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Date: June 20, 1988

To: Members, Governor's Advisory Board in the Underwater Cable Transmission Project

___*FYI*
___*As requested*
___*Please return*
___*Comment and return*
___*Please call re attached*

The attached essay is sent to you at the request of Chairman William F. Quinn.

Attachment

GOL:lta

Essay of William F. Quinn for the
Social Science Association,
Monday, June 6, 1988

ENERGY -- PELE'S GIFT TO HER HAWAII

We first started drilling for geothermal energy on the island of Hawaii in 1960. We engaged the services of a successful driller from New Zealand who had a number of wells which were successfully producing energy for the generation of electricity. Unfortunately, the geothermal resources were so hot, and space metal technology had not yet developed. The metals that our New Zealand driller was using could not survive the heat.

The first operational geothermal plant named The Hawaii Geothermal Project Well A ("HGP-A") in honor of the late Dr. Agatin Abbott was completed in 1981. This facility in the east rift zone of Kilauea Volcano on the Big Island is currently supplying 3 megawatts of energy to Hawaii Electric Light Company. It has been operating successfully since 1982.

A private developer known as Puna Geothermal Venture has undertaken to construct a 25 megawatt geothermal power plant which would supply roughly 25% of the peak power demand on the Big Island. The agreement calls for

delivery of 12.5 megawatts to Hawaii Electric Light Company by the end of 1989 and the remainder by the end of 1993.

Another private developer, True/Mid-Pacific Geothermal Venture, has received a permit to explore, develop and market up to 100 megawatts of geothermal on 9,000 acres of land owned by Campbell Estate in the Kilauea middle east rift zone on the Big Island. This company has spent more than seven years and literally millions of dollars in contested case hearings AND in court appeals relating to the propriety of the issuance of permits to it.

In a case decided by the Supreme Court of Hawaii in July 1987, the appellants' main contention was that the approval of the geothermal project would infringe on their religious practices as "Pele practitioners". According to them, the goddess Pele migrated to the northwestern Hawaiian islands from Tahiti. She then moved down the island chain until she reached the island of Hawaii where she lives today. Areas in the island chain where she established herself are considered sacred. Phenomena associated with the volcanic activity, that is, heat, steam, magma, as well as the surrounding landscape, i.e., ferns, shrubs, land and even the rain were considered sacred by the appellants. Development of geothermal resources in

the area would impinge on the appellants' right to freely exercise their religion as guaranteed under the constitution.

In an opinion written by Chief Justice Lum, the Supreme Court held that there was no merit to appellants' claim that the project would substantially burden their religious practices. The opinion cited Judge Learned Hand to the effect that the first amendment "gives no one the right to insist that in pursuit of their own interests others must conform their conduct to his own religious necessities . . . . We must accommodate our idiosyncrasies, religious as well as secular, to the compromises necessary in communal life."

Less than two months ago the Supreme Court of the United States refused to hear a further appeal on this matter. Ironically, the case has now been brought in federal district court.

Just what is geothermal power? In simple terms, geothermal energy is power generated from harnessing the internal heat of the earth. Hawaii is geologically and technically more suited to produce geothermal power (and prove its economic viability) than almost any other location in the world. The Hawaiian people have enjoyed and utilized the benefits of geothermal resources for centuries. The early Hawaiians used the heat from fumaroles

on Kilauea's summit for heating and cooking. Over a hundred years ago, King Kalakaua visited Thomas A. Edison and when Edison was explaining electricity and electric power to the King, the King asked whether the powers of the volcanoes of Hawaii could not be used similarly to generate electrical power. The HGP-A project has demonstrated the technical feasibility and reliability of commercial geothermal operation in Hawaii.

Geothermal power production uses geothermal steam to drive a steam turbine which in turn rotates an electrical generator and produces electricity. Geothermal fluids are produced by wells which tap a geothermal reservoir. The fluids are separated into two components, brine and steam, at the well pad. The brine is collected and reinjected into the geothermal reservoir. The steam is collected and sent to the power plant's steam turbine. Geothermal fluids contain hydrogen sulfide gas. This gas is malodorous and has possible health impacts associated with exposure to it. Thus, safeguards must be maintained for its control.

A geothermal reservoir is maintained by heat emanating from intruding dikes and possibly from localized secondary magma chambers associated with Kilauea Volcano. Geothermal fluids are found at depths greater than 4,000

feet beneath the ground surface and are above 600 degrees Fahrenheit in temperature.

The present plans call for the supply of 50 to 60 megawatts of power generated by geothermal energy to the Hawaii Electric Light Company on the Big Island. However, it is generally believed that there are a thousand megawatts of geothermal power available to be tapped on the Big Island alone. It has long been a dream that geothermal energy produced on the Big Island could be transmitted to Oahu where the bulk of electrical energy demand is and could be supplied to consumers through the Hawaiian Electric Company grid. The transmission of this power to Oahu would depend on the development of a deep water transmission cable between Oahu and the Big Island. The estimated cost of such a cable is about $450 million. It would require a 138-mile long deep water transmission cable to be laid on the ocean bottom at a depth of 6,300 feet in the Alenuihaha Channel between the Big Island and Maui. The transmission of electricity to Oahu is considered a critical factor to the future of geothermal development in Hawaii. Growth and demand on the Big Island comparable to demand on Oahu is not expected to occur within the near future.

The most efficient way of transmitting electricity over long distances is by cable. The installation of

a cable system between the islands is a formidable problem requiring the resolution of a number of technical, financial and regulatory/permitting issues. The longest underwater power cable constructed to date is between Norway and Denmark and is only 75 miles long and traverses ocean waters whose maximum depth is 1,800 feet.

For some years there has been underway a developmental study intended to establish the technical and economic feasibility of a cable system for Hawaii. This $27 million Hawaii Deep Water Cable Program is funded 3/4ths by the United States Department of Energy and 1/4th by the State. It is expected to be completed by 1990. Such a cable system could, if developed, result in the decreased usage of oil-fired electric energy generating units thereby reducing the amounts of high cost imported fuel oil presently used to produce electric energy and power. This cable study and the overall study of the use of geothermal power in Hawaii is prompted by some very significant factors. Nearly all oil analysts expect that oil, which is the primary fuel for Hawaii's electric generators, will become increasingly expensive starting in the early 1990's.

At the present time, it is expected that geothermal energy might be delivered to Oahu as early as 1995. Geothermal energy could displace a very large amount of

expensive fuel oil imported from overseas as well as reduce Hawaii's vulnerability to oil supply disruptions. Geothermal energy is far more reliable than windmills and solar panels. It is a proven technology with well over a hundred geothermal power plants throughout the world. In other locations it has competed favorably against oil-fueled generators and most other forms of energy with the exception of hydroelectric power. The Big Island has a very high quality geothermal resource, being the hottest of any geothermal field in the world. High temperature is very important in that a small increase in temperature allows a large increase in energy generation. The resource is available at a depth comparable to those that have been developed successfully elsewhere.

In summary, geothermal power is an energy resource which unlike other alternative energy resources in Hawaii offers the promise of a near-term abundant, reliable and possibly competitive source of base load electrical energy.

During this decade the developability of the geothermal resource in the Kilauea rift zones has been studied independently of the ongoing study of the feasibility of transmitting energy from the Big Island to Oahu by underwater cable.

On August 7, 1987, Governor Waihee appointed an Advisory Board on the Underwater Cable Transmission Project. Members include Roger Ulveling, Director of Department of Business and Economic Development, as vice-chairman, John Bellinger, Mayor Dante Carpenter, Paul Finazzo, Sherry Ing, Dr. Fujio Matsuda, Russell Okada of the HGEA, and Howard Tosaka of the Sheet Metal Workers Union. I accepted the job as chairman of the Board. The Board had its first meeting and briefing on September 1, 1987. One thing became immediately clear to the members of the Board. The underwater cable project could not be studied or implemented except in conjunction with the development of the geothermal resource. And the geothermal resource could not be developed in significant megawatt capacity until the ability to transmit the 500 megawatts of electrical energy to Oahu was assured. Thus, it was the Board's strong opinion that the entire geothermal power development and underwater cable transmission should be studied as a single project.

This message was given to the Governor, and on October 13th the Governor enlarged the function of the Board by asking that the Board consider geothermal development as an integral part of the cable system and determine how both can be developed in concert with respect to such issues as permitting, financing and institutional

development. At that time, the Governor enlarged the Board by appointing Bill Paty, Director of Land and Natural Resources, also to serve.

In mid-September, Governor Waihee invited major international cable manufacturers to come and meet with our Advisory Board to review the many issues involved in the installation of a cable system. The meeting would give the manufacturers the opportunity to learn what progress had been made toward establishing the feasibility of the cable system and the strong interest of the State in commercial development. Invited were representatives of Perelli Cable Corporation of Italy, Sumitomo Electric Industries of Japan, Standard Telefon og kablefabrik of Norway, Cables de Lyon of France and ASEA Cable Transmission of Sweden. Our meetings with these great international companies were very interesting and enlightening.

Two things came from the meetings:

First, these cable manufacturers had no doubt that despite the distance and the depth of the water, they could, with present technology, lay a cable which would transmit electrical energy from the Big Island to Oahu.

Secondly, there seemed to be considerable interest in putting together a consortium which would join in producing the power on the Big Island and laying the cable for the transmission of that power to Oahu.

We learned that at the present time there is no American manufacturer of deep water cable who could participate with us in the project. It may well be that the extensive study being conducted by the federal and state government in conjunction with Hawaiian Electric and many others will encourage an American company or group of companies to become interested in manufacturing the cable as designed and tested during the study and perhaps to join in the production of the geothermal power.

In early October, the Board received a copy of a report prepared by Decision Analysts Hawaii, Inc. at the request of the Hawaii Deep Water Cable Program. This report examined the economic feasibility of the geothermal/cable system, and particularly the question whether the fuel oil or other savings would be sufficient to compensate for the large costs required to develop and operate the geothermal power plants and transmission cables.

The report assumed that the electrical energy would be generated by twenty steam-driven 25 megawatt geothermal plants located along the east rift zone of Kilauea Volcano in the Puna district of the island of Hawaii. Hot steam would be extracted from deep underground by a field of production wells collected by a

network of surface pipes, then used to drive steam turbines which in turn would drive electric generators. Water would surface with the steam and water which condenses from the spent steam would then be injected back into the ground. Before transmission from Puna, the electricity would be converted from alternating current to high voltage direct current by four HVDC valve groups. The conversion would be made because the transmission system for HVDC is cheaper than that for AC when transmitting large amounts of energy over long distances.

The report assumed that all permits for the cable and geothermal development would be obtained with no risk of partial or delayed development. This was a very major assumption about which I'll have more to say later.

The report concluded that assuming no delay in permits and sufficient exploratory drilling to assure existence of the resource, the geothermal development and cable transmission project was economically feasible at a cost in excess of $1.6 billion given a future crude oil price in excess of $24.00 a barrel.

As you can readily understand, Hawaiian Electric Company is a key player in all of these deliberations about the feasibility of geothermal energy production and transmission to Oahu. It has played a leading role in all

the studies of the Hawaii deep water cable and the economic feasibility of the development of geothermal power.

On October 2, 1987, I received a letter from Hawaiian Electric Company, Inc. It stated that the Company had just concluded a long analysis of how HECO should meet the growing electrical demand of their Oahu customers for the remainder of this century. HECO had signed letters of intent with two firms, Brown Boveri Company of Baden, Switzerland, and Applied Energy Services, Inc. of Arlington, Virginia. By considering bids from numerous competitive power producers HECO was able to assemble a generation package to meet customers' immediate and long-range needs for reliable power while minimizing capital expenditures and their impact on electrical costs.

Brown Boveri will construct two 70,000 kw combustion turbine generators at Campbell Industrial Park. The first generator would be on line by 1989. HECO had also signed a letter of intent to negotiate the purchase of 146,000 kws from Applied Energy Services, which would build a coal-fired power plant at Campbell Industrial Park. The letter stated that "clean coal" technology has existed for years. At AES's plant, they would use the state of the art technique called circulating fluidized bed combustion. The big incentive to do business with AES was the relative low cost of its proposal. AES would sell

electricity to HECO at a rate comparable to $9.00 per barrel of oil, much less than oil's current market price of less than $20.00 a barrel.

In another letter to me dated December 7, 1987, HECO reassured our Board that their generation planning studies show that the Company can accept 500 mws of geothermal power in 1995 notwithstanding the negotiations under way for power purchase from AES and BBC, provided the cost would be right.

Some of our Board members met with Mr. Williamson of HECO. He had some very critical comments on the economic feasibility study by Decision Analysts Hawaii, Inc. His major criticism is something that has been of great concern to the Board ever since last October. He pointed out that future avoided costs must be dictated not only by fuel oil prices, but by coal prices as well. The feasibility study depended solely on the projection of a fuel oil price at $24.00 a barrel or higher. That's a marked difference from the price HECO will pay to AES for electricity which is at a rate comparable to $9.00 per barrel of oil.

HECO is continuing to examine the possibility of conversion of existing units from oil to coal. Certainly there are social and environmental elements that must be studied in addition to technical and economic factors.

HECO is currently studying the use of micronized coal and medium BTU coal gas to meet the overall system generation needs, and that study will take into account the purchase of geothermal power. HECO has promised to share with us the results of that study when available in the middle of this year.

In December we received a letter from one of the financial advisors to the Hawaii Deep Water Cable Project strongly criticizing the economic feasibility study we had received. He said that the report chose a highly academic approach to assessing the economics and financial issues and as a consequence offered very little "real world" sense of the difficulties and practical tradeoffs that will be inherent in devising an ownership and financing plan for a cable system that would satisfy the requirements of lenders and equity investors in the international capital markets.

According to this advisor, the report greatly underestimated the impact that perceived risks of various kinds will have on the willingness of lenders and investors to provide the funds for construction. The key element in the successful project financing lies in the agreements that are negotiated to minimize the risks.

We were left with the impression that our economic feasibility study offered little practical insight

in terms of the highly complex and often difficult issues involved in risk assessment and contractual mitigation.

In the light of these reactions to the only economic study that the Board has available to it, it's quite apparent that the Board will have to authorize a new realistic economic study which will also include the future costs of coal and the other social and environmental problems that coal might engender. One thing is very clear. Conversion from fuel oil to coal does not achieve the publicly adopted and stated goal of the State of Hawaii to achieve a degree of energy self-sufficiency. This is a very desirable goal. Whether it should be achieved if at all only by the payment of a higher rate per kw hour of electricity by the consumer is another question.

On January 15, 1988, the Advisory Board gave Governor Waihee a preliminary report. This report reached tentative conclusions that geothermal development and underwater cable transmission are technically, economically, financially and socially feasible. The report went on to say that it was too early to determine whether the entire project could be developed and financed by private entities or, if not, the extent of the role state government must play in the geothermal/cable project.

The report urged that two bills, which were transmitted with it, be presented to the legislature. The first would establish a public authority created by the state to determine the feasibility of the project, to prepare a master development plan, to act as the state's central leading agency for the application and facilitation of permitting actions, and otherwise ensure timely development of the project through the private sector. This bill was strongly opposed by Hawaiian Electric Company and got no where in the legislature.

The second bill was to establish a special purpose permit system for the project. This special permit system would establish a single hearing process where all parties and agencies would be heard and all points of view taken into consideration. The project would be permitted as a whole instead of having to obtain 27 different permits in a piecemeal fashion in various types of hearing under varying regulations and much repetitive effort. The Senate strongly endorsed the Board's bill and was able to prevail over the House in conference at the concluding days of the session.

As I said earlier, the assumption that there would be no delay in permitting was totally unrealistic. One of the present developers has been tied up in court for more than seven years without ever drilling a well.

There was considerable public opposition to the single permit bill even though its proponents emphasized that every possible public concern would be fully heard and considered. The purpose of the bill was to provide complete protection to the public through a single set of hearings without the delays caused by multiple hearings and contested cases.

We can expect there will be challenges to the law. They will occur when the permitting process starts. But first a fairly concrete precise design of the project must be developed including location of wells, generators, overhead and underwater transmission lines.

Now that the legislative session is over, I expect to call upon the Governor and ask for guidance and direction for the future of the Advisory Board. It had been our hope that a commission would be created to supplant the Board and to act with professional staff to accomplish a whole project design and to start the permitting process and also to seek both contracting agencies and financing partners. Since this is not to be, it may follow that the Advisory Board will act in some such capacity until the next legislative session.

As we move forward, I can see the Advisory Board attempting to develop the plan for the project in detail, including the precise location of transmitting lines on

the Big Island. In doing this, it will be incumbent on the Board and the Department of Business and Economic Development to work closely and with a maximum exchange of information with the various community groups on the Big Island who will be primarily affected by the development of geothermal power and the installation of transmission lines overland.

Actual underwater testing of the deep water cable will be done during 1988. Additional exploratory wells will be dug in the rift zones to prove the existence of the geothermal resource in adequate quantity to justify planning for a 500-mw production for transmission to Oahu. I predict that a thorough study of the feasibility of relying on coal for the energy future of Hawaii will demonstrate that that is not an acceptable alternative for the state.

This is an enormous project. $1.6 to $1.7 billion is far and away the largest project ever contemplated in the State of Hawaii. It will be possible for the state to adopt certain measures which would encourage private capital to assume the burdens of this monumental project. Tax incentives could be adopted and the 10% royalty that the state is expecting to get from the use of the geothermal resource could be reduced or eliminated.

I think we can learn a lot from the organization and recent successful financing of the $10.4 billion Euro Tunnel project between England and France. The project proposes to build over a six year period a 31-mile underground transportation system beneath the English Channel. Due to the massive financial size of the proposed project, both governments rejected any notion that governmental budget funds or financial guaranties would be available for the construction funding. The governments established and funded a joint quasi-governmental entity to coordinate and oversee early stage development efforts for the project. The agency proceeded then with necessary technical reviews for the project and governmental approvals for construction and operation. It also solicited proposals from various private construction companies to oversee the design, engineering and construction of the project, and with assistance from financial advisors, developed an economic feasibility analysis, an overall financing plan that could be satisfied by the Euro Tunnel's expected economic projections.

In 1987, a $9 billion loan package was negotiated and signed with 198 international banks, and a group of British and French underwriters were sold $1.4 billion of stock. Construction commenced late last year.

I believe, and I think my fellow Board members concur, that a similar public-sponsored and controlled development approach, utilizing private company contractors and relying principally upon private sector financing sources on a "project recourse" basis would work well for the geothermal power production and transmission system.

The Board fully understands that if geothermal energy is to be developed and transmitted to Oahu, it must be done by the middle of the next decade, or Hawaiian Electric will have to proceed to find other alternate sources for its additional power requirements. I hope I'll be around to see the day when we on Oahu will be depending for half of our electric energy on clean and cheap energy which the goddess Pele has made available to her people.