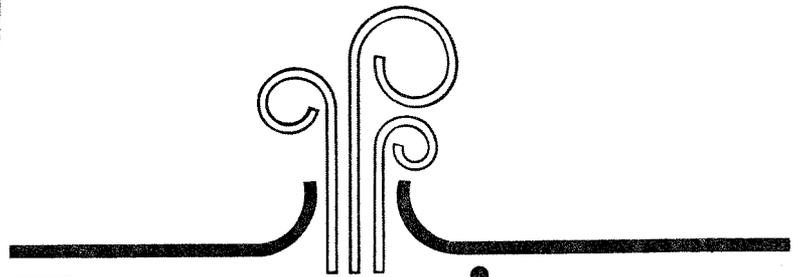


RECEIVED

OCT 15 1985

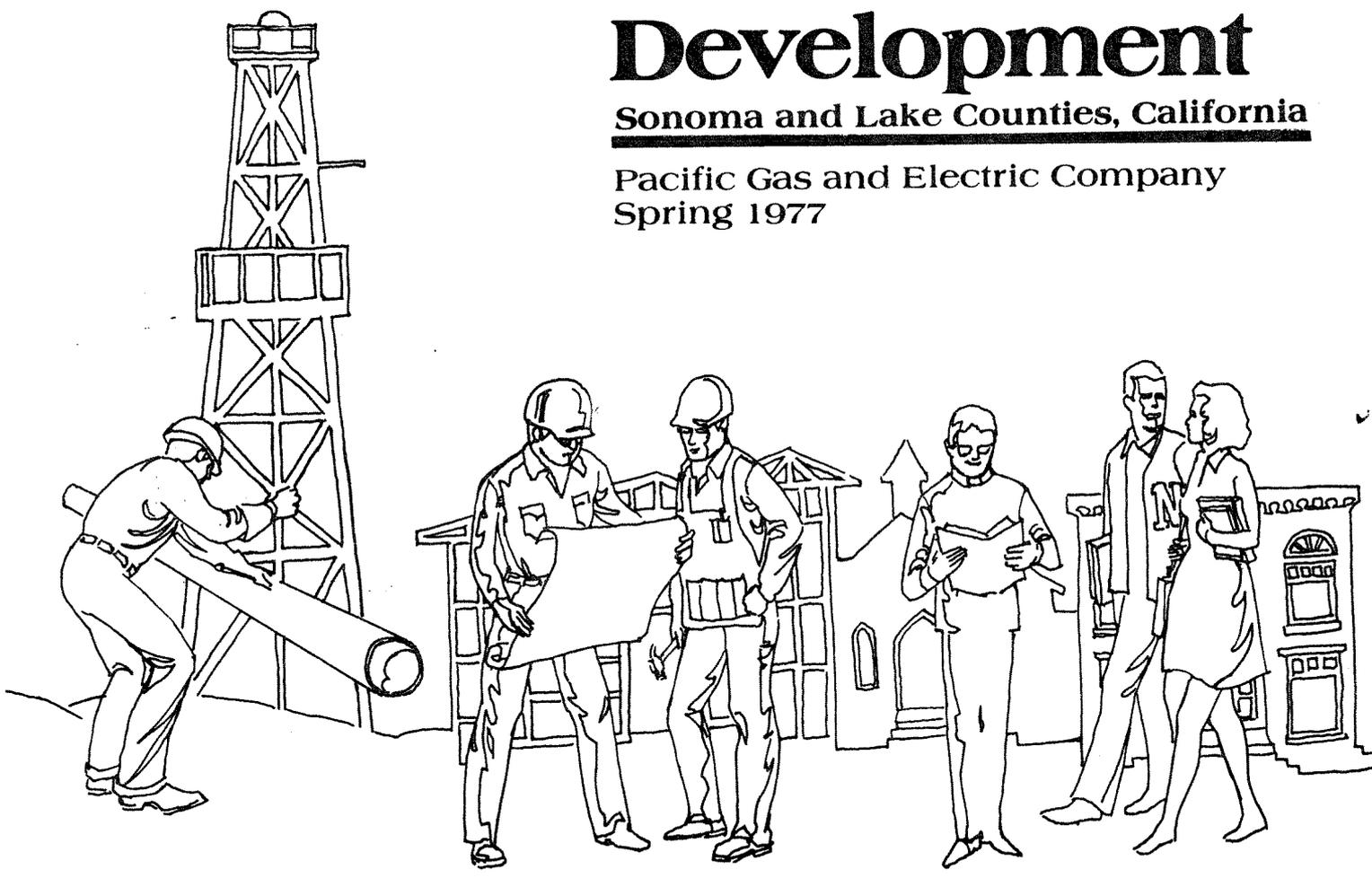
PETROLEUM RESOURCES
DIVISION



Economic Impact of Geothermal Development

Sonoma and Lake Counties, California

Pacific Gas and Electric Company
Spring 1977



This report was prepared for the British Columbia Hydro and Power Authority (“BC Hydro”). BC Hydro does not:

- (a) represent, guarantee or warrant to any third party, either expressly or by implication: (i) the accuracy, completeness or usefulness of; (ii) the intellectual or other property rights of any person or party in; or (iii) the merchantability, safety or fitness for purpose of; any information, product or process disclosed, described or recommended in this report,
- (b) assume any liability of any kind arising in any way out of the use by a third party of any information, product or process disclosed, described or recommended in this report, or any liability arising out of reliance by a third party upon any information, statements or recommendations contained in this report.

Should third parties use or rely on any information, product or process disclosed, described or recommended in this report, they do so entirely at their own risk.

ECONOMIC IMPACT
OF
GEOTHERMAL DEVELOPMENT

SONOMA AND LAKE COUNTIES, CALIFORNIA

SPRING 1977

PACIFIC GAS AND ELECTRIC COMPANY

DENIS J. MAHONEY - ADMINISTRATIVE ANALYST, NORTH BAY DIVISION

A. CHARLES BANGERT - FORECAST ENGINEER, ECONOMICS AND STATISTICS DEPARTMENT

PREFACE

The original purpose for the following text was to provide us at PGandE with a projection of the economic impact of The Geysers Power Plant and what effect its future development will have on the surrounding communities.

In preparing this text it became obvious that the information presented would be valuable to others who will be affected by the economic growth of The Geysers both directly and indirectly.

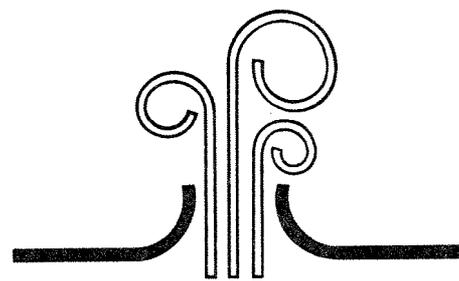
In order that you might join us for a look into the future and share what PGandE sees as the future economic contribution of The Geysers Power Plant to your community, we have made the attached report public with copies available through our local managers' offices.

Portions of this report are presented in technical language, some of which may be unfamiliar to persons other than those directly working in the electric utility industry. Realizing this, we have prefaced the text with brief explanations that should provide you with a more comprehensive understanding of what The Geysers is and what this forecast represents.

A. CHARLES BANGERT

DENIS J. MAHONEY

<u>CONTENTS</u>	<u>PAGE</u>
PREFACE	1
<u>TODAY</u>	
1. HISTORY OF THE GEYSERS	2- 3
2. ASSUMPTIONS	4
3. NEED TO EXPAND	5- 6
4. ALTERNATE SOURCES	7- 8
5. CONSERVATION	9
6. COMPARATIVE COST	10-11
<u>TOMORROW</u>	
1. PLANNED DEVELOPMENT	12-13
2. CAPITAL INVESTMENT	14
A. ECOLOGICAL PROTECTION	15
3. THE ECONOMIC IMPACT MODEL	16-17
A. CHART	18
4. EMPLOYMENT AND POPULATION	19-20
5. WAGES, SALARIES AND INCOME	21-22
6. TAXES	23
A. PROPERTY TAXES	24-25
B. OTHER TAXES	26-27
<u>THE DECISION</u>	
1. ECONOMY - ECOLOGY	28



TODAY



HISTORY

The first unit at The Geysers Power Plant was dedicated on September 30, 1960. It opened a new chapter in the colorful history of a canyon which, with its whistling columns of steam and bubbling mudholes, was described by its discoverer as "the gates of hell".

For 40 years men had dreamed of generating commercial electricity using the vast natural boiler beneath Big Sulphur Canyon in the mountains of Sonoma County. For even longer the steaming hillsides and bubbling waterholes had been used to soak out some of the ills that beset human flesh.

When William B. Elliott, an aide to General Fremont, stumbled onto the area in April 1847, Indians were using it as a hospital, putting the ailing into niches carved in the hot hillside. Elliott persuaded the Indians to give him a treatment for his arthritis, and after 12 hours of baking, he reported all pain had vanished.

Elliott subsequently obtained a 5,000 acre Spanish grant and became the first developer.

From a tent and lean-to shack built in 1848 grew a famous spa whose hissing steam and bubbling springs, in their heyday, boiled the hides of princes and presidents as well as thousands of lesser fry. Elliott named his resort The Geysers, although the "geysers" here are actually fumaroles, jetting out only steam, no water.

In 1921 a Healdsburg cement contractor named John D. Grant acquired the land with the idea of drilling for the vast supply of superheated water trapped in the sponge-like rock underground. He knew that in Lardarello, Italy, steam wells had been producing power since 1904.

Grant's first well blew up "like an earthquake". He drilled two other steam wells successfully, however, and landed a contract to sell electricity to the City of Healdsburg.

In 1923 a Sunday supplement writer thought Grant's steam wells could spawn other projects actually tapping the earth's molten core. "This cheap energy could glut the world with wealth," he enthused, envisioning an end to the "greeds, envies and wars engendered by materialism."

But costs and technical troubles upset Grant's plans, despite their promise. (One power company official, watching the development closely, had estimated that enough wells could be drilled to develop a total of 112,000 kilowatts of generating capacity.) In 1933, Grant and The Geysers Development Company tried again to supply electric power to Healdsburg and Ukiah and again were unable to meet the contract deadlines.

Then in 1955, Magma Power Company obtained a 99-year lease and, with Thermal Power Company, drilled more wells. PGandE made exhaustive corrosion tests, ran a scale model power plant, devised means of keeping rocks out of the turbine, and solved many other problems. In October 1958, PGandE signed a contract to buy geothermal steam.

Today The Geysers Power Plant has long since outstripped the long-ago estimates of the power company official. Still the only geothermal power plant in the United States, it has grown to be the largest such plant in the world, with generating capacity of 502,000 kilowatts.

ASSUMPTIONS

To forecast what economic impact the future development of The Geysers area will have, we must first make certain assumptions about circumstances that could change that development. Thus PGandE assumes the following, and any significant variation from these assumptions could change this forecast:

..That local, state and national government will not mandate curtailment of energy consumption below levels necessary for adequate national economic growth.

..That local, state and national government policies will facilitate expanded energy development, increase the leasing rate of oil shale and coal acreage, moderate the delays in nuclear plant licensing and siting, and maintain a realistic balance between energy, economic, and environmental goals.

..That local, state and national government policies will not reduce the availability or inhibit the formation of capital funds required by the energy industries.

..That energy prices will significantly affect energy consumption, both depressing demand growth and influencing the mix of fuels utilized.

..That consumers show a proprietary interest in energy conservation.

..That the California Public Utilities Commission will allow only moderate delays in obtaining adequate rate relief.

..That oil and natural gas from foreign nations be available as needed.

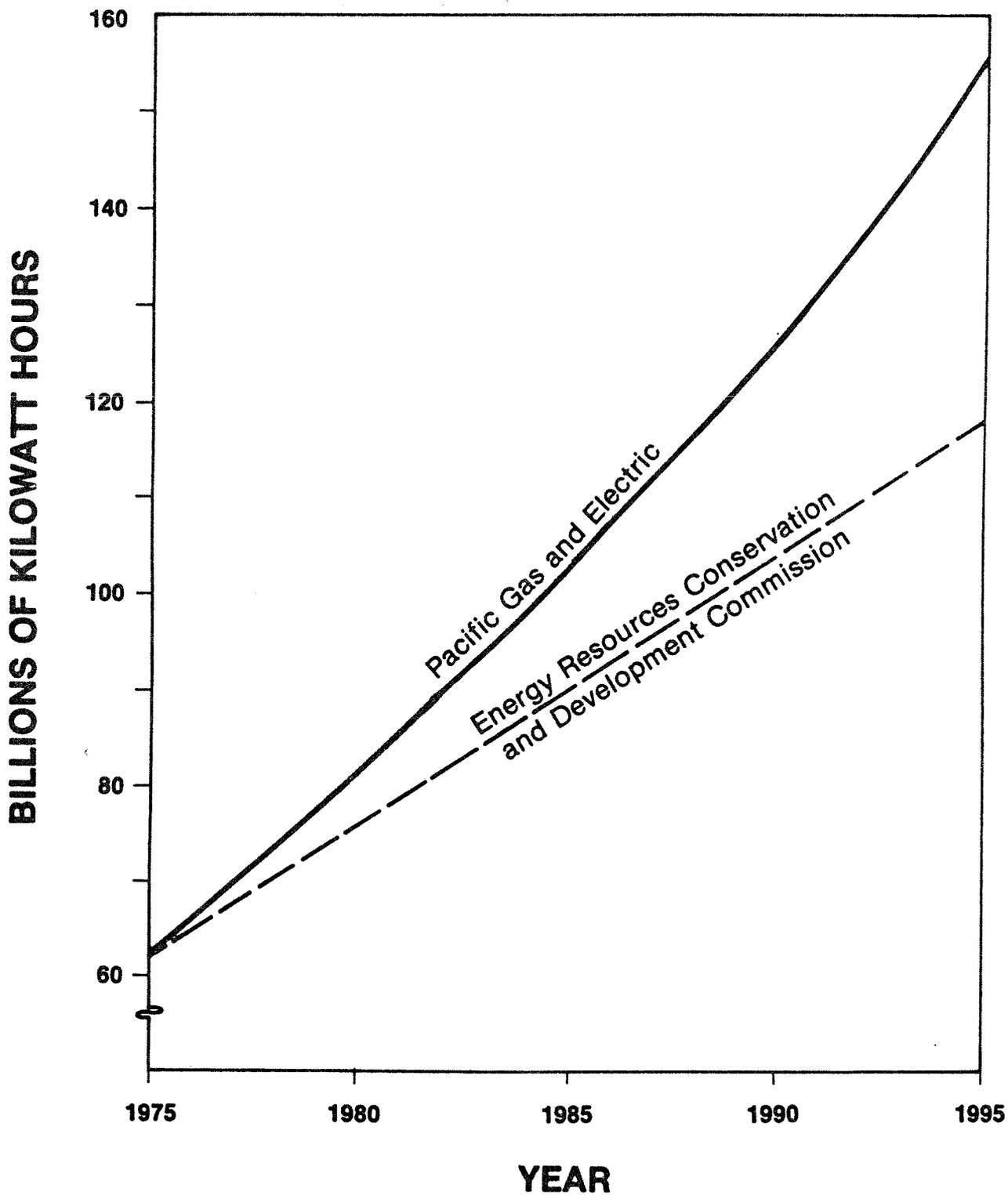
NEED FOR EXPANSION

Since the first unit went into operation at The Geysers, increased demands for electric energy have increased the need for additional generating units.

Every year until 1975 national energy consumption exceeded the previous year (growing at about 5% per year). It required a combination of an oil embargo and an economic recession to reverse this trend. However, as the nation continues to recover from the 1974-75 recession, and the population continues to grow, demands for electricity will continue to grow, the demand for new products, new applications, environmental requirements, shortages of other fuels, production of resource conservation materials and equipment will represent but a few reasons why.

The chart on the following page represents growth of electric energy demand as envisioned by PGandE and the California Energy Resources Conservation and Development Commission.

ELECTRIC ENERGY FORECASTS



ALTERNATE SOURCES

The following is a brief review of the various types of electric generation being used within the PGandE service area and what future rolls are forecast for each.

PGandE generates electricity in more different ways than almost any other American utility. It is the only utility in the nation to employ geothermal steam. The other types of power plants used to generate electricity on the PGandE system are: hydro-electric (falling water); fossil fuel power plants (steam) fueled with low-sulphur oil or natural gas; and nuclear power plants. California's hydro-electric potential is near its practical maximum development. Oil and natural gas are in short supply, increasingly expensive, and there are increasing demands for uses other than the generation of electricity. We must conserve these fossil fuels for other uses such as chemicals, fertilizers, drugs and synthetics.

Nuclear power has an essential role to play in meeting California's energy needs, but today's delays in siting, licensing and construction make it impossible for nuclear power to meet all of the new generating capacity required.

Coal is the nation's most abundant fossil fuel. While oil and natural gas reserves may not outlast this century under current rates of use, U.S. coal reserves are sufficient to fire power plant boilers for an estimated 500 years. But the estimated time required to have a coal fired plant on line from conception is eight years. It is not a choice of coal or nuclear fuel; we'll need both.

Solar power that makes direct use of the sun's energy will some day play an important supplemental role in providing home, space, water

and swimming pool heating; solar power will help to stretch our precious natural gas resources. Solar power generating plants are something else again.

Two possible approaches to solar energy for electricity production are being actively investigated. These are solar-thermal conversion (concentrating the sun's energy to drive conventional steam or gas turbines) and photovoltaic conversion (using solar cells which transform sunlight directly into electricity).

One solar-thermal conversion concept is a power tower in the center of a field of movable mirrors which will follow the sun to create temperatures of 2,000 degrees Fahrenheit -- more than enough to drive steam or gas turbines. The federal government, with the electric utility industries' help, hopes to build a 10,000 kilowatt solar-thermal power plant and to demonstrate commercial applications by the 1980's. The capital cost of a solar-thermal power plant would be three to five times that of a conventional fossil fuel power plant. Hopefully, operating costs will be lower since no fuel is required.

The use of solar cells has been successful in the space program, but solar cells require a meticulous production process which currently makes them far too expensive for use in generating significant amounts of electricity. Based on present technology, photovoltaic systems would be 100 to 200 times more expensive than conventional power plants.

Solar power plants may become competitive with conventional plants for certain part-time applications after the year 2,000, assuming satisfactory technical progress and cost reduction. However, because of the intermittent and diffused nature of solar energy, solar will be complementary to but probably not competitive with coal and base load power plants such as nuclear and geothermal power plants.

CONSERVATION

For a number of years, electric utilities along with others have been promoting the conservation and efficient use of electricity.

Energy conservation goals in the Pacific Gas and Electric territory for 1977 are to save nearly 1.3 billion kilowatt hours of electricity, reduce summer peak demand by 33,000 kilowatts, and reduce uninterruptible demand by 447 million therms of natural gas from consumption that otherwise would occur without the Company's conservation program. The strategy is to supply needed electricity while maximizing conservation to make the most of our valuable natural resources and to minimize the construction of additional facilities consistent with supplying our customers reliable, economic and environmentally acceptable service.

Conservation, though properly being given top priority, should be viewed in proper perspective. Here in California, because of the tremendous decline in energy supplies from present sources of natural gas, conservation can only partially offset the deficiency in available supplies.

Despite rigorous energy conservation efforts, demand for electricity continues to increase in Pacific Gas and Electric Company's service area in northern and central California. The population of this area is projected to increase by about 150,000 people every year through 1980.

Electric energy growth forecasts show that while energy conservation does work, it alone cannot solve the energy quandary.

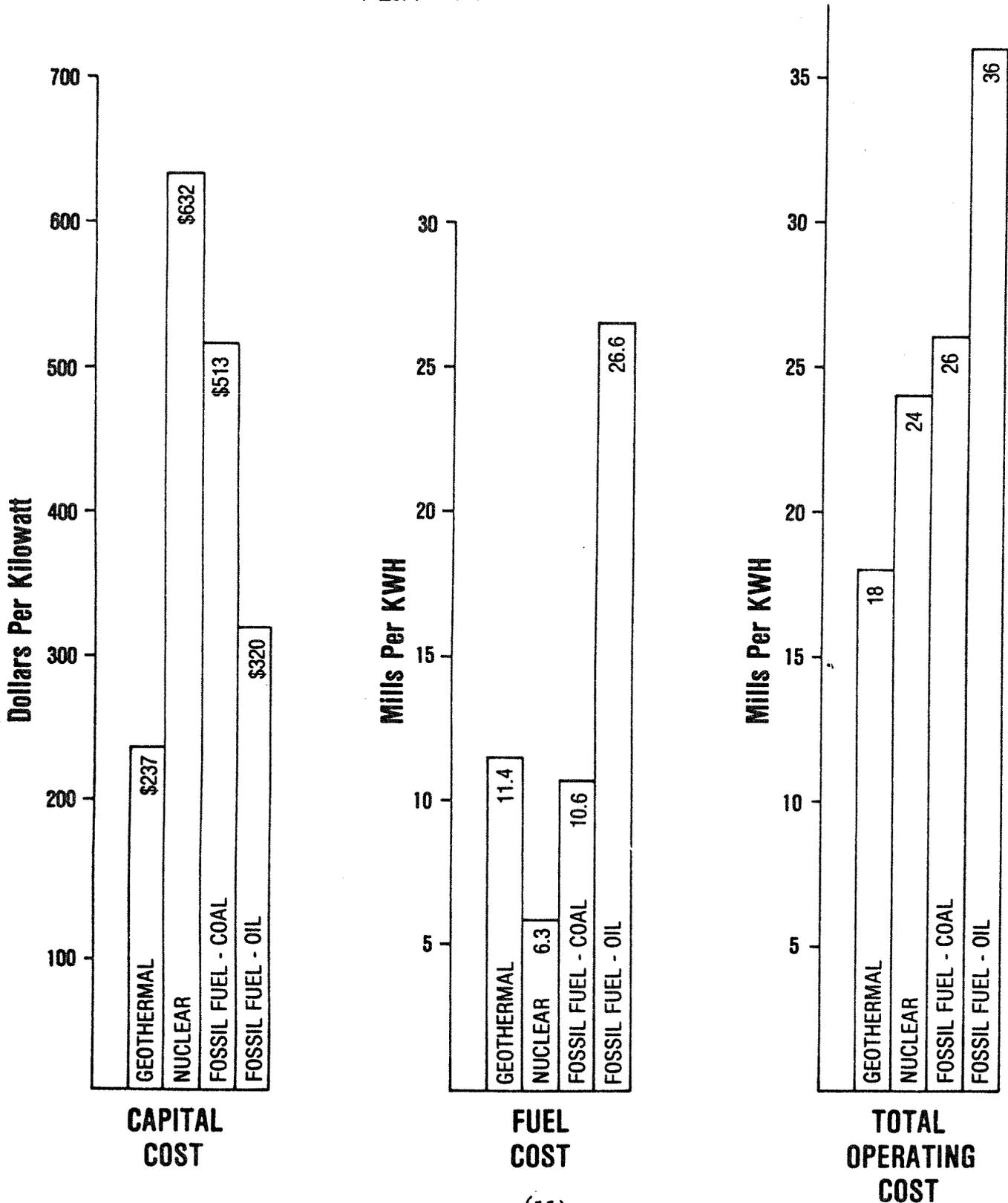
COMPARATIVE COST

On pages 7 and 8 we discussed some of the alternatives to geothermal development in terms of feasibility. But an equally important consideration is the cost to our customers. The graph on the following page shows that based on current costs of construction and fuel, geothermal is our least expensive source of steam powered generation; 25 percent cheaper than nuclear, and only half the cost of our oil fired generation.

In addition, the environmental benefits of geothermal compared to other generation sources make it a very attractive resource indeed.

Comparison of Capital Cost, Fuel Cost and Total Operating Cost for Geothermal Nuclear, and Fossil Fuel Generating Plants

(1977 \$)



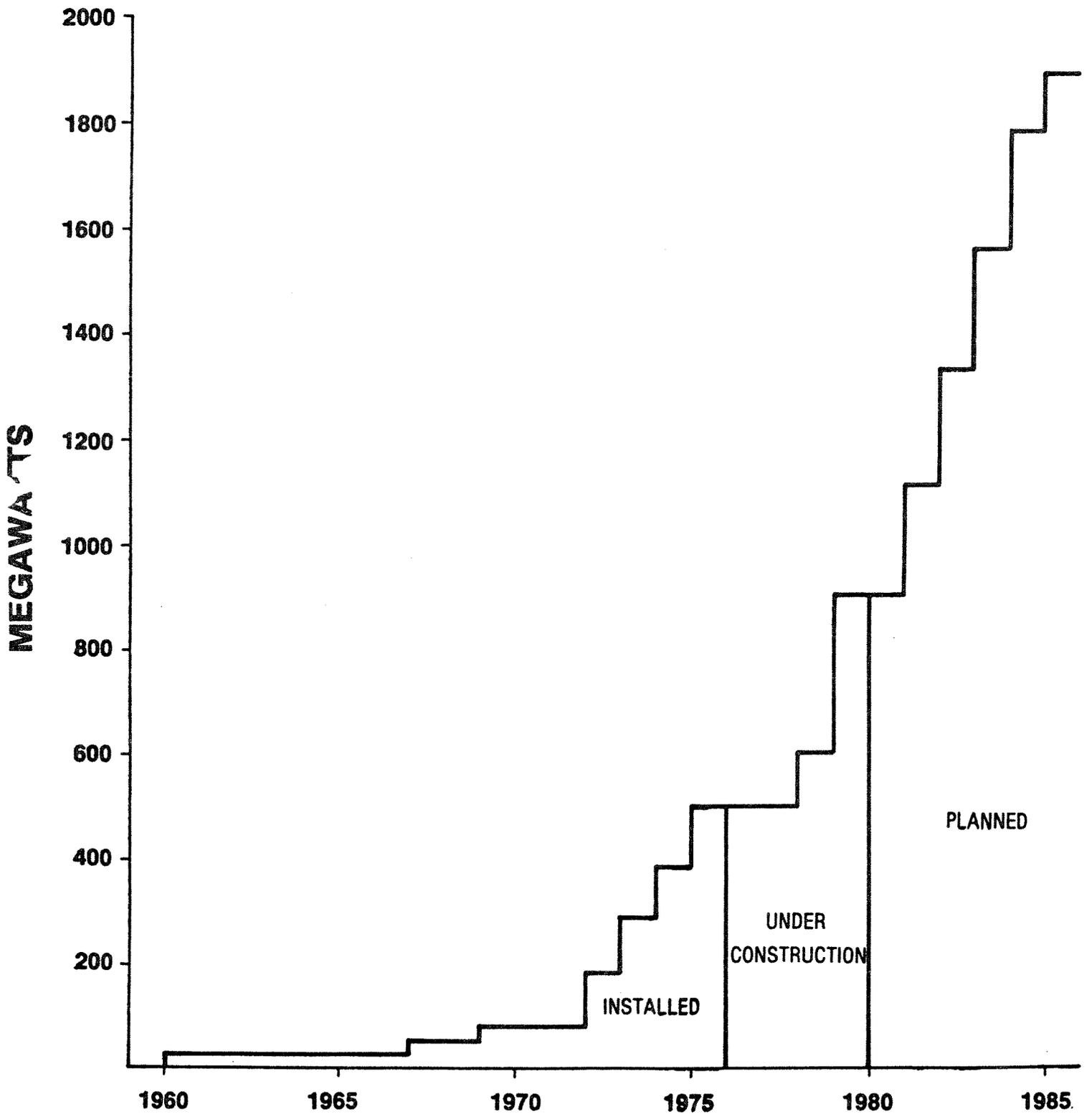
TOMORROW



PLANNED DEVELOPMENT

PGandE has 626,000 kilowatts of additional generating capability scheduled for completion at The Geysers between 1976 and 1981. This represents an estimated construction cost of \$179,700,000. The planned operating dates and estimated cost of these units are current estimates only and may be revised substantially as the result of such factors as regulatory delays, inflation, environmental requirements, and revised system load projections.

PGandE GEOHERMAL GENERATING CAPACITY



GEOHERMAL
CAPITAL INVESTMENT

UNIT No.	STATUS	LOCATION	NET CAPA- BILITY KW	PLANNED OPERATING DATE	ESTIMATED COST OF CONSTRUCTION	
					TOTAL \$	PER KW \$
12	C	Sonoma Co.	106,000	July 1978	21,500,000	203
15	C	Sonoma Co.	55,000	Sept. 1978	17,300,000	315
14	C	Sonoma Co.	110,000	Feb. 1979	28,000,000	255
13	C	Lake County	135,000	July 1979	28,900,000	214
16	P	Lake County	110,000	May 1981	42,400,000	385
17	P	Sonoma County	110,000	May 1981	41,600,000	378

C - Under Construction

P - Planned, Governmental Approvals Pending

CAPITAL INVESTMENT
IN
ECOLOGICAL PROTECTION

In recognition of the willingness of people to trade economic goals for environmental balance, PGandE is leading the way toward improving the ecology of the geothermal resource area. Much of this progress was initiated by conscientious efforts of the citizens and environmental regulators in the two counties.

Improved technology is now becoming available to permit substantial reduction in the level of hydrogen sulfide (H_2S) emissions.

Unit 13 in Lake County will be the first geothermal plant to utilize the "Stretford Process" for H_2S abatement. Developers of the system claim that over 95% of the H_2S that passes through the system can be removed. However, the cost is high. Air quality systems for Unit 13 alone will cost nearly \$3 million. Future units will include similar equipment and costs.

Units 3, 4, 5, 6 and 11 are being retrofitted with another type of H_2S abatement system at a cost of \$5.4 million.

An additional \$2 million is being spent to develop an on-site facility to accommodate the safe and economic disposal of the solid waste materials generated by our new air quality control systems.

THE ECONOMETRIC MODEL

Development of the geothermal resource area is bringing about many changes, not only to the hillsides, but also to the local economy. The building of roads, drilling of wells, and construction of power plants all create jobs. New jobs mean more people and an increased need for housing, food, schools and associated services. Plant construction also increases the demand for many of the materials and supplies that are manufactured and distributed locally. This produces more income for local businesses and a higher standard of living for people working in those industries.

How does one evaluate the full impact of an industry as large as geothermal development? Information on direct impacts such as construction costs, the number of people employed on the job sites and how much they are paid, and property taxes paid to the local governments is readily available. Secondary effects are often less obvious and more difficult to evaluate. A typical problem is determining the number of jobs created or expanded to provide the services required by the higher level of economic activity. Some of the materials to be purchased are manufactured locally. Fuel for construction vehicles and operating vehicles is purchased at local service stations. In many cases the impacts merely increase the work load, in others it means creating new jobs.

One technique to estimate the change in economic activity is to develop a computerized econometric model of the region of interest. An econometric model is a series of integrated statistical relationships that show the cause and effect linkages between different economic events.

In its simplest form: an increase in the population will result in a larger demand for food, hence increased income to the grocery business. More profit to the grocery store provides more disposable income to the proprietor and possibly to the employees, or could increase the number of employees. This disposable income means there will be more demand for other products, perhaps a new car. As should be fairly evident, there is a ripple effect of the original stimulus (e.g., more jobs) and its impact throughout the economy.

An econometric model analyzes historical relationships and develops a numerical relationship between an item of interest (e.g., employment in manufacturing) and variables which the economist feels affect that item (e.g., population, disposable income, GNP, manufacturing wages).

Pacific Gas and Electric Company has developed an econometric model of the combined Sonoma and Lake County region. Using this model we have attempted to determine the total local economic impact of geothermal development, including population, in-migration, jobs, wages and salaries, purchases of goods and property taxes. Later sections describe in detail the results of the computer model's simulations.

The next page shows a schematic diagram of relationships incorporated in Sonoma-Lake County Model.

EMPLOYMENT AND POPULATION

Today an estimated 640 people are working in jobs directly involved in geothermal development in the Sonoma-Lake County region. This includes Pacific Gas and Electric Company's maintenance and operating crews, PGandE's construction personnel, the steam suppliers' drilling, maintenance, and administrative employees, and construction workers hired under contract by PGandE and the steam suppliers. By 1981, the employment level is projected to raise to 740 people. These are not overwhelming figures compared to the current two-county employment level of more than 75,000 people.

While the rate of development of the geothermal resource area is escalating in terms of megawatt capacity (30% annual growth), the manpower needed to provide that growth is increasing at a more constant rate. In fact, the growth rates of geothermal employment and total area employment are similar -- around 4% per year.

Of more significance is the total impact of the project. The jobs described above are only part of the picture. In addition to the direct impacts, there are "induced" and "secondary" impacts. Induced impacts are the additional manhours required to support the construction and operation of the property; for example, (1) people working in factories, manufacturing equipment and materials needed at the plant, and (2) local government employees to regulate geothermal development. Secondary impacts are the people required to provide services for an increased level of economic activity.

Based on the results of our econometric model, we estimate that there are presently 1,000 people employed in jobs supporting the

increased economic activity caused by geothermal development. By 1981, this could increase to 1,300.

The 1970 census shows that the average worker had 1.7 dependents. Assuming that relationship still holds, we can estimate that the total increase in population caused by geothermal development is 4,400 people, or 1.5% of the two-county population. By 1981, we project this figure to be 5,500 people, or 1.6% of the population at that time.

One point worth mentioning is the effects of dispersement of the population. Because of the remoteness of the power plant from any large concentration of people, employees tend to live in many different communities. Interviews with local employers indicate that people are commuting to the job site from Healdsburg, Cloverdale, Lakeport, Santa Rosa, Napa, Vallejo, and other communities. This tends to spread the need for local services and facilities very thinly so that no one community is overburdened by the increase in population.

WAGES, SALARIES, AND INCOME

Here the population and employment impacts discussed in the previous section are converted into economic terms along with three other elements that contribute to local income. Again these results were derived from PG&E's econometric model of Lake and Sonoma counties.

In 1977, wages associated with local, direct, and indirect jobs are estimated to be \$28 million. In 1981, the payroll climbs to over \$45 million; in part because of the growth in employment, and secondly because the average wage will climb.

Most families spend a good portion of their paychecks locally. Some money, such as home mortgage payments, often goes to large financial institutions and may or may not stay in the local community. Another part goes to pay taxes. These payments tend to be spent where government facilities and services are provided. The basic necessities, plus most luxury items, are purchased from local businesses whose employees in turn buy their needs locally.

The second factor that contributes to local income is the purchase of equipment and supplies for the construction, maintenance, and operation of the project. Certain construction goods such as concrete, lumber, and fuels are normally purchased locally. Other construction goods may be procured locally, depending on availability and best source of supply for a particular operator or sub-contractor. Estimates of local procurements range from nearly \$4 million in 1977 to \$8 million by 1981.

A third factor contributing to local income is property tax payments. These payments are very significant in some tax areas. A more detailed discussion of this benefit is included in a separate section on property taxes.

The final element of income is lease payments made to owners of property in the geothermal resource area. Many of the owners live outside the region and do not contribute to local income. However, part of the payments goes toward paying local property and income taxes of the lessors. In total, lease payments are a small portion of total local income.

The composite impact of the above is a contribution of \$66 million to the regional economy in 1977. By 1981, this is forecast to reach \$93 million, or \$226 per person.

TAXES

INTRODUCTION:

PGandE pays a number of different taxes. During 1976 almost \$158 million was paid or accrued in the form of federal and state income taxes, property taxes, federal and state payroll taxes, local payroll and business license taxes, and franchise fees to local governments.

On the following pages is a more detailed explanation of what these taxes represent in relationship to The Geysers Power Plant and its operation.

PROPERTY TAXES

In 1976 PGandE paid over \$144 million in property taxes. This was based on an estimated market value by the State Board of Equalization of \$5.8 billion: an assessment ratio of 25% and a system-wide average tax rate of \$9.85 per hundred. These property tax payments go to local governments to pay for the facilities and services which they provide.

In 1977 geothermal development will provide over \$4 million to taxing jurisdictions in Lake and Sonoma counties. By 1981 we are projecting this figure to reach almost \$14 million annually. These figures exclude tax payments made by employees for their residences.

A frequent question that arises is, "Isn't much of that money spent by local authorities to provide county services for geothermal development?" Actually, the public services required for geothermal development are few. PGandE provides its own fire protection and security system. Road development to The Geysers area is needed both for geothermal activities and for the local residents who are not associated with The Geysers. Some road development is subsidized by PGandE and the steam suppliers. Some regulatory costs are now required to be paid by developers in addition to tax payments.

The majority of the costs of serving the additional population (e.g., schools, hospitals, parks, sewers, etc.) are paid by the property tax payments from the assessment of their residences.

Property tax payments go toward paying many different expenses. The average taxpayer contributes to approximately 10 taxing jurisdictions, some of them countywide and others very localized. The extent of the property tax benefit of geothermal varies by the number of tax jurisdictions that a taxpayer has in common with the contributing

facility. One analysis for Geysers Unit #13 shows that with no increase in the various budgets, the potential tax savings for individuals in Lake County ranges from over 20% for those people living in the same tax code area as the power plant to less than 3% for those receiving only the benefit of the countywide rates. These figures are for the power plant only and do not include the payments made by the leaseholders or the steam suppliers. Their contribution is typically similar in magnitude to PGandE's.

Again, with no change in the county budgets, the average resident of Sonoma or Lake County could expect this average tax rate for the next five years to be \$0.50/hundred higher if there were no geothermal development.

We cannot comment on whether the additional tax revenues should be used for a higher level of community services or a lower tax rate for the citizens. We firmly believe that geothermal development has and will have a very positive economic effect on the cost of living and standard of life of the people living in Sonoma and Lake counties.

OTHER TAXES

The following "other taxes" are paid by PGandE and the steam suppliers. Most of them are paid on total company operations and are attributable to geothermal development only to the extent that they are part of the total system. Their local impact would probably be the same whether the power was produced from geothermal steam or from the burning of fossil fuels.

INCOME TAXES:

PGandE pays state and federal income taxes the same as any other private corporation operating in California.

In computing its income taxes, PGandE utilizes provisions of tax law which will minimize its tax liability and in turn enable it to keep its rates to customers as low as possible.

PGandE pays federal income tax at a statutory rate of 48% and California income tax at a 9% rate on taxable income. Taxable income is computed in strict compliance with federal and state income tax laws.

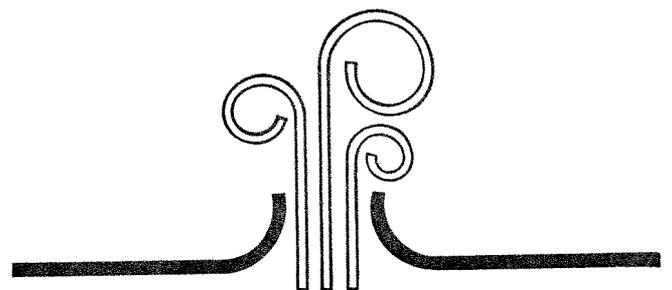
Relative to The Geysers, PGandE has had to borrow large sums of money at increasingly higher interest rates to finance much needed new plant and equipment to serve our customers. Like the person who has a mortgage on his home, PGandE deducts this interest expense in calculating its income taxes.

PAYROLL TAXES:

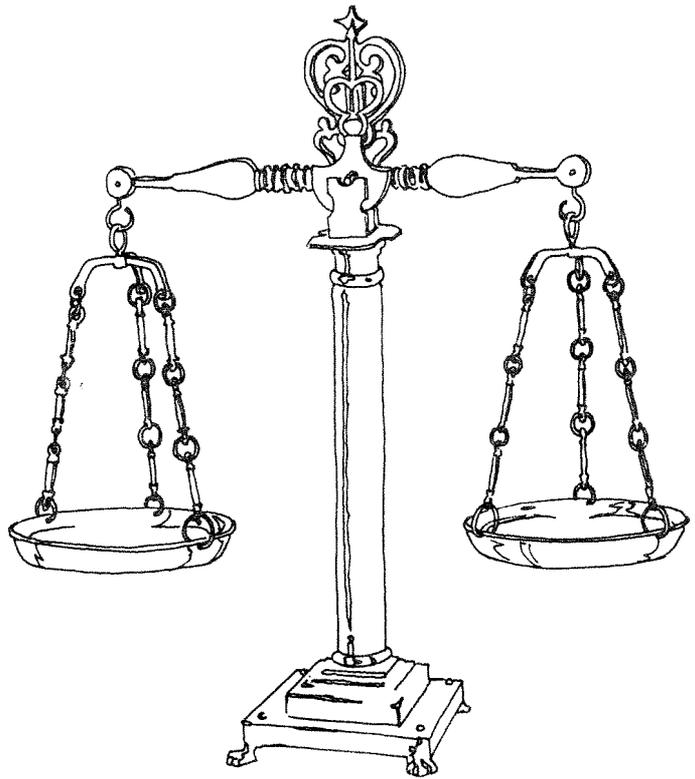
These include social security payments, state and federal unemployment taxes and the San Francisco payroll tax. These amounted to approximately \$24 million in 1976.

FRANCHISE TAXES:

These payments are made to individual counties and cities for the privilege of doing business. In 1976 these amounted to a total of nearly \$16 million, including \$466,000 to Lake and Sonoma counties and cities.



**THE
DECISION**



ECONOMY - ECOLOGY

Decisions are not based on economics alone. However, by realizing the economic impact which future development of The Geysers will generate, it allows us at PGandE Company to plan in a more consistent and coherent manner for our system growth.

The data provided in this text has been primarily devoted to economics. That was its purpose; it is realized that this is but one factor in a complicated equation whose solution balances economic, social and environmental objectives.

Knowing the economic impact of future development at The Geysers will also provide data that contributes to other directly related areas-- the foremost of which is ecology. Ecology in a broad meaning implies: a conviction that everything ultimately depends on everything else. The exact point of view of economic theory.

An example of this inter-relationship can be seen by the \$26 million that is budgeted to be spent over the next five years at The Geysers specifically for air quality control. This single investment not only represents opportunities to breathe cleaner air; it also represents better schools built with the tax dollars generated by the capital investment, fewer unemployed, lower property taxes, and ultimately affects every local person as well as brings our nation closer to energy independence.

To attempt to justify geothermal development because it results in increased contributions to local school districts and state that "based on that, the project is justified" is inappropriate. Rather, a more relevant question is, "What are the costs of the alternatives?"