INTERNATIONAL SUMMER SCHOOL
on Direct Application of Geothermal Energy

Under the auspice of the
Division of Earth Sciences

Hawaii and Geothermal
What has been Happening?

Compiled by
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Introduction

The Hawaiian Islands lie above a geological "hot spot" in the earth's mantle that has been volcanically active for the past 70 million years with the island of Hawaii (the "Big Island") having the most recent activity. The Big Island has an obvious, large potential for geothermal energy resources, both for electrical generation and direct utilization. Since the 1976 drilling of the HGP-A well and the discovery of the Kapoho Geothermal Reservoir in the lower Kilauea East Rift Zone, geothermal power potential on the Big Island has been estimated at between 500 and 700 Megawatts.

As a historical note, King Kalakaua was on the throne of the Hawaiian Kingdom before Hawaii became a state and it was he who had the extraordinary vision when it came to so many things, including electricity. Kalakaua, along with several of his closest advisors, visited Thomas A. Edition in New York in 1881 because the King was interested in replacing the kerosene lamps being used at his Iolani Palace with electric lamps. Because of his efforts, Honolulu became one of the first cities in the West to have electric street lights when Princess Kaiulani closed the switch that provided the power, not from the volcano, but from a nearby hydroelectric plant.

Geothermal Resources

Geothermal interest was motivated by the fact that imported oil is used to supply over 90 percent of Hawaii's energy needs. No place else in the US is a state so critically dependent on imported oil. Obviously, geothermal was originally regarded as a renewable source to help make the islands less dependent on imported energy.

The Hawaii Geothermal Resources Assessment Program was initiated in 1978. The preliminary phase of this effort identified 20 Potential Geothermal Resource Areas (PGRA's) using available geological, geochemical and geophysical data. The second phase of the Assessment Program undertook a series of field studies, utilizing a variety of geothermal exploration techniques, in an effort to confirm the presence of thermal anomalies in the identified PGRA's and, if confirmed, also more completely characterize them. A total of 15 PGRAs on four of the five major islands in the Hawaii chain was subject to at least a preliminary field analysis. The remaining five were not considered to have sufficient resource potential to warrant study under the personnel and budget constraints of the program.

The island of Kauai in the northern most and oldest major island of the Hawaii chain. It is made up of a single volcanic shield which completed its most active stage of volcanism nearly 3.3 million years ago. It was not studied during this phase, due to the absence of significant geochemical or geophysical indications of a geothermal resource. The great age of volcanism on this island would further suggest that should a thermal resource be present, it would be of low temperature. The probability of a viable geothermal resource of even a moderate temperature (less than 100ºC) existing on Kauai is believed to be 5% or less.

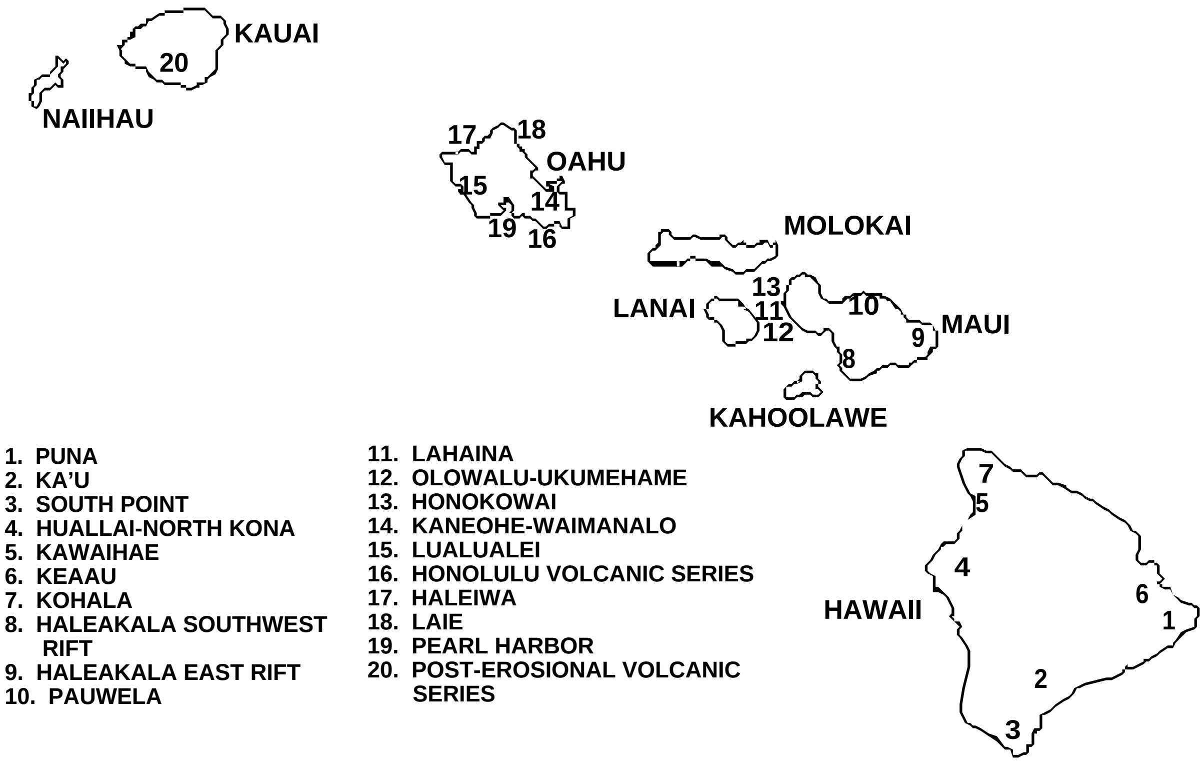

Figure 1. Map of the major islands of Hawaii showing the location of the 20 Potential Geothermal Resource Areas (PGRAs).

The island of Oahu, the major population center of Hawaii including Honolulu with a total population of 865,000 and area of 1,550 km^2, is the second oldest major island and was formed from two independent volcanic systems. A preliminary assessment identified six locations where available data suggested that a thermal resource might be present. The present assessment of the geothermal potential for Lualualei Valley is that there is a 10 to 20% probability of a low-to-moderate temperature resource existing at depths of less than 3 km. The probability of the existence of a moderate-to-high temperature thermal resource within 3 km is less than 5%. The potential for geothermal in Mokapu Peninsula is less than 5% for a low-to-moderate temperature system at a depth less than 3 km. The assessment for Koolau Caldera is less than 10% for a low-to-moderate temperature geothermal system less than 3 km deep. The probability of a high temperature system at these depths is less than 5%. The potential of geothermal system within a depth of 3 km for other PGRAs located on Oahu is considered very unlikely.

The island of Molokai is the smallest of the major islands and was formed principally from two volcanoes. Due to the anticipated small demand for geothermal power on the island of Molokai in the foreseeable future, only preliminary efforts were made to assess the potential for a resource on this island.

Maui is the second largest and second youngest island and is made up of two independent volcanic systems. The preliminary assessment surveys indicated six locations which might have a potential for geo-thermal resources. Of the three located on West Maui only one has a potential greater than 5% for a low-to-moderate geothermal system. The Olowalu-Ukumehame Canyon was assessed at having a 60 to 70% probability of having a low-to-moderate resource and a less than 10% probability of having a moderate-to-high temperature resource. The other three PGRAs are located on Haleakala Volcano. Only two of them show-ed significant findings of a geothermal resource. The

Northwest Rift Zone has a probability of 10 to 20% for a low-to-moderate temperature resource and less than 5% probability for a moderate-to-high temperature resource. The Southwest Riff Zone has a greater probability at 30 to 40% for a low-to moderate temperature resource and 15 to 25% for a moderate-to-high temperature resource.

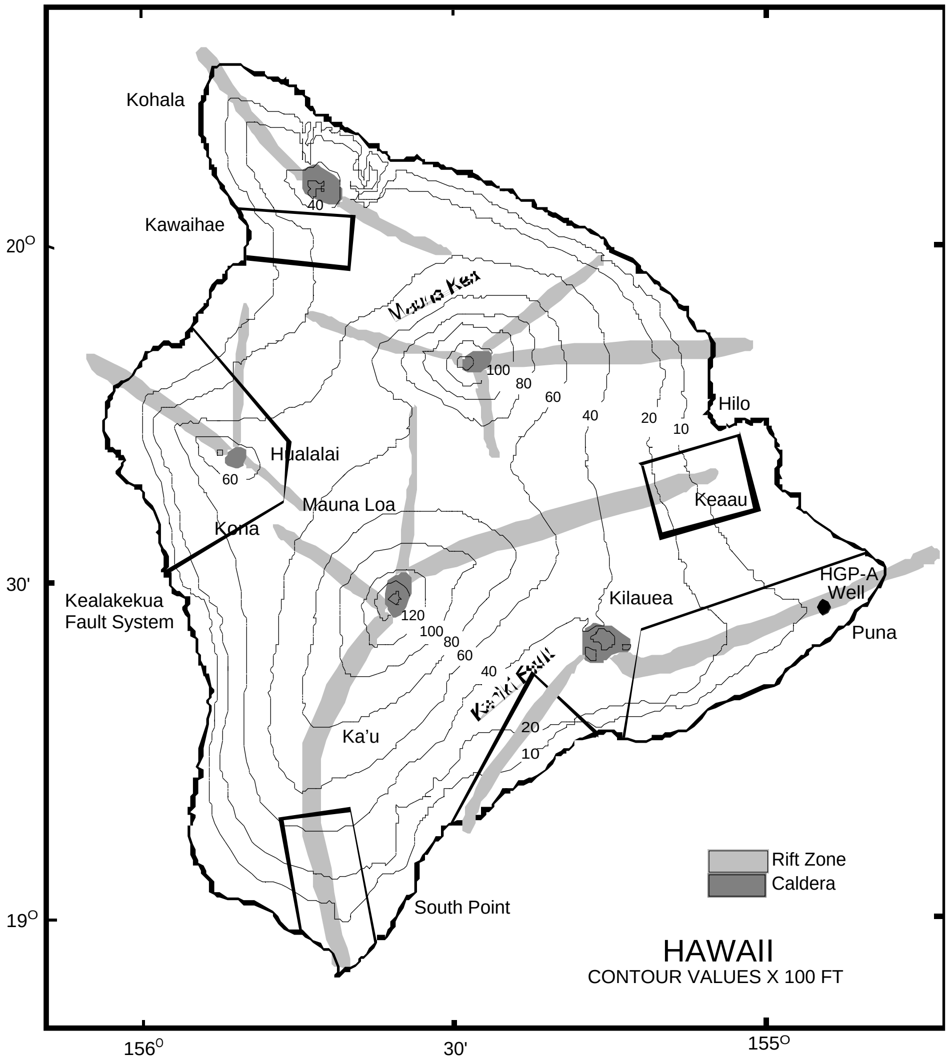

Figure 2. Map of the island of Hawaii showing the major rift zones and calderas of each volcano.

The island of Hawaii, with a population of 142,000 and an area of 10,400 km^2, is the youngest and the largest island in the Hawaii chain which is made up of at least five volcanic systems. Seven locations were identified as PGRAs in the preliminary assessment. One PGRA, the Kilauea East Rift Zone, was later designated as a Known Geothermal Resource Area (KGRA) due to the discovery of a productive geothermal well. The probability of a geothermal resource in this area is 100%. The Kilauea area also includes the Southwest Rift Zone which has a geothermal resource probability of 100% for a low-to-moderate temperature resource and 70 to 80% for a moderate-to high temperature resource within 3 km of depth. The Mauna Loa area did not identify any significant indications of a geothermal resource therefore the probability of a geothermal resource is less than 5% for a low-temperature resource. The probability of a low-to-moderate temperature resource existing in the Kawaihae area is 35 to 45% and the probability of a moderate to high temperature resource is less than 15%. The upper flanks or summit of Haulalai indicated a probability of a low-to-moderate temperature geothermal resource at 35 to 45% and the probability of a moderate-to-high temperature resource at 20 to 30%.

Community Geothermal Technology Program

In 1976, the government brought in the well HGP-A in the lower Kilauea East Rift Zone on the southeast side of the island. It was recognized for being one of the hottest wells in the world. It had a bottom hole temperature of 676ºF (358ºC), depth of 6450 ft (1966 m) and produced 80,000 lb/hr (36.3 tonnes/hr) of a mixed fluid (57% liquid and 43% steam). The surface temperature was 365ºF (186ºC).

An experimental 2.5 MW power plant went on line in 1982, which had an availability factor of 95%. The plant was originally design as a two-year demonstration project. The turbine-generator set was built on skids, so that it could be quickly removed in the event of a lava flow, and the well would be provided with a concrete slab cover. Over the life of the plant it produced between 15 and 19 million kilowatt hours of electricity per year.

Figure 3. The HGP-A power plant showing the generator building to the left and the steam separator to the right.

In 1985, the Noi'i O Puna (Puna Geothermal Research Center) was dedicated adjacent to the power plant. It was established to support direct use of the unutilized heat from the brines of the HGP-A well. The Community Geothermal Technology Program (CGTP) was conceived in 1986. The purpose of the program was to support small business enterprises in the Puna District, encourage the use of waste heat and byproducts from HGP-A, and to allow access to the geothermal resource.

There were two rounds of small grants offered, through the CGTP, to entrepreneurs in 1986 and 1988. The first round awarded grants for five projects. They were 1) Green Papaya Power Drying, 2) Bottom Heating System using Geothermal Power for Propagation, 3) Experimental Lumber Drying Kiln, 4) Hawaii Glass Project, 5) Cloth Dyeing by Geothermal Steam. The second round also awarded five grants which includes 1) a continuation of the Bottom Heat Project, 2) Geothermal Aquaculture Project, 3) Silica Bronze, 4) Media Steam Sterilization and Drying, and 5) Electro-depostion of Minerals in Geothermal Brine. A brief summary of each project follows.

The Green Papaya Powder Drying Project looked at converting an existing fruit product processing business from electric to geothermal heat. This grant included the building and testing of a drying cabinet and production of dried fruit products such as papaya, banana and pineapple slices.

The Bottom Heating System Using Geothermal Power Project was also another proposal to convert an existing system to geothermal. This was a demonstration to see if it was feasible to heat a greenhouse using a bottom heating system which circulates hot water beneath flats of sprouting plants. The soil being warmed by the hot water facilities the germination and growth of certain plants. It was founded that the rate of germination of some species improved as much as ten times during the project.

Figure 4. Ornamental palms in the experimental greenhouse during the Bottom Heating System Project.

The Experimental Lumber Drying Kiln Project proposed to design a kiln and totally automate it. There was no kiln located on the island of Hawaii, so this project was proposed to reduce shipping the lumber out of state for kiln drying or air drying locally which can take up to a year. Even though the heat exchanger design limitation produced lower temperatures than the optimal temperature of 140°F (60°C), they were able to produce satisfactory results repeatedly after four and eight weeks of operation.

The Hawaii Glass Project was proposed to use the silica produced by HGP-A well. This is a waste product from the well which dries to a powder in the brine percolation ponds. A unique glass formula was devised using the silica and the formula contained 93% of indigenous Hawaii origin. The project was not anticipated to result in a commercial glass jar or bottle making company since the amount of silica would be insufficient for a full-scale facility.

The Cloth Dyeing by Geothermal Steam Project was proposed to see if it was viable to transfer their business from Iwate Prefecture, Japan to Hawaii. The proposers found the colors were more colorful in Hawaii than in Iwate due to the chemical composition of the steam. The dyed fabric received high grades for steadfastness and permanency. This is the only project that used raw steam.

The Geothermal Aquaculture Project was proposed to investigate the potential of initiating a business to sell turn-key, small-scale aquacutlure systems, as well as demonstrating the value of geothermal heated water. Tilapia was selected for the initial experiment. The tanks of simple construction used a low-input, recirculating system with a biofilter to allow a high density population. Even though Hawaii has fairly mild and uniform temperatures (20 to 30°C), output can be approximately doubled using the constant temperature geothermal resource.

The Media Steam Sterilization and Drying Project proposal consisted of applying geothermal steam to shredded, local materials such as coconut husks to develop a sterile growing media. To prevent the spread of diseases carried by soil organisms a nursery export business requires pasteurized growing media. Peat moss was the media that was imported at the time. By replacing the peat moss with an indigenous product would benefit the entire industry. This project attracted great interest from local agriculturists.

Figure 5. Samples of the hand-dyed silk treated with raw geothermal steam.

The Silica Bronze project proposed using the silica brine from the disposal ponds as a refractory material used in casting bronze artwork. The silica has been imported to Hawaii in bulk. If the silica can be recovered from the silica pond, washed and dried it may prove to be suitable for refractory use. Part of the project was concerned with developing simple ways to recover the silica from the ponds, wash it, and dry it so would be in the proper form suitable for refractory use.

The Electrodepostion of Minerals in Geothermal Brine research project was aimed at determining the nature and possible utility of minerals deposited from the hot fluid. Past research has indicated that calcium carbonate can be successfully taken from seawater. Possible future commercial applications of the deposited materials made this an intriguing bench-scale research project.

There was significant interest in the direct use of geothermal energy. The following is a list of some of the proposed applications which were not funded by the CGTP - Dehydrating, Fruit fly disinfestation, Media Pasteurization, Refrigeration, Spas, Cement Formula, Curing, Distillation, Electricity, and Polystyrene.

The HGP-A power plant was closed in late 1989 on the order of Governor John Waihee and County of Hawaii Planning Director Duane Kanuha. The closure of the power plant was permanent due to the fact that it was not projecting good public relations. Some of the problems were general appearance of the plant, existence of silica disposal ponds outside the perimeter, community complaints about noise and hydrogen sulfide emissions.

The power plant was originally intended as a two-year demonstration. It proved to be highly reliable and displaced more than 250, 000 barrels of imported oil. Since all the emission control equipment belonged to the owner of the power plant the well itself had to be closed which contributed to the Puna Geothermal Research Center being closed.

Geothermal / Interisland Transmission Project

From 1982 through early 1990, a large-scale 500 megawatt geothermal/interisland submarine cable project was under consideration. About $26 million (Federal and State funding) was expended in studies, design, engineering, fabrication, and testing for the Hawaii Deep Water Cable Project. The design criteria stated that the cable(s) would have to be able to withstand the stresses of at-sea deployment (including strong currents, large waves, and strong winds), the undersea environment (including corrosion and abrasion), and be able to reliably conduct electricity for thirty years.

Since the Alenuihaha Channel is nearly 2,000 meters deep, both deployment (laying of the cables) and operating environment posed unique engineering challenges.

The Hawaii Deep Water Cable (HDWC) program was organized to examine the technical feasibility of installing and operating for 30 years a submarine power cable between the islands of Hawaii and Oahu. The reason for this interest is that there is geothermal energy on the island of Hawaii and the major electrical load is on the island of Oahu where Honolulu is located. The scheme under consideration was to use the geothermal energy to generate power and transmit it to Oahu. At the time is was estimated that up to 500 MW could be used on Oahu, whereas only about 100 MW was needed on the Big Island.

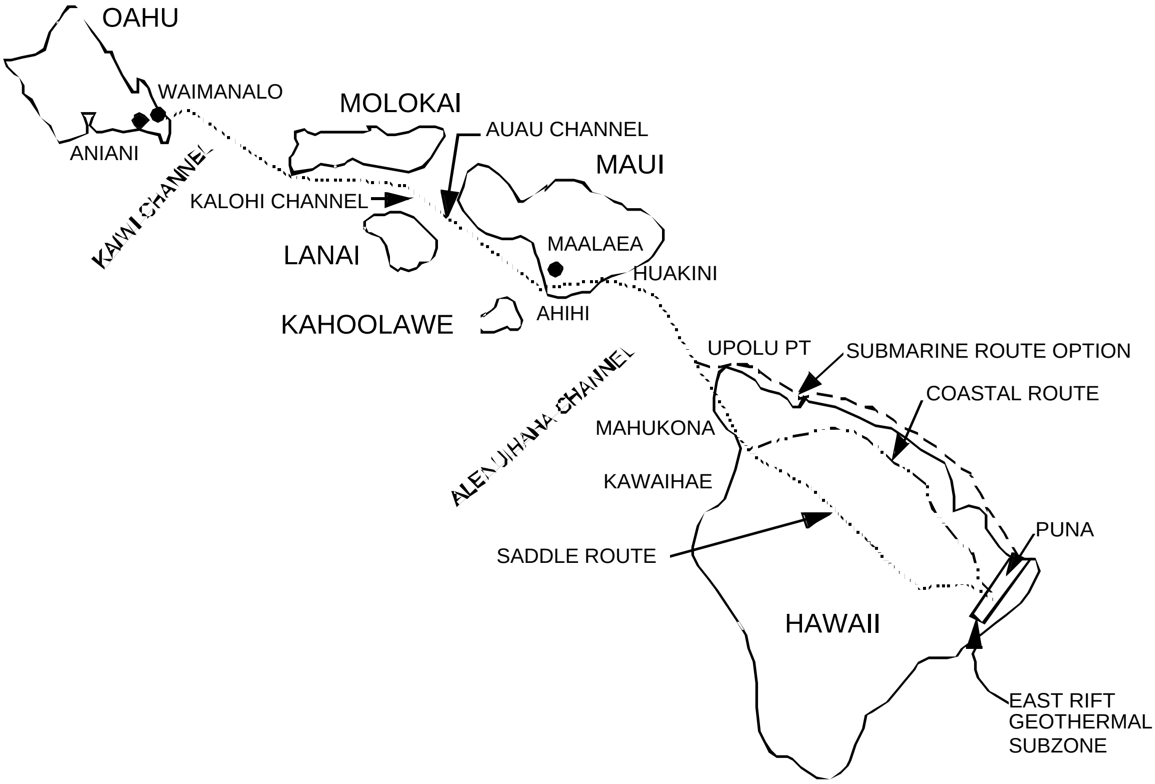

Figure 6. The Hawaii Geothermal/Interisland Submarine Cable Project Proposed Route.

The power produced by the project could potentially represent a large portion of the electric power supply for Oahu. Thus, the project would have to provide a reliable supply of electric power. The amount of power that HECO (Hawaiian Electric Company) would purchase would be dependent on HECO's assessment of the reliability of the power that can be generated by the project and the degree and timing of availability of that power.

Two large scale tests were conducted to examine the technical feasibility of the Hawaii Deep Water Cable. The first was the laboratory test where the cable was subjected to the electrical and mechanical loads expected during the 30 years of service, Second, the at sea tests examined the ability of the projected, integrated control system to place the cable at the bottom accurately and to control the residual tension.

Over 251 different cable designs were considered. The cable tested was double armored, paper insulated, oil filled cable designed to operate at 300 kV and transmit 250 MW of power. The cable, Pirelli Cable Design No. 116, used in the test is shown below in Figure 7.

The scheme of the tests was as follows: one set of tests (the individual tests) subjected cable samples to either single worst case loads or to loads needed to measure a characteristic of the cable; the second set (the sequence tests) subjected on cable sample to a sequence of loads that duplicated the loads the cable would experience during the laying and operating for 30 years on the most hostile part of the route. Upon completion of the sequence tests, the cable sample was subjected to electrical tests. By comparing the results of this test with the results of identical test run earlier on a new piece of cable, the effects of the sequence of mechanical loads on the electrical performance could be assessed.

The individual tests were

1) baselines electrical test 2) High stress tensile test, 3) static flexual rigidity test, 4) dynamic flexual rigidity and damping coefficient, 5) crushing test, 6) repeated flexure test, and 7) internal pressure test.

The sequence tests were

1) crushing test, 2) bending test, 3) cable oscillation test under simulated tidal current, and 4) final electrical test.

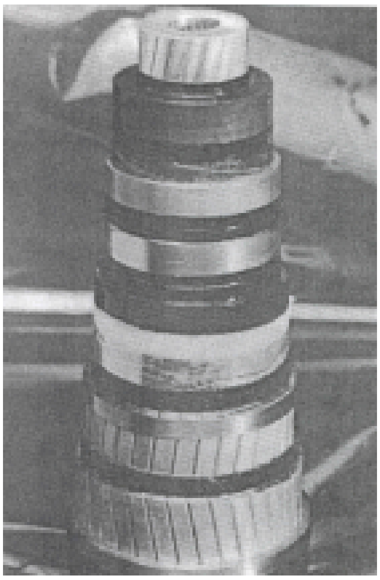

Figure 7. Pirelli Cable Design No. 116.

The conclusions of the individual tests and the sequence tests were the cable met the required guidelines for a 300 kV DC submarine cable. Additional tests that reflected the special conditions of the program were conducted and all tests were passed. The electrical strength of the cable and joints exceed the acceptance requirements for use in the program. After the 30 year simulation there was no evidence of degraded performance of the cable.

A major challenge to laying the proposed underwater power cable is the formidable Aleunuihaha channel between Hawaii and Maui. The Alenuihaha is renown for its difficult currents, harsh wave conditions and strong wind velocities and is the deepest channel in the Hawaii Islands.

A major component of the HDWC program was the at-sea test, where a test cable with similar characteristics to the proposed power cable was laid multiple times. The most difficult portions of the cable route were chosen for cable laying tests to prove the technical feasibility. The primary objects of the at-sea tests were:

To verify the ability to accurately lay a power cable within the required path.

To verify the ability to control the cable tension on the ocean bottom.

A second objective was to monitor and record the performance of the laying control system, environmental conditions and the associated ship motions and dynamic tension loads in the cable for post-cruise analysis.

An 8,000 m surrogate steel cable was selected to be hydrodynamically similar to the power cable. This cable was laid and retrieved a total of three times. The first lay, under Integrated Control System control, established the success of horizontal placement accuracy with the cable being place within 3 meters of the objective. The second and third lays were up and down the steep Kohala slope which is in the Alenuihaha channel.

The cable, while shown to be technically feasible through the research project, did not prove to be economical. Cost proposals for commercial installation of the cable demonstrated that the project could not be supported without significant government subsidies, which were not possible at the time. Currently, the state's policy supports geothermal energy production on the Big Island exclusively for use on that Island.

Puna Geothermal Venture power plant

In 1990, The Puna Geothermal Venture Facility, situated on 25 acres of a 500-acre plot, located 21 miles south of Hilo on the Big Island, replaced the HPG-A facility. This facility is in the geologic region known as the Lower East Rift Zone. Puna Geothermal Venture is the first commercial geothermal power plant in the state of Hawaii and currently is producing about 30 MW of power. The power plant comprises 10 combined cycle ORMAT Energy Convertors (OECs) installed in parallel. Each OEC consists of a Level I topping steam Turbine and a Level II organic turbine connected to a common generator (Figure 8 and 9).

Puna Geothermal Venture provides nearly a quarter of the power consumed on the Island of Hawaii. That is enough electricity to meet the needs for more than 250, 000 residents and visitors. Since the power plant has been in operation until April 2002 it has produced a total of 1.9 billion KWh and displaced a total of 552 tonnes of oil.

In 2000, Puna Geothermal Venture announced its intention of doubling its electrical generation capacity from 30 MW to 60 MW. The expansion, would be over an unspecified period of time. The wells supply geothermal steam at high pressure which must be reduced with valves before the steam geos through the generators. Puna Geothermal Venture plans to place an 8 MW generator at the well to reduce pressure to the other generators while producing power. In the long run, the company can increase capacity to 50 MW without any new wells.

In 2001, Puna Geothermal Venture was chosen to operate the Puna Geothermal Research Center (Noi'i O Puna) facility by the Natural Energy Laboratory of Hawaii Authority. The Puna Geothermal Venture proposal consisted of continuing the existing activities and to develop new operations without doing any further drilling. They plan to solicit proposals from entrepreneurs and sell them thermal energy. PGV will refurbish and expand the visitor center and will also make reasonable efforts to solicit proposals from the public for the development, construction, operation and maintenance of a geothermal heat source on the property. If PGV receives a bona-fide proposal, they will make available, for reasonable compensation, facilities to transfer surplus heat from their neighboring geothermal facility and area within the Noi'i O Puna facility for geothermal related businesses of local entrepreneurs.

Barriers that have been encountered

A number of potential barriers to geothermal development in Hawaii have been overcome but some remain. A couple of the barriers, regulations and public acceptance, are discussed below.

<u>Regulations</u>

The Regulatory Regime seems to be quite complex. There is the Geothermal Resource Subzone (GRS) Assessment and Designation Law (Act 296, SLH 1983), The Board of Land and Natural Resources, Hawaii County Planning Commission's Rule 12, Act 301, SLH 1988 just to name a few.

The Geothermal Resource Subzone stated that the exploration and development of Hawaii's geothermal resources are of statewide benefit and this interest must be balanced with preserving Hawaii's unique social and natural environment.

Three Geothermal Resource Subzones on the Big Island were designated by the Board of Land and Natural Resources after evaluating a number of factors including social and environmental impacts. The subzones total 22,300 acres in the middle and lower Kilauea Rift Zone and 4,000 acres in the Haleakala Southwest Rift Zone.

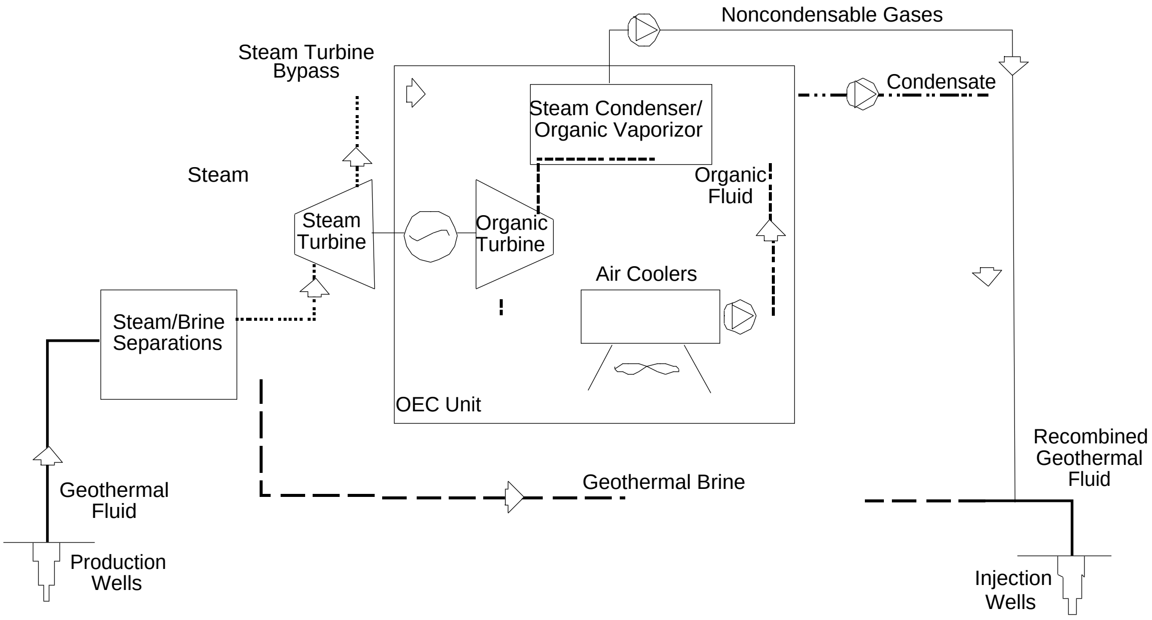

Figure 8. Schematic of the Puna Geothermal Venture Facility.

Figure 9. Puna Geothermal Venture Power Plant.

Public acceptance

Some people regarded the original experimental geothermal power plant development as the unfortunate victim of a series of accidents that could have happened to anyone. Others regard the developers as having invited disaster through its own making and bungling. Another view is that the very nature of the geothermal resource at Puna is such that tapping into it commercially is beyond the reach of existing technology.

As a result, public acceptance was an issue facing development. The issues expressed by the local population included:

+ Interference with worship of the Goddess Pele.
+ Interference with certain Native Hawaiian practices
+ Rainforest destruction
+ Geologic hazards: seismic, lava I nundation, subsidence
+ Disruption, including possible health and safety impacts, of the way of life for nearby residents: hydrogen sulfide and other air quality issues, water quality, noise, destroyed vistas, lights at night, traffic and increased strain on an inadequate infrastructure, transmission line health risks and visual impact, and decreased land values.
+ Impact on native fauna and flora.

In more detail some of these issues are described below.

The exploration and development of geothermal resources can be permitted within conservation, agricultural, rural, and urban areas. Some geothermal resources can be found in the Wao Kele O Puna rainforest, one of Hawaii's nine lowland rainforests, and in residential areas where some residents may not want geothermal activities to occur.

An uncontrolled venting incident in June 1991 at the Puna Geothermal Venture project on the Big Island released hydrogen sulfide and other gases, causing some residents to remain concerned about potential emissions. As a result of the "blowout" a Geothermal Management Plan was developed that has enabled state and county agencies to better regulate geothermal activity and enforce permit conditions.

Geothermal wells are sometimes vented for a few hours to clear the well and pipelines resulting in a temporary release of steam and abated gases. Such events can be noisy for a short time. Some continuous low-level noise is also generated during normal power plant operations.

Some native Hawaiians oppose the development of geothermal power as interfering with their worship of Pele, the Goddess of volcanoes, despite a ruling from the US Supreme Court that geothermal development does not interfere with religious freedom.

In fact, in about 1990, there was so much opposition to geothermal power development, that the mayor of the Big Island, a supporter of geothermal, lost his next election.

Renewable Portfolio Standard

A Renewable Portfolio Standard (RPS) is a policy to encourage the use of renewable energy sources. It sets minimum targets for the production of electricity generated from renewable resources. The aim is to ensure deployment of renewable energy to enjoy the benefits of reduced energy costs, reduced exposure to the economic effects of volatile oil markets, risk management by diversifying generation options, job creation and economic benefits, and environmental benefits.

For a state such as Hawaii, with its extremely high dependence on imported fuels for energy (90% of the energy supplies - oil and coal - are imported), increased use of renewable energy would achieve increased energy security, reduce some of the environmental risk associated with fuel transport, and reduce the flow of money out of the state. The cost of electricity in Hawaii is the highest of any state in the United States with average revenues per kWh in September 2000 of $0.144 -- over twice U.S. average revenues per kWh of $0.0691.

Not only were Hawaii's electricity revenues per kWh the highest in the nation in October 2000, electricity revenues per kWh for Hawaii utilities grew much faster than the U.S. average over the years since 1990. Hawaii's revenues per kWh were 59.6% higher than the average for 1990 while the U.S. average was only 3.3% higher. For comparison, Honolulu consumer prices increased about 25.5% from 1990 to 1999.

Electric utilities in Hawaii are "regulated monopolies" meaning they are allowed to operate without competition, but must follow rules set by the Public Utilities Commission. By adopting a renewable portfolio standard, the use of renewable energy becomes one of those rules.

Hawaii's dependence on fossil fuels is

expected to grow over the coming decade unless action is taken to increase the use of renewable energy. In 1999, Hawaii's four electric utilities sold 9,373.8 Gigawatt hours (GWh) of electricity. Statewide, utility IRPs forecast that electricity sales will grow at an average annual rate of 1.6% during the 1999 through 2010 period, reaching approximately 11,192 GWh in 2010.

In 1999, renewable energy (geothermal, municipal solid waste, bagasse, landfill methane gas, hydro and wind) was used to produce 7.2% of the electricity generated for sale by the four electric utilities. Renewable energy generation capacity was reduced in 2000 by the closure of Lihue Plantation on Kauai and Pioneer and Paia Mills on Maui. If the remaining renewable energy resources in operation at the end of 2000 continue in operation through 2010, they will provide an estimated 642 GWh of sales during each year of the period. This will amount to approximately 6.6% of total electricity sales in 2001. As electricity demand grows, the percentage of electricity sales from renewable resources will decline to approximately 5.7% statewide by 2010.

Table 1 shows the generation in Hawaii used to produce electricity for sale to utility customers in Hawaii as of the end of 2000.

Table 1. Electricity Generation for Utility Sales (End of 2000).

HECO	HELCO	KE	MECO
1161.0 MW OFS	65 MW OFS	10.0 MW OFS	32.4 MW OFS
129.0 MW CT	45.3 MW CT	42.9 MW CT	102.4 MW CT/DTCC
180.0 MW AFBC	42.0 MW IC Diesel	44.0 MW IC Diesel	114.9 MW IC Diesel
180.0 MW LSFD DTCC	22.0 MW Coal Steam	62.0 MW DTCC	
46.0 MW MSW	30.0 MW Geothermal	8.7 MW Hydro	12.0 MW Bagasse/Oil/Coal/Steam
3.2 LF Gas	15.7 Hydro	4.0 MW Bagasse	5.9 MW Hydro
			9.1 Wind

OFS - Oil-fired Steam; CT - Combustion Turbine; AFBC - Atmospheric Fluidized Bed Coal;

LSFO - Low-sulfer Fuel Oil; DTCC - Dual-train Combined Cycle; MSW - Municipal Solid Waste

LF Gas - Landfill Methane Gas; IC Diesel - Internal Combustion Diesel

Hawaii has an abundance of renewable energy resources. Several studies have shown that at least 10.5% of Hawaii's electricity could be generated from renewable resources by 2010 with no increase in cost to Hawaii's residents.

Increased use of renewable energy sources through the implementation of a RPS can result in many benefits to Hawaii including:

Reduced cost of fuel for electricity generation;

Reduced reliance on imported oil supplies and exposure to the volatile prices of the world oil market;

Risk management by diversifying the portfolio of electricity generation options;

Job creation and economic benefits; and Environmental benefits.

Conclusions

There is still resistance to using geothermal energy by the local population even though the above issues have been and will continue to be addressed by the government and the developers. However there are well organized groups such as the Pele Defense Fund, Rain Forest Action Network and various community organizations that will continue to express concern in various ways about the ability of the government and developers to provide socially and environmentally sound geothermal power. Also, there is presently only funding for one geothermal expert at the state level.

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