ECONOMIC IMPACT ANALYSIS
OF
POTENTIAL GEOTHERMAL RESOURCE AREAS

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Division of Water and Land Development

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PREFACE

Act 296, Session Laws of Hawaii 1983, as amended by Act 151, SLH 1984, requires that the Board of Land and Natural Resources examine various factors when designating subzone areas for the exploration, development, and production of geothermal resources. These factors include potential for production, prospects for utilization, geologic hazards, social and environmental impacts, land use compatibility, and economic benefits. The Department of Land and Natural Resources has prepared a series of reports which addresses each of the subzone designation factors. This report analyzes the major economic considerations associated with geothermal activities within potential geothermal areas.

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SUMMARY

To facilitate this economic assessment, two assumptions are made: (1) a 20 to 30 megawatt(MW) plant would be constructed, and (2) the application of the geothermal wells would be for the production of electricity for local consumption only.

The overall assessment is that a 20 to 30 MW geothermal power plant will have some economic impact on a State-wide and County-wide basis, but the impact would probably not be significant. Based upon the data available, the direct wages to the 25 direct project employees will be about $560,000 per year. This direct income will stimulate a multiplier effect totalling an estimated $1.3 million. Additionally, an estimated 57 additional jobs will be created.

The selected sources of public revenue analyzed will not yield a significant amount, in relative terms as well as in absolute ones, due to the size of the plant. However, only after a more complete analysis of the public revenue and public or community resource cost of a specific development will it be known whether the public revenues will outweigh the public costs.

Overall, the impact of the 25 additional households to the community will be primarily in the housing market, assuming that all the 25 workers needed by the plant come from outside the County. Realistically, only a portion will be "imported" into the County. Thus the impact on housing is not expected to be as great. Other community resources will not be affected in a significant manner.

For the production of electricity for local consumption only, the assumed 20 to 30 MW plant size being considered here is reasonable. However, direct use and other applications would alter the plant size requirements. In addition, more significant impacts on the economy would occur, both benefits and costs: more jobs, increased public revenue, increased housing and infrastructure demands, etc.

Regardless of the ultimate size of the plant decided upon, a more definitive assessment of the relative gain or loss to be realized by the existence of the geothermal plant must be made on a case-by-case basis.

ECONOMIC IMPACTS

As with any economic activity, the injection of dollars into the economy will result in direct impacts through the purchases of various goods and services from the other industries. In the case of a geothermal plant, the dollars injected into the economy may be the result of the inflow of investment capital or the dollars prevented from being "exported" from the State or the County in the substitution or displacement of approximately 390 thousand barrels of petroleum each year that would have otherwise been imported into this State for conversion into electricity.[1] The additional purchases made will, in turn, cause these industries to purchase more goods and services from other industries. The result is a chain-reaction of purchases, or a "multiplier" effect produced by the original increase in purchases.

The simpliest way to understand the basics of the multiplier effect is to consider what would happen if one were given a "brand new dollar". It is likely that the person would spend part of it and save the rest. Let's say you spent 80¢ of that dollar. For simplicity, assume that individuals and businesses were equal entities in their economic behavior. If the ratio of .8 was assumed to remain constant, then of the 80¢, 64¢ would be spent and the balance saved. If this process were to continue indefinitely until all the money was either spent or saved in this proportion, the "injection" of this "brand new dollar" would ultimately yield $5.00 in output for our simple economy.

For the purposes of this preliminary analysis, the State's 1977 input-output model will be used.[2] This model summarized the economic activities of the State at a given moment or period in time, providing information on the inter-relationships between all sectors within the economy. The analysis will concentrate on the economic impacts that may result due to the operation of the geothermal plant. It will, for now, disregard the impacts which may occur during the construction phases.

The full measure of these impacts may be offset by the degree to which monies used to finance the operations originated locally or

outside of Hawaii. Additionally, County conditions may not provide the opportunities that can be found on Oahu, and as such, the full impact of the output generated may not occur. Furthermore, one of the major characteristics of the input-output model used to generate these multipliers is that it implicitly assumes that the structure of Hawaii's economy in terms of the state of technology in 1977 has not changed significantly.

OUTPUT

The revenue generated by the sale of electricity to its customers will increase the gross product of the County, as well as the State. If the assumed 25 MW plant yielded approximately 500 megawatt-hours (MWh) per day of electricity[3] at an average rate of $0.054 per kilowatt-hour (KWh)[4], the additional direct revenue would be approximately $27,000 per day or $9.9 million annually. This initial or direct output should stimulate other sectors within the local economy and within the State. These other sectors will increase their output of goods and services as a result. Based on the Department of Planning and Economic Development's multipliers for the State, a $1.00 increase in revenue can potentially increase the total output, i.e., direct-plus-indirect-plus-induced, to approximately $1.70. Therefore, the $9.9 million in direct annual revenue output could provide a long-run total annual output to the State of approximately $16.8 million.

INCOME (WAGES) TO HOUSEHOLDS

A 1982 study done for the Department of Planning and Economic Development (DPED) indicates that total wage earnings for a 25 MW plant will be approximately $560,000 per year.[5] Based on the 1977 DPED multipliers, the total impact will be approximately $1.3 million in annual incomes to households throughout the State when the full impact of the subsequent rounds of economic activity takes place.

EMPLOYMENT

According to the same 1982 study, a 25 MW geothermal plant will require approximately 25 employees to operate it. As a result of this direct employment, an estimated 57 additional jobs will be created after all the repercussions have taken place, both County-wide, as well as within the State.

EVALUATION

The assessments made thus far are rather rough approximations of what might occur. These impacts, especially the total impacts are long run in nature. That is, the subsequent indirect and induced activities do not take place instantaneously, but requires fairly lengthy periods of time for such events to take place, all other things held constant.

The overall assessment is that the assumed 25 MW geothermal power plant will have, at best, some economic impact on a State-wide and County-wide basis. Depending upon the extent to which the assumptions made regarding the inflow and outflow of dollars into the State and County economy are accurate, the total impact may vary.

PUBLIC REVENUE AND COMMUNITY RESOURCE ANALYSIS

Any economic activity results in certain gains and losses to the economy. In particular, an economic activity provides the public sector with additional sources of revenues and also increases the burden on the available public resources. In order to assess the impact of this project, an estimate of the incremental revenues and costs needs to be made. For the purposes of this preliminary analysis, only those major financial impacts likely to occur as a result of this project was considered. Order-of-magnitude estimates of the variables in this section were made where data was available and considered applicable to the assumed 25 MW geothermal plant case

study. The estimation of a revenue-cost ratio was omitted at this preliminary stage of analysis.

For simplicity of analysis, it is assumed that all the employees will be brought in from outside the County. This will provide the "worst case" situation. Furthermore, it is assumed that a one-to-one relationship between employee and household exists. Thus, a total of 25 households will become the basis of the analysis. Lastly, it is assumed that all households will reside within the same district as the geothermal site.

PUBLIC SECTOR REVENUE

At the County level, three major sources of revenue can be addressed in relation to the existence of a geothermal plant. The first is property taxes, followed by fuel taxes and sewer charges.

Property Tax

Whether there will be a net gain or loss in tax revenue due to the geothermal plant will be dependent upon the net change in land values. Some of the potential factors that may influence the immediate and long-term land values are: (1) the existing land use/zoning designation, (2) the change in demand for land in contiguous areas surrounding the geothermal site, (3) the growth and density of population within the immediate community, and (4) the development of existing and new industries. Based upon the 1982 DPED study, a 20 to 30 MW plant would be situated on a 20 to 30 acre site.[6] Due to the size of the plant under consideration in this report and the assumption that it will be used for the production of local electricity consumption only, property tax revenue is expected to increase, but relatively small in magnitude. However, more detailed analysis is needed to assess the probable gain or loss to the community and to the County in terms of the property tax revenue base.

Fuel Tax

The transportation of goods and services to and from the site, as well as the commuting of employees, may increase the consumption of gasoline and diesel fuel. Any increase in fuel consumption will

increase the tax base and the resulting tax revenue. It is unlikely that this will be significant, unless the level of on-site activity is high and commuting distances are extremely long.

Sewer Charge

The additional revenue is not anticipated to be significant for the combined on-site and community usage of the local sewer system, where such public system exists.

On a State-wide level, there are three major sources of public revenue that deserves treatment. The first is the general excise tax. The other is income taxes, both the corporate and the personal.

General Excise Tax

The general excise tax is the State's major source of revenue. This tax is levied at all levels of financial transactions. The revenue generated by the geothermal plant in the form of electricity sales, will be taxed at ½ of 1%.[7] Based on the estimated direct revenue of $9.9 million, the tax revenue would be about $49,000 annually. However, the interpretation of the plant's "public utility" status will ultimately determine whether this variable will be substituted for the an alternate tax source.[8]

Furthermore, general excise tax revenue will be increased by any additional personal consumption that takes place due to wages earned or higher wages earned by the plant workers. Taxed at 4% of sales, if 45% of gross wages are spent on various goods and services, this would yield an estimated average tax revenue due to personal consumption of $10,080 per year.[9]

Corporate Income Tax

The net income of the geothermal plant is subject to the corporation income tax. As such, 5.85% of the taxable base will yield additional income to the State. No data on the possible net income is currently available to estimate the income from this source.

Personal Income Tax

The wages earned are subject to Hawaii's Income Taxes. Assuming an average effective tax rate of 6%, the $560,000 in gross wages paid to the 25 employees would yield about $38,550 in income tax revenues to the State.[10]

Royalty Income

The royalty income under Section 8 of the Department of Land and Natural Resources' "Regulations on Leasing of Geothermal Resources and Drilling for Geothermal Resources in Hawaii" will provide the State with an additional source of revenue for those sites on State-owned lands or private lands with State mineral rights reservations.[11, also includes a brief discussion of potential legal issues] These royalties range from a minimum of 10 percent of the gross amount or value of the geothermal resources produced to a maximum of 20 percent. In the case of the current HGP-A plant on the Island of Hawaii, the royalty rate is set at 10 percent. Assuming this 10 percent royalty rate for our scenerio, the estimated gross annual revenue of $9.9 million would yield to the State an approximate $1 million in annual income.

COMMUNITY RESOURCE ANALYSIS

Although the on-site facility will draw upon the community's resources, this section will address only the probable impacts that may take place due to the increase in population within the immediate community or to the County. The principal resources that will be analyzed includes: housing, lower education, police and fire.

Housing

Each of the 25 households will require housing units. At current market prices, these households will probably rent or lease rather than purchase. With a tight housing market, the additional households will place increasing upward pressure on housing prices. This will be especially true in the rental market where the demand is expected to be the greatest.

Lower Education

At a Statewide average cost per pupil of $2,700 in 1982, the 25 additional households will possibly increase educational expenditures by approximately $62,100 in 1982 dollar terms.[12] This figure will cover the cost of an additional teacher that will probably be required for the estimated 23 school-age children.

Police

Assuming a ratio of 2 sworn police officers per 1,000 resident population, no additional police officers will be required for the additional 78 residents.[13]

Fire

The additional 78 residents within a community will not require additional firemen, assuming a ratio of 2.2 firemen per 1,000 population.[14]

EVALUATION

Based upon the scenerio that all 25 workers are from outside the County, the selected sources of revenues to both the County and to the State will not be a significant amount, in relative terms as well as in absolute ones, due to the size of the plant. However, a more precise delineation of the type of plant, in terms of legal organization and activities, will be required to determine a more accurate public revenue estimate.

Overall, the impact of the 25 additional households to the community will be primarily in the housing market, if all 25 workers are from outside the County. The likelihood of this "worst case" assumption seems to be fairly small. Thus, it is probable that a part of the needed workforce will come from the County and therefore the housing impact will not be as great. Other community resources will not be affected in a significant manner under the current scenerio.

ASSESSMENT OF POTENTIAL RESOURCE AREAS

The following section will highlight the significant aspects of the individual geothermal sub-zones under consideration. Since housing seems to be the principal factor that is likely to have an economic impact under the existing assumptions and scenerio described above,

the discussion will limit its focus on the general housing characteristics in the area. The first five zones are on the Island of Hawaii and the last two are on the Island of Maui.

KILAUEA EAST RIFT ZONE, HAWAII

For the island of Hawaii, the estimated rental vacancy rate is estimated to be 14.1% based on the 1980 Census.[15] The homeowner vacancy rate equalled 2.5%. In 1980, there was an estimated 1,883 housing units available for rent. Island-wide, then, there should be a sufficient supply of rental housing for the 25 households. However, within the Puna district, encompassing the potential Kilauea East Rift Zone,[16] only 25 housing units were counted as being available for rent in 1980. An additional 18 units were for sale. Based upon past growth rates in Puna, housing will be tight within the district.

KILAUEA SOUTHWEST RIFT ZONE, HAWAII

In the Kau district, encompassing the Kilauea Southwest Rift Zone,[17] 68 housing units were available for rent and 16 units for sale, in 1980. The housing stock within this area should satisfy the housing demand of the 25 households should a geothermal plant be located within the Kilauea Southwest Rift Zone.

MAUNA LOA NORTHEAST RIFT ZONE, HAWAII

According to the 1980 Census, the surrounding area had 40 housing units available for rent and 36 units for sale.[18]

MAUNA LOA SOUTHWEST RIFT ZONE, HAWAII

This sub-zone area lies within the same census tract area as the Kilauea Southwest Rift Zone. Thus, the comments made above also applies here.

HUALALAI NORTHWEST RIFT ZONE, HAWAII

This region had over 400 rental units vacant during the 1980 Census.[19] The potential addition of households in this area should not pose a significant problem, unless there is a major change in the market.

HALEAKALA SOUTHWEST RIFT ZONE, MAUI

For the island of Maui, the estimated rental vacancy rate is estimated to be 29.1% based on the 1980 Census.[20] The homeowner vacancy rate equalled 2.1%. In 1980, there was an estimated 1,883 housing units available for rent. Within the Makawao district,[21] 233 housing units were counted as being available for rent in 1980. An additional 37 units were for sale. If this magnitude of housing stock prevails, the impact on the local housing market is not expected to be significant.

HALEAKALA EAST RIFT ZONE, MAUI

This sub-zone area has an extremely tight housing market, as of the Census date, with no housing units for sale and only 25 rental units available for occupancy.[22]

OTHER CONSIDERATIONS

The assumption that the 20 to 30 MW plant would be used solely for the production of electricity for local consumption would be fairly accurate for the plant size being considered here. However, direct use application of geothermal power in "spa" facilities, agriculture, aquaculture, food processing, and other uses, in addition to the use of electricity to support alternate industries such as manganese nodule processing and the transmission of "excess" electricity to Oahu via an undersea transmission cable, in addition to local electricity demand,

would increase the plant size requirements, or at least, increase the total production capacity of the various geothermal plants to be built.[23]

MANGANESE NODULES PROCESSING INDUSTRY

According to a 1981 study prepared by the Department of Planning and Economic Development for the United States Department of Commerce, National Oceanic and Atmospheric Administration, a manganese nodules processing plant would "...require a considerable amount of energy...ranging between 25 MW and 350 MW depending on the process used and the number of metals recovered..."[24] According to this same study, a nodule processing plant would employ between 450 to 750 people, of which 50 to 100 would be hired from outside the County. Under the Puna 3-metal oil-fired plant scenerio, it was estimated that in operation, there would be a total of approximately 900 jobs created. Additionally, the total impact on personal incomes would be an increase of about $29 million per year for the County of Hawaii and approximately $38 million for the State, as a whole. The Gross County Product would increase by $535 million, in comparison with the Statewide figure of $572 million.

SUBMARINE CABLE TRANSMISSION

The potential for fully utilizing the geothermal resources of Hawaii's Kilauea Rift Zone will materialize only if an inter-island electrical "grid" system can be established. It is estimated that the geothermal resource in this area can provide up to 500 MW of electrical energy for a century.[25] However, the electrical demand does not reside within the County, but on the Island of Oahu. Should the technical problems of such a task as laying over 160 miles of cable at depths up to 7,000 feet be overcome, a 500 MW transmission cable could "displace 6.5 million barrels of oil annually, saving as much as $195 million, at current prices.[26]

OTHER DIRECT USE APPLICATIONS

Besides using geothermal energy to produce electricity, the heat from a geothermal resource can also be applied directly. Within existing industries in the State, and most notably for islands with developable geothermal resources, direct heat can be utilized within the tourism industry for spas. Other applications include: processing agricultural products such as sugar cane, vegetable, pineapple canning, food drying for coffee, macadamia nuts, and fruits; aquaculture activities utilizing lower-temperature heat to maintain an optimal growth environment; and the heat requirements of liquor distillation. Another application of direct heat may be in the desalination of water, which may be a feasible alternative in times of "water shortages". In addition, new industries may also find geothermal energy attractive--providing for a more diverse economic base.

IMPACT OF A LARGE SCALE GEOTHERMAL PLANT

The larger scale plants will have greater impacts, along with enhanced benefits to the community-at-large as well as the economy. A plant size up to a range of 500 MW will have significant impact upon the State, County and local community economies. For such a large plant, an estimated $34.8 million would flow into the local economy over a 15-year period.[27] Upon full operation, a 500-MW plant would provide 185 direct jobs and an estimated $4.2 million in direct wages.[28]

Such a large-scale plant would draw more heavily upon the community's resources, as well as that of the State and County. The principal areas which would be most affected would be the much greater housing demands which would be placed in the local housing market. Also, the roadway system would probably require major renovations to accommodate the increased population. Additionally, the educational system, police and fire facilities, and water and wastewater facilities would need improving to meet the increased demands.[29]

Other facility requirements necessary to support a large scale geothermal development would be outside the general responsibility of State and Local Governments. The majority of such other facility requirements are private sector concerns and will be based upon "market forces". Examples of these requirements are: shopping centers, banks, garages and service stations, laundries and cleaners, etc.[30]

The ultimate size of the plant has yet to be set. However, based upon the review of the current literature and the preliminary analysis set forth in this chapter, a plant size up to about 50 MW will probably not have significant impacts on the County and State economy, as well as on the community's resources. This was also the basic conclusion of the 1982 DPED study when it stated that a plant size of up to the range of 50 MW, "...is considered to be too small..."[31] to generate any significant impacts.

Regardless of the ultimate size of the plant decided upon, a site-specific analysis will be required to provide a more definitive assessment of the relative economic gain or loss to be realized by the existence of the geothermal plant.

NOTES

1. Source: Hawaii Electric Light Company. These estimates were provided by Mr. Norman Oss, President of HELCo. For Maui, the same factors would also apply according to Maui Electric Company's Chief Engineer, Mr. Tom Sato. A 25 MW geothermal plant would produce approximately 500 MWh per day of electricity. For every 470 KWh of electricity produced by geothermal, one barrel of crude oil can be displaced. Thus, (500,000 KWh or 500 MWh)/(470 KWh)x(365 days per year) is equal to 388,298 barrels or approximately 390,000 barrels of crude oil displaced per year. The average price per barrel of oil varied between $30 for Hawaii and $33 for Maui. This is due to the difference in the mix between diesel and bunker oil. The reduction of oil imports would save Hawaii an estimated $11,648,940 to $12,813,834 each year.

2. Source: Department of Planning and Economic Development. unpublished 1977 input-output multipliers. The "electricity" sector's output, income and employment multipliers were used. County-allocated multipliers were presented in the Hawaii Integrated Assessment Study, but have not been used in this preliminary assessment.

3. see note #1.

4. DLNR. Geothermal Resource Development. p.22. Between the period of October 1982 to October 1983, the HGP-A plant's gross revenue per KWh generated averaged $0.054.

5. DPED, Geothermal Power Development in Hawaii, Vol. II, page 7-11. The 1987 figure of 25 employees and $562,500 was used. The total estimated wage earnings was rounded to $560 thousand.

6. DPED, Geothermal Power Development in Hawaii, Vol. II, page 6-4. "..., a surface land planning factor of 1.0 acre per MW was selected..."

7. Hawaii Revised Statutes, Sections 237-13(2)(a), 237-13.5 and 182-16. The tax revenue generated is calculated as follows: ($9,855,000 annual sales of electricity) x (½ of 1%) = $49,275 per year.

8. Should the geothermal plant be classified as a public utility under HRS 269, the gross earnings will be subject to the Public Service Company Tax under Chapter 239, HRS, and may also be subject to the Franchise Tax under Chapter 240, HRS.

9. The calculation is based on the assumption that 25% of the gross wage is withheld for income taxes and FICA. Of the remaining 75%, 60% of this disposable or spendable income is subsequently used for personal consumption expenditures. Thus, the product

of 75% and 60% yields 45%. If it is further assumed that the total gross wages earned will be $560,000, then $560,000x.45x.04= $10,080 per year.

10. It is assumed that the average effective tax rate is 6%. Based on two workers per household, averaging a combined adjusted gross income of $32,600 per year, with a taxable income assumed to be 80% of the adjusted gross income or $25,700, the annual tax revenue is estimated to be $25,700x.06x25=$38,550.

11. DPED's Geothermal Power Development in Hawaii, Vol. I. See the discussion in Section XI, pp. 70-73, and Section XV, pp. 93-94. This section contains a summary of the principal issues associated with mineral rights and and land ownership. According to the study, two principal questions of resource ownership must be addressed: (1) "...is a mineral reservation to be implied in some or all titles issued without expressed mineral reservations?" and (2) "...are geothermal resources included in mineral reservation clauses in grants issued prior to the 1974 amendment?". In addition, two broad issues involving surface ownership was identified: (1) type of surface deed or conveyance and (2) rights of the surface owner in the case which grants resource ownership to the State. In each case, the final determination will be made within the courts.

12. Sources include DPED's 1983 Hawaii Data Book, Tables 26 and 88, and DPED's Geothermal Power Development in Hawaii, Vol. II. The calculations makes the following assumptions: 3.11 persons per household and 29.5% under 18 years of age. The average household contains an average of .92 K-12 household member (3.11x.295). The total number of K-12 pupils equals .92 pupil per household x 25 households. Total incremental cost to lower education is equal to 23 pupils x $2,700 per pupil or $62,100.

13. 3.11 persons per household x 25 households = 78 persons. The ratio of two sworn police officers per 1,000 population was taken from DPED's Geothermal Power Development in Hawaii, Vol. II, section 7.4.1.

14. ibid.

15. DPED. 1983 Data Book. Table 539.

16. This corresponds to Census Tract 211.

17. This corresponds to Census Tract 212.

18. This corresponds to Census Tract 210.

19. This corresponds to Census Tract 215.

20. DPED. 1983 Data Book. Table 539.

21. This corresponds to Census Tract 303.

22. This corresponds to Census Tract 301.

23. DPED's Geothermal Power Development in Hawaii, Vol. I. See the discussions in Section IV, pp. 25-35, and Section IX, pp. 63-64.

24. DPED. The Feasibility and Potential Impact of Manganese Nodule Processing in the Puna and Kohala Districts of Hawaii. page xix of the Executive Summary. See also discussions in Chapter 6, especially section 6.3.1 on pp.155-159.

25. DPED. Hawaii State Plan: Technical Reference Document. page III-46.

26. DPED. Geothermal Power Development in Hawaii, Vol. I. section IX, pp. 63-65.

27. DPED. Geothermal Power Development in Hawaii, Vol. II. page 7-10.

28. ibid., page 7-12.

29. ibid., Section 7.

30. ibid., page 7-25.

31. op. cit., page 7-10.

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