has been funded to continue their geothermal assessment work in the state. They are currently working on the Big Island, but plan to be looking at Maui and Oahu at a later date.
- Water Resources International, Inc. will soon be drilling a step-out well from their "dry hole" recently abandoned at a depth of 5,500 feet where a drill bit was broken. The thermal gradients in the abandoned "dry hole" were encouraging enough to justify a second geothermal well in the Puu Waa Waa area situated above Kailua-Kona.
- HGP/DG is seeking funding for a step-out well in the Puna rift zone.
- Studies by VTN, Pacific Analysis and Pacific Resources all working as subcontractors to SAI (Scientific Analysis, Inc.) in process, concern the commercial applications of geothermal fluid from the HGP-A well.
- The recent offer by the County of Hawaii to the Department of Energy (DOE) titled "Direct Utilization of the Puna, Hawaii Geothermal Resource for the Processing of Manganese

Nodules" was screened out of further consideration by a selection panel within DOE.

- The County of Hawaii has been funded by a grant from the Department of Energy in the amount of \$125,000 for the purpose of developing an action plan to guide the Big Island community of 78,000 population to a high degree of energy self-sufficiency by 1990.
- The Puna Sugar Company (AMFAC, Inc.) was awarded \$125,000 in 1977 to conduct an engineering and economic analysis for the utilization of geothermal fluids in a cane sugar processing plant.
- The State of Hawaii has appropriated \$50,000 for an initial study of the feasibility of connecting the islands by submarine power cable.

Discussion:

If these projects lead to their most optimistic conclusion, the following could happen:

1. There will be a proven geothermal resource in the geologically active Puna District
2. There will be a geothermal resource in the Puu Waa Waa District

The exploitation of these resources will be:

1. To provide for Hawaii Electric Light Company's expansion of
± 23 MWe

2. To provide some process steam to the Puna Sugar Mill

It is the payoff beyond these first two projects that will be hard to realize. Geothermal development will not progress if there is not an assured market to offer a payback to the development companies. The user companies that will be attracted to relocate to utilize the geothermal energy will not make the necessary investments if there is not a proven reliable resource. For example, representatives of the U.S. Ocean Mining Consortium in a recent meeting in Honolulu indicated that substantial amounts of reliable power (80 to 300 MWe) would be required by 1985/86 if Hawaii were to be considered for a manganese nodule processing plant. However, a geothermal developer will not make the investment to prove that an adequate resource exists based solely on the possible payoff some five years later if a manganese nodule processing plant locates nearby.

To develop the geothermal resource, and realize the benefit from the potential opportunities, the time appears right for increased industrial interest. The State, County and University of Hawaii have done an outstanding job of bringing geothermal energy development to its present healthy condition and will continue to play important roles. However, because the Federal Department of Energy will fund development activities that can enhance the likelihood of early commercialization, it is proposed that the private sector now step forward and, using DOE funding, act to make commercialization happen.

Specifically, it is proposed that Dillingham act as a catalyst heading up a broad group of private interest to become involved in an upcoming DOE research effort. The research will be invited in a PRDA (Program Research & Development Announcement) issued by the DOE regional office in Oakland, California sometime after the beginning of

the fiscal year; a good estimate is November 15, 1978. The PRDA will probably invite proposals for engineering and economic studies of applications for utilization of hydrothermal resources. The study model used would be a community surrounding an industrial park with cascading uses of geothermal fluid, such as generating electricity, making energy intensive products, manufacturing of construction panels from eucalyptus chips, hydroponic farming, spas, etc. The study would analyze each business opportunity on a rigorous commercial basis and also would investigate the synergism that could accrue from locating the plants close to each other.

This PRDA can provide a mechanism to develop a commercial program that would bring geothermal energy application to fruition in a finite time. Hopefully, this research would show the opportunities to be so attractive that private developers would take up the ideas independent of future federal funding. If the study does not identify such commercial opportunities then it will identify what action the public sector must take to make geothermal development happen in Hawaii.

A core group of researchers, involving experts in finance, geothermal assessment, and process engineering would conduct this study. The core team will include:

Dillingham Corporation - Hawaiian Dredging & Construction Company
Energy Projects Department: Program Manager, institutional, regulatory, utility and economic considerations. Strategic planning.

Dillingham Corporation - Business Planning Group: Analysis of commercial viability of various businesses.

Merrill Lynch Pierce Fenner & Smith: Geothermal incentives and investor considerations. Marketing of investment opportunities.

Carlsmith Carlsmith Wichman & Case: Legal and resource ownership issues.

Dr. C. Helsley, Director, Hawaii Institute of Geophysics, resource assessment.

Ralph M. Parsons, Inc.: Technical evaluation of business opportunities.

A vital component of the study will be to involve landowners and potential investors in analyzing both the opportunities and the problem in developing a geothermal business. Some of the landowners/investors to be invited to participate would include:

Landowners:	Investors:	Geothermal Developers:
AMFAC	Bank of Hawaii	Arco
Alexander & Baldwin	First Hawaiian Bank	Phillips
Bishop Estate	PRI	Union
Bohnett		Republic
C. Brewer		Thermal Power
Castle & Cooke		
Davies		

Additionally, the study would explore the cultural, social and environmental barriers and related perceived problems, and involve authoritative parties in their area of expertise. This group would include:

County of Hawaii
DPED, State of Hawaii
Environmental Associations
Labor Unions

Native Claims
University of Hawaii

Recommendations:

It is time to mount a sustained, in-depth effort to assess and establish key steps that need to be taken now to assure that Hawaii's geothermal energy potential is fully realized. Industry, working with government and other interests, should assume a leadership role as outlined in the enclosures. Dillingham proposes to provide the principal investigator and support the research study that will point the way and detail the procedures required to provide maximum and economical use of our geothermal energy resource.

Outline
A Geothermal Research Proposal
For Industrial Applications in Hawaii

Introduction and Summary:

This proposal will contain the essential requirements spelled out in the Program Research and Development Announcement (PRDA) to be issued by the Department of Energy (DOE), Oakland Regional Office in the near future. The technical discussion will include:

Study objectives. Develop the business plan for a number of businesses that would be the nucleus of a geothermal community surrounding an industrial park on the Big Island. This would be integrated with a program to make County of Hawaii energy self-sufficient by 1990 and to produce 300 MWe power for export to Oahu and for manganese nodule processing.

Background. This portion of the proposal will explain the rationale for our research approach, i.e., in seven tasks we intend to define and analyze markets, evaluate barriers, review the adequacy of available technology, discuss relevant finance and investment factors, integrate the issues and then finalize the work effort with a marketing strategy and a description of business plans to be offered investors. The input of both the private and public sector of this development work in Hawaii will be described. Related research and summary of recent publications will be presented to assure the DOE evaluators that our research team is thoroughly familiar with the state-of-the-art and with current and prior research in the pertinent fields.

Study Plan/Statement of Work. The seven tasks to be accomplished

in the research are listed below in the order for accomplishment. These tasks will be expanded to describe in detail the methods of attainment for each, and the relationship to other tasks. A graphic schedule of events and activity with key decisive points will be included.

Task 1. Market Identification.

Markets will be identified through a carefully researched and documented study of geothermal applications based on previous work, plans for western states on the mainland and other resources for consideration on the Island of Hawaii. Markets to be evaluated will include:

1. Industrial:
 - a. Space heating
 - b. Refrigeration
 - c. Eucalyptus chip and bagasse processing into pulp, construction materials and fuel for binary processes
 - d. Timber seasoning and drying, sawmills
 - e. Chemical production: ammonia, ammonium-carbonate, -chloride and -sulfate; anhydrous gypsum, borax, boric acid, boron, bromine, calcium chloride, chlorine, dry ice, heavy water, hydrogen for fertilizers and for fuel, hydrogen chloride, iodine, lithium magnesium, magnesium chloride, methane recovery for peak heating demands, methanol production for fuel, potassium chloride, soda ash, sodium bicarbonate, sodium chloride, sulfur
 - f. Hemp processing
 - g. Textile processing
 - h. Manufacture of plastic explosives
 - i. Hot feedwater for solar stills
 - j. Cold for the production of synthetic rubber

- k. Sewage heat treatment
- l. Diatomite production
- m. Recovery of trace elements
- n. Fermentation - ethyl alcohol, butanol acetone, citric acid
- o. Cement drying and curing
- p. Minerals recovery - gold, zinc, titanium, silver, lead, tin, beryllium, copper, antimony, manganese nodules

2. Agriculture:

- a. Greenhouses for vegetables, flowers, plants
- b. Hot beds, hot houses
- c. Soil warming
- d. Animal husbandry - heating of fowl runs, pigsties, cattle breeding
- e. Irrigation
- f. Water desalination
- g. Cooling for food storage
- h. Thermal food culture - seaweed, algae; seaweed harvesting and manufacture of alginates
- i. Frost protection
- j. Plant cooling and humidity control
- k. Pest and disease control
- l. Fish culture (aquaculture and mariculture) pond culture, cage culture, flowing water culture; ayn, carp, catfish, eels, flatfish, lobster, mussels, oysters, rainbow trout, seabream, shrimp, whitefish, yellow tail; breeding of alligators and crocodiles
- m. Drying - fish meal, grain, hay, paprika, rice, tobacco
- n. Canning

- o. Refrigeration
- p. Freeze drying - coffee, fish, fruit juices, meat, mushrooms
- q. Brewing and distillation
- r. Sugar processing and refining
- s. Pasteurization of milk; production of dried milk, casein, and sucrose; cheese processing
- t. Rice processing
- u. Dehydrated vegetable products
- v. Fruit processing - drying, packaging, refrigeration
- w. Hydroponic farming of vegetables to make State of Hawaii independent of the mainland

3. Space Heating

- a. Space heating
- b. Space cooling, air conditioning
- c. Domestic hot and cold water
- d. Swimming pools
- e. Cooking
- f. Clothes drying
- g. Refrigeration
- h. Horticulture

4. Health Spa/Tourism

- a. Health spas
- b. Hospitals, sanatoriums
- c. Tourist centers and resorts
- d. Bottled water

5. Electrical

- a. Dry steam
- b. Wet steam - low salinity

- c. Wet steam - high salinity
- d. Low enthalpy - less than 356° F
- e. Electric power generation and distribution on the Big Island and throughout the state using connecting submarine cables.
- f. manufacture of energy intensive products such as hydrazine

Task 2. Market Analysis.

Each potential market will be tested for economic viability. The external impact of cheaper geothermal energy (using best available estimates of costs) will be measured against freight and logistics cost. Those that survive this fundamental economic test will be examined in further detail.

Timing of entry into certain markets will be critical, e.g., when ocean mining interests need assurance of power for nodule processing.

The businesses selected in this task will be those that survive the scrutiny of hard commercial analysis and which also survive the further barriers of technology, ecology and local compatibility.

Task 3. Barrier Assessment.

Various non-technological barriers to commercial scale development will be reviewed, synthesized and evaluated for each market selected. Recommendations for steps to be taken will be set forth identifying time tables and procedures for implementation. These barriers include, but are not limited to:

1. Organizational structure within industry and government currently inhibiting progress

2. Planning inadequacies
3. Political support/timing/format
4. Cost. The comparative cost of developing geothermal energy can be a barrier. For example, \$1.0 - \$1.2 M to drill a hole in Hawaii to a depth of 6,500 feet versus less cost and shallower wells to drill in western mainland states, which are closer in proximity to a larger population center could discriminate against Hawaii geothermal development unless we have an economically efficient and highly directed goal oriented program fully supported by government and industry.
5. Environment. Compliance with federal/state/county regulations, cost impact, EIS
6. Logistics - infrastructure
7. Legal/land ownership
8. Legislative/permit regulation
9. Social/cultural

Task 4. Technology Overview.

Technology requirements for distribution and use of hydrothermal fluid to support the industrial park and geothermal community will be assessed for the market processes identified in earlier tasks.

1. Clear understanding of process procedures and costs for both resource development and market applications
2. Transport of hydrothermal energy
3. Special needs for support industries for industrial park

and community

4. Synergism of collocation of industries
5. Feasibility of electrical distribution grid covering entire state using submarine cable to reduce risk and provide increasing reliability.

Task 5. Finance/Investment.

The economic competitiveness of geothermal power/energy on the Big Island for various markets will be assessed in comparison with power or energy supplied by fossil fuel, nuclear power or coal.

1. Risk assessment
2. Forecast future costs for process steam delivered to the industrial park and for busbar power delivered to Hawaiian Electric Company, for consumption on:
 - a. The Big Island
 - b. State grid via connecting cables
3. Components of geothermal capital costs will be detailed, including:
 - a. Construction and site
 - b. Operating/maintenance
 - c. Capital/debt
 - d. Insurance
 - e. Taxes
 - f. Depreciation
 - g. Incentives
4. Effectiveness of legislative/federal/state/county support will be evaluated
5. Innovative investment packages will be developed for those market processes that were selected in Task 2 and that have

survived the barrier and technology assessment screening.

Task 6. Integration of Opportunity Issues.

The primary work in this research task will be accomplished by representatives of public utilities, industrial consortium, investors and land owners together with planners and managers of key firms that have been selected in earlier tasks. These key people will describe the decision making processes and will identify the criteria that will be applied to geothermal energy applications.

In this task all issues from preceding tasks will be integrated into realistic program opportunities including specific milestones, procedures, programs and requirements.

Task 7. Business Plans for Investors.

A product of this research effort will be business plans and scenarios for potential businesses that will be offered to investors to take geothermal energy potential on the Island of Hawaii through a demonstration and proven commercial stage of development. A marketing strategy will be prepared to sell business plans developed in this task to potential investors.

In those industries, including the distribution of the power to the principal neighbor islands where the business attraction does not appear sufficiently viable to present to private investors, a scenario involving quasi-government participation or legislative action will be detailed.

A conceptual design of a complete geothermal community surround-

ing an industrial park on the Big Island will be generated.

A plan for geothermal energy's role in the energy self-sufficiency of the County of Hawaii will be included.

Organization and Management Plan.

This portion of the proposal will provide an organizational chart showing the working relationship of the key tasks and performers together with a narrative plan which clearly describes the proposed arrangements for direction coordination and control of the project. Dillingham, HD&C Energy Projects Department will provide the necessary leadership and the principal investigator. The role of all key landowners, investors, government representation and social/cultural group representatives will be clearly depicted. In view of the research objectives to establish criteria needed to establish an industrial park on the Island of Hawaii with usable new business ventures it is essential that the participation of several key people from the various groups express themselves candidly in appropriately structured forums such as workshops and seminars and through advisory bodies. Participants in the forthcoming December workshop together with the workshop content will be incorporated in this plan.

Milestones will include necessary studies/conceptual design/analyses to produce a plan of action that will not only integrate developed geothermal power into a grid connecting entire state, but will also indicate step-by-step development of geothermal industrial applications for each stage of resource development on the Big Island.

Finally, a description of how the results of the research will be synthesized and tested for validity will be described. These results

will include a plan to implement marketing strategy to sell the business plans to potential investors.

It is anticipated that a one-year work effort will be required.