ECONOMIC IMPACTS OF A POTENTIAL GEOTHERMAL ELECTRICITY GENERATION FACILITY AT WILLOW SPRINGS, IDAHO


Old Faithful Geyser, Yellowstone National Park

Idaho Department of Water Resources
Energy Division
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By

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DISCLAIMER

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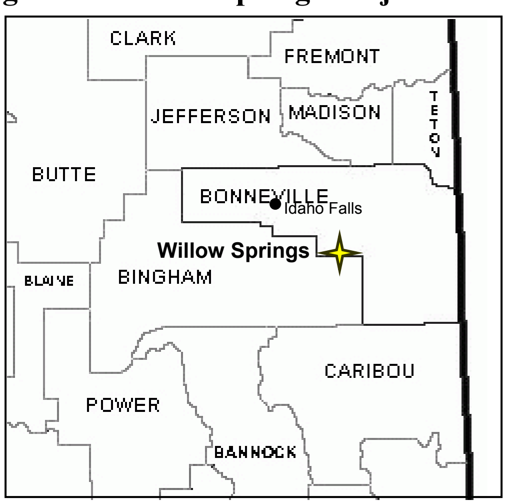
I. Introduction and Statement of Purpose

This report presents estimates of the economic impacts of a proposed 100 megawatt geothermal electricity generation facility at Willow Springs, Idaho. Willow Springs is located in southeastern Idaho on the Bingham County – Bonneville County border (Figure 1).

To estimate the economic impacts of the proposed project during all phases of development from prospecting to construction and operation, an input-output model of the Idaho state economy was built using an economic base modeling approach. Expected revenue/expenditure streams[1] from the project are entered into an input-output model. These revenue/expenditure streams filter throughout the economy in the form of input demand, employment, and earnings (both employee and proprietor), generating further economic activity. Like all *economic impact assessments*, input-output models measure the expected increase in economic activity due to a basic activity within the defined economy.

Figure 1. Willow Springs Project Location



Source: Bonneville County – Idaho.gov

A state model is used rather than local county models because of the diffused nature of expenditures by the project, particularly during the first three phases of the project. Approximately 50 percent of the expected revenue/expenditure stream from the operation phase of the project is expected to remain in Idaho. An estimated 85 percent of economic impacts generated by the revenue/expenditure stream that remains in Idaho (during the operations phase of the project) are expected to accrue to the *Idaho Falls-Pocatello Economic Region*, with the remaining 15 percent distributed throughout Idaho.

[1] Input-output models assume that supply equals demand, implying that revenues equal expenditures. In other words, all revenues accrued to an entity will be distributed in the form of expenditures to input suppliers, capital stocks and inventories, employee earnings, proprietor earnings, returns to capital, taxes, and etc. The term revenue/expenditure stream is a term commonly used to represent that every revenue stream has a corresponding expenditure stream.

II. Geothermal Electricity Generation

The time during which the estimated impacts occur is largely dependent on the timing of expenditures from the proposed project. As the developers survey the geology of the site, fulfill permitting requirements, complete leasing agreements, drill test wells, construct the plant, and finally operate the plant; some portion of the total expenditures during each activity flow into the local economy. Understanding the unique characteristics of individual projects provides information in regards to the timing of the economic impacts that will be felt locally. While the developers provided information on the expected budget for each phase of the project, there is still uncertainty surrounding the timeline when the first three phases of the project would be carried out.

In beginning to understand the potential timeline, it is important to recognize that the unique characteristics of individual geothermal reservoirs describe their potential utilization. Geothermal reservoirs vary in volume, temperature, pressure, and the state of the fluid (steam or water). These are key factors in determining whether the resource is suitable for use in electricity generation and the appropriate geothermal power plant technology to be applied. According to the Geothermal Education Office (GEO) and the U.S. Department of Energy – Energy Efficiency and Renewable Energy (EERE), there are four main technologies used to generate electricity using geothermal energy:

1. **Dry Steam Power Plants** (Figure 2): Dry steam plants use geothermal reservoirs that primarily produce steam with very little water. The steam goes directly to the turbine, driving a generator to create electricity. There are very few geothermal resources in the world suitable for application of dry steam plants. The Geysers, located in northern California, is a dry steam power plant and is still the largest single source of geothermal power in the world. The electricity produced at The Geysers could supply a city the size of San Francisco (GEO and EERE).
2. **Flash Steam Power Plants** (Figure 3): Reservoirs containing geothermal water above 360°F can be used in flash steam plants. The geothermal water is "flashed" to steam by moving it from the higher pressure reservoir into a tank with a much lower pressure. The steam is then used to drive a turbine, which drives a generator, thus producing electricity. The liquid is sometimes moved to a second, "lower-pressure tank" and flashed again. Most geothermal energy plants operating in the world today are flash plants (GEO and EERE).
3. **Binary Cycle Power Plants** (Figure 4): Reservoirs containing geothermal water at temperatures of 175°F to 400°F were considered too cool for use in electricity generation in the past. With the onset of binary power technologies, this is no longer true. Through the employment of a heat exchanger, geothermal water can be used to heat a second (*binary*) fluid in a separate, adjacent pipe loop. The second fluid, usually isobutane or isopentane, boils and flashes at a lower temperature than water. The vapor from the working fluid (binary), like the steam in a flash plant, powers the turbine generator, producing electricity. Binary power plants are usually more expensive, but allow for utilization of moderate-temperature geothermal resources and are more environmentally-

friendly because they are closed systems, resulting in less heat loss and almost no release of water (GEO and EERE).

4. **Hybrid Power Plants**: There are a few geothermal power plants that combine both flash and binary processes. A hybrid power plant provides about 25 percent of the power to the Big Island of Hawai'i (GEO).

III. The Willow Springs Geothermal Energy Project

During the 1970's the region surrounding the Willow Springs project site was identified by oil companies as a potential geographic location for petroleum resources. In 1978, a petroleum test well was drilled on the Bonneville – Bingham county line. While drillers did not find any petroleum, they did encounter hot water at 13,000 feet that registered 249°C or about 480°F (Moulton, Peter). Based on that information, as well as preliminary geological survey data indicating a significant geothermal resource, Idatherm, LLC identified Willow Springs as a potential location for a geothermal energy generation facility.

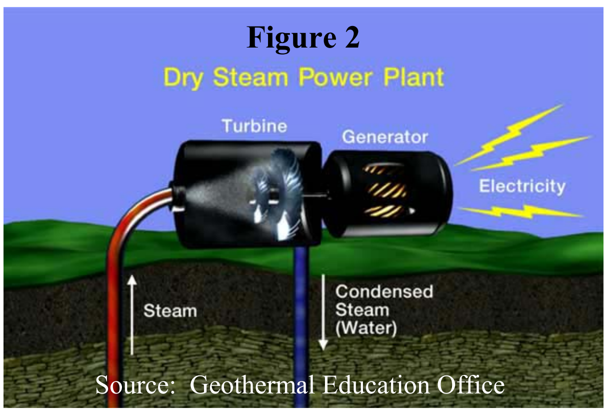


Figure 2

Source: Geothermal Education Office

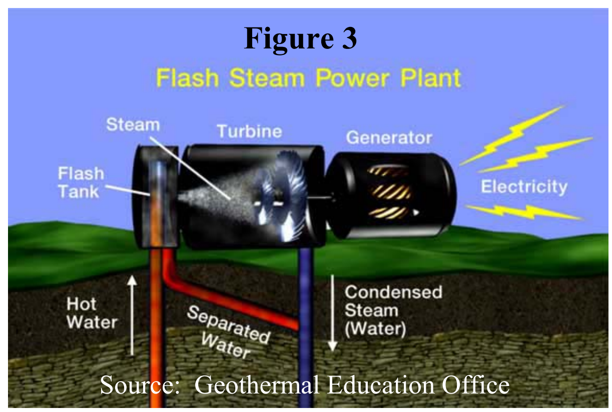


Figure 3

Source: Geothermal Education Office

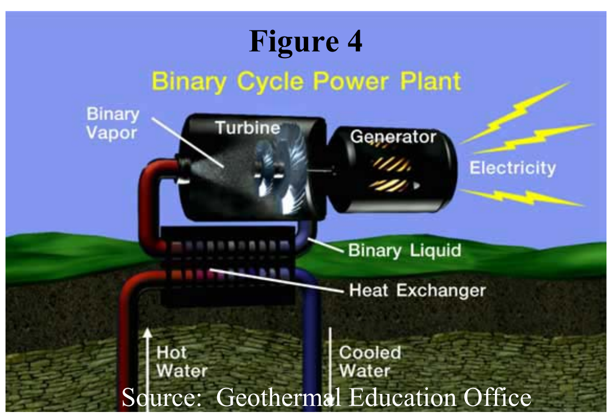


Figure 4

Source: Geothermal Education Office

Complete geological surveys must be completed and test wells must be drilled to confirm the Willow Springs resource. Technologies vary depending on the nature of the resource; therefore, significant site analysis is necessary, including test drilling, to evaluate the resource and determine whether it is suitable for electricity generation and the appropriate technology to be applied. Test drilling can cost up to $1 million per well and "hitting" the geothermal reservoir on the first test well is not guaranteed (GEO). In addition, environmental and land use permitting and leasing arrangements must be completed before project construction can take place.

The uncertainty of the resource combined with the significant financial and regulatory requirements make it difficult to specify a timeline for the period between potential site identification and completion of plant construction. Three years from the beginning of prospecting to completion of construction would be possible under the best circumstances. However, the time required for raising venture capital, completing the permitting process, negotiating land leasing arrangements, assessing the geothermal resource, sourcing the technology, and planning construction could easily stretch the timeline to 10 years, depending on individual project characteristics. For example, initial prospecting for the Willow Springs Project began in 2003. As of October 2005, no test drilling had been completed. The first turbine is expected to come online two years after test drilling is completed (Geothermal Energy Association (GEA) and Austin & Austin).

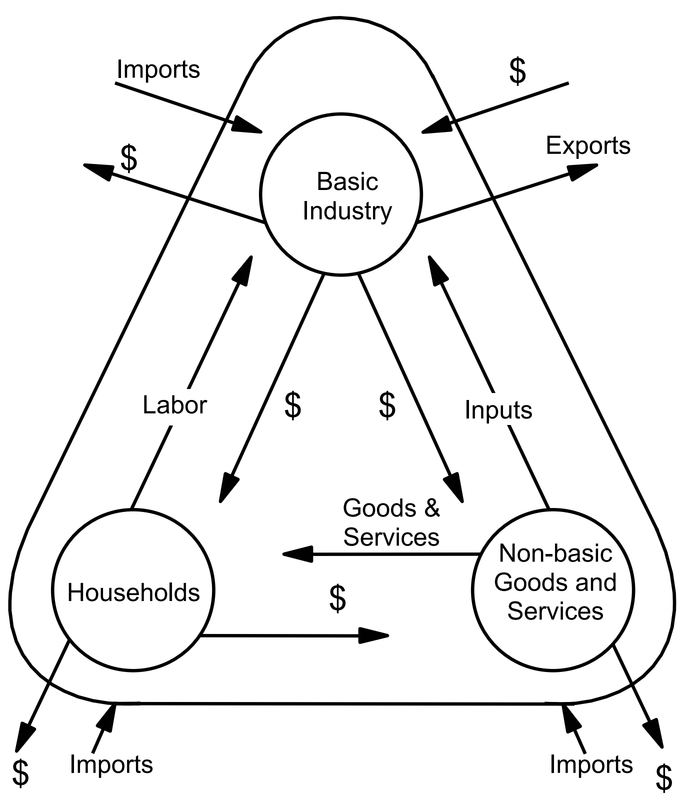
Economic impacts from operation of the proposed geothermal electricity generating facility are expected to be long-term. Electricity generated by geothermal resources is classified as renewable by the U.S. Department of Energy. In terms of long-term operations, geothermal wells for electricity generating plants have life spans that vary from several decades to centuries, depending on the geothermal resource, the rate of resource renewal, the effectiveness of reinjection, and the rate of extraction (EERE). The phrase “long-term” is used in this report in reference to the operation of the proposed geothermal plant at Willow Springs to reflect that the plant will continue to produce electricity in perpetuity. Estimated impacts will be reported on an annual basis with the expectation that they will continue to accrue for as long as the facility operates.

IV. The Basics of Economic Bases

Economies are built on what economists call basic business activity or basic industry (Figure 5). Basic business activity in a local economy includes sales and related activity (wages paid, taxes paid, profits made) by firms that sell their products outside the economy (export). Common exporting or basic firms in an economy are farms and manufacturing firms. In general, these types of firms produce goods and services that are consumed by people from outside the area. Non-exporting or non-basic firms in an economy provide goods and services to the basic firms, the people who are employed in the basic firms, and other non-basic goods and services providers and their employees; thus recirculating dollars generated within a region. Common non-basic firms in an economy are retail stores, service firms (doctors, lawyers, hair dressers, accountants, mechanics, etc.), and firms that supply inputs to basic firms.

There are however, lots of exceptions to the general cases specified above. A large retail trade mall or a big car dealership may draw customers from an entire state, or even from a multi-state region. The same may be true for the health care workers in a large hospital. So retail trade and services can be basic (exporting) firms. Also, a firm that starts-up in an area to provide goods or services that were previously purchased

Figure 5. A Flow Chart of Economic Activity



outside the area (import substitution) can have the same types of impacts on the area's economy as a firm producing exports.

A modified IMPLAN input/output model was employed to build the state economic model. A technical discussion of the model and the supporting mathematics can be found in: M. C. Guaderrama, N. Meyer, and R. G. Taylor, Developing Coefficients and Building Input–Output Models, University of Idaho Department of Agricultural Economics and Rural Sociology, September 2000.

Economic base models estimate direct, indirect, and induced impacts of basic economic activity within the defined economy. The State of Idaho is the defined economy for the model used in this study. In order to understand what is being measured and estimated in an economic impact assessment, it is useful to define direct, indirect, and induced economic impacts.

Direct impacts of economic activity in an area are impacts associated with product demand (usually from outside the area) and the local product sales that meet that demand. So, direct impacts of basic economic activity include output, jobs, earnings, value added and taxes of basic firms, and of the employees and proprietors of those firms.

Indirect impacts of basic economic activity are the impacts associated with the in-area purchase of inputs that are needed to produce a product. Thus they are the value of locally purchased inputs needed by basic firms: the jobs, value added, taxes of local firms producing those inputs, and the earnings of employees and proprietors of those firms.

Induced impacts of basic economic activity are impacts associated with consumption of local goods and services by proprietors and wage earners employed by –

- local basic firms generating direct impacts (by producing and selling products),
- local firms generating indirect impacts (by producing and selling inputs), and
- other local firms generating induced impacts.

For example, grocers and car dealers generate induced impacts when they sell groceries and cars to employees of firms selling products outside the area (basic or exporting firms), to employees of local firms selling inputs to the exporting firms, and to their own employees (and employees of other retail firms) whose jobs have resulted from sales to exporting and input firms.

For the purposes of this analysis, five measures of economic activity are used to report estimated economic impacts (direct, indirect, and induced) of the proposed geothermal electricity generating facility: sales, value-added, earnings, number of jobs, and taxes.

1. **Sales** measures the estimated additional gross sales in the defined economy attributed to the base activity being evaluated (the geothermal electricity-generating facility). Sales includes sales from the base activity (direct sales impact), but also includes indirect and induced sales impacts. It is a good measure of the total transactions occurring within the economy during a given period of time. However, this measure is not the best measure of economic output because of "double counting". Total sales include intermediate sales in production, which get counted over and over again as productive activity moves from raw materials to final goods and services sold to the public. For example, the dollar sales value of milk paid to producers is counted several times as milk moves from dairy farms through processing to the end consumers in supermarkets.
2. **Value-added** measures additional economic output resulting from the base activity. Total value-added for the state is the regional equivalent of Gross Domestic Product (GDP), which is used to measure output at the national level. Intermediate sales and the resulting double-counting are removed in this measure.
3. **Earnings** measures wage and salary income accruing to employees as well as the income to proprietors. If a new base activity is introduced to the economy, earnings to proprietors and employees in the economy will rise.
4. **The Number of Jobs** measures the actual jobs in the economy. If a new base activity is introduced to the economy, jobs are created. New employment opportunities are due directly to the new base activity and new employment in supporting industries.
5. **Indirect business taxes** include all taxes paid by businesses and households except personal and corporate income taxes, primarily property, sales, and excise taxes. Indirect business taxes are expected to rise when new base activity is introduced to the economy.

In this study, economic impacts are estimated by project phases of the Willow Springs geothermal project. These phases were defined as:

1. Prospecting
2. Leasing
3. Drilling and Construction, and
4. Operations.

The first three phases of the project are relatively short-term in duration. Each may overlap subsequent phases to some extent. While the exact timeline for the first three phases is not known, they are expected to be completed in a three to ten-year time frame (GEA). Consequently, their impacts are temporary and fleeting relative to the impacts from the operations phase. The fourth phase is long-term, and impacts from that phase will be felt for as long as the geothermal plant is in operation. The period of time the plant is expected to operate is largely unknown at this point due to uncertainty regarding the geothermal resource under consideration. Years of operation will be more easily ascertained once test drilling is completed, but will probably remain proprietary until the project is completed. However, as indicated earlier, geothermal electricity generating facilities normally operate for at least two decades and "may last 100 years or more if reservoir conditions are sustained" (Neely).

V. Expenditures and Revenues by Project Phases

Each of the phases of the planned Willow Springs Geothermal Electricity Generation Project has expected costs and/or revenues. Estimates of these expected costs and revenues, and where they would be spent or distributed (in or out of Idaho), respectively, were provided to the authors by the developer of the project, Idatherm, LLC. This information is presented below.

Phase One of the project is the prospecting stage, which consists of hiring the professional and technical expertise to evaluate the geology and conduct the seismic data review. Total expenditures for Phase One are estimated at $82,500, of which approximately $26,250 occurs in Idaho.

Phase Two of the project is the leasing stage. Activities during this stage of the project include professional consulting, one year of lease payments, environmental impact analysis, and attorney/legal assistance. The total expected expenditures during this period are approximately $85,000, all occurring in Idaho.

Phase Three of the project is the drilling and construction phase, during which time approximately 40 wells will be drilled, including the necessary test wells as well as the production wells. This phase includes the construction of pads for the well drilling and other related infrastructure. The plant alone is estimated to cost approximately $150 million. Total expected cost of Phase Three of the project is approximately $260 million, of which about $15.1 million expenditures are expected to occur in Idaho. These expenditures will be primarily composed of construction labor, services, and supplies. The largest portion of the costs associated with the drilling and construction phase is the power plant itself, which will be sourced from out of the State, thus these expenditures will generate no economic activity in Idaho.

Phase Four of the project is the long-term operation of the geothermal electricity generation facility. The plant is expected to produce average annual revenues of approximately $50 million. Approximately 15 percent of revenues will be expended in annual operation and maintenance expenditures (a total of $7.5 million of which $6.75 million occurs in Idaho). There will be approximately $1,000,000 per year in annual local property tax payments. In addition there will be approximately $1.4 million in interest payments (of which $140,000 are expected to occur in Idaho) on $20 million of debt. Annual leasing payments are $15,000 and annual royalties paid to the State of

Idaho and private land holders are approximately $3.125 million. Royalty payments are made annually to landowners. They are 10 percent on State of Idaho land and 2.5 percent to private land owners. Approximately 50 percent of the project is on private land and 50 percent on state owned land.

After all direct operating expenditures are paid, an approximate balance of $37 million annual net revenue is left. This revenue will create a flow of expenditures accruing both in-Idaho and out-of-state. At the time of this report residencies of the investors receiving the flow of revenues were not yet determined. After a discussion with the project developers, it was estimated that approximately 50 percent of this revenue/expenditure stream would stay in Idaho.

The expenditure patterns for all four phases of the project purged of imports (purchases out of Idaho) were margined for producer prices, adjusted for inflation, and entered into the economic model.

VI. The Economic Impacts of the Willow Springs Geothermal Project

Economic impacts of the Willow Springs geothermal project include the direct, indirect, and induced effects of economic activity. Thus, these impacts include the direct impacts of project related expenditures and the backward linkages of that spending as it circulates throughout the economy, i.e. the multiplier effects. It also includes the impacts of consumer spending relating to this economic activity.

Table 1. Summary of Economic Impacts of Willow Springs Geothermal Plant

Short-Term Economic Impacts	Sales	Value-Added	Earnings	Jobs	Taxes
Geothermal Prospecting	$ 50,122	$ 31,078	$ 24,060	0.64	$ 1,607
Geothermal Leasing	$ 146,181	$ 92,150	$ 67,726	1.76	$ 4,931
Geothermal Drilling and Construction	$25,636,563	$ 12,601,789	$ 9,181,004	256.62	$ 754,690
Total Short-Term Economic Impacts	**$25,832,866**	**$ 12,725,017**	**$ 9,272,790**	**259.02**	**$ 761,227**
Long-Term Economic Impacts	Sales	Value-Added	Earnings	Jobs	Taxes
Geothermal Plant Operation	**$42,513,977**	**$ 24,985,410**	**$ 12,088,656**	**240.23**	**$ 2,938,249**

Estimated economic impacts for each of the four phases of the Willow Springs project are presented in summary form in Table 1. The impacts of each of the first three phases will be short-term and spread over whatever period of time the phase is carried out. The impacts of phase four will be long-term annual impacts over the operating life of the project. (*Note that Sales, Value-Added, Earnings, and Taxes are reported in dollar terms and jobs are reported in terms of the number of people employed on either a part-time or full-time basis.*)

The economic model reports the impacts by economic sector. Tables 2 and 3 show estimated impacts on each sector of Idaho's economy of project short term development activities and long term operations, respectively. So the numbers reported in each row of Table 2 and Table 3 indicate estimated economic impacts (Table 2 – short term; Table 3 – long term) of the Willow Springs project on the Idaho industry sector indicated on the left side of that row. For example –

- The construction sector would gain about 94 jobs and almost $3.9 million in earnings during the development phase of the project (Table 2).
- The manufacturing sector would gain about 20 jobs and greater than $1 million in earnings during each year of the operations phase of the project (Table 3).

VII. Conclusions

The development of the geothermal resource located at Willow Springs, Idaho for the purposes of electricity generation would have significant and lasting impacts on the local Idaho Falls-Pocatello Economic Region. It is expected that 85 percent of the impacts from operation will accrue to local communities in the Idaho Falls-Pocatello Economic Region. Of the 240 jobs created in Idaho, approximately 200 new jobs would be in the local region. An estimated additional $10.2 million in earnings is also expected to accrue to the region. In addition, the increased property tax revenues that can be expected to accrue to the local counties can be used to reduce the property tax burden of existing constituents and to support new community projects. It is expected that the project alone would contribute $1 million in local property taxes annually to Bonneville and Bingham Counties, with distribution of taxes to the counties dependent on final project location. An estimated additional $1.9 million in indirect business taxes (primarily property and sales taxes) would be distributed throughout the state, with approximately $1.5 million of that accruing locally. In the rural areas of Idaho, these benefits accrued to local communities could be very important to the future well-being of local residents.

Table 2. Economic Impacts of Short-Term Geothermal Expenditures

Industry	Sales	Value-Added	Earnings	Jobs	Taxes
Ag, Forestry, Fish & Hunting	$ 285,905	$ 101,940	$ 62,407	2.71	$ 7,146
Mining	$ 87,810	$ 50,162	$ 29,985	0.59	$ 3,237
Utilities	$ 148,891	$ 98,317	$ 32,485	0.18	$ 16,115
Construction	$ 9,662,856	$ 3,873,200	$ 3,520,569	93.83	$ 43,121
Manufacturing	$ 4,489,063	$ 1,336,392	$ 937,834	17.65	$ 35,345
Wholesale Trade	$ 828,595	$ 599,900	$ 331,922	7.55	$ 137,873
Transportation & Warehousing	$ 622,189	$ 307,888	$ 241,003	6.07	$ 11,434
Retail trade	$ 1,632,322	$ 1,229,108	$ 744,261	31.43	$ 238,376
Information	$ 303,321	$ 139,074	$ 68,750	1.72	$ 12,885
Finance & insurance	$ 785,417	$ 394,389	$ 214,937	5.70	$ 16,490
Real estate & rental	$ 851,176	$ 593,434	$ 121,428	6.28	$ 71,336
Professional scientific & tech svcs	$ 1,745,962	$ 1,207,040	$ 1,160,400	24.90	$ 18,696
Management of companies	$ 890,379	$ 618,323	$ 422,483	5.61	$ 9,854
Administrative & waste services	$ 349,422	$ 197,177	$ 159,918	8.04	$ 5,764
Health & social services	$ 1,028,767	$ 629,593	$ 556,186	15.87	$ 7,373
Arts, entertainment & recreation	$ 133,301	$ 71,020	$ 50,566	2.43	$ 5,785
Accomodation & food services	$ 440,437	$ 193,625	$ 147,903	11.39	$ 18,548
Other services	$ 502,606	$ 195,531	$ 179,947	10.48	$ 5,445
Federal Government	$ 126,040	$ 124,726	$ 119,002	2.03	$ -
State and Local	$ 197,249	$ 187,359	$ 170,801	4.57	$ 12
Other	$ 721,156	$ 576,817	$ -	-	$ 96,393
Total	**$ 25,832,866**	**$ 12,725,017**	**$ 9,272,790**	**259.02**	**$ 761,227**

Table 3. Annual Economic Impacts of Geothermal Plant Operation

Industry	Sales	Value-Added	Earnings	Jobs	Taxes
Ag, Forestry, Fish & Hunting	$ 323,609	$ 115,384	$ 70,637	3.07	$ 8,088
Mining	$ 1,056,601	$ 603,595	$ 360,810	7.07	$ 38,950
Utilities	$ 19,686,454	$ 12,999,594	$ 4,295,254	23.54	$ 2,130,746
Construction	$ 1,665,113	$ 667,433	$ 606,668	16.17	$ 7,431
Manufacturing	$ 5,273,527	$ 1,569,926	$ 1,101,721	20.74	$ 41,522
Wholesale Trade	$ 816,612	$ 591,224	$ 327,122	7.44	$ 135,879
Transportation & Warehousing	$ 1,659,368	$ 821,132	$ 642,751	16.18	$ 30,493
Retail trade	$ 1,269,725	$ 956,079	$ 578,934	24.45	$ 185,424
Information	$ 355,754	$ 163,115	$ 80,634	2.02	$ 15,112
Finance & insurance	$ 2,178,992	$ 1,094,160	$ 596,302	15.81	$ 45,748
Real estate & rental	$ 1,045,160	$ 728,679	$ 149,102	7.72	$ 87,593
Professional scientific & tech svcs	$ 1,179,786	$ 815,625	$ 784,109	16.83	$ 12,634
Management of companies	$ 1,540,473	$ 1,069,780	$ 730,952	9.70	$ 17,048
Administrative & waste services	$ 391,098	$ 220,694	$ 178,991	9.00	$ 6,452
Health & social services	$ 1,341,094	$ 820,733	$ 725,040	20.69	$ 9,611
Arts, entertainment & recreation	$ 174,659	$ 93,055	$ 66,254	3.18	$ 7,580
Accomodation & food services	$ 625,979	$ 275,194	$ 210,210	16.18	$ 26,362
Other services	$ 569,340	$ 221,493	$ 203,839	11.87	$ 6,168
Federal Government	$ 172,016	$ 170,222	$ 162,411	2.77	$ -
State and Local	$ 250,503	$ 237,942	$ 216,915	5.81	$ 16
Other	$ 938,115	$ 750,351	$ -	-	$ 125,393
Total	**$ 42,513,977**	**$ 24,985,410**	**$ 12,088,656**	**240.23**	**$ 2,938,249**

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