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Supply of Geothermal Power from Hydrothermal Sources: A Study of the Cost of Power in 20 and 40 Years

Susan Petty
Susan Petty Consulting
654 Glenmont Avenue
Solano Beach, CA 92075

B. J. Livesay
Livesay Consultants, Inc.
126 Countrywood Lane
Encinitas, CA 92024

William P. Long
Carlin Gold Company, Inc.
1240 East Main Street, Suite 3
Grass Valley, CA 95945

John Geyer
John Geyer and Associates
11914 Northeast 18th Street
Vancouver, WA 98684

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John Geyer
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Abstract

This study develops estimates for the amount of hydrothermal geothermal power that could be on line in 20 and 40 years. This study was intended to represent a "snapshot" in 20 and 40 years of the hydrothermal energy available for electric power production should a market exist for this power. This does not represent the total or maximum amount of hydrothermal power, but is instead an attempt to estimate the rate at which power could be on line constrained by the exploration, development and support infrastructure available to the geothermal industry, but not constrained by the potential market for power.

*The work described in this report was performed for Sandia National Laboratories under Contract No. 66-8860.

SUPPLY OF GEOTHERMAL POWER FROM HYDROTHERMAL SOURCES: A STUDY OF THE COST OF POWER IN 20 AND 40 YEARS

1.0 Summary

At the request of the DOE/Energy Information Agency and Geothermal Development Department a study was made to evaluate the amount of hydrothermal geothermal power that could be on line in 20 and 40 years. This study was intended to represent a "snapshot" in 20 and 40 years of the hydrothermal energy available for electric power production should a market exist for this power. This does not represent the total or maximum amount of hydrothermal power, but is instead an attempt to estimate the rate at which power could be on line constrained by the exploration, development and support infrastructure available to the geothermal industry, but not constrained by the potential market for power.

This study extended existing data bases prepared by the US Geological Survey, the Bonneville Power Administration, the National Ocean and Atmosphere Administration and state energy offices and geological surveys with recently published exploration and development information and the input of geothermal developers, operators and exploration companies. The potential impact of evolutionary technology improvements on cost was calculated. Current DOE policy has concentrated research efforts on incremental technology changes, so revolutionary technology changes were not considered. However, revolutionary technology improvements may occur as a result of any research effort and would certainly have a larger impact on cost than the incremental improvements assumed for this study. Twenty-three individuals in the geothermal development industry, including reservoir engineers, geologists, production engineers, project managers, and management, were contacted in order to up date the published data bases. In addition state energy offices and utility contacts were asked to review resource estimates made by industry.

This study found that a minimum of 27,400 MWe of geothermal power from hydrothermal sources will be available for development in the next 40 years if only those resources now identified are considered. The majority of this power, 22,000 MWe, should cost less than 120 mils/kw-hr to produce. About 18,000 MWe would be available at less than 75 mils/kw-hr. Incremental technology improvement could decrease the cost of developing the more expensive resources by as much as 53%

Since not all potential geothermal resources have been currently identified, an estimate of the unidentified resources which could become available over the next 40 years was made. When these resources are included the total available resource base in 40 years is estimated at 50,000 MWe. Even at current technology levels this could mean 30,000 MWe at less than 75 mils/kw-hr.

These estimates do not include the widespread non-electric use of geothermal power for space heating, industrial processes, agriculture and aquaculture. The energy displaced by the rapidly growing use of geothermal or groundwater source heat pumps which result in significant reduction in use of other energy sources for space heating and cooling was also not estimated for this study. The potential for electric power production from advanced technologies for extracting geothermal energy from geopressured reservoirs, hot dry rock heat sources and magma bodies was not projected for this study of hydrothermal electric power production.

Political, environmental, regulatory, transmission access and market constraints will limit the marketability of geothermal power. This study attempts to eliminate these market driven constraints and estimate the potential for geothermal power production independent of demand factors. Transmission costs were not included since these costs can change dramatically over a 40 year time frame as utilities expand and upgrade power transmission networks. All of these constraints have been demonstrated to be amenable to mitigation by regulatory change and government incentives.

2.0 Geothermal Power Study

This study was undertaken at the request of the Energy Information Agency to determine the supply of geothermal power in the western U.S. At the request of the EIA, the core states of Washington, Oregon, California, Nevada, Idaho and Utah were examined first, with all the states in regions 6 and 8 - 10 added to the original task. Alaska was not included in this study although Hawaii was. The problems of access to geothermal areas in Alaska, especially the Aleutian Islands present a set of special circumstances which it was felt required further work.

The primary goal of the effort was to determine the available supply of electric power from geothermal resources and the cost of producing that power at present, in 20 years and in 40 years. It was also desired to estimate the change in cost of this power and in the supply of power available due to technological improvement.

The information in this report is intended for use in geothermal market penetration studies planned by the EIA.

2.1 Project team

The investigation team consisted of a specialist in each of four areas: Reservoir engineering, well drilling, leasing and economics and power marketing. The team members are listed below with a summary of their area of expertise and experience:

1. Susan Petty - Reservoir engineer with 11 years experience in flow testing and evaluation of geothermal resources. Responsible for gathering resource data into a database for use in calculating the cost of geothermal power and in assessing the size of each resource. Calculated cost of power using IMGEO code developed as part of an earlier study of impact of research on cost of power. Tested and analyzed data from many geothermal resources in the western U.S. including Coso Hot Springs, Long Valley Caldera, Valles Caldera, East Mesa, Brawley, Niland, Salton Sea, Raft River, Soda Lake, Fish Lake, Fallon, Fernly, Desert Peak, the Geysers, and Puna.

2. B. J. Livesay, Ph.D. - Geothermal drilling engineer with over 25 years experience in drilling technology. Responsible for well cost calculation. Involved with development of high temperature downhole instrumentation. Also provided resource input. Has drilling experience and knowledge of Coso Hot Springs, Salton Sea, Heber, East Mesa, the Geysers and Long Valley Caldera.

3. William P. Long, Ph.D. - Mineral economist with experience in the leasing and marketing of geothermal properties. Responsible for assessing resource economics and cross checking of calculated costs to produce power output from IMGEO code. Experienced with Roosevelt Hot Springs, Fish Lake, Soda Lake, Medicine Lake, Desert Peak, Humbolt House and the Geysers.

4. John Geyer - Consultant in marketing of geothermal power. Responsible for assessing market penetration and checking power cost calculations. Currently working with Citizen's Power to negotiate power sales agreements for geothermal developers. Knowledgeable about resources and power prices all over the western U.S., but in particular the Pacific Northwest.

Resumes of the project team members are provided as Appendix A.

2.2 Scope of the study

Geothermal power is produced from the heat of the earth. The earth's heat can be used directly or converted to electrical power. Some transport medium is needed to extract the heat from the earth. Hydrothermal resources rely on naturally occurring water or steam to sweep heat from reservoir rocks. Hot dry rock and magma energy require water from the surface to be added to artificially created cracks in the hot rocks to extract heat from the reservoir. Geopressured geothermal resources are a special case of hydrothermal resources in areas where deeply buried sediments contain hot fluids with dissolved methane under high pressure.

The energy carried to the surface through a geothermal well can be used directly as heat through heat exchangers or heat pumps or can be converted to electric power. There are three primary electric power conversion processes. Dry steam plants use naturally occurring steam in conventional turbines to turn a generator. The earth acts as the boiler would in a conventional power plant. In hot water resources, the water boils at the surface or in the wellbore, the steam is separated from the water and used to turn a turbine in a single or dual flash process. Geothermal hot water can also be used to heat a working fluid which boils and turns a turbine in a binary power plant.

Hydrothermal resources were given primary consideration for this study, but advanced technologies such as hot dry rock or magma energy may be available and economic over the next forty years. The amount of energy in hot dry rock resources alone could be extremely large and may have a considerable impact on the future of energy development in the United States. The size of the task of evaluation of hot dry rock and magma energy was such that it was decided to leave this for a separate study.

Although past studies have considered only resources above 150°C to be suitable for electrical generation, this is not a technology limitation. Current binary technology could make power from resources with temperatures as low as 90°C, although this would be very inefficient and costly. However, the recent construction and operation of a power plant using fluid with a temperature close to 110°C in the Wendell-Amedee Known Geothermal Area suggested a drop in the lower limit for electric power generation would be appropriate for this study. Since existing technology and economics make this project economic, a temperature cut off of 110•C was used for the lower limit in this study.

3 Resource assessment

The supply of geothermal power assessment was based on three sources: 1) USGS Circular 790 estimates of hydrothermal electric power, 2) Other published reports including the NOAA maps of geothermal resources for the states of California, Nevada, New Mexico, Washington, Oregon, Colorado, Montana, Idaho and Utah, the Bonneville Power Resource Assessment of geothermal electric power in the Pacific Northwest and other published reports and scientific papers, 3) Personal knowledge on the part of the investigative team and their contacts in the geothermal business.

Using Circular 790 as a starting point, lists were made of all the resources in the states of California, Nevada, Oregon, Washington, Idaho and Utah which the USGS felt had any potential for generating power. The original intention was to use the USGS temperature limit of 150°C as the cut off for power generation. However, we also wanted to assess the cost of producing power from any resource for which it is technically feasible regardless of current power production economics. Resources which are currently not economic may become economic in the future through technologic advances or through changes in the economy. Also, a power plant at Amedee in northern California from a 108°C resource. It may be expensive to produce power from such low temperature resources, but it is certainly technically feasible. Since the study was also aimed at determining the impact of research on the cost of power in the future we lowered the temperature cut off for electric grade resources to 110 C.

Since the USGS limited electric grade resources to those above 150°C it was necessary to use their data on low to moderate temperature resources to estimate the potential for lower temperature power production. The USGS and many other studies give their low temperature data in terms of recoverable heat. We used a conversion efficiency of 25% and an availability of 90% for 30 years to calculate the amount of potential electric power production from these low temperature resources. A conversion efficiency of 25% is lower than the 33% conversion efficiency used by the USGS in their estimates of recoverable power from higher temperature resources, but for low temperature resources it was felt that this was more reasonable. Geothermal power plants usually have a very high availability factor, often exceeding 95%. An availability of 90% was considered conservative for geothermal power generation even though utilities normally use 80 - 85%.

Once the lists of resources from USGS Circular 790 had been generated we checked the Bonneville Power study of the Pacific Northwest to augment the resources in the Cascades. The USGS considered a resource identified only if it had some surface manifestation such as hot springs, fumaroles or geysers or if a well had been drilled into the resource. The presence of very high heat flow, active volcanism or hydrothermal alteration was not considered indicative of a hydrothermal resource. However, in the Cascades very high rainfall tends to sweep heat away from the surface so that hot springs and other surface thermal features don't often occur. The Bonneville Power study used recent drilling activity, active volcanism and the existence of high heat flow anomalies to identify many more resources than the USGS sited.

The identified resources were then checked against state geothermal maps prepared under the auspices of National Ocean and Atmosphere Administration (NOAA). Several further resources were added to the lists from these maps.

We then gathered information on temperature, depth, well flow, geology and fluid chemistry for each resource. We used published reports, the state geothermal maps, USGS publications, personal knowledge and contacts with resource developers to obtain this information. We also checked our estimates of the recoverable power against these sources.

For some resources little information was available. For these resources we found a resource with available data with similar geology and reservoir conditions in the same physiographic province and state. The recoverable power from the low data resource was then added to power producible from the high data resource. The combined resource kept the name of the high data resource. The list was thus shortened to a total of 54 resources.

3.1 Geothermal electric power resource base

The resource data base consisted of the resource temperature, depth to the resource, estimated average well flow rate and the total power producible from the resource. We looked at two scenarios for estimating the size of the total hydrothermal resource base: 1) The identified resource base with current exploration technology, and 2) The unidentified resource base with accelerated exploration scenario. The current exploration scenario includes only the identified resource base and makes some judgements about what can reasonably be brought on line over the next 40 years. The accelerated exploration scenario was intended to provide an estimate of the unidentified resource base and assumes an increased pace for exploration than that currently underway.

We first estimated the identified resource base available over time. Identified resources are defined as those with some surface manifestation such as hot springs, fumaroles, active volcanos or other thermal features or those with high heat flow or a well with anomolously high temperatures. A resource would be available for development if land were leased and an active program of exploration were under way. We tried to base these estimates on how much hydrothermal energy would be available for sale not on how much could be sold. In other words we attempted to eliminate considerations such as project economics, environmental constraints, proximity to power transmission lines, the local market for power, social and political considerations. These estimates are limited by exploration technology, the availability of exploration equipment and infrastructure and the rate at which this type of exploration can proceed.

We started by determining the amount of power currently on line at each resource or the amount of power which would be on line within the next five years. For power to be on line in five years we required that a power plant be under construction or a firm power sales agreement with permits for plant construction to be in effect. We then looked at the status of exploration at the resource. If active exploration was under way we contacted the developer to ask how much power they felt could be on line in 20 and 40 years if power sales agreements were possible. We felt it was important to eliminate institutional considerations from these estimates since sale of power, access to transmission lines, division of the resource into lease blocks and social and political factors are related to marketability not to the size of the available resource. If environmental factors limited the production of power we asked the developer to give us an estimate with and without environmental constraints. We used the estimates of power which neglect environmental considerations, but these factors should be considered separately in any marketability assessment.

For resources where active exploration is not ongoing, we estimated the possible resource available in 20 and 40 years using first the USGS estimate, then published data, our own judgement and industry contacts. In cases where no USGS estimate has been made and little is known about the resource and no current interest has been shown in exploring it, we estimated that 25% of the total potential resource could be available in 20 years and 50% in 40 years. The Bonneville Power estimates of the size of the Cascades resources presented a special problem. Their estimates of recoverable power are based on estimates of the rock volume and heat content of rocks under Cascades volcanos. The estimates in some cases are extremely large, much larger than any other existing hydrothermal resource. This heat may be recoverable, but possibly not as hydrothermal power. Since no existing hydrothermal resource in the US has proved larger than about 2000 MWe, we felt that estimates of single resources larger than this size were unrealistic at the present time. Where exploration is ongoing we used estimates made by the developer, published reports and our own judgement. Where no exploration data is available we set a ceiling of 1000 MWe in 40 years, or half of the maximum of 2000 MWe, from an individual resource, with 25% of that available in 20 years.

Another difficulty arose with the potential power from resources with temperatures between 110^{0}C and 150^{0}C. Exploration of these resources is at a standstill at present. There is little data available on most of them and the estimates of recoverable power made of USGS estimates of beneficial heat were extremely large. For estimates of the current exploration scenario we assumed that 25% of this very large resource base could be available in 40 years. The size of the resource base with power on line now or in 5 years, 20 years and 40 years is shown in Table 1.

Geothermal exploration has to date concentrated on the easy to find resources tied to some sort of surface manifestation such as a hot spring or recent volcanism. However, there should be many more resources as yet unidentified by either surface expression or current exploration efforts. It is important to make an attempt to quantify such resources since they may provide a long term, large electric power base. However, increased exploration would be needed to identify these resources.

In order to examine the unidentified resource base and estimate the cost to develop, we needed to tie the costs found for the identified resources to the unidentified resources. Past estimates of the unidentified resource base, such as that made by the USGS in Circular 790, have just multiplied the total resource by some factor, in the case of the USGS, by five. Since we wanted to estimate the supply at a cost to produce the power, this would not work for our study. Resources which are currently economic or relatively inexpensive to produce are more likely to have good data on their size. It is the marginal resources with high costs to produce that aren't being explored. These resources have not been explored because they are deep, moderate temperature, have no surface expression and thus require more expensive and less reliable exploration methods.

Therefore, in order to make a realistic estimate of the unidentified resource base, we expanded the size of the potential power production for the low temperature resources to the USGS Circular 790 estimate modified by our conversion to electric power. For the Cascades we either used the Bonneville Power estimates or doubled the current exploration estimate, whichever was smaller. For resources with ample data which were already under development, we used the USGS estimate, the estimate of the developer or our own judgement whichever was largest. For other resources we used the USGS estimate or 50% more than our current exploration estimate if the USGS estimate was smaller than our estimate for the identified resource base. Table 2 presents the data on the size of the identified and unidentified resource base under the accelerated exploration scenario. This is not to suggest that these unidentified resources would be found around the fringes of our identified resources, only that the cost to produce them, whatever their location, would be similar to existing resources.

The USGS in Circular 790 estimates the total identified hydrothermal resource base at 23,000 $\pm$ 3400 MWe. They estimate the total unidentified hydrothermal resource base at between 72,000 and 127,000 MWe. This study estimates the identified hydrothermal resource base available in 20 years at 11,600 MWe and in 40 years at 27,400 MWe for 30 years. Including the unidentified resources, this study estimates that 18,000 MWe could be available in 20 years and 50,000 MWe could be available in 40 years. It should be remembered that although these numbers are smaller than the USGS estimates of the total hydrothermal unidentified and identified resources, the estimates made for this study include consideration of the time needed for exploration. In other words the estimates made for this study include a time component and do not represent the total hydrothermal resource base.

3.2 Cost of electric power

The cost of producing electric power from each resource was calculated using IMGEO vers. 3.05. This model was developed as part of a DOE study of the impact of research on the cost of geothermal power. Since this study was concerned with calculating the change in cost of power over time, the IMGEO model was extremely useful for estimating the changes in cost of power due to improvements in technology with time. The model estimates the cost of the risk associated with development of geothermal resources by using a "best guess" value for critical reservoir parameters such as depth, temperature, well flow rate, etc., and a worst case estimate for each of these parameters. The model calculates the cost of power production using the best and worst case values. The difference in cost is the cost of the risk associated with lack of knowledge of the resource.

The model calculates levelized busbar costs on a revenue requirements basis following the recommendations of the EPRI Technical Assessment Guides of 1978. Costs are based on 1986 dollars. However, since well costs for IMGEO are calculated outside the model and entered as input values with risk, new well costs for each resource were calculated using the newly developed DRILCOS code. This code was developed as part of the ongoing study conducted by DOE of which IMGEO was the first phase. The well costs are therefore consistent with 1990 costs for actual geothermal wells. Because construction costs have not escalated rapidly in the past four years, the costs calculated by IMGEO should still be accurate within an error of ±10%. Some of the important financial assumptions made for IMGEO are included in Table 3. (See Traeger, Petty, Entingh and Livesay, 1988, for more detail about the IMGEO model.)

The cost of developing a geothermal resource is related to the geology of the resource as well as physical factors such as temperature, flowrate and depth. For IMGEO, geothermal resources were divided into four physiographic regions roughly equivalent to USGS physiographic provinces. The four regions are: 1) Imperial Valley, 2) Basin and Range, 3) Cascades and 4) Young Volcanics. Moderate and high temperature cases for each province were included. The young volcanics regions is a catch-all for hydrothermal resources associated with recent volcanism other than the Cascades. Cost factors such as fluid chemistry, number of dry holes per producer, number of injectors per producer, rate of well workover, cost of well workover, etc. are tied to these regional designations.

For this study the resources in the data base were assigned to a physiographic province. For each resource, individual temperatures, well flowrates and well depths were used as input for the IMGEO code. Some of the resources, particularly those in Colorado, Montana, and Idaho did not fit into the physiographic regions used for IMGEO. These resources were categorized as part of the region with closest geology and the input data was modified for IMGEO where necessary.

For each physiographic region, a high temperature (>200^{0}C) flash steam case and a low temperature (<200^{0}C) binary case was defined. Each resource was then assigned to either the flash steam or binary development default input for the appropriate physiographic region.

Three factors, temperature, depth and flowrate per well, were estimated for each resource as input to IMGEO. Risk values for these factors were also estimated. Large risk factors were imposed on the hypothetical cases used in the studies of the impact of research on cost of power done using the IMGEO code. The composite resources were meant to represent generic new developments prior to the start of exploration. For this study, specific data about each resource was known and the variation in the critical factors could be estimated. The difference between best and worst case values was therefore smaller than for previous published studies using IMGEO. Data on temperature was the easiest to obtain, so the difference between high and low temperatures was in general no more than 10% and on average was closer to 5%. Flowrate is the hardest parameter to estimate for a resource. If actual flowrate data was not available, a risk of 15% less flow was used for the IMGEO calculations. Values of reservoir parameters used for each of the resources are contained in the database accompanying this report as Appendix D. For all other factors used as input in the IMGEO calculations, the default values shown in Table 4 for the appropriate physiographic province were used as input. Table 5 shows the geothermal sites used ranked by cost with the state in which the site is located and the estimated resource size under the accelerated exploration scenario.

The cost of tying a geothermal power plant into the electric grid was included in plant cost estimates by IMGEO. However, the cost of transmitting geothermal electric power long distances to the electric power grid was not included in the calculations of power cost for this study. Geothermal power can not be transported except as electric power. Power has to be generated at the site of the resource. The cost of transmitting geothermal power from a remote location can be very high. Although transmission costs are an important part of the cost of producing geothermal power they are also directly impacted by utility decisions which are unrelated to the economics of geothermal resource development. For instance, the construction of north-south high capacity power lines between northern California and Oregon would be an important stimulant to geothermal development. The decision to build such a line is largely political and although geothermal power may be considered in this decision, it is not likely to be a primary factor. The changes in the utility transmission grid in the future are difficult to project. The cost of transmission lines to tie individual resources into the electric power grid needs to be estimated and included in calculating the cost of power production. However, this task was more time consuming than was possible for this study and so was left for future efforts.

Figure 1 shows a plot of the supply of geothermal power from presently identified resources at costs ranging from about 20 mills/kw-hr. up to 250 mills/kw-hr assuming the current rate of technology improvement continues. This is the business as usual scenario, with few developers taking the risk of trying new technologies and a limited budget for government sponsored research. Figure 2 shows a similar plot with unidentified resources included in the total. Appendix B contains the output from IMGEO used to produce these cost/supply plots.

250 mills/kw-hr was used as an upper cost limit. Some upper limit had to be chosen to reduce the number of potential resources for consideration due to the lack of data on these less economic resources and the amount of time necessary to process this scarce data. However, it should be understood that this is an artificial cut off. Resources which are currently costly to produce are in general much more amenable to improvement in cost through research efforts. Future studies should include more of these low temperature, low productivity, deep, or high salinity resources.

For those familiar with traditional cost/supply curves, the curves calculated or this study may appear unfamiliar in shape. The cost/supply curve flattens with increasing cost of power. One would expect to find an ever increasing supply of power available with increasing cost to produce that power. The shape of these curves is caused by several factors all related to the fact that hydrothermal power is a natural resource. The scarcity of data on less explored resources limits our knowledge of the amount of the more expensive to produce resources. The USGS and other published reports concentrate by necessity on identified resources. Data is most likely to be available on resources which are more economic to produce. Deep resources, resources with low temperatures or low potential productivity are not explored by either researchers or developers until more likely prospects are studied. Besides the lack of knowledge of deeper, lower temperature resources, the amount of expensive hydrothermal power is limited by the nature of the resources. Geologic formations tend to decrease in permeability and porosity with depth as pressure closes fractures and compresses pore spaces. There is also a limit to the depth that conventional drilling technology can reach. Thus at some point hydrothermal resources become so low permeability that some artificial reservoir creation is needed to produce them. These resources then require hot dry rock technology to be productive. If the hot dry rock cost supply curve were superimposed on the hydrothermal curve, the total geothermal curve might look more like a cost supply curve for nuclear power.

When the unidentified resources were included in the cost/supply curves this flattening was reduced. Further study of unidentified resources could reveal the actual shape of the cost/supply curve.

3.3 Comparison of calculated costs with actual and planned project costs

Once the cost to produce power for each resource had been calculated using IMGEO, developers and other experts in the geothermal field were contacted to check the validity of the calculated costs. In most cases it was not possible to obtain direct information on the cost to produce power at a particular resource. Instead, contacts were asked to comment on the calculated cost to produce. In all cases of developed resources the calculated costs were within 2-5 mills/kw-hr of the actual cost to produce the power according to our sources. This gave us increased confidence in the validity of both the calculated costs and the data used as input.

The information about which developers were contacted and who provided comment on our cost calculations is highly confidential since at least two competitive bids for power contracts with utilities are currently in progress. Other fields are involved in law suits and release of any information related to cost to produce may jeopardize the outcome of these suits.

3.4 Cost of power with new technology in 20 & 40 years

The next step in the study was recalculating the cost to produce power given some reasonable assumptions about technology improvements over the next 40 years. IMGEO was used for these calculation with the following research and development achievements:

Wildcat Success Ratio	20% greater
Confirmation Success Ration	25% greater
Testing Costs, Confirmation	25% less
Dry Holes/Producer	15% fewer
Testing Costs/Producer	25% less
Base Cost, Ave. Well	20% less
Capital Cost, Deep Well Pump	25% less
O&M Cost, Deep Well Pump	20% less
Workover Interval, Prod.	50% shorter
Workover Interval Inj.	50% shorter
Flash Plant efficiency	5% better
Flash Plant, Cap. Cost	5% less
Binary Plant efficiency	20% greater
Binary Plant Cap. Cost	24% less
Removal of solids, Cap. Cost	10% less
Removal of solids, O&M Cost	20% less
H_2S Treatment, Cap. Cost	20% less

These research goals are a result of discussion with DOE researchers, developers and the project team of the maximum improvement possible using existing methods for each of the chosen R&D impacts. No major breakthroughs in drilling, testing or exploration are considered. The improvements are through evolutionary change in currently available technology. The assumption was made by the project team that the maximum improvement could be reached by 2030 if this was the goal of the geothermal industry and government. Straight line interpolation was used between present cost of power and the R&D impacted cost. Risk on these resources was not included as an R&D impact for this phase of the study effort. Risk had been reduced for resources with good data available to levels currently accepted by developers when reservoir insurance is included in the cost of power as it is in the IMGEO model. For less well understood resources, risk costs are still fairly high. The impact of risk reduction research should be included in future phases, but time constraints prevented its inclusion at this stage.

DOE Geothermal research goals and objectives were examined for use in this modelling effort. Our team then examined the realistic <u>evolutionary</u> technology change possible for a range of technology improvements. Our results show that DOE goals for reducing total cost of power by 30 - 35% are definitely achievable for high cost resources. For resources which are now economic, research would probably have less impact on cost, in the range of a 10 - 15% cost reduction. This is to be expected, since new technology would of necessity impact resources where larger number of wells, more expensive wells, more difficult to handle fluids or deeper, harder to find resources are involved. In other words, if a resource can support a 50 MWe power plant with only 2 wells, reducing the cost of each well by 10% will have much less impact than a similar cost reduction for a plant requiring 16 equally expensive wells to produce 50 MWe.

It is also important to consider the impact on cost of major breakthroughs which radically change technology. Drilling technology makes a good example. Improvements in rate of penetration, cost of materials, bit life, etc. can potentially reduce the cost of drilling with conventional rotary technology. However, major costs such as cementing difficulties, lost circulation and casing cost are really not amenable to dramatic improvements. It is possible to imagine revolutionary technology changes which could circumvent the high cost of these areas which can not be greatly improved using current methods. The development of casing which could be applied to borehole walls as drilling proceeds would radically change the cost of geothermal wells. Lost circulation cost, casing cost, time to place casing and cement it all would be very much reduced. Future studies could look at the impact on cost of some of these revolutionary changes. Unless a national energy emergency arises, research will continue to be directed toward improvement of existing technologies.

Figure 3 shows the supply of power at cost with technology improvement for the identified resources in Federal Regions 6, and 8-10. Figure 4 shows a similar plot with unidentified resources included. The output from IMGEO showing the percentage cost reduction for each resource due to technology improvement is provided in Appendix B. The largest percentage impact in cost improvement was found for the resources with the highest cost to produce. This is as expected and suggests that further study of these high cost resources could increase the resource base.

Figure 5 shows the lowest estimates for amount of power with the highest cost, the identified resources using current technology bracketed by the highest estimates for power available at the lowest cost, the improved technology with unidentified and identified resources. This envelope shows the range of realistic values for power available in 20 years. Figure 6 shows the same scenarios at 40 years. Figure 7 shows a map of the composite sites used for the study.

Appendix C is a compilation of plots for separate regions with and without the inclusion of the unidentified resources.

4 Current Power on Line

Development of geothermal electric power began in 1958 at the Geysers. During the late 1970's and early 1980's power production at the Geysers progressed very rapidly with a maximum power production of 1948 MWe reached in 1986. Declines in wellhead pressure in the field due to overproduction of steam have reduced the total electric output at the Geysers to 1354 MWe in 1990 (CA Energy Commission, 1990 Electricity Report). Along with reduced wellhead pressures, plants located on the edge of the field have experienced problems with plant operations caused by increasing non-condensible gases and corrosion. The CCPA Coldwater Creek plant is currently operating only one unit due to corrosion problems. The other unit is being modified, however, and may be back on line in early 1991.

The pressure decline problems at the Geysers point out the risks associated with geothermal power production. However, long term management strategies involving injection of field condensate and imported water may mean a better outlook for this field, since the heat content of the rock in the field remains very high. It is important to understand that most estimates of resource size in this report are based on the size of the temperature anomaly observed for a particular area. The recoverable fluid is generally much smaller than the recoverable heat associated with a temperature anomaly. Injection of produced fluids increases the amount of heat which can be recovered and improves the potential for long project life. In hydrothermal systems, most developers plan an injection strategy which will maintain field pressures and increase heat recovery. Dry steam resources such as the Geysers must seek outside sources of water to augment steam reserves in place. Table 6 shows current generating capacity and actual power production for the Geysers. The current geothermal installed capacity is 2810 MWe with 2163 on line. The shortfall is the result of production decline in the Geysers and operating and legal problems at Heber.

Table 7 shows non-Geysers power on line in California by geothermal area with power purchaser, steam or heat supplier, gross and net power production and capacity factor where known. For some fields power production has been consistently greater than the rated capacity for the plant and/or the amount of power contracted for by the purchasing utility. For these fields use of the rated capacity or the contract power sales to calculate the capacity factor results in a capacity factor greater than 100%. Therefore, capacity factors greater than 100% are shown with the contract capacity in parentheses. Table 8 shows the same information for non-California power on line by state and geothermal area.

5. Constraints on Marketability of Geothermal Power

Utilities in the areas with geothermal power potential have different demands for power and varying acceptance of geothermal power as a potential power supply. The study team can work with the EIA to determine how the demand for power meshes with the supply of geothermal power. However, there are some constraints on the availability of geothermal power which are not directly related to the cost to produce power or the demand for that power, but which can affect both the marketability and the time frame for bringing power on line. These include: environmental constraints, political and social constraints, access to transmission lines, and the utility and regulatory environment.

5.1 Environmental Constraints on Geothermal Development

This study considered several resources which have serious environmental restrictions on their development. These include:

- Island Park, Idaho - Adjoins Yellowstone National Park
- Crater Lake, 3 Creeks Butte, Oregon - Crater Lake National Park, Three Sisters Wilderness Area
- Newberry Caldera, China Hat, Oregon - Deschutes National Forest
- Long Valley Caldera, California - Mammoth Lakes Ski Area, near Yosemite National Park
- Puna, Hawaii - Adjoins Volcanoes National Park
- Kilauea, Hawaii - In Volcanoes National Park
- Mt. Lassen (includes Mt. Shasta), California - Lassen Volcanic National Park
- Mt. Baker (includes Rainier, Adams and St. Helens), Washington - Northern Cascades National Park, Mt. Rainier National Park, Mt. St. Helens National Monument
- Sespe Hot Springs, California - California Condor nesting

area

These resources are all in or adjoining major national parks, wilderness areas or recreation areas. If it is impossible to develop these resources the total resource base would be reduced by as much as 9410 MWe. However, it is unlikely that restrictions on development would stop development entirely. Development would be more likely to be limited to the margins of these areas with severe restrictions on the appearance of any construction, noise, emissions, water quality and water sources. All of these restrictions could increase the cost of developing these resources and slow development while permits are obtained. However, it may be possible over a longer time period than the 40 years looked at for this study to extract all of the power possible from these resources using directional drilling and exercising extreme care in development.

Although the resources listed above which are in or adjoin National Parks, Recreation Areas or Monuments were included in the study, the hot, shallow resource at Yellowstone National Park was not included. All previous studies by the USGS have excluded Yellowstone. No developers have done any exploration in the Park. The USGS has drilled some scientific holes and there is some available data, but it is so unlikely that the Yellowstone resource would ever be made available for development or that development would even be allowed around the Park boundaries, that this resource was not evaluated for the study.

5.2 Institutional Constraints on Geothermal Development

Other factors may influence the rate at which power can be brought on line from geothermal resources. Issues which directly impact the rate of development include the number of geothermal development companies actively involved in exploration, the availability of federal land for leasing of geothermal rights and the social climate and politics of an area with geothermal resources. Access to transmission lines can severely limit the development of geothermal resources and if transmission costs are born by the developer, they can seriously impact the cost to produce power. The attitude of utilities and of utility regulators toward alternative energy sources and geothermal energy in particular can either facilitate rapid development or slow development to a snails pace.

5.2.1 Development issues-based on current activity level, land, political/social

Interest in and acceptance of geothermal power grew during the 1970's and early 1980's as oil prices climbed and the federal government enacted the Public Utility Regulatory Policy Act (PURPA) of 1978. In the early 80's interest in renewable energy sources waned as oil prices stabilized and then declined. In 1983 large energy deficits predicted in the Pacific Northwest were replaced by predictions of surpluses.

The result of these changes is that only a very few developers remain actively involved in geothermal exploration and development. One major oil company, UNOCAL, and a few geothermal companies such as Magma, California Energy Company, Geysers Geothermal, Pacific Energy, Oxbow Geothermal and Ormat are still active. Other companies have declared bankruptcy or sold out their geothermal lease holdings. Because of this shortage of companies actively developing geothermal power, increases in demand for power may not be met with increases in supply. There is bound to be a lag in the ability of those holding geothermal leases who have cut back on exploration and development staff to move toward active development. Leases may also be caught in the limbo of court controlled bankruptcy proceedings. Other companies have defaulted on federal lease payments and allowed leases to return to the control of the Bureau of Land Management.

Leasing of geothermal rights by the Bureau of Land Management has slowed to a standstill. Recent queries concerning the time table for preparation of bid packages for leases allowed to revert to the BLM in southern California were answered with probable time lapse of two years prior to releasing of these lands. New leases in competitive bid areas are not proceeding at all.

The political climate in some areas has also stymied geothermal development. While interest in alternative energy sources has declined, public distress over environmental degradation has increased. Even though geothermal energy presents a relatively clean source of electric power with a low emission of greenhouse effect gases, any development in some areas is viewed with disfavor. In Puna, Hawaii, native Hawaiians and environmentalists object to potential emissions of hydrogen sulfide which amount to a small fraction of the natural emissions of this gas by Kilauea Volcano which dominates the landscape. There is also a problem with geothermal development in areas occupied by native Hawaiian and other native Americans. Tribal religious rites may require the use of thermal features or be linked to lands surrounding geothermal developments. Developers at Beowowe, the Valles Caldera and Coso Hot Springs have encountered such conflicts between the religious practices of native Americans and the desire to exploit a natural resource. The Long Valley Caldera, an area of scenic beauty and high recreational use is now the scene of an ongoing battle between geothermal developers and the public perception of geothermal as noisy and ugly.

5.2.2 Transmission access and integration

Problems with access to transmission lines has resulted in several tactics by developers of geothermal resources. At Dixie

Valley, Oxbow Geothermal built their own transmission line to connect to lines tied to the lucrative southern California power market. Other areas such as Beowowe remain stalled as transmission capacity is negotiated. Some developers have marketed power to local municipalities or irrigation districts to avoid dealing with power wheeling agreements and utility tie-ins. In Hawaii, the feasibility was studied of constructing a deep underwater cable between the island of Hawaii where potential for large scale production of geothermal power exists and the population centers on Maui and Oahu. The cable was found to be feasible and probably will be constructed.

Today power transmission cost and access to power markets remain a significant problem facing geothermal development. The cost of transmission and the resources most affected by transmission access should be studied as a further phase of this study.

5.2.3 Utility/regulatory environment

During the 70's and early 80's utilities offered standard contracts for purchase of geothermal power which encouraged active exploration. Tax incentives further promoted geothermal exploration and government funding of research to reduce the risks in geothermal development and improve technology spurred the construction of fields and power plants by oil companies and geothermal companies alike.

In the late 1980's exploration has virtually come to a halt except for a few locations. Tax incentives have been withdrawn or reduced and falling oil and gas prices have encouraged utilities to use these fossil fuel resources. Given these constraints, the rate of exploration and development of geothermal resources is likely to continue at a low rate unless new incentives, access to markets and affirmative policies by utilities are adopted. The recent crisis in the Persian Gulf may result in some regulatory changes and utility attitude changes, but the long term affect of the recent political events on oil prices remains to be seen.

6. Conclusions and Recommendations

We conclude that a minimum of 27,400 MWe of geothermal power from hydrothermal sources will be available for development in the next 40 years. The majority of this power, 22,000 MWe, should cost less than 120 mils/kw-hr to produce. Over 17,000 MWe would be available at less than 75 mils/kw-hr. Increased technology improvement could provide 20,000 MWe at less than 75 mils/kw-hr. If unidentified resources are included the total available resource base in 40 years is estimated at more than 50,000 MWe. Even at current technology levels this could mean 30,000 MWe at less than 75 mils/kw-hr.

Political, environmental, regulatory, transmission access and market constraints will limit the supply of geothermal power. All of the constraints have been demonstrated to be amenable to reduction by regulatory change and government incentives.

Further study to improve the findings of this study should include:

1. Inclusion of advanced technologies such as Hot Dry Rock, Magma Energy and Geopressured Energy in the geothermal resource base. New developments in these technologies make updating of the resource base and calculation of cost to produce power important to our understanding of these resources.

2. Maintain the existing hydrothermal resource database and provide updates on a regular basis. The database gathered for this study includes information on resource temperature, well flowrates, depth to resource, current lease holders, development status, exploration status, contacts for information, resource size and date of last contact. It would be a fairly simple task to maintain this database and add new resources to it as information becomes available. Updates of the figures provided with this report could then be made on regular basis with little expense.

3. Integrate resource data with data on distance to transmission lines, size and capacity of transmission lines, costs for wheeling power, potential markets, power demand and price paid for power at nearest market.

4. In depth study of resources which are currently very expensive to produce because of depth, low temperature, low flowrate or other resource characteristic. The impact of technology improvement on these resources may be significant, bringing more resources into resource base and increasing our understanding of the shape of the cost/supply curve for geothermal resources.

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TABLE 1

SIZE OF HYDROTHERMAL RESOURCES Regions 6, 8-10, Identified Resources Only			
NAME OF RESOURCE	MWe on line by 1995	MWe in 20 years	MWe in 40 Years
GEYSERS	1950	2000	2000
ROOSEVELT	34	250	500
MEDICINE LAKE	25	500	2000
DIXIE VALLEY	62	250	500
CLEAR LAKE	0	500	900
ISLAND PARK	0	250	1000
3 CREEKS BUTTE	0	100	500
VALLES CALDERA	0	250	1000
STEAMBOAT	21	75	150
KLAMATH FALLS	0	100	500
NEWBERRY	0	100	1000
LONG VALLEY (LT)	30	250	500
BEOWOWE	17	50	130
DESERT PEAK	17	100	500
COSO	240	650	650
SALTON SEA	219	500	1000
BRAWLEY	0	150	300
RANDSBURG	0	25	85
PUNA	3	100	500
LONG VALLEY (HT)	0	500	1600
EAST MESA	220	360	360
HEBER	92	250	250
COVE FORT	11	150	500
COVE CREEK	0	25	100
ALVORD DESERT	0	100	200
SURPRISE VALLEY	10	250	500
KILAUEA SW RIFT	0	50	150

SIZE OF HYDROTHERMAL RESOURCES Regions 6, 8-10, Identified Resources Only			
NAME OF RESOURCE	MWe on line by 1995	MWe in 20 years	MWe in 40 Years
POWER RANCHES	0	190	475
LASSEN	0	116	250
WESTMORELAND	0	50	150
VALE	2	425	1062
WUANITA	0	205	515
MAGIC RESERVOIR	0	360	900
WILBUR HS	0	500	1500
MT. BAKER	0	25	200
HOT SPRINGS RANCH	0	540	1350
PARADISE HS	0	25	100
RAFT RIVER	0	30	195
ROUTT	0	65	165
KELLY HS	0	300	760
WENDELL	0	250	650
RIO GRANDE RIFT	0	120	300
SESPE HS	0	125	330
GLAMIS	0	275	680
BUCKEYE HS	0	250	635
TOTAL AVAILABLE RESOURCE	2,953	11,736	27,592

TABLE 2

SIZE OF HYDROTHERMAL RESOURCES Regions 6, 8-10, Accelerated Exploration Case		
NAME OF RESOURCE	MWe in 20 Years	MWe in 40 Years
GEYSERS	2000	2000
ROOSEVELT	250	500
MEDICINE LAKE	750	3000
DIXIE VALLEY	250	500
CLEAR LAKE	500	900
ISLAND PARK	500	2000
CRATER LAKE, 3 CREEKS AREA	500	2000
VALLES CALDERA	250	1000
STEAMBOAT	300	600
KLAMATH FALLS	500	2000
NEWBERRY	250	1500
LONG VALLEY (LT)	350	750
BEOWOWE	150	250
DESERT PEAK	250	1000
COSO	650	1000
SALTON SEA	500	3000
BRAWLEY	350	640
RANDSBURG	100	250
PUNA	200	1000
LONG VALLEY (HT)	500	1600
EAST MESA	360	500
HEBER	250	500
COVE FORT	300	1000
COVE CREEK	200	300
ALVORD DESERT	100	575
SURPRISE VALLEY	500	1490
KILAUEA SW RIFT	100	300
POWER RANCHES	380	950

SIZE OF HYDROTHERMAL RESOURCES Regions 6, 8-10, Accelerated Exploration Case		
NAME OF RESOURCE	MWe in 20 Years	MWe in 40 Years
LASSEN	100	350
WESTMORELAND	150	1710
VALE	850	2000
WUANITA	410	1030
MAGIC RESERVOIR	720	1800
WILBUR HS	1000	2800
MT. BAKER	50	400
HOT SPRINGS RANCH	540	1350
PARADISE HS	50	200
RAFT RIVER	250	1000
ROUTT	130	330
KELLY HS	1180	3000
WENDELL	250	650
RIO GRANDE RIFT S	240	600
SESPE HS	250	660
GLAMIS	275	680
BUCKEYE HS	500	1270
TOTAL AVAILABLE RESOURCE	17,935	50,335

TABLE 3

ECONOMIC FACTOR VALUES

FACTOR	VALUE
- Cost reporting year, average	1987.5
- Cost reporting year, wells	1990.5
- Cost reporting year, power plant	1986.0
- Years to construct power plant	2.5
- Levelized annual Capacity Factor	0.80
- Cost Basis: Overnight Construction, AFDC not included in model costs	
- Allowance for interest during construction	1.081
- General and fuel inflation rate	0.06
- Discount rate = Weighted cost of capital (For levelization in current $.) (For level. in constant $, use: 1 - (1.1249)/(1.06))	0.1249
- Levelized Annual Capital Charge Rate for Calculations in <u>Current Dollars</u> (Includes Amortization, Income Taxes, Tax Incentives, Property Tax, General Property Insurance)	0.1683
- Current $ Cost / <u>Constant $ Cost</u>:	1.747961
- General and fuel cost levelization factor	1.748
- Book life of project, years:	30
- Tax Life:, years:	15
- Federal + State Income Tax Rate	0.38
- Investment Tax Credit Rate:	.00
- Prop. Tax & Insurance:	.02
- Accounting Method: Normalization	
- Accelerated Deprec.: Double Declining Balance	
Geothermal Production Field Special Financial Factors:	
- Royalty Rate	.10
- Severance Tax	.04
- Percent Depletion Allowance	.15
- Intangible Fract. of Well Cost	.75

TABLE 4

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"Imperial Valley - Flash  ", "Imperial Valley - Binary "
"Basin & Range - Flash    ", "Basin & Range - Binary   "
"Cascades - Flash         ", "Cascades - Binary        "
"Young Volcanics - Flash 1", "Young Volcanics - Flash 2"
"Dry Steam                "
"IV-FL","IV-BI","BR-FL","BR-BI"
"CS-FL","CS-BI","YV-F1","YV-F2","GY-DS"
1., "YES", "YES",  "Energy in Region, MW*30Y "
    5750, 1041, 3060,1751, 4559, 51490.,3250, 3250, 4000
    -750,  -41,-1500,-751,-1559,-48490.,-750, -750,-1500
2., "YES", "NO",   "Energy in SubArea, MW*30Y"
     500,  250,  250,  250,  500,  250,  250,  250,  500
       0,    0,    0,    0,    0,    0,    0,    0,    0
3., "YES", "NO",    "Wildcat Success Rate     "
     .20,  .20,  .20,  .20,  .20,  .20,  .20,  .20,  .20
       0,    0,    0,    0,    0,    0,    0,    0,    0
4., "YES", "NO",    "Confirmation Success Rate"
     .60,  .60,  .60,  .60,  .60,  .60,  .60,  .60,  .60
       0,    0,    0,    0,    0,    0,    0,    0,    0
5., "YES", "YES",  "Reservior Satur. Temp, F "
     525,  360,  450,  300,  425,  280,  600,  550,  375
     -25,  -20,  -50,  -20,  -50,  -10,  -25,  -75,   -3
6., "NO", "NO",     "Resv. Temp at 10 Years, F"
     548,  358,  448,  298,  423,  278,  590,  520,  370
     -10,  -10,  -10,  -10,  -10,  -10,  -10,  -10,  -10
7., "YES", "YES",  "Wellhead Temperature, F  "
     375,  350,  400,  288,  375,  270,  385,  406,  347
     -20,  -20,  -25,  -10,  -65,  -10,  -10,  -31,   -2
8., "NO", "NO",     "Wellhead Pressure., PSIA "
     380,  500,  225,  500,  225,  500,  166,  235,  100
     -38,  -50,  -23,  -50,  -23,  -50,  -17,  -24,  -10
9., "NO", "NO",     "Wellhead Enthalpy, BTU/lb"
     419,  340,  375,  280,  366,  260,  900,  370, 1100
     -42,  -34,  -38,  -28,  -37,  -26,  -90,  -37, -110
10.,"NO", "NO",     "Non-Cond. Gases, PPM     "
    5000,1000, 1000, 2000, 1000, 1000, 2000, 1000,10000
   15000,5000, 5000, 8000, 1000, 1000,  700,  200,10000
11.,"YES", "YES",   "H2S, PPM                 "
      50,    0,   10,    0,    0,    0, 1500    50, 2000
      50,   50,   50,  200,   25,   25,  500,   75, 2500
12.,"YES", "YES",   "Tot. Dis. Solids, PPK    "
     250,    5,  1.5,  1.2,  1.0,  0.5,   15,   10,    0
     125,    1,  1.0,  1.3,  1.5,  0.5,   20,    5,    0
13.,"YES", "NO",    "Well Depth, 1000 Feet    "
       6,    9,    8,    3,   10,    3,    6,    5,   10
       0,    0,    0,    0,    0,    0,    0,    0,    0
14.,"NO", "NO",     "Wellhead Separat., Ft    "
    2600, 2600, 2600, 1000, 2600, 1000, 1320, 2600, 2600
       0,    0,    0,    0,    0,    0,    0,    0,    0
15.,"YES","YES",    "Producer Redrill Fraction"
     .15,   .10,  .33,  .20, .35, .20,   .35,  .20,  .35
     .05,   .05,  .07,  .05, .10, .05,   .10,  .05,  .10
16.,"YES","YES",    "Dry Holes per Producer   "
     .17,  .17,  .25,  .17,  .17,  .17,  .20,  .14,  .14
     .03,  .03,  .08,  .03,  .33,  .08,  .13,  .06,  .06
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TABLE 5

GEOTHERMAL SITES RANKED BY COST TO PRODUCE POWER, UNIDENTIFIED RESOURCES INCLUDED						
RESOURCE NAME	State	Cost in mils/kw-hr	Net MWe in 20 yrs.	Net MWe in 40 yrs.	Cumulative MWe in 20 yrs.	Cumulative MWe in 40 yrs.
GEYSERS	CA	26.00	2000.00	2000.00	2000	2000
ROOSEVELT	UT	31.90	250.00	500.00	2250	2500
MEDICINE LAKE	CA	37.20	750.00	3000.00	3000	5500
DIXIE VALLEY	NV	37.70	250.00	500.00	3250	6000
CLEAR LAKE	CA	38.80	500.00	900.00	3750	6900
ISLAND PARK	ID	39.10	500.00	2000.00	4250	8900
3 CREEKS BUTTE	OR	39.30	500.00	2000.00	4750	10900
VALLES CALDERA	NM	41.30	250.00	1000.00	5000	11900
STEAMBOAT	NV	42.30	300.00	600.00	5300	12500
KLAMATH FALLS	OR	42.70	500.00	2000.00	5800	14500
NEWBERRY	OR	43.90	250.00	1500.00	6050	16000
LONG VALLEY (LT)	CA	44.70	350.00	750.00	6400	16750
BEOWOWE	NV	45.80	150.00	250.00	6550	17000
DESERT PEAK	NV	45.90	250.00	1000.00	6800	18000
COSO	CA	48.30	650.00	1000.00	7450	19000
SALTON SEA	CA	48.30	500.00	3000.00	7950	22000
BRAWLEY	CA	49.50	350.00	640.00	8300	22640
RANDSBURG	CA	50.20	100.00	250.00	8400	22890
PUNA	HI	50.70	200.00	1000.00	8600	23890
LONG VALLEY (HT)	CA	52.20	500.00	1600.00	9100	25490
EAST MESA	CA	52.20	360.00	500.00	9460	25990
HEBER	CA	53.70	250.00	500.00	9710	26490
COVE FORT	UT	54.90	300.00	1000.00	10010	27490
COVE CREEK	ID	55.20	200.00	300.00	10210	27790
ALVORD DESERT	OR	58.30	100.00	575.00	10310	28365
SURPRISE VALLEY	CA	58.80	500.00	1490.00	10810	29855

GEOTHERMAL SITES RANKED BY COST TO PRODUCE POWER, UNIDENTIFIED RESOURCES INCLUDED						
RESOURCE NAME	State	Cost in mils/kw-hr	Net MWe in 20 yrs.	Net MWe in 40 yrs.	Cumulative MWe in 20 yrs.	Cumulative MWe in 40 yrs.
KILAUEA SW RIFT	HI	59.30	100.00	300.00	10910	30155
POWER RANCHES	AZ	61.30	380.00	950.00	11290	31105
LASSEN	CA	61.90	100.00	350.00	11390	31455
WESTMORELAND	CA	69.50	150.00	1710.00	11540	33165
VALE	OR	70.70	850.00	2000.00	12390	35165
WUANITA	CO	75.30	410.00	1030.00	12800	36195
MAGIC RESERVOIR	ID	81.60	720.00	1800.00	13520	37995
WILBUR HS	CA	93.70	1000.00	2800.00	14520	40795
MT. BAKER	WA	98.00	50.00	400.00	14570	41195
HOT SPRINGS RANCH	NV	102.00	540.00	1350.00	15110	42545
PARADISE HS	CO	109.50	50.00	200.00	15160	42745
RAFT RIVER	ID	114.80	250.00	1000.00	15410	43745
ROUTT	CO	124.00	130.00	330.00	15540	44075
KELLY HS	CA	141.50	1180.00	3000.00	16720	47075
WENDELL	CA	149.00	250.00	650.00	16970	47725
RIO GRANDE RIFT S.	NM	155.10	240.00	600.00	17210	48325
SESPE HS	CA	172.50	250.00	660.00	17460	48985
GLAMIS	CA	172.60	275.00	680.00	17735	49665
BUCKEYE HS	CA	240.30	500.00	1270.00	18235	50935

TABLE 6

CURRENT POWER PRODUCTION

THE GEYSERS, CALIFORNIA

POWER PRODUCER UNIT	STEAM SUPPLER	PLANT OWNER	RATED CAPACITY MWe	1990 AVE. GENERATED MWe
PG&E				
Units 1-12	UNOCAL	PG&E	608	
Units 13 & 16	Calpine	PG&E	246	
West Ford Flat Bear Creek Cyn. Jos. W. Aidlin	Calpine	Calpine	67	
Subtotal PG&E			1394	989
Dept. Water Res.				
Bottlerock	DWR	DWR	52	14
NCPA				
GEO 1 & 2	GEO	NCPA/GEO	220	150
Santa Fe 1	Santa Fe	Santa Fe	80	70
Subtotal NCPA			300	220
SMUD				
GEO 1	GEO	SMUD/GEO	72	68
CCPA				
Coldwater Cr.	GEO	CCPA/GEO	130	65
TOTAL GEYSERS			1948	1354

TABLE 7

CURRENT POWER PRODUCTION

CALIFORNIA NON-GEYSERS

GEOTHERMAL AREA / UNIT	POWER PURCHASER	STEAM (HEAT) SUPPLIER	RATED CAP. MWe	1990 AVE. MWe	Cap. Factor %
COSO					
Navy 1, Unit 1, 2 & 3	SCE	CA Energy	88	80	
BLM, East & West	SCE	CA Energy	88	80	
Navy 2	SCE	CA Energy	88	80	
TOTAL COSO			264.00	240	
EAST MESA					90
BC McCabe	SDG&E	Magma	13.4	12.5	
ORMESA I, II & IE	SCE	ORMAT	68	60	
GEM 1,2 & 3	SCE	GEO/Mission	47		
Heber - Binary	SDG&E	Chevron	45	0	
Heber - Flash	SCE	Chevron	47	39	
TOTAL EAST MESA			220.40		
SALTON SEA					
CEP Unit #1	SCE	UNOCAL	11	8	80
Unit #2 (Unit 1 add on)	SCE	UNOCAL	20	18	118 Contract 15.5MW
Unit #3	SCE	UNOCAL	53	50	106 Contract 47.5MW
Del Ranch	SCE	Red Hill	34		
Elmore #1	SCE	Red Hill	34		
Leathers #1	SCE	Red Hill	34		
Vulcan	SCE	Red Hill	34		
TOTAL SALTON SEA			219.00		

GEOTHERMAL AREA UNIT	POWER PURCHASER	STEAM (HEAT) SUPPLIER	RATED CAP. MWe	1990 AVE. MWe	Cap. Factor %
WENDELL-AMEDEE					
Honey Lake - Wood/ Geothermal hybrid	PG&E	Geoproducts	30		
Amedee	PG&E	Amedee Geothermal	2		
Wineagle	PG&E	Wineagle	1		
TOTAL WENDELL-AMEDEE			33.00		
LONG VALLEY					
Casa Diablo	SCE	Mammoth-Pacific	12		
TOTAL LONG VALLEY			12.00		
TOTAL NON-GEYSERS CA			748.40		

TABLE 8

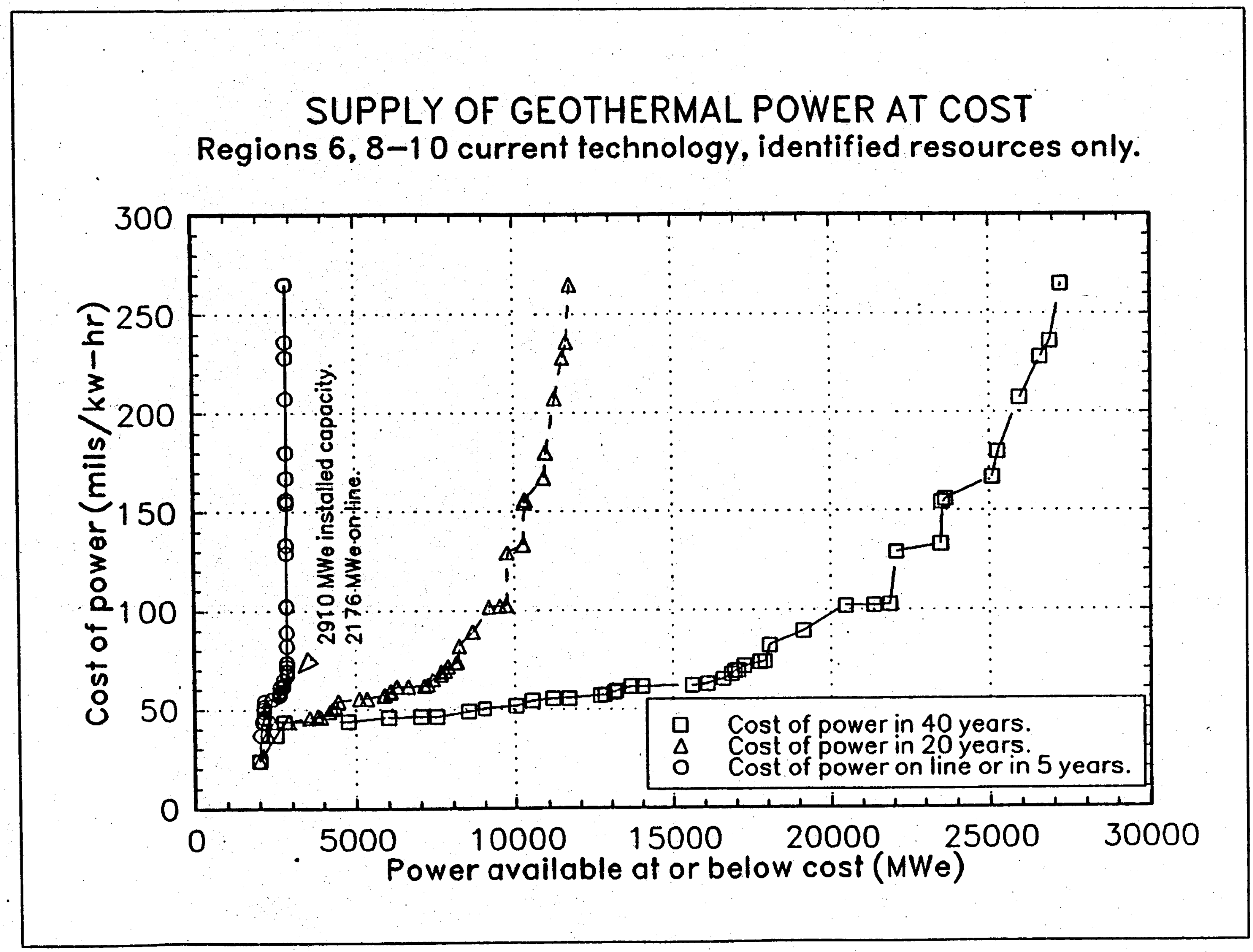
CURRENT POWER PRODUCTION

WESTERN STATES EXCLUSIVE OF CALIFORNIA

GEOTHERMAL AREA UNIT	POWER PURCHASER	STEAM (HEAT) SUPPLIER	RATED CAP. MWe	1990 AVE. MWe	Cap. Factor %
NEVADA					
Dixie Valley	SCE	Oxbow	62	56	111 Contract 49.5MW
Beowowe	SCE	Crescent Valley/ Oxbow	16.5	13	96
Desert Peak	Sierra Pacific	Cal Energy	9		
San Emidio Desert	Sierra Pacific	ORMAT	3		
Stillwater	Sierra Pacific	ORMAT	3		
Soda Lake	Sierra Pacific	ORMAT		13	
Brady Hot Sprs.	Sierra Pacific		5	0	Contract Default
Steamboat					
Geo 1 & 1A	Sierra Pacific	ORMAT	7	.	
Yankee/Caithness	Sierra Pacific		12	11	
TOTAL NEVADA			117.50		
UTAH					
Cove Fort - Unit #1	Provo/ UMPA	Mother Earth	3		
Steam	"	"	2		
Unit #2	"	"	7	11	

GEOTHERMAL AREA / UNIT	POWER PURCHASER	STEAM (HEAT) SUPPLIER	RATED CAP. MWe	1990 AVE. MWe	Cap. Factor %
Roosevelt	Utah Power	Cal Energy	34		
TOTAL UTAH			46.00		
HAWAII					
Puna	HECO	ORMAT	36	30	April, '91
Puna	HECO	UH/DOE	3	0	Off Line Env. Problems
TOTAL HAWAII			39.00		
TOTAL OTHER STATES			202.50		

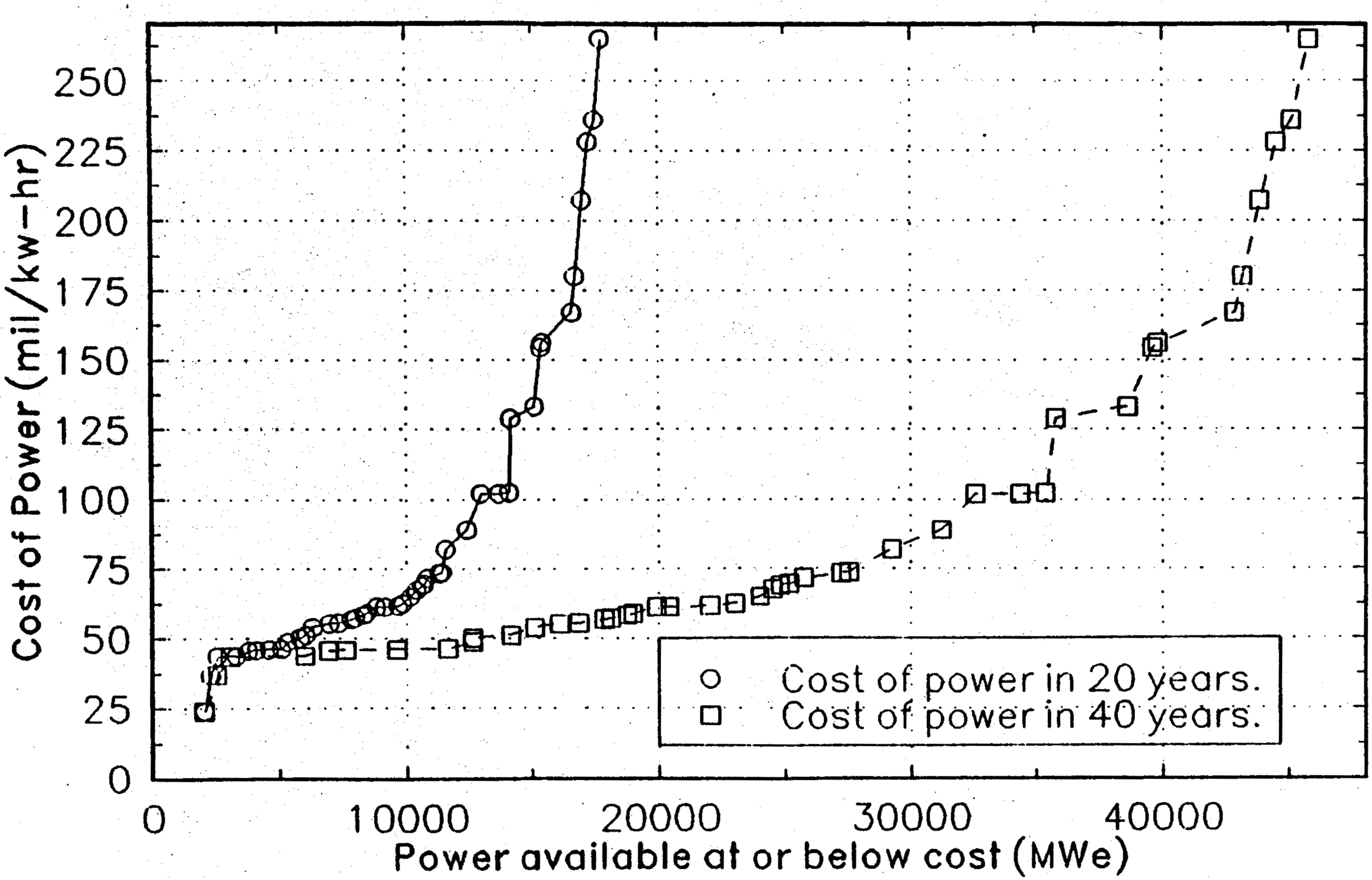
FIGURE 1



SUPPLY OF GEOTHERMAL POWER AT COST
Regions 6, 8–10 current technology, identified resources only.
Cost of power (mils/kw–hr)
Power available at or below cost (MWe)
0
50
100
150
200
250
300
0
5000
10000
15000
20000
25000
30000
2910 MWe installed capacity.
2176 MWe on-line.
Cost of power in 40 years.
Cost of power in 20 years.
Cost of power on line or in 5 years.

SUPPLY OF GEOTHERMAL POWER AT COST

Regions 6, 8–10, current technology, unidentified resources included.



SP Consulting

FIGURE 3

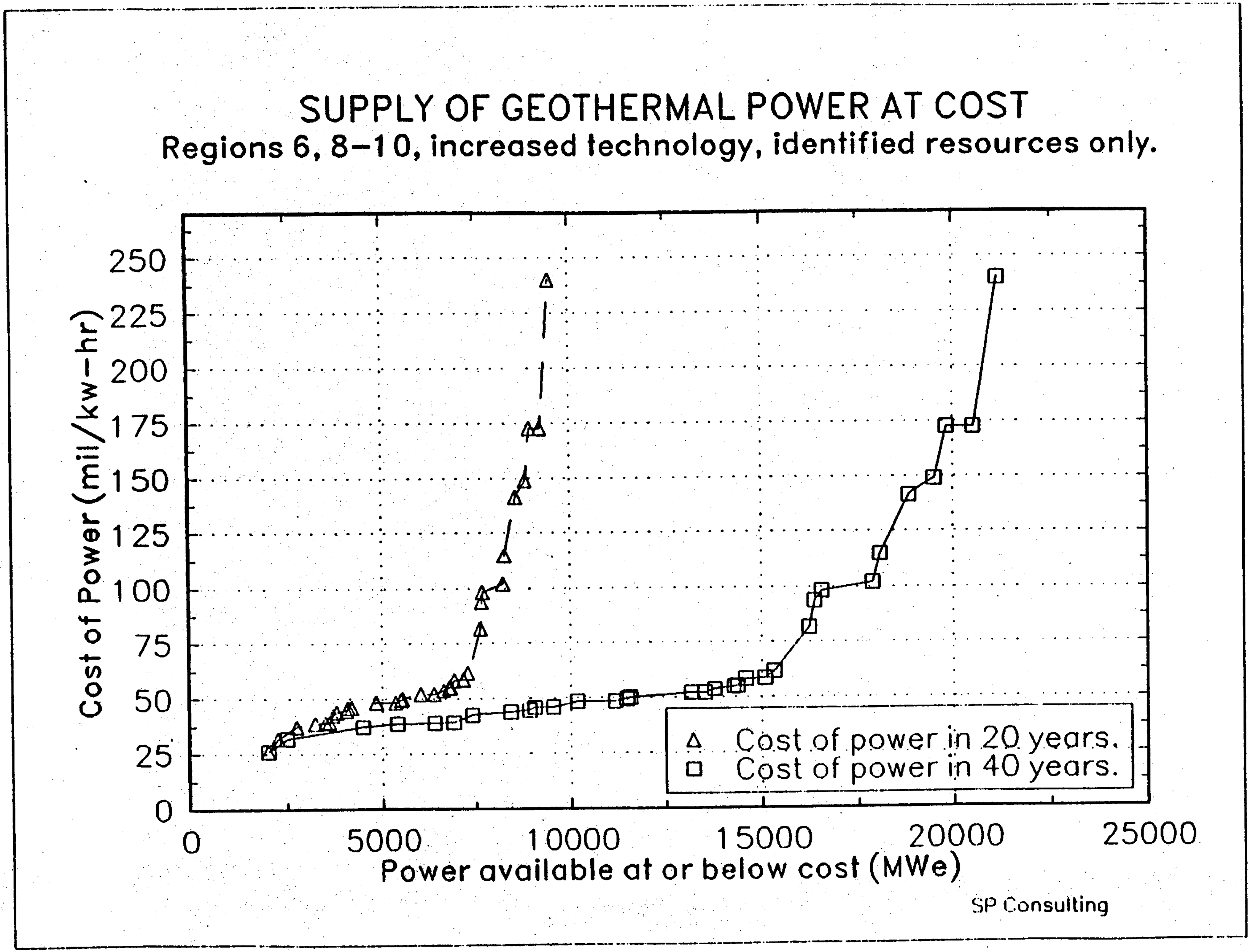
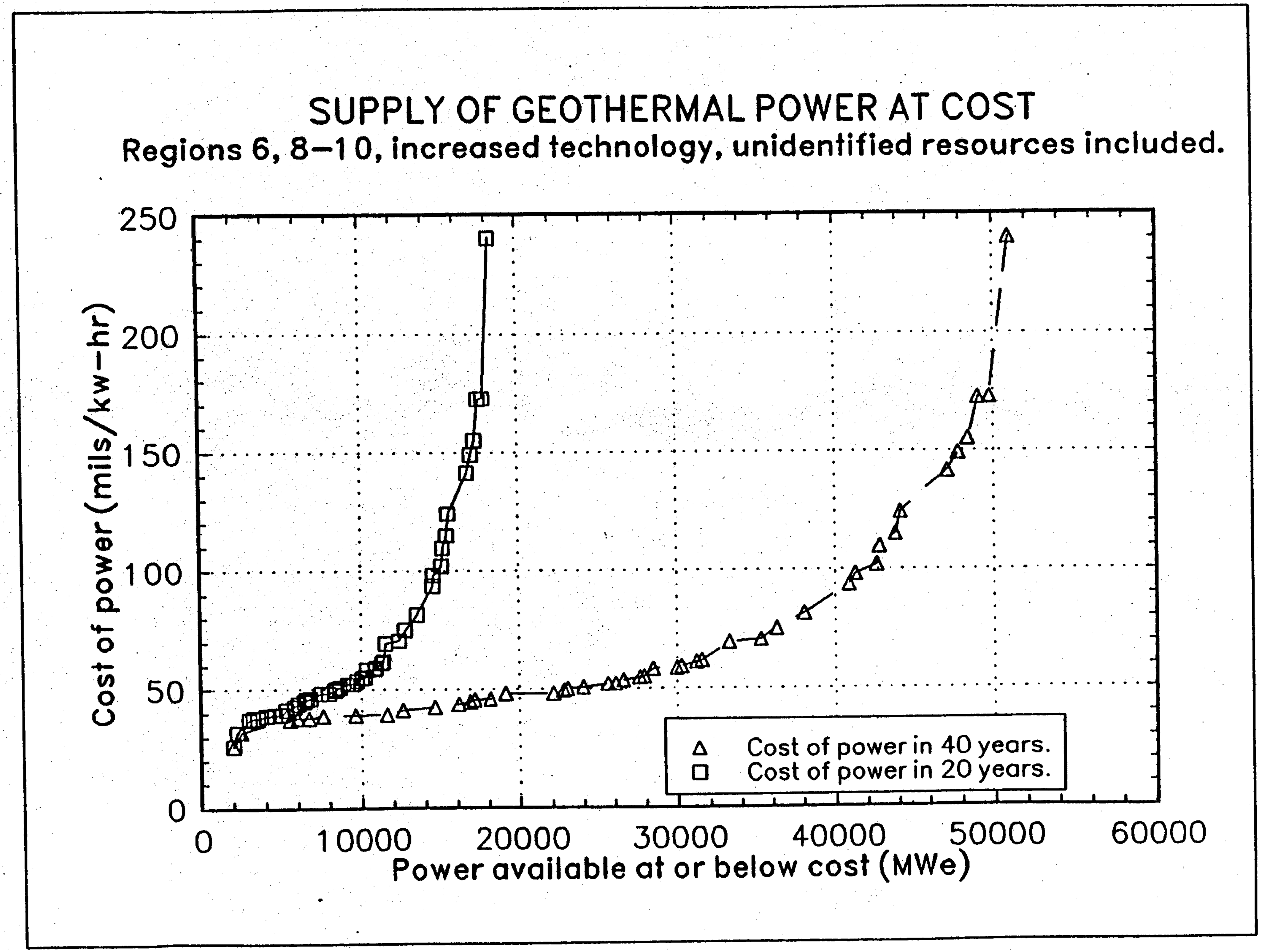

SUPPLY OF GEOTHERMAL POWER AT COST
Regions 6, 8-10, increased technology, identified resources only.
Cost of Power (mil/kw-hr)
250
225
200
175
150
125
100
75
50
25
0
0
5000
10000
15000
20000
25000
Power available at or below cost (MWe)
Cost of power in 20 years.
Cost of power in 40 years.
SP Consulting

FIGURE 4



SUPPLY OF GEOTHERMAL POWER AT COST
Regions 6, 8–10, increased technology, unidentified resources included.
Cost of power (mils/kw-hr)
250
200
150
100
50
0
0
10000
20000
30000
40000
50000
60000
Power available at or below cost (MWe)
Cost of power in 40 years.
Cost of power in 20 years.

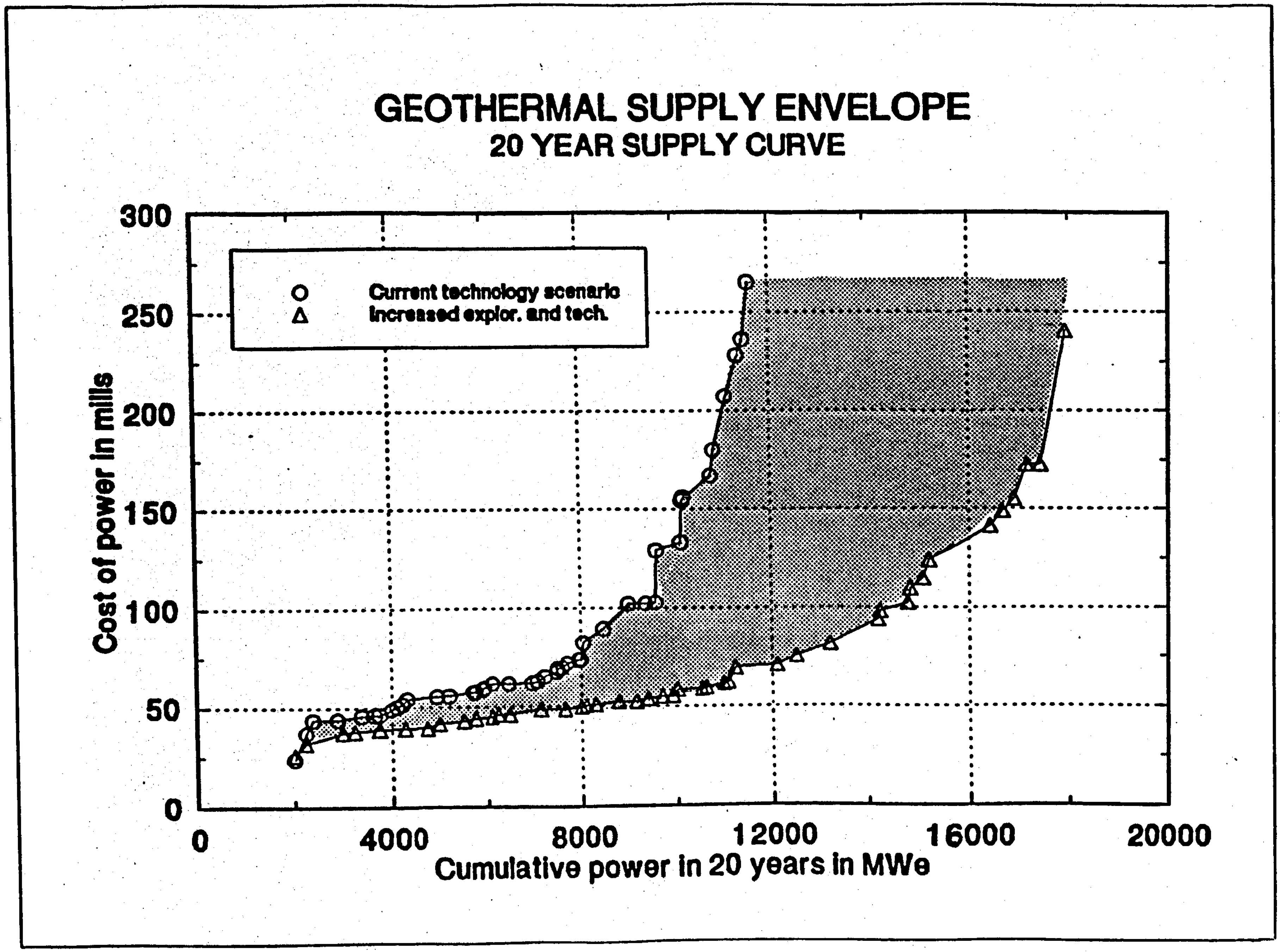
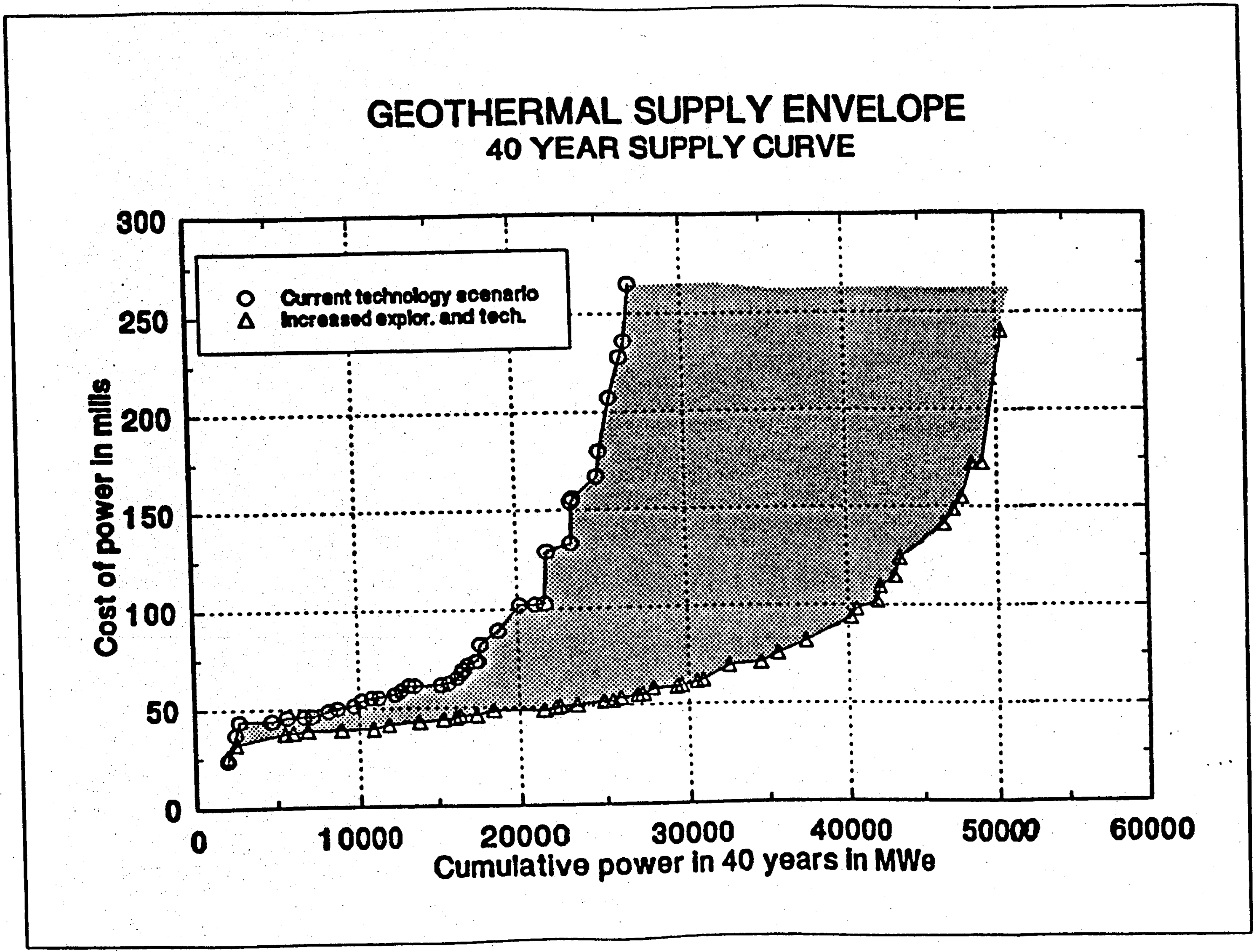
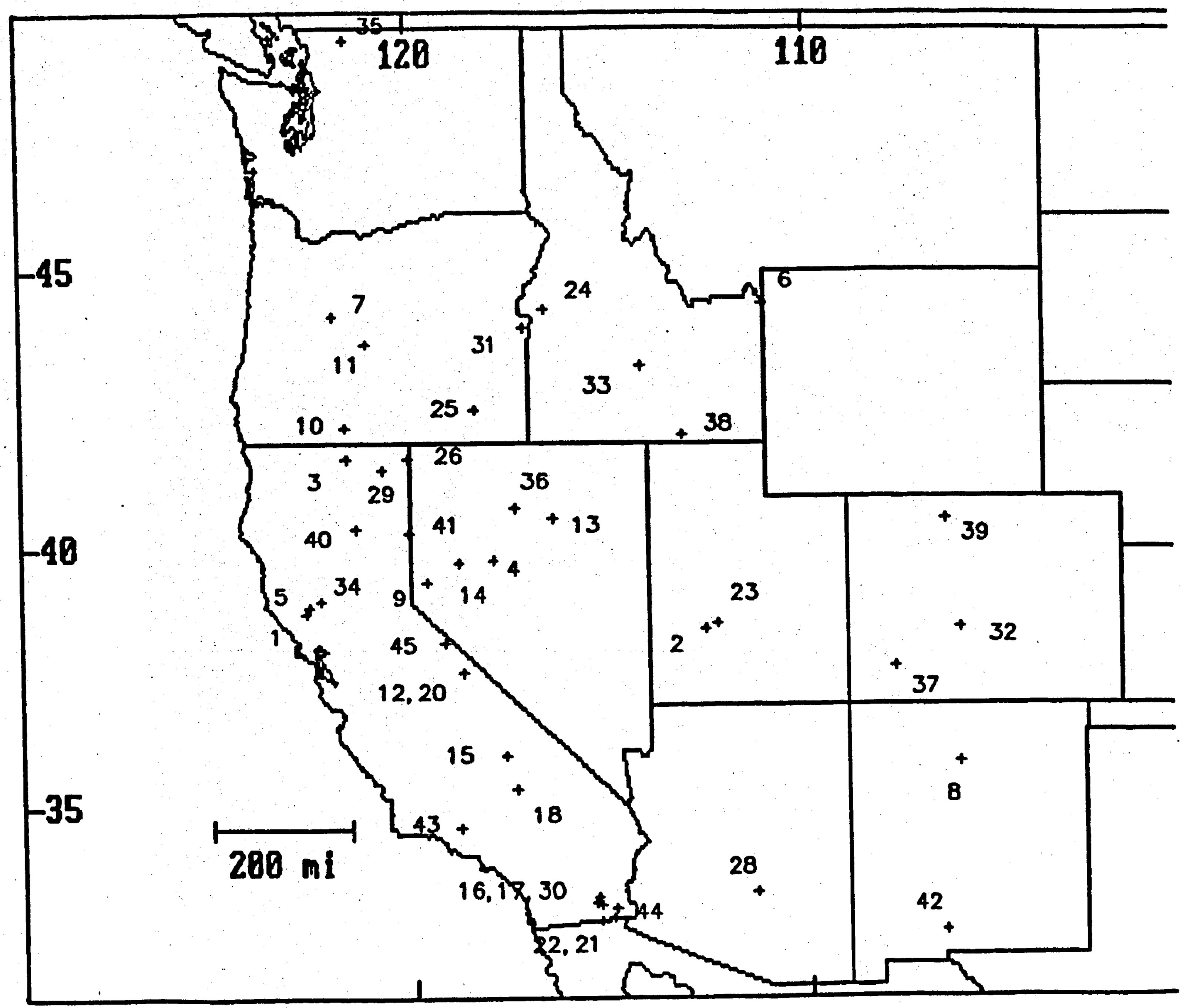

GEOTHERMAL SUPPLY ENVELOPE
20 YEAR SUPPLY CURVE
Current technology scenario
Increased explor. and tech.
Cost of power in mills
300
250
200
150
100
50
0
0
4000
8000
12000
16000
20000
Cumulative power in 20 years in MWe

FIGURE 6



GEOTHERMAL SUPPLY ENVELOPE
40 YEAR SUPPLY CURVE
Current technology scenario
Increased explor. and tech.
Cost of power in mills
Cumulative power in 40 years in MWe
0
50
100
150
200
250
300
0
10000
20000
30000
40000
50000
60000

FIGURE 7



resource	number
GEYSERS	1
ROOSEVELT	2
MEDICINE LAKE	3
DIXIE VALLEY	4
CLEAR LAKE	5
ISLAND PARK	6
3 CREEKS BUTTE	7
VALLES CALDERA	8
STEAMBOAT	9
KLAMATH FALLS	10
NEWBERRY	11
LONG VALLEY (LT)	12
BEOWOWE	13
DESERT PEAK	14
COSO	15
SALTON SEA	16
BRAWLEY	17
RANDSBURG	18
PUNA	19
LONG VALLEY (HT)	20
EAST MESA	21
HEBER	22
COVE FORT	23
COVE CREEK	24
ALVORD DESERT	25
SURPRISE VALLEY	26
KILAUEA SW RIFT	27
POWER RANCHES	28
LASSEN	29
WESTMORELAND	30
VALE	31
WUANITA	32
MAGIC RESERVOIR	33
WILBUR HS	34
MT BAKER	35
HOT SPRINGS RANCH	36
PARADISE HS	37
RAFT RIVER	38
ROUTT	39
KELLY HS	40
WENDELL	41
RIO GRANDE RIFT S.	42
SESPE HS	43
GLAMIS	44
BUCKEYE HS	45

APPENDIX A

RESUME

SUSAN PETTY

EXPERIENCE SUMMARY:
Petty brings a unique combination of geology, field drilling involvement and general geothermal knowledge. Her experience bridges the gap between geology and engineering. She has been involved in fluid flow in a porous media for 15 years with her geothermal experience from the hydrology view point as well as the reservoir engineering view point. She has varied experience in waste monitoring and waste disposal design and analysis.

EMPLOYMENT EXPERIENCE:
1984 to present CONSULTANT
Performed reservoir analysis of Niland and other geothermal resources. Planned well tests for Coso geothermal resource. Provided technical consulting on instrument development and testing. Assisted in instrument test and evaluation at the deep Salton Sea test well.

1981 to 1984 WELL PRODUCTION TESTING, Carlsbad CA
Reservoir Engineering Manager and Secretary/Treasurer-Managed reservoir assessment projects in geothermal and oil and gas areas. Planned and carried out geothermal well tests and reinjection well tests. Supervised collection of reservoir data and performed analysis for resource evaluation. Performed technical analysis of fracture stimulation at Fenton Hill and North Sea reservoirs.

1979 to 1981 EG&G IDAHO, Idaho Falls
Project Manager and Senior Scientist Geothermal Reservoir Engineering-Provided management and planning of geothermal well testing at the Raft River Geothermal Project. Collected and analyzed well test data. Wrote procedures for test operation. Planned and managed national programs studying reservoir engineering methods for low to moderate temperature geothermal systems and the movement of injected fluid in fractured rock. Provided technical assistance for the testing of small to large geothermal wells in Utah, Idaho, Colorado, Montana, California (Geysers, Coso Hot Springs, Imperial Valley) and British Columbia. Performed technical analysis on fracture stimulation projects at Raft River.

1976 to 1979 UNIVERSITY OF HAWAII WATER RESOURCES RESEARCH CENTER
Research Assistant-Assessed problems of injection wells in Hawaii for State of Hawaii, Department of Natural Resources. Wrote numerical model to simulate waste water injection wells. Assessed potential for recharge to Hawaii Geothermal Project well at Puna,

Hawaii.

1976 to 1979 CONSULTANT
Geohydrology-Supervised and analyzed well testing in Maryland. Investigated movement of radionuclides through groundwater on Enewetak Atoll including drilling and testing of monitor wells for Department of Energy and the Department of Defense. Assessed potential for groundwater contamination from surface sources in the Trust Territories of the Pacific Islands for the Environmental Protection Agency.

1975 to 1976 DELAWARE GEOLOGICAL SURVEY, Newark, Delaware
Lead Project Geologist-Carried out project to assess groundwater resources of northern Delaware including extent of water bearing formation and recharge to aquifers. Supervised two geologist and a drilling crew. Planned and drilling and testing of 58 wells in northern Delaware.

1973 TO 1974 GEOLOGIST FOR ENVIRONMENTAL CONCERN, Maryland
Geologist- Assessed environmental impact on ground and surface waters associated with development projects in the wetlands

ASSOCIATIONS, MEMBERSHIPS, PUBLICATIONS
Is a member of Geothermal Resources Council and the Society of Petroleum Engineers. Has authored papers on ground water hydrology, geothermal reservoir analysis, reservoir testing and waste injection problems.

EDUCATION:
B A, Geology, Princeton University, 1973
M A, Hydrology, University of Hawaii, 1980
Additional training in Management Skills Development and Petroleum Drilling Technology

RESUME

DR. BILL LIVESAY

EXPERIENCE SUMMARY:
Over 20 years experience in design and technology of drilling methods gained through industrial consulting as user, builder and researcher of equipment and instrumentation. Has been involved in the development of new technology in the geothermal area through long term association with Sandia Labs.

EMPLOYMENT EXPERIENCE
1977 to Present: LIVESAY INC.
Principal consultant--Managed development program for mud pulse MWD system for AMF/Scientific Drilling Inc., bringing together numerous consultants and contractors to build state-of-the-art prototype which was successful in the field. Has worked with the DOE and Sandia National Laboratories in geothermal equipment, instrumentation, well design, geothermal well cost models, program development and project review. Taught courses for AMOCO in drilling optimization, deviation control and directional drilling.

1974 to 1977: KENNECOTT COPPER COMPANY, San Diego
Managing Director, Manganese Nodule Mining Program--Managed program for ocean mining of manganese nodules. Responsible for staff of 140 involved in development of technology, design of equipment and instrumentation, program control of construction and operations for port facility, transport vessels, mining ship, subsea mining equipment and marine geology.

1972 to 1974: DRESSER INDUSTRIES, Dallas
Manager of Research-Developed drill bits, drilling tools and drilling equipment, special lubricants, bearing materials and seals. Provided analytical support and in-house consulting for other divisions of Dresser.

1967 to 1972: UNIVERSITY OF TULSA
Professor of Petroleum and Mechanical Engineering and Director of the Drilling Research Projects--Directed cooperative research program in drilling and rock mechanics, researching drilling and off-shore operations, rock mechanics and structure analysis. Served as industrial consultant in drilling operations, drilling and offshore technology.

1964 to 1967: ESSO PRODUCTION RESEARCH, Houston
Senior Research Engineer--Performed R & D work in drilling and offshore structures, platform response and floating drilling vessel structural design and analysis. Worked in the drilling

optimization task force group.

ASSOCIATIONS, MEMBERSHIPS, PUBLICATIONS
Is a member of SPE and ASME. Has also been on various advisory boards and panels for Sandia, Los Alamos, the Marine Board of the National Academy of Engineering and others. Has authored 8 papers on various aspects of drilling equipment and procedures.

EDUCATION
BS ME, Oklahoma State University, 1960
PHD ME, Kansas State University, 1966

RESUME

WILLIAM P. LONG, Ph.D

MINERAL ECONOMIST AND CHEMICAL ENGINEER

PROFESSIONAL EXPERIENCE Corporate and project evaluations, planning and forecasting, marketing, acquisitions, financing, financial reporting, project engineering and environmental protection.

1987 - Present Associate Mineral Economist and Engineering Consultant, Cascadia Exploration Corporation; President, Carlin Gold Company

Assisted clients with geothermal acquisitions. Advised a client in structuring an audit with regard to a major lawsuit against an operating partner. Provided market analyses for clients in the geothermal business. Assisted with the preparation of documents and the sale of publicly traded securities. Provided mineral property land status reports for clients. Arranged acquisitions and sale of precious metal properties. Supervised evaluation and drilling of a gold property.

1980-1986 Executive Vice President and Chief Financial Officer, Thermal Exploration Company

Reviewed and negotiated many joint venture opportunities including a geothermal exploration services agreement with AMAX Exploration and a multi million dollar geothermal joint venture with a major oil company. Served on the technical committee and reviewed the operator's proposals for the development of the Roosevelt Hot Springs Geothermal Field. Provided merger and acquisition evaluations and negotiated such arrangements. Analyzed numerous projects in minerals, geothermal, oil and gas. Assumed total responsibility for geothermal marketing and negotiated with Sierra Pacific Power Company to arrange a transmission path from the Beowowe Geothermal Unit in Nevada to Southern California Edison. Prepared business plans, financial forecasts and annual reports for the corporation. Supervised all legal, financial and engineering work. Negotiated a merger in 1984 of O'Brien Resources Corporation and Thermal Exploration Company.

1978-1980 Business Manager - Geothermal Div., AMAX Exploration, Inc.

Pursued geothermal business opportunities and coordinated all business activities. Assisted the firm's attorneys in contract preparation and negotiated appropriate contracts. Overall responsibility for the office, accounting, land records, permitting and marketing. Determined the need for and defined the scope of engineering, feasibility, financial, and legislative studies.

1976-1978 Systems Engineer and Business Analyst - Geothermal Div., AMAX Exploration, Inc.

Assisted in negotiating many major joint venture and acquisition agreements including the purchase of Phillips Petroleum's phosphate property in Florida. Provided business, economic and engineering guidance to the geothermal group. Supervised and developed financial and economic studies on a variety of mineral and geothermal projects.

1974-1976 Systems Engineer, AMAX Exploration, Inc.

Provided financial and economic analysis of various projects and joint ventures. Mineral projects analyzed included specific property evaluation for: gold, silver, platinum, lead, zinc, molybdenum, copper, trona, clay, phosphate, coal, iron, limestone and uranium.

1970-1971 Lieutenant - Operations Officer, 544th Construction Support, Vietnam, U.S. Army Corps of Engineers

Assumed operating responsibility for a large rock quarry and an asphalt production facility. Managed three waste water treatment facilities at Fort Benning, Georgia.

ACADEMIC BACKGROUND

Professional Degree (1969) Chemical and Petroleum Refining Engineering, Colorado School of Mines
Ph.D (1974) Mineral Economics, Colorado School of Mines.

PROFESSIONAL AFFILIATIONS

American Institute of Chemical Engineers
Society for Mining, Metallurgy, and Exploration, Inc.
Geothermal Resources Council

APPENDIX B

CURRENT TECHNOLOGY

GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-01-1990 - 13:30:44
Base Case Costs: Imperial Valley - Salton

[From IMGEO Model] ACCOUNT	Million $: Capital Cost, $	Million $: O&M Cost, $/Yr	Mills/KWhour: Capital Part of System	Mills/KWhour: Total Busbar Cost
TOTAL :	126.6	8.0	33.6	56.9
RISK FRACTION :	11.7	0.7	3.0	5.2
1. Identify Reservoir	6.0	0.0	1.2	1.2
2. Confirm Reservoir	17.8	0.0	3.9	3.9
3. Prod./Inject. Wells	31.5	3.5	7.1	17.6
4. Downhole Pumps	0.0	0.0	0.0	0.0
5. Gathering Equip.	5.9	0.2	1.8	2.6
6. Make-Up Wells	0.0	0.0	0.0	0.0
7. Power Plant (Core)	40.5	2.0	12.1	17.9
8. Brine TDS Effects	16.4	2.0	4.9	10.7
9. Gas Handling	3.6	0.2	1.1	1.6
10. Reservoir Insurance	4.9	0.0	1.5	1.5

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-01-1990 - 13:30:44

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

(End of Page)

GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-01-1990 - 13:30:44
Base Case Costs: Imperial Valley - Heber

[From IMGEO Model] ACCOUNT	Million $: Capital Cost, $	Million $: O&M Cost, $/Yr	Mills/KWhour: Capital Part of System	Mills/KWhour: Total Busbar Cost
TOTAL :	166.1	6.3	47.7	67.4
RISK FRACTION :	15.0	0.1	5.7	6.5
1. Identify Reservoir	16.2	0.0	3.5	3.5
2. Confirm Reservoir	18.0	0.0	4.3	4.3
3. Prod./Inject. Wells	31.1	1.1	7.5	11.2
4. Downhole Pumps	1.6	0.3	0.5	1.4
5. Gathering Equip.	8.9	0.2	3.0	3.5
6. Make-Up Wells	0.0	1.2	0.0	4.0
7. Power Plant (Core)	83.6	3.4	26.8	37.4
8. Brine TDS Effects	0.3	0.0	0.1	0.1
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	6.3	0.0	2.0	2.0

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-01-1990 - 13:30:44

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

(End of Page)

GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-01-1990 - 13:30:44
Base Case Costs: Basin & Range - Dixie Val

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ----- Capital Part of System	Total Busbar Cost
TOTAL :	125.6	3.8	32.6	43.6
RISK FRACTION :	12.8	0.2	3.2	3.8
1. Identify Reservoir	11.6	0.0	2.3	2.3
2. Confirm Reservoir	19.9	0.0	4.4	4.4
3. Prod./Inject. Wells	30.6	1.1	6.9	10.3
4. Downhole Pumps	0.0	0.0	0.0	0.0
5. Gathering Equip.	4.8	0.1	1.5	1.8
6. Make-Up Wells	0.0	0.0	0.0	0.0
7. Power Plant (Core)	43.5	2.2	13.0	19.3
8. Brine TDS Effects	7.2	0.2	2.2	2.7
9. Gas Handling	3.4	0.1	1.0	1.4
10. Reservoir Insurance	4.5	0.0	1.3	1.3

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-01-1990 - 13:30:44

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

(End of Page)

GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-01-1990 - 13:30:44
Base Case Costs: Basin & Range - Raft R.

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ----- Capital Part of System	Total Busbar Cost
TOTAL :	386.0	11.6	115.8	154.3
RISK FRACTION :	64.3	1.5	26.1	33.1
1. Identify Reservoir	47.1	0.0	10.6	10.6

2. Confirm Reservoir	26.9	0.0	6.7	6.7
3. Prod./Inject. Wells	90.9	2.8	23.2	32.8
4. Downhole Pumps	5.8	1.0	2.0	5.5
5. Gathering Equip.	41.8	0.8	14.7	17.5
6. Make-Up Wells	0.0	1.2	0.0	4.1
7. Power Plant (Core)	158.0	5.7	53.4	71.8
8. Brine TDS Effects	0.7	0.0	0.2	0.3
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	14.9	0.0	5.0	5.0

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-01-1990 - 13:30:44

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

(End of Page)

GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-01-1990 - 13:30:44
Base Case Costs: Cascades - Lassen

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ----- Capital Part of System	Total Busbar Cost
TOTAL :	233.3	3.8	58.3	69.5
RISK FRACTION :	27.8	-0.2	7.3	6.8
1. Identify Reservoir	24.9	0.0	5.0	5.0
2. Confirm Reservoir	33.3	0.0	7.5	7.5
3. Prod./Inject. Wells	102.7	0.7	23.7	25.9
4. Downhole Pumps	0.0	0.0	0.0	0.0
5. Gathering Equip.	9.6	0.2	3.0	3.6
6. Make-Up Wells	0.0	0.4	0.0	1.1
7. Power Plant (Core)	54.5	2.5	16.6	24.0
8. Brine TDS Effects	0.0	0.0	0.0	0.0
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	8.3	0.0	2.5	2.5

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-01-1990 - 13:30:44

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

(End of Page)

GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-01-1990 - 13:30:44
Base Case Costs: Cascades - Alvord Desert

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ----- Capital Part of System	Total Busbar Cost
TOTAL :	206.0	5.7	54.9	71.7
RISK FRACTION :	21.7	0.6	6.7	8.6
1. Identify Reservoir	38.3	0.0	7.8	7.8
2. Confirm Reservoir	23.4	0.0	5.3	5.3
3. Prod./Inject. Wells	32.6	1.3	7.5	11.6
4. Downhole Pumps	2.5	0.5	0.8	2.2
5. Gathering Equip.	12.7	0.3	4.0	4.8
6. Make-Up Wells	0.0	0.0	0.0	0.0
7. Power Plant (Core)	89.6	3.6	27.4	38.1
8. Brine TDS Effects	0.0	0.0	0.0	0.0
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	6.9	0.0	2.1	2.1

IM-GEO: SENSITIVITY FACTORS IN EFFECT   08-01-1990 - 13:30:44

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

(End of Page)

GEOTHERMAL COST OF POWER ESTIMATE   RUN: 08-01-1990 - 13:30:44
Base Case Costs: Young Volcanics - Coso

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ----- Capital Part of System	Total Busbar Cost
TOTAL :	114.1	8.4	30.9	55.3
RISK FRACTION :	7.0	0.3	1.8	2.8
1. Identify Reservoir	6.6	0.0	1.3	1.3
2. Confirm Reservoir	15.8	0.0	3.5	3.5
3. Prod./Inject. Wells	19.5	2.8	4.4	12.8
4. Downhole Pumps	0.0	0.0	0.0	0.0
5. Gathering Equip.	4.8	0.2	1.5	2.0
6. Make-Up Wells	0.0	0.1	0.0	0.4
7. Power Plant (Core)	42.7	2.1	12.8	18.9
8. Brine TDS Effects	17.0	2.9	5.1	13.5
9. Gas Handling	3.3	0.2	1.0	1.6
10. Reservoir Insurance	4.4	0.0	1.3	1.3

IM-GEO: SENSITIVITY FACTORS IN EFFECT   08-01-1990 - 13:30:44

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

(End of Page)

GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-01-1990 - 13:30:44
Base Case Costs: Young Vol. - Long Valley

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ----- Capital Part of System	Total Busbar Cost
TOTAL :	138.4	5.1	40.0	55.5
RISK FRACTION :	12.4	0.4	4.2	5.7
1. Identify Reservoir	8.3	0.0	1.7	1.7
2. Confirm Reservoir	9.9	0.0	2.3	2.3
3. Prod./Inject. Wells	20.2	1.1	4.8	8.3
4. Downhole Pumps	1.4	0.3	0.5	1.5
5. Gathering Equip.	11.1	0.2	3.6	4.3
6. Make-Up Wells	0.0	0.0	0.0	0.0
7. Power Plant (Core)	81.8	3.4	25.5	35.6
8. Brine TDS Effects	0.1	0.0	0.0	0.0
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	5.7	0.0	1.8	1.8

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-01-1990 - 13:30:44

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-01-1990 - 12:57:28
Base Case Costs: Imperial Valley - Westmor

[From IMGEO Model]	----- Million $ ------		---- Mills/KWhour -----	
ACCOUNT	Capital Cost, $	O&M Cost, $/Yr	Capital Part of System	Total Busbar Cost
TOTAL :	181.8	11.8	47.5	82.1
RISK FRACTION :	20.1	1.3	5.2	9.1
1. Identify Reservoir	10.8	0.0	2.2	2.2
2. Confirm Reservoir	19.7	0.0	4.4	4.4
3. Prod./Inject. Wells	61.2	5.5	13.9	30.4
4. Downhole Pumps	0.0	0.0	0.0	0.0
5. Gathering Equip.	11.9	0.5	3.7	5.1
6. Make-Up Wells	0.0	0.0	0.0	0.0
7. Power Plant (Core)	49.7	2.4	14.9	21.8
8. Brine TDS Effects	17.2	3.2	5.2	14.3
9. Gas Handling	3.9	0.2	1.2	1.8
10. Reservoir Insurance	7.2	0.0	2.2	2.2

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-01-1990 - 12:57:28

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-01-1990 - 12:57:28
Base Case Costs: Imperial Valley - E. Mesa

[From IMGEO Model]	----- Million $ ------		---- Mills/KWhour -----	
ACCOUNT	Capital Cost, $	O&M Cost, $/Yr	Capital Part of System	Total Busbar Cost
TOTAL :	147.3	6.3	41.6	61.4
RISK FRACTION :	13.9	0.1	5.1	6.0
1. Identify Reservoir	16.2	0.0	3.4	3.4
2. Confirm Reservoir	18.0	0.0	4.2	4.2
3. Prod./Inject. Wells	31.0	1.1	7.5	11.2
4. Downhole Pumps	1.6	0.3	0.5	1.4
5. Gathering Equip.	8.9	0.2	3.0	3.5
6. Make-Up Wells	0.0	1.2	0.0	4.0
7. Power Plant (Core)	65.9	3.4	21.1	31.7
8. Brine TDS Effects	0.3	0.0	0.1	0.1
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	5.4	0.0	1.7	1.7

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-01-1990 - 12:57:28

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-01-1990 - 12:57:28
Base Case Costs: Basin & Range - Desert Pe

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ----- Capital Part of System	Total Busbar Cost
TOTAL :	159.4	4.4	41.2	54.0
RISK FRACTION :	19.4	0.3	4.9	5.9
1. Identify Reservoir	15.5	0.0	3.1	3.1
2. Confirm Reservoir	21.3	0.0	4.7	4.7
3. Prod./Inject. Wells	46.0	1.4	10.4	14.6
4. Downhole Pumps	0.0	0.0	0.0	0.0
5. Gathering Equip.	7.3	0.1	2.3	2.7
6. Make-Up Wells	0.0	0.0	0.0	0.0
7. Power Plant (Core)	52.7	2.5	15.8	22.9
8. Brine TDS Effects	7.3	0.2	2.2	2.8
9. Gas Handling	3.5	0.2	1.0	1.5
10. Reservoir Insurance	5.8	0.0	1.7	1.7

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-01-1990 - 12:57:28

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-01-1990 - 12:57:28
Base Case Costs: Basin & Range - Cove Cr.

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ----- Capital Part of System	Total Busbar Cost
TOTAL :	160.1	6.9	47.3	69.0
RISK FRACTION :	20.3	0.4	7.5	9.6
1. Identify Reservoir	5.9	0.0	1.3	1.3

2. Confirm Reservoir	10.2	0.0	2.4	2.4
3. Prod./Inject. Wells	37.8	1.6	9.2	14.2
4. Downhole Pumps	2.7	0.5	0.9	2.5
5. Gathering Equip.	15.7	0.3	5.2	6.2
6. Make-Up Wells	0.0	0.5	0.0	1.7
7. Power Plant (Core)	80.5	4.0	25.9	38.3
8. Brine TDS Effects	0.4	0.0	0.1	0.2
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	6.9	0.0	2.2	2.2

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-01-1990 - 12:57:28

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-01-1990 - 12:57:28
Base Case Costs: Cascades - Medicine L.

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ----- Capital Part of System	Total Busbar Cost
TOTAL :	138.3	3.0	35.0	43.8
RISK FRACTION :	14.0	-0.2	3.6	2.9
1. Identify Reservoir	10.2	0.0	2.0	2.0
2. Confirm Reservoir	27.9	0.0	6.2	6.2
3. Prod./Inject. Wells	48.8	0.6	11.2	13.0
4. Downhole Pumps	0.0	0.0	0.0	0.0
5. Gathering Equip.	4.5	0.1	1.4	1.7
6. Make-Up Wells	0.0	0.2	0.0	0.6
7. Power Plant (Core)	42.2	2.1	12.8	18.9
8. Brine TDS Effects	0.0	0.0	0.0	0.0
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	4.8	0.0	1.4	1.4

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-01-1990 - 12:57:28

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-01-1990 - 12:57:28
Base Case Costs: Cascades - Klamath Falls

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ----- Capital Part of System	Total Busbar Cost
TOTAL :	128.1	5.1	35.1	50.2
RISK FRACTION :	14.3	0.4	4.3	5.7
1. Identify Reservoir	10.5	0.0	2.1	2.1
2. Confirm Reservoir	12.2	0.0	2.7	2.7
3. Prod./Inject. Wells	26.2	1.2	6.0	9.6
4. Downhole Pumps	1.6	0.4	0.5	1.7
5. Gathering Equip.	10.2	0.2	3.2	3.8
6. Make-Up Wells	0.0	0.0	0.0	0.0
7. Power Plant (Core)	62.4	3.3	19.0	28.7
8. Brine TDS Effects	0.0	0.0	0.0	0.0
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	5.0	0.0	1.5	1.5

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-01-1990 - 12:57:28

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-01-1990 - 12:57:28
Base Case Costs: Young Volcanics - Clear L

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ----- Capital Part of System	Total Busbar Cost
TOTAL :	95.1	6.7	26.1	45.6
RISK FRACTION :	6.1	0.3	1.6	2.6
1. Identify Reservoir	5.1	0.0	1.0	1.0
2. Confirm Reservoir	15.4	0.0	3.4	3.4
3. Prod./Inject. Wells	11.0	2.1	2.5	8.9
4. Downhole Pumps	0.0	0.0	0.0	0.0
5. Gathering Equip.	3.0	0.1	0.9	1.3
6. Make-Up Wells	0.0	0.1	0.0	0.4
7. Power Plant (Core)	37.3	1.9	11.2	16.8
8. Brine TDS Effects	16.5	2.2	5.0	11.3
9. Gas Handling	3.2	0.2	1.0	1.5
10. Reservoir Insurance	3.6	0.0	1.1	1.1

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-01-1990 - 12:57:28

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-01-1990 - 12:57:28
Base Case Costs: Young Volcanics - Randsbu

[From IMGEO Model] ACCOUNT	Million $ Capital Cost, $	Million $ O&M Cost, $/Yr	Mills/KWhour Capital Part of System	Mills/KWhour Total Busbar Cost
TOTAL :	147.4	5.6	41.8	59.0
RISK FRACTION :	16.0	0.5	5.4	7.4
1. Identify Reservoir	15.5	0.0	3.2	3.2
2. Confirm Reservoir	12.9	0.0	3.0	3.0
3. Prod./Inject. Wells	24.9	1.3	5.9	9.9
4. Downhole Pumps	2.2	0.4	0.7	2.0
5. Gathering Equip.	13.6	0.3	4.4	5.3
6. Make-Up Wells	0.0	0.0	0.0	0.0
7. Power Plant (Core)	72.6	3.7	22.7	33.9
8. Brine TDS Effects	0.1	0.0	0.0	0.0
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	5.7	0.0	1.8	1.8

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-01-1990 - 12:57:28

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-01-1990 - 14:56:47
Base Case Costs: Imperial Valley - Brawley

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ----- Capital Part of System	Total Busbar Cost
TOTAL :	129.3	8.3	34.4	58.5
RISK FRACTION :	7.1	0.5	1.8	3.3
1. Identify Reservoir	8.0	0.0	1.6	1.6
2. Confirm Reservoir	18.7	0.0	4.1	4.1
3. Prod./Inject. Wells	27.8	3.1	6.3	15.6
4. Downhole Pumps	0.0	0.0	0.0	0.0
5. Gathering Equip.	5.6	0.2	1.8	2.4
6. Make-Up Wells	0.0	0.0	0.0	0.0
7. Power Plant (Core)	43.8	2.2	13.1	19.4
8. Brine TDS Effects	16.7	2.5	5.0	12.2
9. Gas Handling	3.8	0.2	1.1	1.7
10. Reservoir Insurance	4.9	0.0	1.5	1.5

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-01-1990 - 14:56:47

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-01-1990 - 14:56:47
Base Case Costs: B & R - Roosevelt HS.

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ----- Capital Part of System	Total Busbar Cost
TOTAL :	101.4	3.5	26.7	36.9
RISK FRACTION :	4.7	-0.1	1.2	1.0
1. Identify Reservoir	15.4	0.0	3.1	3.1
2. Confirm Reservoir	21.1	0.0	4.6	4.6
3. Prod./Inject. Wells	5.9	0.8	1.3	3.6
4. Downhole Pumps	0.0	0.0	0.0	0.0
5. Gathering Equip.	2.2	0.0	0.7	0.8
6. Make-Up Wells	0.0	0.2	0.0	0.5
7. Power Plant (Core)	43.1	2.2	12.9	19.1
8. Brine TDS Effects	7.2	0.2	2.2	2.7
9. Gas Handling	3.3	0.1	1.0	1.4
10. Reservoir Insurance	3.1	0.0	0.9	0.9

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-01-1990 - 14:56:47

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-01-1990 - 14:56:47
Base Case Costs: B & R - Cove Fort

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ----- Capital Part of System	Total Busbar Cost
TOTAL :	149.7	6.8	43.8	65.0
RISK FRACTION :	15.6	0.2	5.9	7.4
1. Identify Reservoir	10.3	0.0	2.2	2.2
2. Confirm Reservoir	11.9	0.0	2.8	2.8
3. Prod./Inject. Wells	29.3	1.4	7.1	11.4
4. Downhole Pumps	2.1	0.4	0.7	1.9
5. Gathering Equip.	12.5	0.2	4.1	4.9
6. Make-Up Wells	0.0	0.9	0.0	3.0
7. Power Plant (Core)	77.2	3.9	24.7	36.6
8. Brine TDS Effects	0.4	0.0	0.1	0.1
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	6.1	0.0	1.9	1.9

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-01-1990 - 14:56:47

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-01-1990 - 14:56:47
Base Case Costs: Cascades - Newberry

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ----- Capital Part of System	Total Busbar Cost
TOTAL :	157.7	3.9	39.9	51.3
RISK FRACTION :	16.9	-0.5	4.4	3.1
1. Identify Reservoir	13.5	0.0	2.7	2.7

2. Confirm Reservoir	29.1	0.0	6.5	6.5
3. Prod./Inject. Wells	58.4	0.6	13.4	15.4
4. Downhole Pumps	0.0	0.0	0.0	0.0
5. Gathering Equip.	5.6	0.1	1.8	2.1
6. Make-Up Wells	0.0	0.8	0.0	2.5
7. Power Plant (Core)	45.5	2.3	13.8	20.4
8. Brine TDS Effects	0.0	0.0	0.0	0.0
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	5.5	0.0	1.7	1.7

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-01-1990 - 14:56:47

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-01-1990 - 14:56:47
Base Case Costs: Y Vol. - Long Valley HT

[From IMGEO Model]	----- Million $ ------		---- Mills/KWhour -----	
ACCOUNT	Capital Cost, $	O&M Cost, $/Yr	Capital Part of System	Total Busbar Cost
TOTAL :	127.3	9.4	34.1	61.6
RISK FRACTION :	7.6	0.4	2.0	3.2
1. Identify Reservoir	9.1	0.0	1.8	1.8
2. Confirm Reservoir	16.9	0.0	3.7	3.7
3. Prod./Inject. Wells	26.2	3.3	5.9	15.8
4. Downhole Pumps	0.0	0.0	0.0	0.0
5. Gathering Equip.	6.1	0.2	1.9	2.6
6. Make-Up Wells	0.0	0.1	0.0	0.3
7. Power Plant (Core)	43.8	2.2	13.1	19.5
8. Brine TDS Effects	17.1	3.3	5.1	14.7
9. Gas Handling	3.4	0.2	1.0	1.6
10. Reservoir Insurance	4.8	0.0	1.4	1.4

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-01-1990 - 14:56:47

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

(End of Page)

GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-01-1990 - 16:03:49
Base Case Costs: B & R - Beowowe

[From IMGEO Model]	Million $		Mills/KWhour	
ACCOUNT	Capital Cost, $	O&M Cost, $/Yr	Capital Part of System	Total Busbar Cost
TOTAL :	175.2	4.4	44.5	57.3
RISK FRACTION :	16.2	0.3	4.2	5.0
1. Identify Reservoir	27.8	0.0	5.5	5.5
2. Confirm Reservoir	25.9	0.0	5.7	5.7
3. Prod./Inject. Wells	43.9	1.4	10.0	14.0
4. Downhole Pumps	0.0	0.0	0.0	0.0
5. Gathering Equip.	7.1	0.1	2.2	2.6
6. Make-Up Wells	0.0	0.0	0.0	0.0
7. Power Plant (Core)	53.9	2.5	16.1	23.4
8. Brine TDS Effects	7.3	0.2	2.2	2.8
9. Gas Handling	3.5	0.2	1.1	1.5
10. Reservoir Insurance	5.8	0.0	1.7	1.7

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-01-1990 - 16:03:49

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-01-1990 - 16:03:49
Base Case Costs: B & R - Surprise Valley

[From IMGEO Model]	Million $		Mills/KWhour	
ACCOUNT	Capital Cost, $	O&M Cost, $/Yr	Capital Part of System	Total Busbar Cost
TOTAL :	172.5	7.2	50.8	73.5
RISK FRACTION :	22.4	0.4	8.3	10.6
1. Identify Reservoir	8.6	0.0	1.8	1.8
2. Confirm Reservoir	11.3	0.0	2.7	2.7
3. Prod./Inject. Wells	41.1	1.6	10.1	15.4
4. Downhole Pumps	2.9	0.5	1.0	2.6
5. Gathering Equip.	17.1	0.3	5.7	6.8
6. Make-Up Wells	0.0	0.6	0.0	1.8
7. Power Plant (Core)	83.8	4.1	27.0	39.8
8. Brine TDS Effects	0.4	0.0	0.1	0.2
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	7.3	0.0	2.3	2.3

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-01-1990 - 16:03:49

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-01-1990 - 16:03:49
Base Case Costs: Cascades - 3 Creeks Butte

[From IMGEO Model] ACCOUNT	Million $ Capital Cost, $	Million $ O&M Cost, $/Yr	Mills/KWhour Capital Part of System	Mills/KWhour Total Busbar Cost
TOTAL :	140.3	3.7	35.5	46.2
RISK FRACTION :	13.8	-0.4	3.6	2.5
1. Identify Reservoir	13.5	0.0	2.7	2.7
2. Confirm Reservoir	29.1	0.0	6.5	6.5
3. Prod./Inject. Wells	45.7	0.6	10.5	12.3
4. Downhole Pumps	0.0	0.0	0.0	0.0
5. Gathering Equip.	4.5	0.1	1.4	1.7
6. Make-Up Wells	0.0	0.8	0.0	2.4
7. Power Plant (Core)	42.8	2.2	13.0	19.3
8. Brine TDS Effects	0.0	0.0	0.0	0.0
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	4.7	0.0	1.4	1.4

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-01-1990 - 16:03:49

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-01-1990 - 16:03:49
Base Case Costs: Cascades - Mt. Baker

[From IMGEO Model] ACCOUNT	Million $ Capital Cost, $	Million $ O&M Cost, $/Yr	Mills/KWhour Capital Part of System	Mills/KWhour Total Busbar Cost
TOTAL :	352.0	10.4	97.2	129.0
RISK FRACTION :	61.3	1.7	19.8	25.9
1. Identify Reservoir	40.1	0.0	8.3	8.3

2. Confirm Reservoir	24.5	0.0	5.6	5.6
3. Prod./Inject. Wells	98.1	2.7	23.3	31.6
4. Downhole Pumps	6.3	1.1	2.0	5.6
5. Gathering Equip.	43.5	0.9	14.2	16.9
6. Make-Up Wells	0.0	0.0	0.0	0.0
7. Power Plant (Core)	125.7	5.7	39.4	56.6
8. Brine TDS Effects	0.1	0.0	0.0	0.0
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	13.7	0.0	4.3	4.3

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-01-1990 - 16:03:49

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-01-1990 - 16:03:49
Base Case Costs: Y Vol. - Island Park

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ----- Capital Part of System	Total Busbar Cost
TOTAL :	107.8	5.7	29.3	46.1
RISK FRACTION :	7.5	0.3	2.1	3.0
1. Identify Reservoir	6.6	0.0	1.3	1.3
2. Confirm Reservoir	14.8	0.0	3.3	3.3
3. Prod./Inject. Wells	18.5	2.8	4.2	12.5
4. Downhole Pumps	0.0	0.0	0.0	0.0
5. Gathering Equip.	4.5	0.1	1.4	1.7
6. Make-Up Wells	0.0	0.1	0.0	0.3
7. Power Plant (Core)	48.6	2.4	14.6	21.5
8. Brine TDS Effects	7.2	0.2	2.2	2.7
9. Gas Handling	3.5	0.2	1.0	1.6
10. Reservoir Insurance	4.1	0.0	1.2	1.2

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-01-1990 - 16:03:49

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 08:46:39
Base Case Costs: Imperial Valley - Glamis

[From IMGEO Model] ACCOUNT	Million $ Capital Cost, $	Million $ O&M Cost, $/Yr	Mills/KWhour Capital Part of System	Mills/KWhour Total Busbar Cost
TOTAL :	536.2	16.0	156.1	207.3
RISK FRACTION :	110.6	2.9	37.2	48.3
1. Identify Reservoir	7.9	0.0	1.7	1.7
2. Confirm Reservoir	14.7	0.0	3.5	3.5
3. Prod./Inject. Wells	226.4	5.2	55.9	72.8
4. Downhole Pumps	10.3	1.9	3.5	9.5
5. Gathering Equip.	87.7	1.8	29.7	35.4
6. Make-Up Wells	0.0	0.0	0.0	0.0
7. Power Plant (Core)	163.9	7.2	53.5	76.0
8. Brine TDS Effects	0.9	0.0	0.3	0.3
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	24.5	0.0	8.0	8.0

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-02-1990 - 08:46:39

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

(End of Page)

GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 08:46:39
Base Case Costs: B & R - Hot Springs Ranch

[From IMGEO Model] ACCOUNT	Million $ Capital Cost, $	Million $ O&M Cost, $/Yr	Mills/KWhour Capital Part of System	Mills/KWhour Total Busbar Cost
TOTAL :	274.3	8.2	76.6	101.9
RISK FRACTION :	34.5	0.7	11.2	14.1
1. Identify Reservoir	10.4	0.0	2.2	2.2
2. Confirm Reservoir	18.9	0.0	4.4	4.4
3. Prod./Inject. Wells	100.5	2.2	24.0	30.9
4. Downhole Pumps	3.7	0.7	1.2	3.3
5. Gathering Equip.	24.7	0.5	8.1	9.6
6. Make-Up Wells	0.0	0.0	0.0	0.0
7. Power Plant (Core)	104.0	4.9	32.8	47.6
8. Brine TDS Effects	0.6	0.0	0.2	0.2
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	11.7	0.0	3.7	3.7

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-02-1990 - 08:46:39

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

(End of Page)

GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 08:46:39
Base Case Costs: Basin & Range - Wendell

[From IMGEO Model] ACCOUNT	Million $ Capital Cost, $	Million $ O&M Cost, $/Yr	Mills/KWhour Capital Part of System	Mills/KWhour Total Busbar Cost
TOTAL :	427.2	21.2	149.5	228.1
RISK FRACTION :	82.6	3.4	40.2	59.2
1. Identify Reservoir	4.8	0.0	1.2	1.2
2. Confirm Reservoir	9.4	0.0	2.6	2.6
3. Prod./Inject. Wells	123.4	4.7	35.2	52.9
4. Downhole Pumps	6.8	1.7	2.7	8.9
5. Gathering Equip.	85.5	1.7	33.4	39.9
6. Make-Up Wells	0.0	5.5	0.0	20.8
7. Power Plant (Core)	176.6	7.6	66.6	94.0
8. Brine TDS Effects	0.9	0.0	0.4	0.4
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	19.7	0.0	7.4	7.4

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-02-1990 - 08:46:39

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 08:46:39
Base Case Costs: Cascades - Kelly HS

[From IMGEO Model] ACCOUNT	Million $ Capital Cost, $	Million $ O&M Cost, $/Yr	Mills/KWhour Capital Part of System	Mills/KWhour Total Busbar Cost
TOTAL :	488.8	10.6	133.6	166.7
RISK FRACTION :	79.4	1.3	25.2	30.2
1. Identify Reservoir	16.5	0.0	3.5	3.5

2. Confirm Reservoir	29.4	0.0	6.9	6.9
3. Prod./Inject. Wells	249.2	3.0	60.5	70.2
4. Downhole Pumps	5.6	1.0	1.9	5.1
5. Gathering Equip.	40.8	0.8	13.6	16.2
6. Make-Up Wells	0.0	0.0	0.0	0.0
7. Power Plant (Core)	126.0	5.7	40.4	58.0
8. Brine TDS Effects	0.1	0.0	0.0	0.1
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	21.1	0.0	6.8	6.8

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-02-1990 - 08:46:39

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 08:46:39
New Techology Costs: B & R - Vale

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ----- Capital Part of System	Total Busbar Cost
TOTAL :	215.7	8.5	62.8	88.9
RISK FRACTION :	37.6	1.2	12.4	16.9
1. Identify Reservoir	5.3	0.0	1.1	1.1
2. Confirm Reservoir	10.1	0.0	2.4	2.4
3. Prod./Inject. Wells	58.2	2.4	13.9	21.5
4. Downhole Pumps	4.3	0.8	1.4	3.9
5. Gathering Equip.	27.7	0.6	9.1	10.8
6. Make-Up Wells	0.0	0.0	0.0	0.0
7. Power Plant (Core)	100.5	4.8	31.8	46.3
8. Brine TDS Effects	0.1	0.0	0.0	0.0
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	9.5	0.0	3.0	3.0

IM-GEO: SENSITIVITY FACTORS IN EFFECT . 08-02-1990 - 08:46:39

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 08:46:39
Base Case Costs: Y. Vol. - Sespe HS

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ----- Capital Part of System	Total Busbar Cost
TOTAL :	629.1	22.2	192.5	265.0
RISK FRACTION :	179.6	5.6	61.5	82.6
1. Identify Reservoir	4.3	0.0	1.0	1.0
2. Confirm Reservoir	8.6	0.0	2.1	2.1
3. Prod./Inject. Wells	213.7	7.5	53.7	78.7
4. Downhole Pumps	15.4	2.8	5.3	14.6
5. Gathering Equip.	150.0	3.0	51.7	61.6
6. Make-Up Wells	0.0	0.0	0.0	0.0
7. Power Plant (Core)	207.5	8.9	68.9	97.3
8. Brine TDS Effects	0.2	0.0	0.1	0.1
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	29.3	0.0	9.7	9.7

IM-GEO: SENSITIVITY FACTORS IN EFFECT   08-02-1990 - 08:46:39

R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

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A REPORT FROM THE IM-GEO PROGRAM

GEOTHERMAL COST OF POWER ESTIMATE RUN : 08-08-1990 - 11:45:11
BASE CASE COSTS: SITE = Deep fractures - Paradise

[From IM-GEO 3.05]	-- Costs ---		------ Cents / KWhour -----			
ACCOUNT	CAP. $M	O&M $M/YR	CAP. PART	O&M PART	TOTAL COST	TOTAL % CHG
TOTAL :	414.9	13.3	11.46	4.13	15.60	0.0
RISK FRACTION :	39.7	1.4	1.34	0.52	1.86	0.0
1. Identify Reservoir	36.4	0.0	0.76	0.00	0.76	0.0
2. Confirm Reservoir	27.9	0.0	0.65	0.00	0.65	0.0
3. Prod./Inject. Wells	135.2	2.6	3.22	0.81	4.03	0.0
4. Downhole Pumps	5.0	0.9	0.16	0.29	0.45	0.0
5. Gathering Equip.	34.9	0.7	1.14	0.22	1.36	0.0
6. Make-Up Wells	0.0	5.0	0.00	1.57	1.57	0.0
7. Power Plant (Core)	158.2	4.1	4.98	1.25	6.23	0.0
8. Brine TDS Effects	0.7	0.0	0.02	0.00	0.03	0.0
9. Gas Handling	0.0	0.0	0.00	0.00	0.00	0.0
10. Reservoir Insurance	16.7	0.0	0.53	0.00	0.53	0.0

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A REPORT FROM THE IM-GEO PROGRAM

GEOTHERMAL COST OF POWER ESTIMATE RUN : 08-08-1990 - 11:45:11
BASE CASE COSTS: SITE = Deep fractures - Routt HS

[From IM-GEO 3.05]	-- Costs ---		------ Cents / KWhour -----			
ACCOUNT	CAP. $M	O&M $M/YR	CAP. PART	O&M PART	TOTAL COST	TOTAL % CHG
TOTAL :	460.5	15.5	13.14	4.87	18.01	0.0
RISK FRACTION :	47.1	1.7	1.70	0.67	2.37	0.0
1. Identify Reservoir	29.2	0.0	0.62	0.00	0.62	0.0
2. Confirm Reservoir	22.8	0.0	0.53	0.00	0.53	0.0
3. Prod./Inject. Wells	143.3	3.3	3.46	1.04	4.50	0.0
4. Downhole Pumps	6.7	1.2	0.22	0.39	0.61	0.0
5. Gathering Equip.	50.8	1.0	1.68	0.32	2.00	0.0
6. Make-Up Wells	0.0	5.2	0.00	1.66	1.66	0.0
7. Power Plant (Core)	187.4	4.7	5.97	1.45	7.43	0.0
8. Brine TDS Effects	0.9	0.0	0.03	0.00	0.03	0.0
9. Gas Handling	0.0	0.0	0.00	0.00	0.00	0.0
10. Reservoir Insurance	19.5	0.0	0.62	0.00	0.62	0.0

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A REPORT FROM THE IM-GEO PROGRAM

GEOTHERMAL COST OF POWER ESTIMATE RUN : 08-08-1990 - 11:45:11
BASE CASE COSTS: SITE = Basin & Range - Power Ran

[From IM-GEO 3.05]	-- Costs ---		------ Cents / KWhour -----			
ACCOUNT	CAP. $M	O&M $M/YR	CAP. PART	O&M PART	TOTAL COST	TOTAL % CHG
TOTAL :	180.6	4.6	4.77	1.36	6.13	0.0
RISK FRACTION :	5.9	0.2	0.21	0.07	0.28	0.0
1. Identify Reservoir	41.0	0.0	0.83	0.00	0.83	0.0
2. Confirm Reservoir	30.4	0.0	0.68	0.00	0.68	0.0
3. Prod./Inject. Wells	13.2	0.9	0.31	0.27	0.58	0.0
4. Downhole Pumps	0.8	0.1	0.02	0.04	0.07	0.0
5. Gathering Equip.	4.4	0.1	0.14	0.03	0.16	0.0
6. Make-Up Wells	0.0	0.9	0.00	0.27	0.27	0.0
7. Power Plant (Core)	85.4	2.6	2.61	0.75	3.36	0.0
8. Brine TDS Effects	0.3	0.0	0.01	0.00	0.01	0.0
9. Gas Handling	0.0	0.0	0.00	0.00	0.00	0.0
10. Reservoir Insurance	5.2	0.0	0.16	0.00	0.16	0.0

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A REPORT FROM THE IM-GEO PROGRAM

GEOTHERMAL COST OF POWER ESTIMATE RUN : 08-08-1990 - 11:45:11
BASE CASE COSTS: SITE = Rio Grande Rift - Wuanita

[From IM-GEO 3.05]	-- Costs ---		------ Cents / KWhour -----			
ACCOUNT	CAP. $M	O&M $M/YR	CAP. PART	O&M PART	TOTAL COST	TOTAL % CHG
TOTAL :	263.2	8.7	7.56	2.67	10.23	0.0
RISK FRACTION :	18.0	0.7	0.67	0.26	0.93	0.0
1. Identify Reservoir	20.0	0.0	0.42	0.00	0.42	0.0
2. Confirm Reservoir	15.3	0.0	0.35	0.00	0.35	0.0
3. Prod./Inject. Wells	48.4	2.0	1.15	0.61	1.76	0.0
4. Downhole Pumps	3.6	0.7	0.12	0.20	0.32	0.0
5. Gathering Equip.	23.4	0.5	0.76	0.15	0.90	0.0
6. Make-Up Wells	0.0	1.9	0.00	0.58	0.58	0.0
7. Power Plant (Core)	141.0	3.8	4.41	1.13	5.54	0.0
8. Brine TDS Effects	0.6	0.0	0.02	0.00	0.02	0.0
9. Gas Handling	0.0	0.0	0.00	0.00	0.00	0.0
10. Reservoir Insurance	10.9	0.0	0.34	0.00	0.34	0.0

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A REPORT FROM THE IM-GEO PROGRAM

GEOTHERMAL COST OF POWER ESTIMATE RUN : 08-08-1990 - 11:45:11
BASE CASE COSTS: SITE = Rio Grande Rift - Valles

[From IM-GEO 3.05]	-- Costs ---		------ Cents / KWhour -----			
ACCOUNT	CAP. $M	O&M $M/YR	CAP. PART	O&M PART	TOTAL COST	TOTAL % CHG
TOTAL :	135.9	4.9	3.44	1.44	4.87	0.0
RISK FRACTION :	11.9	0.4	0.29	0.11	0.40	0.0
1. Identify Reservoir	10.4	0.0	0.21	0.00	0.21	0.0
2. Confirm Reservoir	27.9	0.0	0.61	0.00	0.61	0.0
3. Prod./Inject. Wells	42.8	1.0	0.97	0.31	1.28	0.0
4. Downhole Pumps	0.0	0.0	0.00	0.00	0.00	0.0
5. Gathering Equip.	4.3	0.1	0.13	0.03	0.16	0.0
6. Make-Up Wells	0.0	2.0	0.00	0.59	0.59	0.0
7. Power Plant (Core)	34.6	1.4	1.04	0.41	1.45	0.0
8. Brine TDS Effects	7.1	0.2	0.21	0.05	0.26	0.0
9. Gas Handling	4.3	0.2	0.13	0.05	0.18	0.0
10. Reservoir Insurance	4.7	0.0	0.14	0.00	0.14	0.0

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A REPORT FROM THE IM-GEO PROGRAM

GEOTHERMAL COST OF POWER ESTIMATE RUN : 08-08-1990 - 11:45:11
BASE CASE COSTS: SITE = Rio Grande Rift - Lower

[From IM-GEO 3.05]	-- Costs ---		------ Cents / KWhour -----			
ACCOUNT	CAP. $M	O&M $M/YR	CAP. PART	O&M PART	TOTAL COST	TOTAL % CHG
TOTAL :	567.4	20.5	17.00	6.61	23.61	0.0
RISK FRACTION :	74.2	2.8	2.83	1.13	3.96	0.0
1. Identify Reservoir	21.6	0.0	0.47	0.00	0.47	0.0
2. Confirm Reservoir	16.5	0.0	0.40	0.00	0.40	0.0
3. Prod./Inject. Wells	161.1	5.2	3.98	1.69	5.68	0.0
4. Downhole Pumps	10.2	1.9	0.35	0.60	0.95	0.0
5. Gathering Equip.	88.8	1.8	3.01	0.58	3.59	0.0
6. Make-Up Wells	0.0	5.7	0.00	1.86	1.86	0.0
7. Power Plant (Core)	242.8	5.9	7.93	1.86	9.80	0.0
8. Brine TDS Effects	1.1	0.0	0.04	0.01	0.04	0.0
9. Gas Handling	0.0	0.0	0.00	0.00	0.00	0.0
10. Reservoir Insurance	25.2	0.0	0.82	0.00	0.82	0.0

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A REPORT FROM THE IM-GEO PROGRAM

GEOTHERMAL COST OF POWER ESTIMATE RUN : 08-08-1990 - 11:45:11
BASE CASE COSTS: SITE = Young Volcanics - Puna

[From IM-GEO 3.05] ACCOUNT	-- Costs --- CAP. $M	O&M $M/YR	------ Cents / KWhour ----- CAP. PART	O&M PART	TOTAL COST	TOTAL % CHG
TOTAL :	136.1	9.4	3.48	2.78	6.26	0.0
RISK FRACTION :	8.8	0.7	0.22	0.22	0.44	0.0
1. Identify Reservoir	9.2	0.0	0.18	0.00	0.18	0.0
2. Confirm Reservoir	15.5	0.0	0.34	0.00	0.34	0.0
3. Prod./Inject. Wells	54.3	5.1	1.23	1.53	2.76	0.0
4. Downhole Pumps	0.0	0.0	0.00	0.00	0.00	0.0
5. Gathering Equip.	10.2	0.2	0.32	0.06	0.38	0.0
6. Make-Up Wells	0.0	2.3	0.00	0.68	0.68	0.0
7. Power Plant (Core)	30.3	1.3	0.91	0.39	1.29	0.0
8. Brine TDS Effects	7.1	0.2	0.21	0.07	0.28	0.0
9. Gas Handling	4.2	0.2	0.13	0.05	0.18	0.0
10. Reservoir Insurance	5.3	0.0	0.16	0.00	0.16	0.0

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A REPORT FROM THE IM-GEO PROGRAM

GEOTHERMAL COST OF POWER ESTIMATE RUN : 08-08-1990 - 11:45:11
BASE CASE COSTS: SITE = Young Volcanics - SW Rift

[From IM-GEO 3.05] ACCOUNT	-- Costs --- CAP. $M	O&M $M/YR	------ Cents / KWhour ----- CAP. PART	O&M PART	TOTAL COST	TOTAL % CHG
TOTAL :	121.9	14.0	3.23	4.15	7.38	0.0
RISK FRACTION :	6.9	1.1	0.18	0.35	0.53	0.0
1. Identify Reservoir	5.1	0.0	0.10	0.00	0.10	0.0
2. Confirm Reservoir	8.8	0.0	0.19	0.00	0.19	0.0
3. Prod./Inject. Wells	43.0	6.9	0.97	2.05	3.02	0.0
4. Downhole Pumps	0.0	0.0	0.00	0.00	0.00	0.0
5. Gathering Equip.	15.4	0.3	0.48	0.09	0.57	0.0
6. Make-Up Wells	0.0	4.9	0.00	1.47	1.47	0.0
7. Power Plant (Core)	33.1	1.4	0.99	0.40	1.39	0.0
8. Brine TDS Effects	7.2	0.3	0.22	0.08	0.29	0.0
9. Gas Handling	4.3	0.2	0.13	0.05	0.18	0.0
10. Reservoir Insurance	5.1	0.0	0.15	0.00	0.15	0.0

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INCREASED RATE OF TECHNOLOGY IMPROVEMENT

GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 19:02:08
New Techology Costs: Imperial Valley - Brawley

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ----- Capital Part of System	Total Busbar Cost
TOTAL :	110.0	6.8	29.8	49.5
RISK FRACTION :	5.7	0.3	1.5	2.4
1. Identify Reservoir	4.5	0.0	0.9	0.9
2. Confirm Reservoir	14.3	0.0	3.2	3.2
3. Prod./Inject. Wells	21.6	1.7	4.9	10.0
4. Downhole Pumps	0.0	0.0	0.0	0.0
5. Gathering Equip.	5.3	0.2	1.6	2.3
6. Make-Up Wells	0.0	0.0	0.0	0.0
7. Power Plant (Core)	41.6	2.2	12.4	18.7
8. Brine TDS Effects	15.3	2.5	4.6	11.6
9. Gas Handling	3.1	0.2	0.9	1.5
10. Reservoir Insurance	4.3	0.0	1.3	1.3

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-02-1990 - 19:02:08

R&D Achvmt: Wildcat Success Ratio	: 1.20
R&D Achvmt: Confirm. Success Ratio	: 1.25
R&D Achvmt: Testing Costs, Confirm	: 0.75
R&D Achvmt: Dry Holes / Producer	: 0.85
R&D Achvmt: Testing Costs, Producer	: 0.75
R&D Achvmt: BASE Cost, Average Well	: 0.80
R&D Achvmt: Cap.Cost, Deep Well Pump	: 0.75
R&D Achvmt: O&M Cost, Deep Well Pump	: 0.80
R&D Achvmt: Workover Interval, Prod.	: 0.50
R&D Achvmt: Workover Interval, Injc.	: 0.50
R&D Achvmt: FLASH Plant - Efficiency	: 1.05
R&D Achvmt: FLASH Plant - Capital Cost	: 0.95
R&D Achvmt: BINARY Plant - Efficiency	: 1.20
R&D Achvmt: BINARY Plant - Capital Cost	: 0.76
R&D Achvmt: TDS-Clarifier, Capital Cost	: 0.90
R&D Achvmt: TDS-Clarifier, O&M Cost	: 0.80
R&D Achvmt: H2S Treatment, Capital Cost	: 0.80

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 19:02:08
New Techology Costs: B & R - Roosevelt HS.

[From IMGEO Model]	----- Million $ ------ Capital Cost,	O&M Cost,	---- Mills/KWhour ----- Capital Part of	Total Busbar

ACCOUNT	$	$/Yr	System	Cost
TOTAL :	83.0	3.3	22.5	31.9
RISK FRACTION :	3.8	-0.1	1.0	0.8
1. Identify Reservoir	8.7	0.0	1.7	1.7
2. Confirm Reservoir	15.4	0.0	3.4	3.4
3. Prod./Inject. Wells	4.0	0.6	0.9	2.7
4. Downhole Pumps	0.0	0.0	0.0	0.0
5. Gathering Equip.	2.0	0.0	0.6	0.8
6. Make-Up Wells	0.0	0.1	0.0	0.4
7. Power Plant (Core)	40.9	2.2	12.2	18.5
8. Brine TDS Effects	6.5	0.2	1.9	2.4
9. Gas Handling	2.7	0.1	0.8	1.2
10. Reservoir Insurance	2.8	0.0	0.8	0.8

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-02-1990 - 19:02:08

R&D Achvmt: Wildcat Success Ratio	: 1.20
R&D Achvmt: Confirm. Success Ratio	: 1.25
R&D Achvmt: Testing Costs, Confirm	: 0.75
R&D Achvmt: Dry Holes / Producer	: 0.85
R&D Achvmt: Testing Costs, Producer	: 0.75
R&D Achvmt: BASE Cost, Average Well	: 0.80
R&D Achvmt: Cap.Cost, Deep Well Pump	: 0.75
R&D Achvmt: O&M Cost, Deep Well Pump	: 0.80
R&D Achvmt: Workover Interval, Prod.	: 0.50
R&D Achvmt: Workover Interval, Injc.	: 0.50
R&D Achvmt: FLASH Plant - Efficiency	: 1.05
R&D Achvmt: FLASH Plant - Capital Cost	: 0.95
R&D Achvmt: BINARY Plant - Efficiency	: 1.20
R&D Achvmt: BINARY Plant - Capital Cost	: 0.76
R&D Achvmt: TDS-Clarifier, Capital Cost	: 0.90
R&D Achvmt: TDS-Clarifier, O&M Cost	: 0.80
R&D Achvmt: H2S Treatment, Capital Cost	: 0.80

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 19:02:08
New Techology Costs: B & R - Cove Fort

[From IMGEO Model]	----- Million $ ------		---- Mills/KWhour -----	
ACCOUNT	Capital Cost, $	O&M Cost, $/Yr	Capital Part of System	Total Busbar Cost
TOTAL :	124.6	5.7	37.2	54.9
RISK FRACTION :	11.6	0.1	4.6	5.6
1. Identify Reservoir	5.9	0.0	1.3	1.3
2. Confirm Reservoir	8.2	0.0	1.9	1.9
3. Prod./Inject. Wells	18.9	0.8	4.6	7.2
4. Downhole Pumps	1.3	0.2	0.4	1.2
5. Gathering Equip.	9.6	0.2	3.2	3.8

6. Make-Up Wells	0.0	0.6	0.0	2.0
7. Power Plant (Core)	75.1	3.8	24.0	35.6
8. Brine TDS Effects	0.4	0.0	0.1	0.1
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	5.3	0.0	1.7	1.7

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-02-1990 - 19:02:08

R&D Achvmt: Wildcat Success Ratio	:	1.20
R&D Achvmt: Confirm. Success Ratio	:	1.25
R&D Achvmt: Testing Costs, Confirm	:	0.75
R&D Achvmt: Dry Holes / Producer	:	0.85
R&D Achvmt: Testing Costs, Producer	:	0.75
R&D Achvmt: BASE Cost, Average Well	:	0.80
R&D Achvmt: Cap.Cost, Deep Well Pump	:	0.75
R&D Achvmt: O&M Cost, Deep Well Pump	:	0.80
R&D Achvmt: Workover Interval, Prod.	:	0.50
R&D Achvmt: Workover Interval, Injc.	:	0.50
R&D Achvmt: FLASH Plant - Efficiency	:	1.05
R&D Achvmt: FLASH Plant - Capital Cost	:	0.95
R&D Achvmt: BINARY Plant - Efficiency	:	1.20
R&D Achvmt: BINARY Plant - Capital Cost	:	0.76
R&D Achvmt: TDS-Clarifier, Capital Cost	:	0.90
R&D Achvmt: TDS-Clarifier, O&M Cost	:	0.80
R&D Achvmt: H2S Treatment, Capital Cost	:	0.80

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 19:02:08
New Techology Costs: Cascades - Newberry

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ----- Capital Part of System	Total Busbar Cost
TOTAL :	128.8	3.6	33.2	43.9
RISK FRACTION :	13.6	-0.4	3.6	2.5
1. Identify Reservoir	7.5	0.0	1.5	1.5
2. Confirm Reservoir	22.6	0.0	5.0	5.0
3. Prod./Inject. Wells	45.4	0.5	10.4	12.1
4. Downhole Pumps	0.0	0.0	0.0	0.0
5. Gathering Equip.	5.3	0.1	1.7	2.0
6. Make-Up Wells	0.0	0.7	0.0	2.1
7. Power Plant (Core)	43.2	2.3	13.1	19.7
8. Brine TDS Effects	0.0	0.0	0.0	0.0
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	4.7	0.0	1.4	1.4

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-02-1990 - 19:02:08

R&D Achvmt: Wildcat Success Ratio : 1.20

R&D Achvmt: Confirm. Success Ratio	:	1.25
R&D Achvmt: Testing Costs, Confirm	:	0.75
R&D Achvmt: Dry Holes / Producer	:	0.85
R&D Achvmt: Testing Costs, Producer	:	0.75
R&D Achvmt: BASE Cost, Average Well	:	0.80
R&D Achvmt: Cap.Cost, Deep Well Pump	:	0.75
R&D Achvmt: O&M Cost, Deep Well Pump	:	0.80
R&D Achvmt: Workover Interval, Prod.	:	0.50
R&D Achvmt: Workover Interval, Injc.	:	0.50
R&D Achvmt: FLASH Plant - Efficiency	:	1.05
R&D Achvmt: FLASH Plant - Capital Cost	:	0.95
R&D Achvmt: BINARY Plant - Efficiency	:	1.20
R&D Achvmt: BINARY Plant - Capital Cost	:	0.76
R&D Achvmt: TDS-Clarifier, Capital Cost	:	0.90
R&D Achvmt: TDS-Clarifier, O&M Cost	:	0.80
R&D Achvmt: H2S Treatment, Capital Cost	:	0.80

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 19:02:08
New Techology Costs: Y Vol. - Long Valley HT

[From IMGEO Model] ACCOUNT	Million $: Capital Cost, $	Million $: O&M Cost, $/Yr	Mills/KWhour: Capital Part of System	Mills/KWhour: Total Busbar Cost
TOTAL :	108.0	7.8	29.5	52.2
RISK FRACTION :	6.1	0.2	1.6	2.4
1. Identify Reservoir	5.2	0.0	1.0	1.0
2. Confirm Reservoir	12.6	0.0	2.8	2.8
3. Prod./Inject. Wells	20.3	1.8	4.6	10.0
4. Downhole Pumps	0.0	0.0	0.0	0.0
5. Gathering Equip.	5.7	0.2	1.8	2.5
6. Make-Up Wells	0.0	0.1	0.0	0.3
7. Power Plant (Core)	41.6	2.2	12.5	18.8
8. Brine TDS Effects	15.6	3.3	4.7	14.1
9. Gas Handling	2.7	0.2	0.8	1.4
10. Reservoir Insurance	4.3	0.0	1.3	1.3

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-02-1990 - 19:02:08

R&D Achvmt: Wildcat Success Ratio	:	1.20
R&D Achvmt: Confirm. Success Ratio	:	1.25
R&D Achvmt: Testing Costs, Confirm	:	0.75
R&D Achvmt: Dry Holes / Producer	:	0.85
R&D Achvmt: Testing Costs, Producer	:	0.75
R&D Achvmt: BASE Cost, Average Well	:	0.80
R&D Achvmt: Cap.Cost, Deep Well Pump	:	0.75
R&D Achvmt: O&M Cost, Deep Well Pump	:	0.80
R&D Achvmt: Workover Interval, Prod.	:	0.50
R&D Achvmt: Workover Interval, Injc.	:	0.50
R&D Achvmt: FLASH Plant - Efficiency	:	1.05

R&D Achvmt: FLASH Plant - Capital Cost : 0.95
R&D Achvmt: BINARY Plant - Efficiency : 1.20
R&D Achvmt: BINARY Plant - Capital Cost : 0.76
R&D Achvmt: TDS-Clarifier, Capital Cost : 0.90
R&D Achvmt: TDS-Clarifier, O&M Cost : 0.80
R&D Achvmt: H2S Treatment, Capital Cost : 0.80

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 19:02:08
New Techology Costs: Y Vol. - Long Valley HT

[From IMGEO Model] ACCOUNT	Million $: Capital Cost, $	Million $: O&M Cost, $/Yr	Mills/KWhour: Capital Part of System	Mills/KWhour: Total Busbar Cost
TOTAL :	108.0	7.8	29.5	52.2
RISK FRACTION :	6.1	0.2	1.6	2.4
1. Identify Reservoir	5.2	0.0	1.0	1.0
2. Confirm Reservoir	12.6	0.0	2.8	2.8
3. Prod./Inject. Wells	20.3	1.8	4.6	10.0
4. Downhole Pumps	0.0	0.0	0.0	0.0
5. Gathering Equip.	5.7	0.2	1.8	2.5
6. Make-Up Wells	0.0	0.1	0.0	0.3
7. Power Plant (Core)	41.6	2.2	12.5	18.8
8. Brine TDS Effects	15.6	3.3	4.7	14.1
9. Gas Handling	2.7	0.2	0.8	1.4
10. Reservoir Insurance	4.3	0.0	1.3	1.3

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-02-1990 - 19:02:08

R&D Achvmt: Wildcat Success Ratio : 1.20
R&D Achvmt: Confirm. Success Ratio : 1.25
R&D Achvmt: Testing Costs, Confirm : 0.75
R&D Achvmt: Dry Holes / Producer : 0.85
R&D Achvmt: Testing Costs, Producer : 0.75
R&D Achvmt: BASE Cost, Average Well : 0.80
R&D Achvmt: Cap.Cost, Deep Well Pump : 0.75
R&D Achvmt: O&M Cost, Deep Well Pump : 0.80
R&D Achvmt: Workover Interval, Prod. : 0.50
R&D Achvmt: Workover Interval, Injc. : 0.50
R&D Achvmt: FLASH Plant - Efficiency : 1.05
R&D Achvmt: FLASH Plant - Capital Cost : 0.95
R&D Achvmt: BINARY Plant - Efficiency : 1.20
R&D Achvmt: BINARY Plant - Capital Cost : 0.76
R&D Achvmt: TDS-Clarifier, Capital Cost : 0.90
R&D Achvmt: TDS-Clarifier, O&M Cost : 0.80
R&D Achvmt: H2S Treatment, Capital Cost : 0.80

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 18:47:58
New Techology Costs: Y. Vol.- Buckeye HS

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ----- Capital Part of System	Total Busbar Cost
TOTAL :	582.3	20.7	173.2	240.3
RISK FRACTION :	102.1	2.1	34.9	43.7
1. Identify Reservoir	5.4	0.0	1.2	1.2
2. Confirm Reservoir	13.3	0.0	3.2	3.2
3. Prod./Inject. Wells	235.1	2.9	58.9	68.3
4. Downhole Pumps	7.4	1.4	2.5	7.3
5. Gathering Equip.	92.2	1.8	31.6	37.7
6. Make-Up Wells	0.0	6.0	0.0	19.7
7. Power Plant (Core)	201.8	8.6	66.7	93.9
8. Brine TDS Effects	0.2	0.0	0.1	0.1
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	26.8	0.0	8.9	8.9

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-02-1990 - 18:47:58

R&D Achvmt: Wildcat Success Ratio	: 1.20
R&D Achvmt: Confirm. Success Ratio	: 1.25
R&D Achvmt: Testing Costs, Confirm	: 0.75
R&D Achvmt: Dry Holes / Producer	: 0.85
R&D Achvmt: Testing Costs, Producer	: 0.75
R&D Achvmt: BASE Cost, Average Well	: 0.80
R&D Achvmt: Cap.Cost, Deep Well Pump	: 0.75
R&D Achvmt: O&M Cost, Deep Well Pump	: 0.80
R&D Achvmt: Workover Interval, Prod.	: 0.50
R&D Achvmt: Workover Interval, Injc.	: 0.50
R&D Achvmt: FLASH Plant - Efficiency	: 1.05
R&D Achvmt: FLASH Plant - Capital Cost	: 0.95
R&D Achvmt: BINARY Plant - Efficiency	: 1.20
R&D Achvmt: BINARY Plant - Capital Cost	: 0.76

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 18:47:58
New Techology Costs: Imperial Valley - Glamis

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ----- Capital Part of System	Total Busbar Cost
TOTAL :	450.1	[illegible]	[illegible]	[illegible]

RISK FRACTION :	93.4	1.8	31.4	38.4
1. Identify Reservoir	4.5	0.0	1.0	1.0
2. Confirm Reservoir	11.0	0.0	2.6	2.6
3. Prod./Inject. Wells	172.5	2.6	42.4	50.9
4. Downhole Pumps	7.0	1.4	2.4	6.8
5. Gathering Equip.	76.2	1.5	25.7	30.6
6. Make-Up Wells	0.0	0.3	0.0	0.9
7. Power Plant (Core)	157.4	6.9	51.1	72.8
8. Brine TDS Effects	0.9	0.0	0.3	0.3
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	20.7	0.0	6.7	6.7

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-02-1990 - 18:47:58

R&D Achvmt: Wildcat Success Ratio	:	1.20
R&D Achvmt: Confirm. Success Ratio	:	1.25
R&D Achvmt: Testing Costs, Confirm	:	0.75
R&D Achvmt: Dry Holes / Producer	:	0.85
R&D Achvmt: Testing Costs, Producer	:	0.75
R&D Achvmt: BASE Cost, Average Well	:	0.80
R&D Achvmt: Cap.Cost, Deep Well Pump	:	0.75
R&D Achvmt: O&M Cost, Deep Well Pump	:	0.80
R&D Achvmt: Workover Interval, Prod.	:	0.50
R&D Achvmt: Workover Interval, Injc.	:	0.50
R&D Achvmt: FLASH Plant - Efficiency	:	1.05
R&D Achvmt: FLASH Plant - Capital Cost	:	0.95
R&D Achvmt: BINARY Plant - Efficiency	:	1.20
R&D Achvmt: BINARY Plant - Capital Cost	:	0.76

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 18:47:58
New Techology Costs: B & R - Hot Springs Ranch

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ----- Capital Part of System	Total Busbar Cost
TOTAL :	274.8	7.8	77.8	102.0
RISK FRACTION :	42.5	0.6	13.7	16.2
1. Identify Reservoir	5.9	0.0	1.2	1.2
2. Confirm Reservoir	14.3	0.0	3.3	3.3
3. Prod./Inject. Wells	101.4	1.5	24.3	28.9
4. Downhole Pumps	3.3	0.6	1.1	3.1
5. Gathering Equip.	28.8	0.6	9.5	11.3
6. Make-Up Wells	0.0	0.1	0.0	0.4
7. Power Plant (Core)	108.4	5.0	34.3	49.7
8. Brine TDS Effects	0.6	0.0	0.2	0.2
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	12.1	0.0	3.8	3.8

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-02-1990 - 18:47:58

R&D Achvmt: Wildcat Success Ratio	:	1.20
R&D Achvmt: Confirm. Success Ratio	:	1.25
R&D Achvmt: Testing Costs, Confirm	:	0.75
R&D Achvmt: Dry Holes / Producer	:	0.85
R&D Achvmt: Testing Costs, Producer	:	0.75
R&D Achvmt: BASE Cost, Average Well	:	0.80
R&D Achvmt: Cap.Cost, Deep Well Pump	:	0.75
R&D Achvmt: O&M Cost, Deep Well Pump	:	0.80
R&D Achvmt: Workover Interval, Prod.	:	0.50
R&D Achvmt: Workover Interval, Injc.	:	0.50
R&D Achvmt: FLASH Plant - Efficiency	:	1.05
R&D Achvmt: FLASH Plant - Capital Cost	:	0.95
R&D Achvmt: BINARY Plant - Efficiency	:	1.20
R&D Achvmt: BINARY Plant - Capital Cost	:	0.76

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 18:47:58
New Techology Costs: Basin & Range - Wendell

[From IMGEO Model] ACCOUNT	Million $: Capital Cost, $	Million $: O&M Cost, $/Yr	Mills/KWhour: Capital Part of System	Mills/KWhour: Total Busbar Cost
TOTAL :	368.2	12.7	109.6	149.0
RISK FRACTION :	62.0	1.7	22.3	29.1
1. Identify Reservoir	2.7	0.0	0.6	0.6
2. Confirm Reservoir	7.0	0.0	1.6	1.6
3. Prod./Inject. Wells	102.1	2.6	24.7	33.0
4. Downhole Pumps	3.9	1.0	1.3	4.5
5. Gathering Equip.	71.3	1.4	23.6	28.1
6. Make-Up Wells	0.0	0.5	0.0	1.7
7. Power Plant (Core)	163.2	7.0	52.1	73.7
8. Brine TDS Effects	0.9	0.0	0.3	0.3
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	17.1	0.0	5.4	5.4

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-02-1990 - 18:47:58

R&D Achvmt: Wildcat Success Ratio	:	1.20
R&D Achvmt: Confirm. Success Ratio	:	1.25
R&D Achvmt: Testing Costs, Confirm	:	0.75
R&D Achvmt: Dry Holes / Producer	:	0.85
R&D Achvmt: Testing Costs, Producer	:	0.75
R&D Achvmt: BASE Cost, Average Well	:	0.80
R&D Achvmt: Cap.Cost, Deep Well Pump	:	0.75
R&D Achvmt: O&M Cost, Deep Well Pump	:	0.80
R&D Achvmt: Workover Interval, Prod.	:	0.50
R&D Achvmt: Workover Interval, Injc.	:	0.50

R&D Achvmt: FLASH Plant - Efficiency : 1.05
R&D Achvmt: FLASH Plant - Capital Cost : 0.95
R&D Achvmt: BINARY Plant - Efficiency : 1.20
R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 18:47:58
New Techology Costs: Cascades - Kelly HS

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ----- Capital Part of System	Total Busbar Cost
TOTAL :	440.1	9.4	122.0	151.5
RISK FRACTION :	79.1	0.8	25.0	28.4
1. Identify Reservoir	9.3	0.0	2.0	2.0
2. Confirm Reservoir	22.4	0.0	5.3	5.3
3. Prod./Inject. Wells	216.2	1.8	52.5	58.2
4. Downhole Pumps	4.3	0.8	1.4	4.1
5. Gathering Equip.	41.1	0.8	13.7	16.3
6. Make-Up Wells	0.0	0.2	0.0	0.7
7. Power Plant (Core)	127.3	5.8	40.9	58.6
8. Brine TDS Effects	0.1	0.0	0.0	0.1
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	19.5	0.0	6.2	6.2

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-02-1990 - 18:47:58

R&D Achvmt: Wildcat Success Ratio : 1.20
R&D Achvmt: Confirm. Success Ratio : 1.25
R&D Achvmt: Testing Costs, Confirm : 0.75
R&D Achvmt: Dry Holes / Producer : 0.85
R&D Achvmt: Testing Costs, Producer : 0.75
R&D Achvmt: BASE Cost, Average Well : 0.80
R&D Achvmt: Cap.Cost, Deep Well Pump : 0.75
R&D Achvmt: O&M Cost, Deep Well Pump : 0.80
R&D Achvmt: Workover Interval, Prod. : 0.50
R&D Achvmt: Workover Interval, Injc. : 0.50
R&D Achvmt: FLASH Plant - Efficiency : 1.05
R&D Achvmt: FLASH Plant - Capital Cost : 0.95
R&D Achvmt: BINARY Plant - Efficiency : 1.20
R&D Achvmt: BINARY Plant - Capital Cost : 0.76

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 18:47:58
New Techology Costs: B & R - Vale

[From IMGEO Model] ACCOUNT	Million $ Capital Cost, $	Million $ O&M Cost, $/Yr	Mills/KWhour Capital Part of System	Mills/KWhour Total Busbar Cost
TOTAL :	170.2	6.7	50.3	70.7
RISK FRACTION :	25.8	0.6	8.7	11.2
1. Identify Reservoir	3.0	0.0	0.6	0.6
2. Confirm Reservoir	7.6	0.0	1.8	1.8
3. Prod./Inject. Wells	35.0	1.2	8.3	12.0
4. Downhole Pumps	2.5	0.5	0.8	2.4
5. Gathering Equip.	19.4	0.4	6.4	7.6
6. Make-Up Wells	0.0	0.1	0.0	0.2
7. Power Plant (Core)	95.0	4.5	29.9	43.7
8. Brine TDS Effects	0.1	0.0	0.0	0.0
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	7.6	0.0	2.4	2.4

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-02-1990 - 18:47:58

R&D Achvmt: Wildcat Success Ratio	1.20
R&D Achvmt: Confirm. Success Ratio	1.25
R&D Achvmt: Testing Costs, Confirm	0.75
R&D Achvmt: Dry Holes / Producer	0.85
R&D Achvmt: Testing Costs, Producer	0.75
R&D Achvmt: BASE Cost, Average Well	0.80
R&D Achvmt: Cap.Cost, Deep Well Pump	0.75
R&D Achvmt: O&M Cost, Deep Well Pump	0.80
R&D Achvmt: Workover Interval, Prod.	0.50
R&D Achvmt: Workover Interval, Injc.	0.50
R&D Achvmt: FLASH Plant - Efficiency	1.05
R&D Achvmt: FLASH Plant - Capital Cost	0.95
R&D Achvmt: BINARY Plant - Efficiency	1.20
R&D Achvmt: BINARY Plant - Capital Cost	0.76

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 18:47:58
New Techology Costs: Y. Vol. - Wilbur HS

[From IMGEO Model] ACCOUNT	Million $ Capital Cost, $	Million $ O&M Cost, $/Yr	Mills/KWhour Capital Part of System	Mills/KWhour Total Busbar Cost
TOTAL :	243.8	7.8	69.9	93.7
RISK FRACTION :	37.9	0.6	12.0	14.5
1. Identify Reservoir	4.6	0.0	1.0	1.0

2. Confirm Reservoir	11.3	0.0	2.6	2.6
3. Prod./Inject. Wells	77.4	1.4	18.5	23.0
4. Downhole Pumps	3.2	0.6	1.1	3.0
5. Gathering Equip.	28.3	0.6	9.2	11.0
6. Make-Up Wells	0.0	0.1	0.0	0.3
7. Power Plant (Core)	108.0	5.0	34.0	49.3
8. Brine TDS Effects	0.1	0.0	0.0	0.0
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	10.9	0.0	3.4	3.4

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-02-1990 - 18:47:58

R&D Achvmt: Wildcat Success Ratio	: 1.20
R&D Achvmt: Confirm. Success Ratio	: 1.25
R&D Achvmt: Testing Costs, Confirm	: 0.75
R&D Achvmt: Dry Holes / Producer	: 0.85
R&D Achvmt: Testing Costs, Producer	: 0.75
R&D Achvmt: BASE Cost, Average Well	: 0.80
R&D Achvmt: Cap.Cost, Deep Well Pump	: 0.75
R&D Achvmt: O&M Cost, Deep Well Pump	: 0.80
R&D Achvmt: Workover Interval, Prod.	: 0.50
R&D Achvmt: Workover Interval, Injc.	: 0.50
R&D Achvmt: FLASH Plant - Efficiency	: 1.05
R&D Achvmt: FLASH Plant - Capital Cost	: 0.95
R&D Achvmt: BINARY Plant - Efficiency	: 1.20
R&D Achvmt: BINARY Plant - Capital Cost	: 0.76

Regional Weights = Regional Capacity

(End of Page)

GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 18:47:58
New Techology Costs: Y. Vol. - Sespe HS

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ----- Capital Part of System	Total Busbar Cost
TOTAL :	422.0	14.0	128.0	172.5
RISK FRACTION :	96.5	2.3	32.7	41.3
1. Identify Reservoir	2.5	0.0	0.5	0.5
2. Confirm Reservoir	6.4	0.0	1.5	1.5
3. Prod./Inject. Wells	123.2	2.9	30.4	39.8
4. Downhole Pumps	8.0	1.5	2.7	7.7
5. Gathering Equip.	90.4	1.8	30.5	36.4
6. Make-Up Wells	0.0	0.3	0.0	0.8
7. Power Plant (Core)	171.6	7.5	55.9	79.2
8. Brine TDS Effects	0.2	0.0	0.1	0.1
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	19.7	0.0	6.4	6.4

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-02-1990 - 18:47:58

R&D Achvmt: Wildcat Success Ratio	:	1.20
R&D Achvmt: Confirm. Success Ratio	:	1.25
R&D Achvmt: Testing Costs, Confirm	:	0.75
R&D Achvmt: Dry Holes / Producer	:	0.85
R&D Achvmt: Testing Costs, Producer	:	0.75
R&D Achvmt: BASE Cost, Average Well	:	0.80
R&D Achvmt: Cap.Cost, Deep Well Pump	:	0.75
R&D Achvmt: O&M Cost, Deep Well Pump	:	0.80
R&D Achvmt: Workover Interval, Prod.	:	0.50
R&D Achvmt: Workover Interval, Injc.	:	0.50
R&D Achvmt: FLASH Plant - Efficiency	:	1.05
R&D Achvmt: FLASH Plant - Capital Cost	:	0.95
R&D Achvmt: BINARY Plant - Efficiency	:	1.20
R&D Achvmt: BINARY Plant - Capital Cost	:	0.76

Regional Weights = Regional Capacity

(End of Page)

GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 16:43:23
New Techology Costs: Imperial Valley - Salton

[From IMGEO Model] ACCOUNT	Million $: Capital Cost, $	Million $: O&M Cost, $/Yr	Mills/KWhour: Capital Part of System	Mills/KWhour: Total Busbar Cost
TOTAL :	112.4	6.3	30.1	48.3
RISK FRACTION :	9.6	0.4	2.5	3.8
1. Identify Reservoir	5.4	0.0	1.1	1.1
2. Confirm Reservoir	16.2	0.0	3.6	3.6
3. Prod./Inject. Wells	24.5	1.9	5.5	11.2
4. Downhole Pumps	0.0	0.0	0.0	0.0
5. Gathering Equip.	5.6	0.2	1.7	2.4
6. Make-Up Wells	0.0	0.0	0.0	0.0
7. Power Plant (Core)	38.5	2.0	11.5	17.3
8. Brine TDS Effects	15.0	2.0	4.5	10.1
9. Gas Handling	3.0	0.2	0.9	1.3
10. Reservoir Insurance	4.3	0.0	1.3	1.3

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-02-1990 - 16:43:23

R&D Achvmt: Wildcat Success Ratio	: 1.20
R&D Achvmt: Confirm. Success Ratio	: 0.80
R&D Achvmt: Testing Costs, Confirm	: 0.75
R&D Achvmt: Dry Holes / Producer	: 0.85
R&D Achvmt: Testing Costs, Producer	: 0.75
R&D Achvmt: BASE Cost, Average Well	: 0.80
R&D Achvmt: Cap.Cost, Deep Well Pump	: 0.75
R&D Achvmt: O&M Cost, Deep Well Pump	: 0.80
R&D Achvmt: Workover Interval, Prod.	: 0.50
R&D Achvmt: Workover Interval, Injc.	: 0.50
R&D Achvmt: FLASH Plant - Efficiency	: 1.05
R&D Achvmt: FLASH Plant - Capital Cost	: 0.95
R&D Achvmt: BINARY Plant - Efficiency	: 1.20
R&D Achvmt: BINARY Plant - Capital Cost	: 0.76
R&D Achvmt: TDS-Clarifier, Capital Cost	: 0.90
R&D Achvmt: TDS-Clarifier, O&M Cost	: 0.80
R&D Achvmt: H2S Treatment, Capital Cost	: 0.80

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 16:43:23
New Techology Costs: Imperial Valley - Heber

[From IMGEO Model] ACCOUNT	Million $: Capital Cost, $	Million $: O&M Cost, $/Yr	Mills/KWhour: Capital Part of System	Mills/KWhour: Total Busbar Cost

TOTAL :	130.4	5.3	37.1	53.7
RISK FRACTION :	10.4	0.1	4.0	4.8
1. Identify Reservoir	14.7	0.0	3.1	3.1
2. Confirm Reservoir	18.4	0.0	4.3	4.3
3. Prod./Inject. Wells	19.8	0.7	4.8	7.1
4. Downhole Pumps	1.0	0.2	0.3	0.9
5. Gathering Equip.	7.0	0.1	2.3	2.8
6. Make-Up Wells	0.0	0.9	0.0	2.8
7. Power Plant (Core)	64.5	3.4	20.6	31.1
8. Brine TDS Effects	0.3	0.0	0.1	0.1
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	4.6	0.0	1.5	1.5

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-02-1990 - 16:43:23

R&D Achvmt: Wildcat Success Ratio : 1.20
R&D Achvmt: Confirm. Success Ratio : 0.80
R&D Achvmt: Testing Costs, Confirm : 0.75
R&D Achvmt: Dry Holes / Producer : 0.85
R&D Achvmt: Testing Costs, Producer : 0.75
R&D Achvmt: BASE Cost, Average Well : 0.80
R&D Achvmt: Cap.Cost, Deep Well Pump : 0.75
R&D Achvmt: O&M Cost, Deep Well Pump : 0.80
R&D Achvmt: Workover Interval, Prod. : 0.50
R&D Achvmt: Workover Interval, Injc. : 0.50
R&D Achvmt: FLASH Plant - Efficiency : 1.05
R&D Achvmt: FLASH Plant - Capital Cost : 0.95
R&D Achvmt: BINARY Plant - Efficiency : 1.20
R&D Achvmt: BINARY Plant - Capital Cost : 0.76
R&D Achvmt: TDS-Clarifier, Capital Cost : 0.90
R&D Achvmt: TDS-Clarifier, O&M Cost : 0.80
R&D Achvmt: H2S Treatment, Capital Cost : 0.80

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 16:43:23
New Techology Costs: Basin & Range - Dixie Val

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ---- Capital Part of System	Total Busbar Cost
TOTAL :	112.3	3.3	29.3	39.1
RISK FRACTION :	10.5	0.1	2.6	3.0
1. Identify Reservoir	10.5	0.0	2.1	2.1
2. Confirm Reservoir	19.2	0.0	4.2	4.2
3. Prod./Inject. Wells	23.7	0.8	5.4	7.7
4. Downhole Pumps	0.0	0.0	0.0	0.0
5. Gathering Equip.	4.5	0.1	1.4	1.7
6. Make-Up Wells	0.0	0.0	0.0	0.0
7. Power Plant (Core)	41.4	2.2	12.4	18.7

8. Brine TDS Effects	6.5	0.2	1.9	2.4
9. Gas Handling	2.7	0.1	0.8	1.1
10. Reservoir Insurance	3.9	0.0	1.2	1.2

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-02-1990 - 16:43:23

R&D Achvmt: Wildcat Success Ratio	:	1.20
R&D Achvmt: Confirm. Success Ratio	:	0.80
R&D Achvmt: Testing Costs, Confirm	:	0.75
R&D Achvmt: Dry Holes / Producer	:	0.85
R&D Achvmt: Testing Costs, Producer	:	0.75
R&D Achvmt: BASE Cost, Average Well	:	0.80
R&D Achvmt: Cap.Cost, Deep Well Pump	:	0.75
R&D Achvmt: O&M Cost, Deep Well Pump	:	0.80
R&D Achvmt: Workover Interval, Prod.	:	0.50
R&D Achvmt: Workover Interval, Injc.	:	0.50
R&D Achvmt: FLASH Plant - Efficiency	:	1.05
R&D Achvmt: FLASH Plant - Capital Cost	:	0.95
R&D Achvmt: BINARY Plant - Efficiency	:	1.20
R&D Achvmt: BINARY Plant - Capital Cost	:	0.76
R&D Achvmt: TDS-Clarifier, Capital Cost	:	0.90
R&D Achvmt: TDS-Clarifier, O&M Cost	:	0.80
R&D Achvmt: H2S Treatment, Capital Cost	:	0.80

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 16:43:23
New Techology Costs: Basin & Range - Raft R.

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ----- Capital Part of System	Total Busbar Cost
TOTAL :	293.4	8.8	86.2	114.8
RISK FRACTION :	40.1	0.8	16.7	21.0
1. Identify Reservoir	43.3	0.0	9.6	9.6
2. Confirm Reservoir	32.2	0.0	7.9	7.9
3. Prod./Inject. Wells	57.7	1.4	14.6	19.2
4. Downhole Pumps	3.3	0.6	1.2	3.3
5. Gathering Equip.	29.9	0.6	10.4	12.4
6. Make-Up Wells	0.0	0.8	0.0	2.7
7. Power Plant (Core)	116.1	5.3	38.8	56.0
8. Brine TDS Effects	0.7	0.0	0.2	0.3
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	10.4	0.0	3.5	3.5

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-02-1990 - 16:43:23

R&D Achvmt: Wildcat Success Ratio	:	1.20
R&D Achvmt: Confirm. Success Ratio	:	0.80
R&D Achvmt: Testing Costs, Confirm	:	0.75

R&D Achvmt: Dry Holes / Producer : 0.85
R&D Achvmt: Testing Costs, Producer : 0.75
R&D Achvmt: BASE Cost, Average Well : 0.80
R&D Achvmt: Cap.Cost, Deep Well Pump : 0.75
R&D Achvmt: O&M Cost, Deep Well Pump : 0.80
R&D Achvmt: Workover Interval, Prod. : 0.50
R&D Achvmt: Workover Interval, Injc. : 0.50
R&D Achvmt: FLASH Plant - Efficiency : 1.05
R&D Achvmt: FLASH Plant - Capital Cost : 0.95
R&D Achvmt: BINARY Plant - Efficiency : 1.20
R&D Achvmt: BINARY Plant - Capital Cost : 0.76
R&D Achvmt: TDS-Clarifier, Capital Cost : 0.90
R&D Achvmt: TDS-Clarifier, O&M Cost : 0.80
R&D Achvmt: H2S Treatment, Capital Cost : 0.80

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 16:43:23
New Techology Costs: Cascades - Lassen

[From IMGEO Model] ACCOUNT	Million $: Capital Cost, $	Million $: O&M Cost, $/Yr	Mills/KWhour: Capital Part of System	Mills/KWhour: Total Busbar Cost
TOTAL :	203.9	3.6	51.2	61.9
RISK FRACTION :	22.7	-0.2	6.1	5.7
1. Identify Reservoir	22.3	0.0	4.5	4.5
2. Confirm Reservoir	33.1	0.0	7.4	7.4
3. Prod./Inject. Wells	80.7	0.6	18.6	20.4
4. Downhole Pumps	0.0	0.0	0.0	0.0
5. Gathering Equip.	9.0	0.2	2.8	3.4
6. Make-Up Wells	0.0	0.3	0.0	0.9
7. Power Plant (Core)	51.8	2.5	15.7	23.1
8. Brine TDS Effects	0.0	0.0	0.0	0.0
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	7.1	0.0	2.2	2.2

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-02-1990 - 16:43:23

R&D Achvmt: Wildcat Success Ratio : 1.20
R&D Achvmt: Confirm. Success Ratio : 0.80
R&D Achvmt: Testing Costs, Confirm : 0.75
R&D Achvmt: Dry Holes / Producer : 0.85
R&D Achvmt: Testing Costs, Producer : 0.75
R&D Achvmt: BASE Cost, Average Well : 0.80
R&D Achvmt: Cap.Cost, Deep Well Pump : 0.75
R&D Achvmt: O&M Cost, Deep Well Pump : 0.80
R&D Achvmt: Workover Interval, Prod. : 0.50
R&D Achvmt: Workover Interval, Injc. : 0.50
R&D Achvmt: FLASH Plant - Efficiency : 1.05
R&D Achvmt: FLASH Plant - Capital Cost : 0.95
R&D Achvmt: BINARY Plant - Efficiency : 1.20

R&D Achvmt: BINARY Plant - Capital Cost : 0.76
R&D Achvmt: TDS-Clarifier, Capital Cost : 0.90
R&D Achvmt: TDS-Clarifier, O&M Cost : 0.80
R&D Achvmt: H2S Treatment, Capital Cost : 0.80

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 16:43:23
New Techology Costs: Cascades - Alvord Desert

[From IMGEO Model] ACCOUNT	----- Million $ ------ Capital Cost, $	O&M Cost, $/Yr	---- Mills/KWhour ----- Capital Part of System	Total Busbar Cost
TOTAL :	167.9	4.8	44.0	58.3
RISK FRACTION :	14.9	0.4	4.7	6.0
1. Identify Reservoir	34.9	0.0	7.1	7.1
2. Confirm Reservoir	27.6	0.0	6.2	6.2
3. Prod./Inject. Wells	20.9	0.8	4.8	7.3
4. Downhole Pumps	1.5	0.3	0.5	1.4
5. Gathering Equip.	9.6	0.2	3.0	3.6
6. Make-Up Wells	0.0	0.0	0.0	0.0
7. Power Plant (Core)	68.3	3.5	20.9	31.3
8. Brine TDS Effects	0.0	0.0	0.0	0.0
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	5.0	0.0	1.5	1.5

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-02-1990 - 16:43:23

R&D Achvmt: Wildcat Success Ratio : 1.20
R&D Achvmt: Confirm. Success Ratio : 0.80
R&D Achvmt: Testing Costs, Confirm : 0.75
R&D Achvmt: Dry Holes / Producer : 0.85
R&D Achvmt: Testing Costs, Producer : 0.75
R&D Achvmt: BASE Cost, Average Well : 0.80
R&D Achvmt: Cap.Cost, Deep Well Pump : 0.75
R&D Achvmt: O&M Cost, Deep Well Pump : 0.80
R&D Achvmt: Workover Interval, Prod. : 0.50
R&D Achvmt: Workover Interval, Injc. : 0.50
R&D Achvmt: FLASH Plant - Efficiency : 1.05
R&D Achvmt: FLASH Plant - Capital Cost : 0.95
R&D Achvmt: BINARY Plant - Efficiency : 1.20
R&D Achvmt: BINARY Plant - Capital Cost : 0.76
R&D Achvmt: TDS-Clarifier, Capital Cost : 0.90
R&D Achvmt: TDS-Clarifier, O&M Cost : 0.80
R&D Achvmt: H2S Treatment, Capital Cost : 0.80

Regional Weights = Regional Capacity

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GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 16:43:23
New Techology Costs: Young Volcanics - Coso

[From IMGEO Model] ACCOUNT	Million $: Capital Cost, $	Million $: O&M Cost, $/Yr	Mills/KWhour: Capital Part of System	Mills/KWhour: Total Busbar Cost
TOTAL :	102.8	7.0	28.0	48.3
RISK FRACTION :	5.7	0.2	1.5	2.0
1. Identify Reservoir	6.0	0.0	1.2	1.2
2. Confirm Reservoir	14.6	0.0	3.2	3.2
3. Prod./Inject. Wells	15.0	1.6	3.4	8.1
4. Downhole Pumps	0.0	0.0	0.0	0.0
5. Gathering Equip.	4.5	0.2	1.4	1.9
6. Make-Up Wells	0.0	0.1	0.0	0.3
7. Power Plant (Core)	40.6	2.1	12.2	18.3
8. Brine TDS Effects	15.5	2.9	4.7	12.9
9. Gas Handling	2.7	0.2	0.8	1.3
10. Reservoir Insurance	3.9	0.0	1.2	1.2

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-02-1990 - 16:43:23

R&D Achvmt: Wildcat Success Ratio	: 1.20
R&D Achvmt: Confirm. Success Ratio	: 0.80
R&D Achvmt: Testing Costs, Confirm	: 0.75
R&D Achvmt: Dry Holes / Producer	: 0.85
R&D Achvmt: Testing Costs, Producer	: 0.75
R&D Achvmt: BASE Cost, Average Well	: 0.80
R&D Achvmt: Cap.Cost, Deep Well Pump	: 0.75
R&D Achvmt: O&M Cost, Deep Well Pump	: 0.80
R&D Achvmt: Workover Interval, Prod.	: 0.50
R&D Achvmt: Workover Interval, Injc.	: 0.50
R&D Achvmt: FLASH Plant - Efficiency	: 1.05
R&D Achvmt: FLASH Plant - Capital Cost	: 0.95
R&D Achvmt: BINARY Plant - Efficiency	: 1.20
R&D Achvmt: BINARY Plant - Capital Cost	: 0.76
R&D Achvmt: TDS-Clarifier, Capital Cost	: 0.90
R&D Achvmt: TDS-Clarifier, O&M Cost	: 0.80
R&D Achvmt: H2S Treatment, Capital Cost	: 0.80

Regional Weights = Regional Capacity

(End of Page)

GEOTHERMAL COST OF POWER ESTIMATE RUN: 08-02-1990 - 16:43:23
New Techology Costs: Young Vol. - Long Valley

[From IMGEO Model]	Million $: Capital Cost,	Million $: O&M Cost,	Mills/KWhour: Capital Part of	Mills/KWhour: Total Busbar

ACCOUNT	$	$/Yr	System	Cost
TOTAL :	108.4	4.5	31.2	44.7
RISK FRACTION :	8.9	0.3	3.1	4.1
1. Identify Reservoir	7.7	0.0	1.6	1.6
2. Confirm Reservoir	10.0	0.0	2.3	2.3
3. Prod./Inject. Wells	13.4	0.7	3.1	5.4
4. Downhole Pumps	0.9	0.2	0.3	1.0
5. Gathering Equip.	8.7	0.2	2.8	3.4
6. Make-Up Wells	0.0	0.0	0.0	0.0
7. Power Plant (Core)	63.4	3.3	19.7	29.7
8. Brine TDS Effects	0.1	0.0	0.0	0.0
9. Gas Handling	0.0	0.0	0.0	0.0
10. Reservoir Insurance	4.3	0.0	1.3	1.3

IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-02-1990 - 16:43:23

R&D Achvmt: Wildcat Success Ratio : 1.20
R&D Achvmt: Confirm. Success Ratio : 0.80
R&D Achvmt: Testing Costs, Confirm : 0.75
R&D Achvmt: Dry Holes / Producer : 0.85
R&D Achvmt: Testing Costs, Producer : 0.75
R&D Achvmt: BASE Cost, Average Well : 0.80
R&D Achvmt: Cap.Cost, Deep Well Pump : 0.75
R&D Achvmt: O&M Cost, Deep Well Pump : 0.80
R&D Achvmt: Workover Interval, Prod. : 0.50
R&D Achvmt: Workover Interval, Injc. : 0.50
R&D Achvmt: FLASH Plant - Efficiency : 1.05
R&D Achvmt: FLASH Plant - Capital Cost : 0.95
R&D Achvmt: BINARY Plant - Efficiency : 1.20
R&D Achvmt: BINARY Plant - Capital Cost : 0.76
R&D Achvmt: TDS-Clarifier, Capital Cost : 0.90
R&D Achvmt: TDS-Clarifier, O&M Cost : 0.80
R&D Achvmt: H2S Treatment, Capital Cost : 0.80

Regional Weights = Regional Capacity

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IM-GEO: SENSITIVITY FACTORS IN EFFECT 08-02-1990 - 16:43:23

R&D Achvmt: Wildcat Success Ratio : 1.20
R&D Achvmt: Confirm. Success Ratio : 0.80
R&D Achvmt: Testing Costs, Confirm : 0.75
R&D Achvmt: Dry Holes / Producer : 0.85
R&D Achvmt: Testing Costs, Producer : 0.75
R&D Achvmt: BASE Cost, Average Well : 0.80
R&D Achvmt: Cap.Cost, Deep Well Pump : 0.75
R&D Achvmt: O&M Cost, Deep Well Pump : 0.80
R&D Achvmt: Workover Interval, Prod. : 0.50
R&D Achvmt: Workover Interval, Injc. : 0.50
R&D Achvmt: FLASH Plant - Efficiency : 1.05
R&D Achvmt: FLASH Plant - Capital Cost : 0.95
R&D Achvmt: BINARY Plant - Efficiency : 1.20
R&D Achvmt: BINARY Plant - Capital Cost : 0.76

R&D Achvmt: TDS-Clarifier, Capital Cost	:	0.90
R&D Achvmt: TDS-Clarifier, O&M Cost	:	0.80
R&D Achvmt: H2S Treatment, Capital Cost	:	0.80

Regional Weights = Regional Capacity

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A REPORT FROM THE IM-GEO PROGRAM

GEOTHERMAL COST OF POWER ESTIMATE RUN : 08-08-1990 - 11:45:11
NEW TECHNOLOGY COSTS: SITE = Deep fractures - Paradise

[From IM-GEO 3.05]	-- Costs ---		------ Cents / KWhour -----			
	CAP.	O&M	CAP.	O&M	TOTAL	TOTAL
ACCOUNT	$M	$M/YR	PART	PART	COST	% CHG
TOTAL :	283.3	9.9	7.89	3.05	10.95	-29.8
RISK FRACTION :	24.7	0.9	0.84	0.33	1.17	-37.3
1. Identify Reservoir	20.6	0.0	0.43	0.00	0.43	-43.6
2. Confirm Reservoir	17.7	0.0	0.41	0.00	0.41	-36.7
3. Prod./Inject. Wells	87.1	1.6	2.07	0.49	2.56	-36.6
4. Downhole Pumps	2.9	0.6	0.10	0.18	0.27	-39.2
5. Gathering Equip.	25.3	0.5	0.82	0.16	0.98	-27.8
6. Make-Up Wells	0.0	3.4	0.00	1.05	1.05	-33.1
7. Power Plant (Core)	117.4	3.9	3.68	1.18	4.86	-22.0
8. Brine TDS Effects	0.7	0.0	0.02	0.00	0.02	-6.7
9. Gas Handling	0.0	0.0	0.00	0.00	0.00	-7.6
10. Reservoir Insurance	11.7	0.0	0.37	0.00	0.37	-30.4

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A REPORT FROM THE IM-GEO PROGRAM

GEOTHERMAL COST OF POWER ESTIMATE RUN : 08-08-1990 - 11:45:11
NEW TECHNOLOGY COSTS: SITE = Deep fractures - Routt HS

[From IM-GEO 3.05]	-- Costs ---		------ Cents / KWhour -----			
	CAP.	O&M	CAP.	O&M	TOTAL	TOTAL
ACCOUNT	$M	$M/YR	PART	PART	COST	% CHG
TOTAL :	311.1	11.2	8.91	3.49	12.40	-31.1
RISK FRACTION :	28.1	1.0	1.02	0.40	1.42	-40.1
1. Identify Reservoir	16.5	0.0	0.35	0.00	0.35	-44.0
2. Confirm Reservoir	14.4	0.0	0.33	0.00	0.33	-37.3
3. Prod./Inject. Wells	90.3	1.9	2.17	0.60	2.77	-38.6
4. Downhole Pumps	3.8	0.7	0.13	0.24	0.36	-40.6
5. Gathering Equip.	35.7	0.7	1.17	0.23	1.40	-30.1
6. Make-Up Wells	0.0	3.4	0.00	1.08	1.08	-35.0
7. Power Plant (Core)	136.2	4.4	4.32	1.34	5.66	-23.8
8. Brine TDS Effects	0.8	0.0	0.03	0.00	0.03	-8.9
9. Gas Handling	0.0	0.0	0.00	0.00	0.00	-9.8
10. Reservoir Insurance	13.3	0.0	0.42	0.00	0.42	-31.8

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A REPORT FROM THE IM-GEO PROGRAM

GEOTHERMAL COST OF POWER ESTIMATE RUN : 08-08-1990 - 11:45:11
NEW TECHNOLOGY COSTS: SITE = Basin & Range - Power Ran

[From IM-GEO 3.05]	-- Costs ---		------ Cents / KWhour -----			
ACCOUNT	CAP. $M	O&M $M/YR	CAP. PART	O&M PART	TOTAL COST	TOTAL % CHG
TOTAL :	124.7	4.0	3.37	1.20	4.57	-25.5
RISK FRACTION :	4.1	0.1	0.15	0.05	0.20	-28.2
1. Identify Reservoir	23.4	0.0	0.48	0.00	0.48	-42.8
2. Confirm Reservoir	19.2	0.0	0.43	0.00	0.43	-36.6
3. Prod./Inject. Wells	7.2	0.7	0.17	0.21	0.38	-34.7
4. Downhole Pumps	0.5	0.1	0.02	0.03	0.04	-35.5
5. Gathering Equip.	3.5	0.1	0.11	0.02	0.13	-19.9
6. Make-Up Wells	0.0	0.6	0.00	0.19	0.19	-29.1
7. Power Plant (Core)	66.7	2.5	2.04	0.74	2.78	-17.2
8. Brine TDS Effects	0.3	0.0	0.01	0.00	0.01	-1.1
9. Gas Handling	0.0	0.0	0.00	0.00	0.00	-2.0
10. Reservoir Insurance	3.9	0.0	0.12	0.00	0.12	-25.0

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A REPORT FROM THE IM-GEO PROGRAM

GEOTHERMAL COST OF POWER ESTIMATE RUN : 08-08-1990 - 11:45:11
NEW TECHNOLOGY COSTS: SITE = Rio Grande Rift - Wuanita

[From IM-GEO 3.05]	-- Costs ---		------ Cents / KWhour -----			
ACCOUNT	CAP. $M	O&M $M/YR	CAP. PART	O&M PART	TOTAL COST	TOTAL % CHG
TOTAL :	187.2	6.9	5.43	2.11	7.53	-26.4
RISK FRACTION :	11.7	0.4	0.44	0.17	0.61	-34.0
1. Identify Reservoir	11.6	0.0	0.24	0.00	0.24	-41.9
2. Confirm Reservoir	9.6	0.0	0.22	0.00	0.22	-37.7
3. Prod./Inject. Wells	31.3	1.3	0.74	0.39	1.13	-35.8
4. Downhole Pumps	2.1	0.4	0.07	0.13	0.20	-38.0
5. Gathering Equip.	17.5	0.3	0.57	0.11	0.67	-25.4
6. Make-Up Wells	0.0	1.3	0.00	0.39	0.39	-31.9
7. Power Plant (Core)	106.6	3.6	3.32	1.08	4.41	-20.4
8. Brine TDS Effects	0.6	0.0	0.02	0.00	0.02	-4.9
9. Gas Handling	0.0	0.0	0.00	0.00	0.00	-5.8
10. Reservoir Insurance	7.9	0.0	0.25	0.00	0.25	-27.3

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A REPORT FROM THE IM-GEO PROGRAM

GEOTHERMAL COST OF POWER ESTIMATE RUN : 08-08-1990 - 11:45:11
NEW TECHNOLOGY COSTS: SITE = Rio Grande Rift - Valles

[From IM-GEO 3.05]	-- Costs ---		------ Cents / KWhour -----			
ACCOUNT	CAP. $M	O&M $M/YR	CAP. PART	O&M PART	TOTAL COST	TOTAL % CHG
TOTAL :	111.9	4.3	2.88	1.26	4.13	-15.2
RISK FRACTION :	9.6	0.3	0.23	0.09	0.32	-19.7
1. Identify Reservoir	5.8	0.0	0.12	0.00	0.12	-43.6
2. Confirm Reservoir	22.0	0.0	0.48	0.00	0.48	-21.1
3. Prod./Inject. Wells	33.1	0.8	0.75	0.25	0.99	-22.2
4. Downhole Pumps	0.0	0.0	0.00	0.00	0.00	0.0
5. Gathering Equip.	4.0	0.1	0.12	0.02	0.15	-6.1
6. Make-Up Wells	0.0	1.6	0.00	0.48	0.48	-18.7
7. Power Plant (Core)	32.9	1.4	0.98	0.41	1.40	-3.6
8. Brine TDS Effects	6.4	0.1	0.19	0.04	0.23	-11.2
9. Gas Handling	3.7	0.2	0.11	0.05	0.16	-9.8
10. Reservoir Insurance	4.0	0.0	0.12	0.00	0.12	-14.0

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A REPORT FROM THE IM-GEO PROGRAM

GEOTHERMAL COST OF POWER ESTIMATE RUN : 08-08-1990 - 11:45:11
NEW TECHNOLOGY COSTS: SITE = Rio Grande Rift - Lower

[From IM-GEO 3.05]	-- Costs ---		------ Cents / KWhour -----			
ACCOUNT	CAP. $M	O&M $M/YR	CAP. PART	O&M PART	TOTAL COST	TOTAL % CHG
TOTAL :	371.8	13.9	11.09	4.43	15.51	-34.3
RISK FRACTION :	40.7	1.5	1.55	0.62	2.17	-45.3
1. Identify Reservoir	12.6	0.0	0.27	0.00	0.27	-42.3
2. Confirm Reservoir	10.3	0.0	0.24	0.00	0.24	-38.4
3. Prod./Inject. Wells	97.8	2.8	2.39	0.89	3.28	-42.2
4. Downhole Pumps	5.6	1.1	0.19	0.35	0.54	-43.5
5. Gathering Equip.	58.7	1.2	1.96	0.38	2.34	-34.7
6. Make-Up Wells	0.0	3.6	0.00	1.16	1.16	-37.8
7. Power Plant (Core)	169.3	5.3	5.46	1.65	7.11	-27.4
8. Brine TDS Effects	1.0	0.0	0.03	0.00	0.04	-13.2
9. Gas Handling	0.0	0.0	0.00	0.00	0.00	-14.0
10. Reservoir Insurance	16.6	0.0	0.54	0.00	0.54	-34.9

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A REPORT FROM THE IM-GEO PROGRAM

GEOTHERMAL COST OF POWER ESTIMATE RUN : 08-08-1990 - 11:45:11
NEW TECHNOLOGY COSTS: SITE = Young Volcanics - Puna

[From IM-GEO 3.05]	-- Costs ---		------ Cents / KWhour -----			
ACCOUNT	CAP. $M	O&M $M/YR	CAP. PART	O&M PART	TOTAL COST	TOTAL % CHG
TOTAL :	113.0	7.2	2.94	2.13	5.07	-18.9
RISK FRACTION :	7.1	0.5	0.18	0.15	0.33	-24.3
1. Identify Reservoir	5.3	0.0	0.11	0.00	0.11	-42.5
2. Confirm Reservoir	11.6	0.0	0.26	0.00	0.26	-25.1
3. Prod./Inject. Wells	43.2	3.4	0.98	1.02	2.00	-27.6
4. Downhole Pumps	0.0	0.0	0.00	0.00	0.00	0.0
5. Gathering Equip.	9.5	0.2	0.30	0.06	0.35	-6.3
6. Make-Up Wells	0.0	1.9	0.00	0.56	0.56	-17.9
7. Power Plant (Core)	28.8	1.3	0.86	0.39	1.25	-3.5
8. Brine TDS Effects	6.4	0.2	0.19	0.06	0.26	-10.3
9. Gas Handling	3.6	0.2	0.11	0.05	0.16	-9.8
10. Reservoir Insurance	4.6	0.0	0.14	0.00	0.14	-13.7

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A REPORT FROM THE IM-GEO PROGRAM

GEOTHERMAL COST OF POWER ESTIMATE RUN : 08-08-1990 - 11:45:11
NEW TECHNOLOGY COSTS: SITE = Young Volcanics - SW Rift

[From IM-GEO 3.05]	-- Costs ---		------ Cents / KWhour -----			
ACCOUNT	CAP. $M	O&M $M/YR	CAP. PART	O&M PART	TOTAL COST	TOTAL % CHG
TOTAL :	104.4	10.5	2.81	3.12	5.93	-19.6
RISK FRACTION :	5.8	0.8	0.16	0.24	0.40	-24.5
1. Identify Reservoir	3.0	0.0	0.06	0.00	0.06	-40.7
2. Confirm Reservoir	6.5	0.0	0.14	0.00	0.14	-26.0
3. Prod./Inject. Wells	34.4	4.5	0.78	1.35	2.13	-29.6
4. Downhole Pumps	0.0	0.0	0.00	0.00	0.00	0.0
5. Gathering Equip.	14.4	0.3	0.45	0.09	0.53	-6.4
6. Make-Up Wells	0.0	3.9	0.00	1.17	1.17	-20.9
7. Power Plant (Core)	31.4	1.4	0.94	0.40	1.34	-3.6
8. Brine TDS Effects	6.5	0.2	0.19	0.07	0.26	-10.1
9. Gas Handling	3.7	0.2	0.11	0.05	0.16	-9.8
10. Reservoir Insurance	4.5	0.0	0.14	0.00	0.14	-12.2

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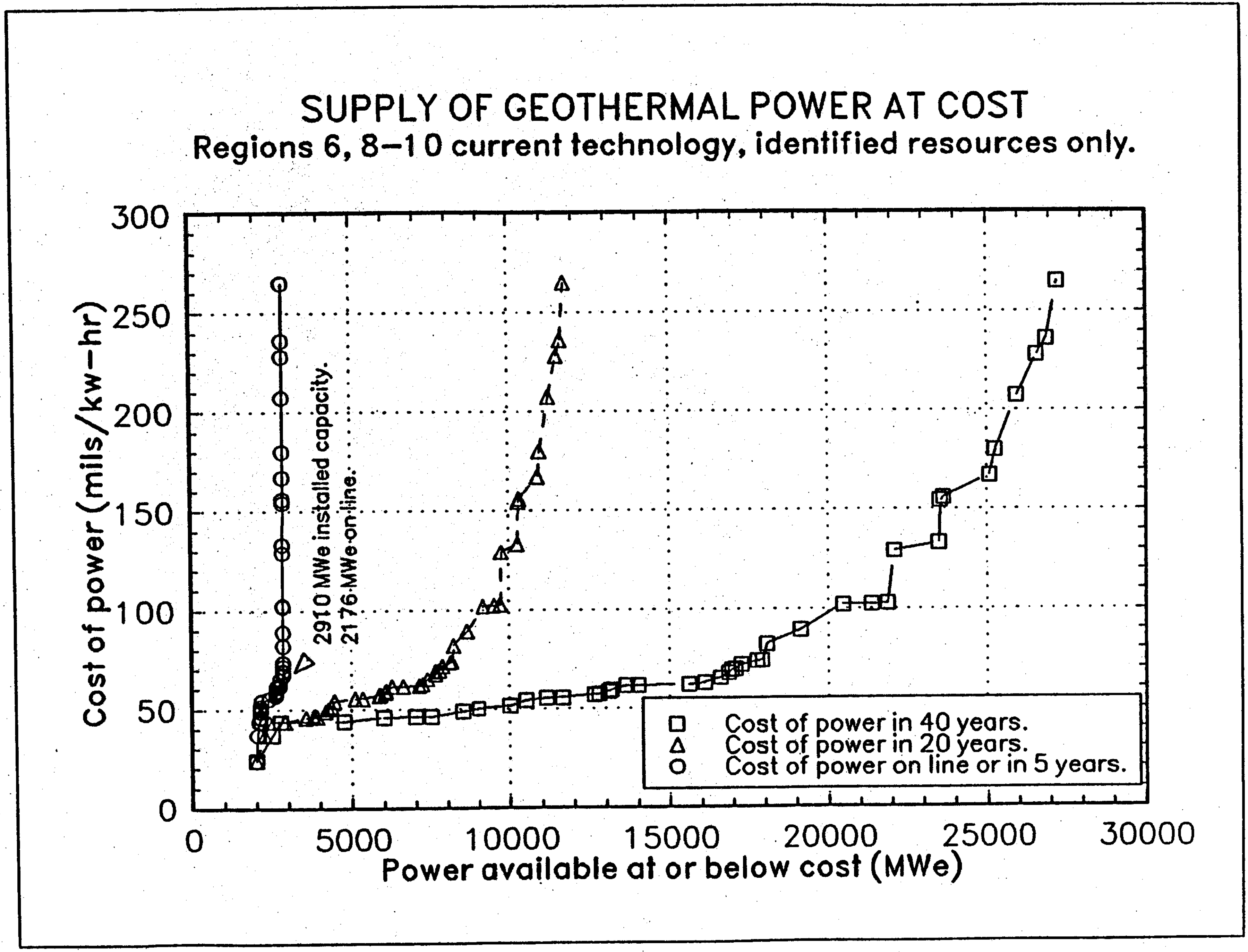
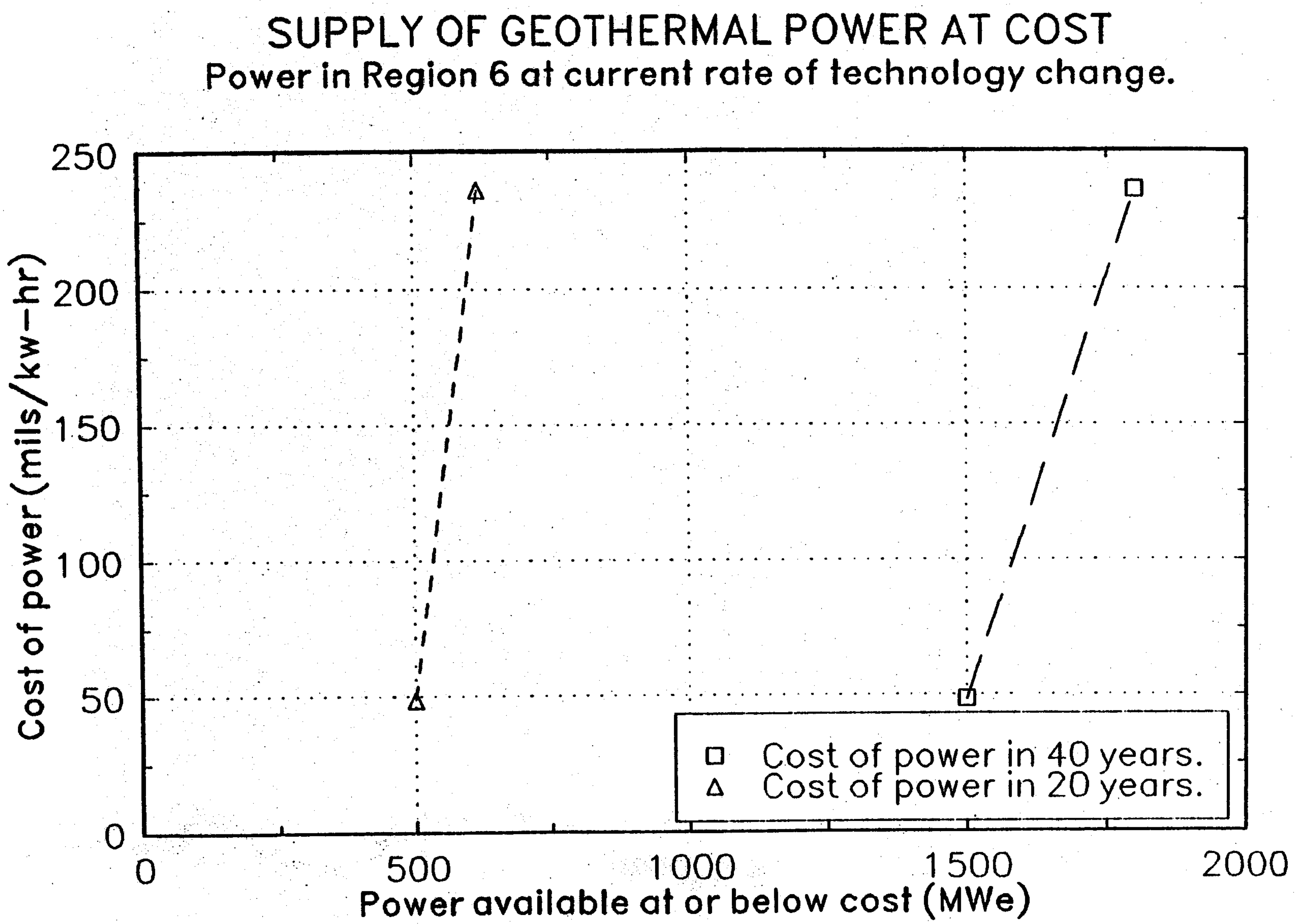
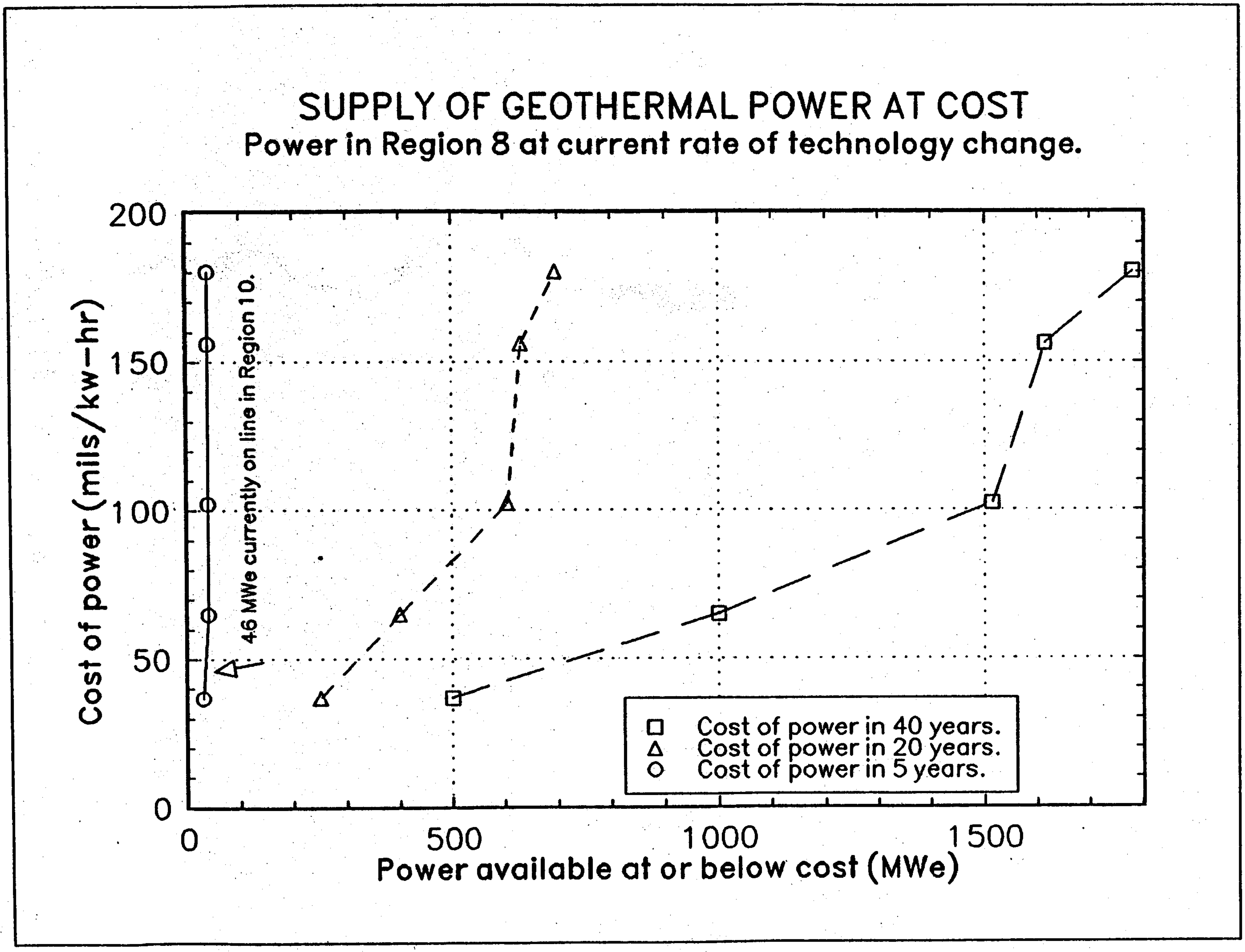
APPENDIX C



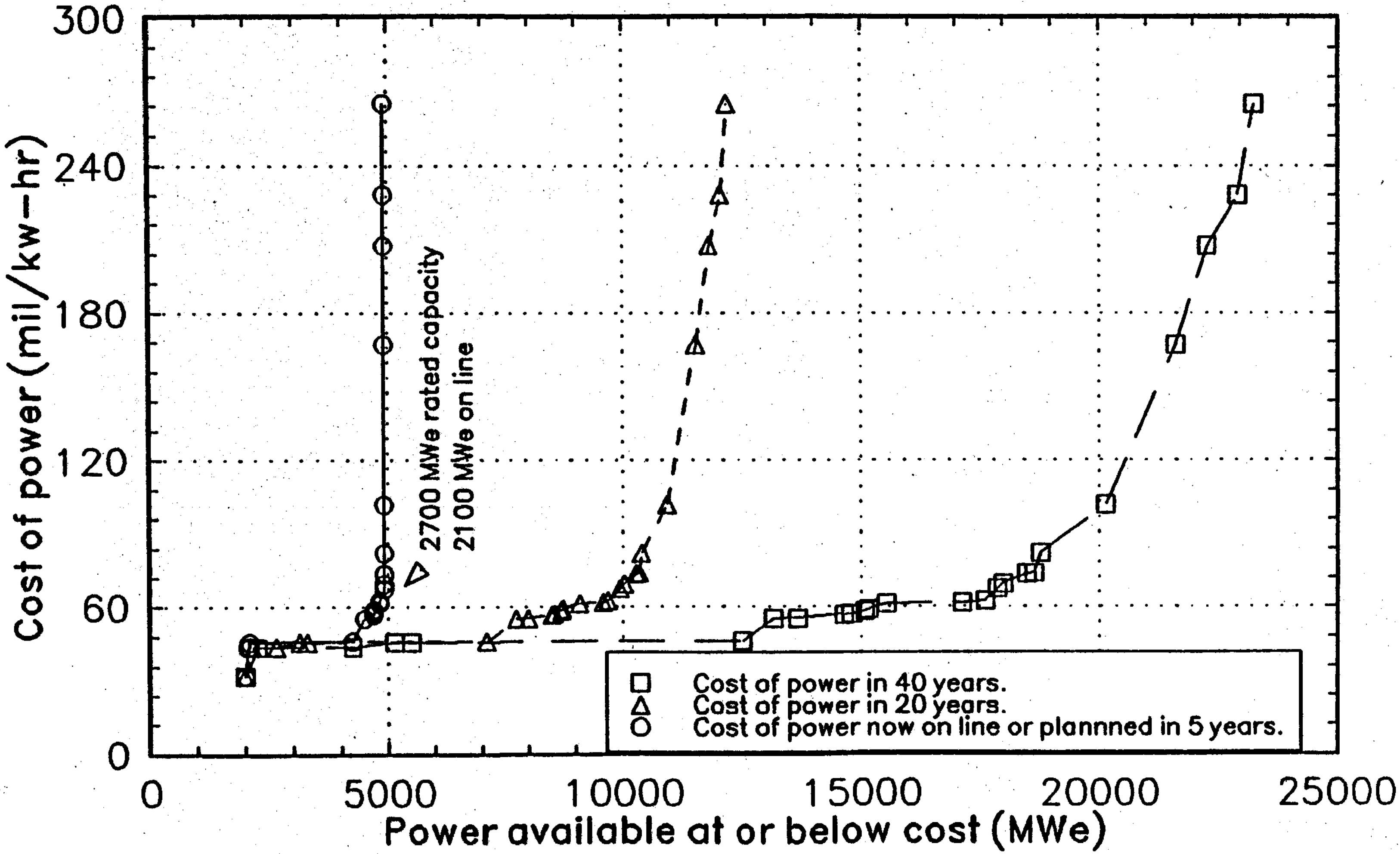
SUPPLY OF GEOTHERMAL POWER AT COST
Regions 6, 8–10 current technology, identified resources only.
Cost of power (mils/kw–hr)
Power available at or below cost (MWe)
2910 MWe installed capacity.
2176 MWe on line.
Cost of power in 40 years.
Cost of power in 20 years.
Cost of power on line or in 5 years.
0
50
100
150
200
250
300
5000
10000
15000
20000
25000
30000


SUPPLY OF GEOTHERMAL POWER AT COST
Power in Region 6 at current rate of technology change.
Cost of power (mils/kw-hr)
250
200
150
100
50
0
0
500
1000
1500
2000
Power available at or below cost (MWe)
Cost of power in 40 years.
Cost of power in 20 years.


SUPPLY OF GEOTHERMAL POWER AT COST
Power in Region 8 at current rate of technology change.
Cost of power (mils/kw-hr)
Power available at or below cost (MWe)
46 MWe currently on line in Region 10.
Cost of power in 40 years.
Cost of power in 20 years.
Cost of power in 5 years.
200
150
100
50
0
0
500
1000
1500

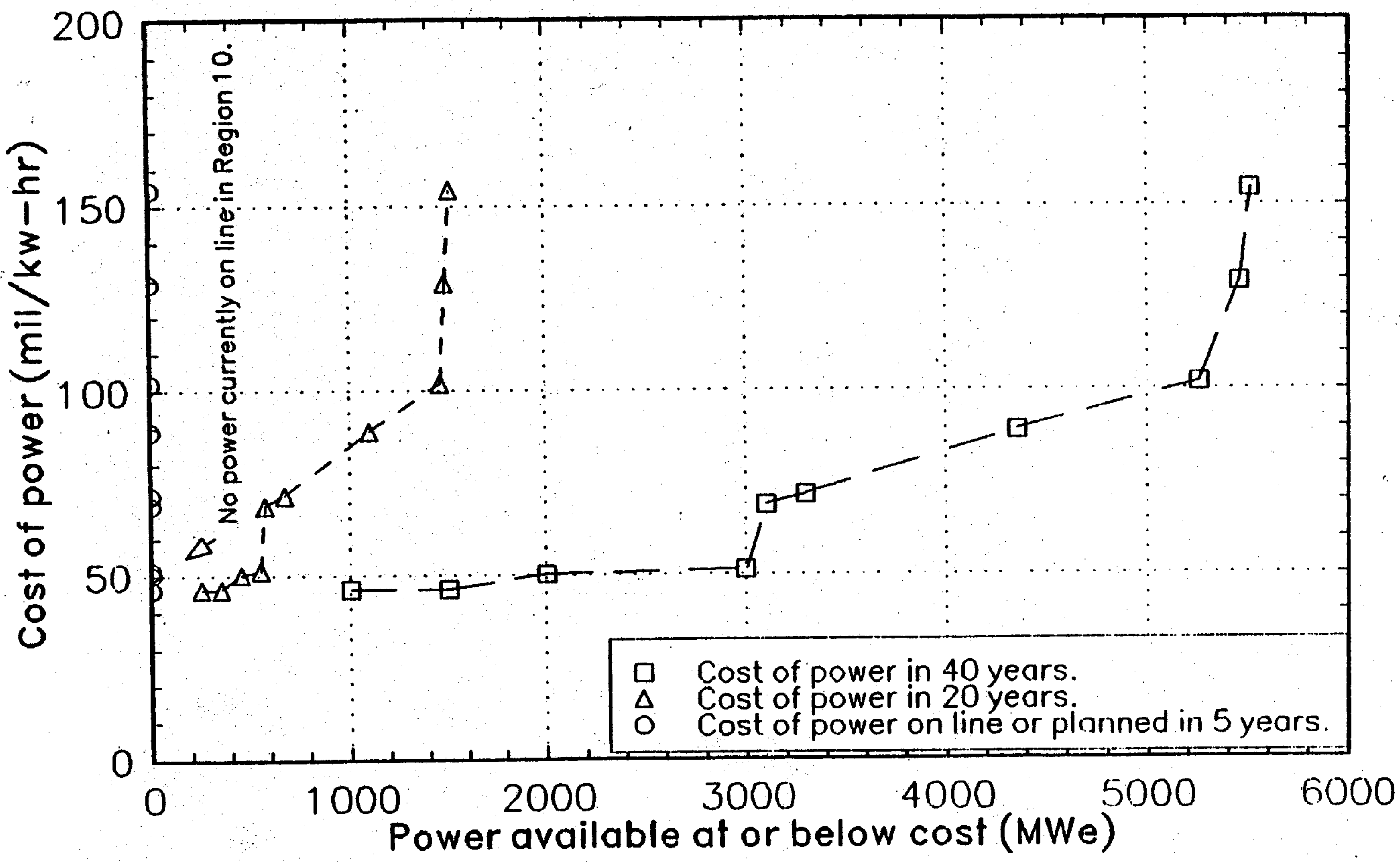
SUPPLY OF GEOTHERMAL POWER AT COST

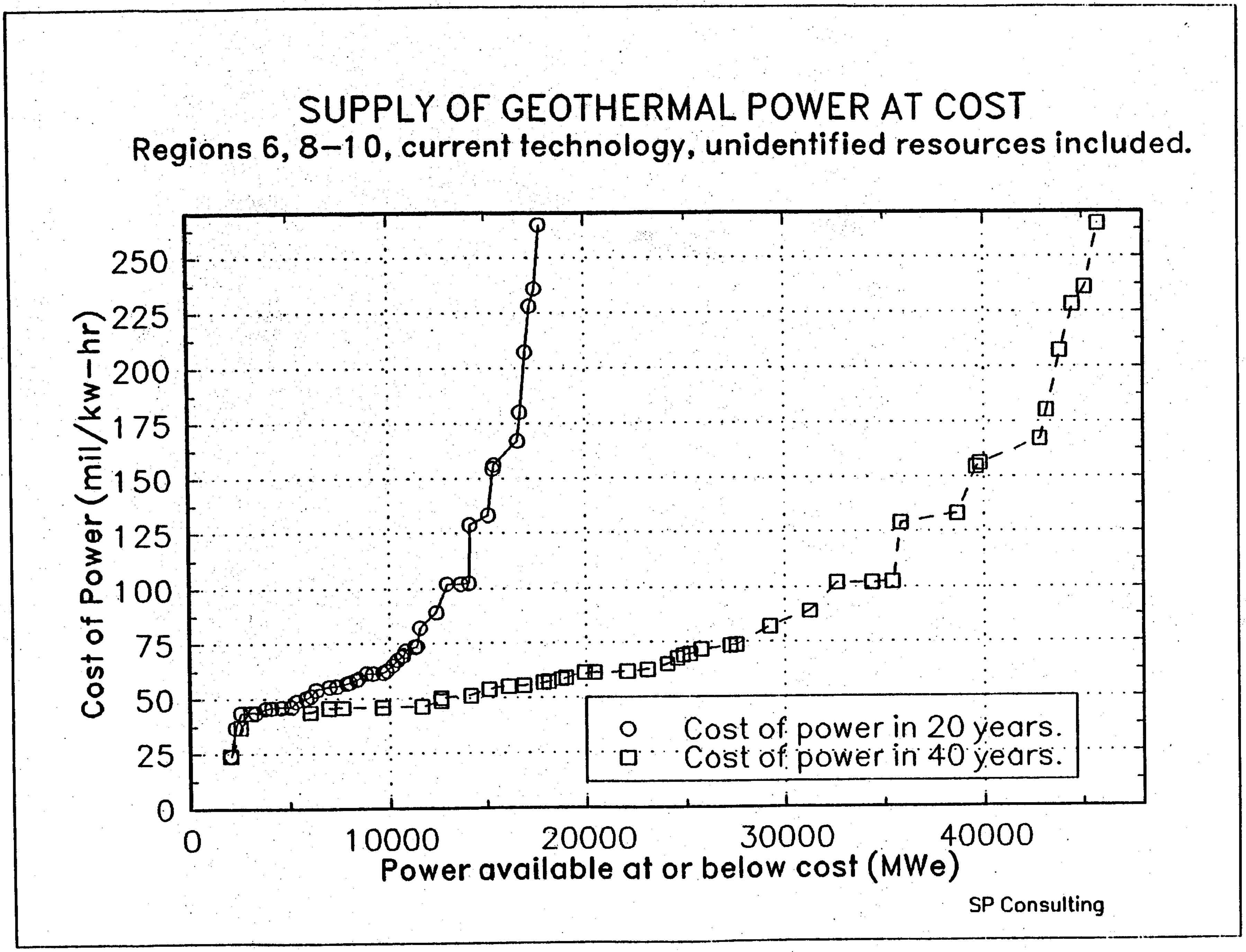
Power in Region 9 at current rate of technology change.

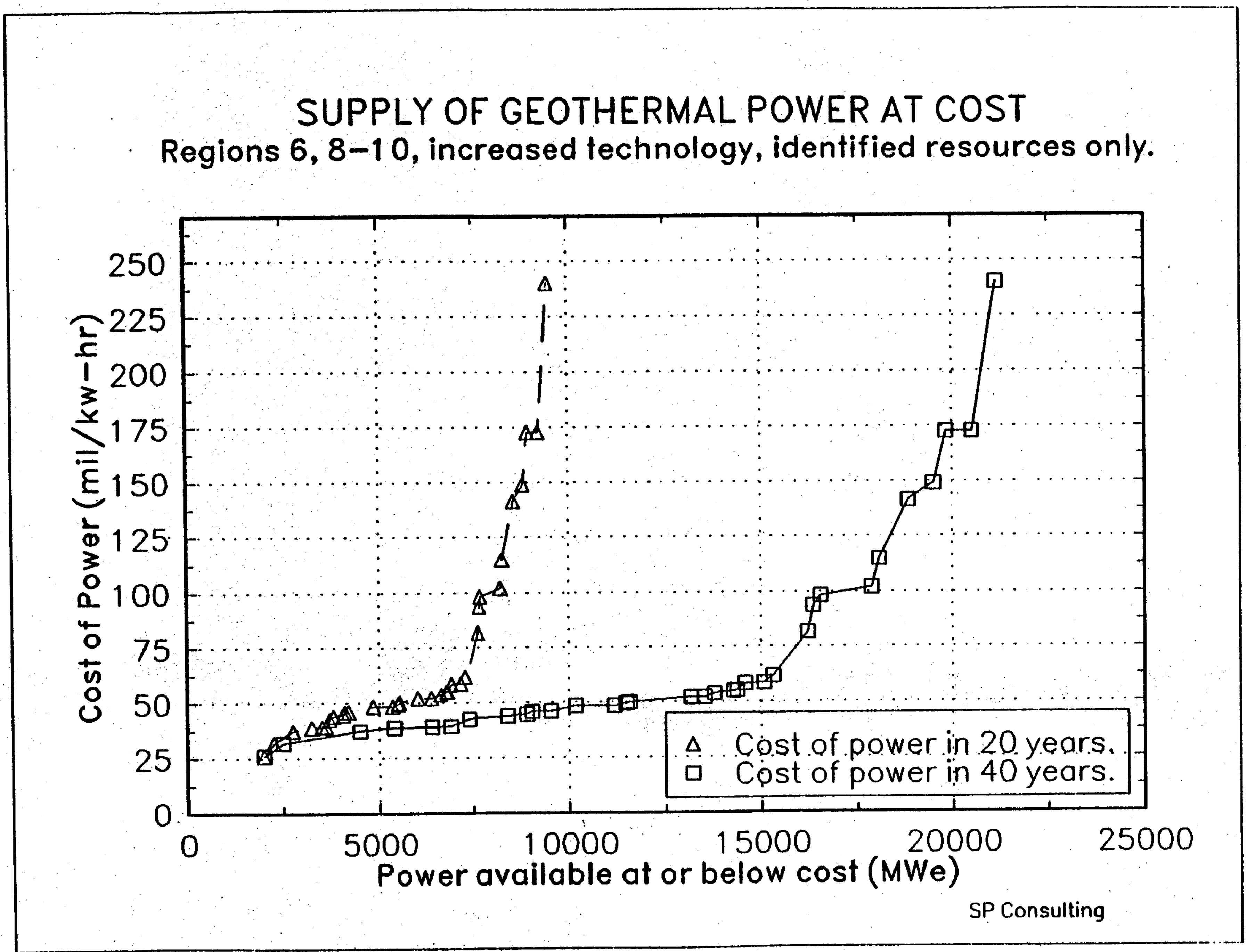


SUPPLY OF GEOTHERMAL POWER AT COST

Power in Region 10 at current rate of technology change.

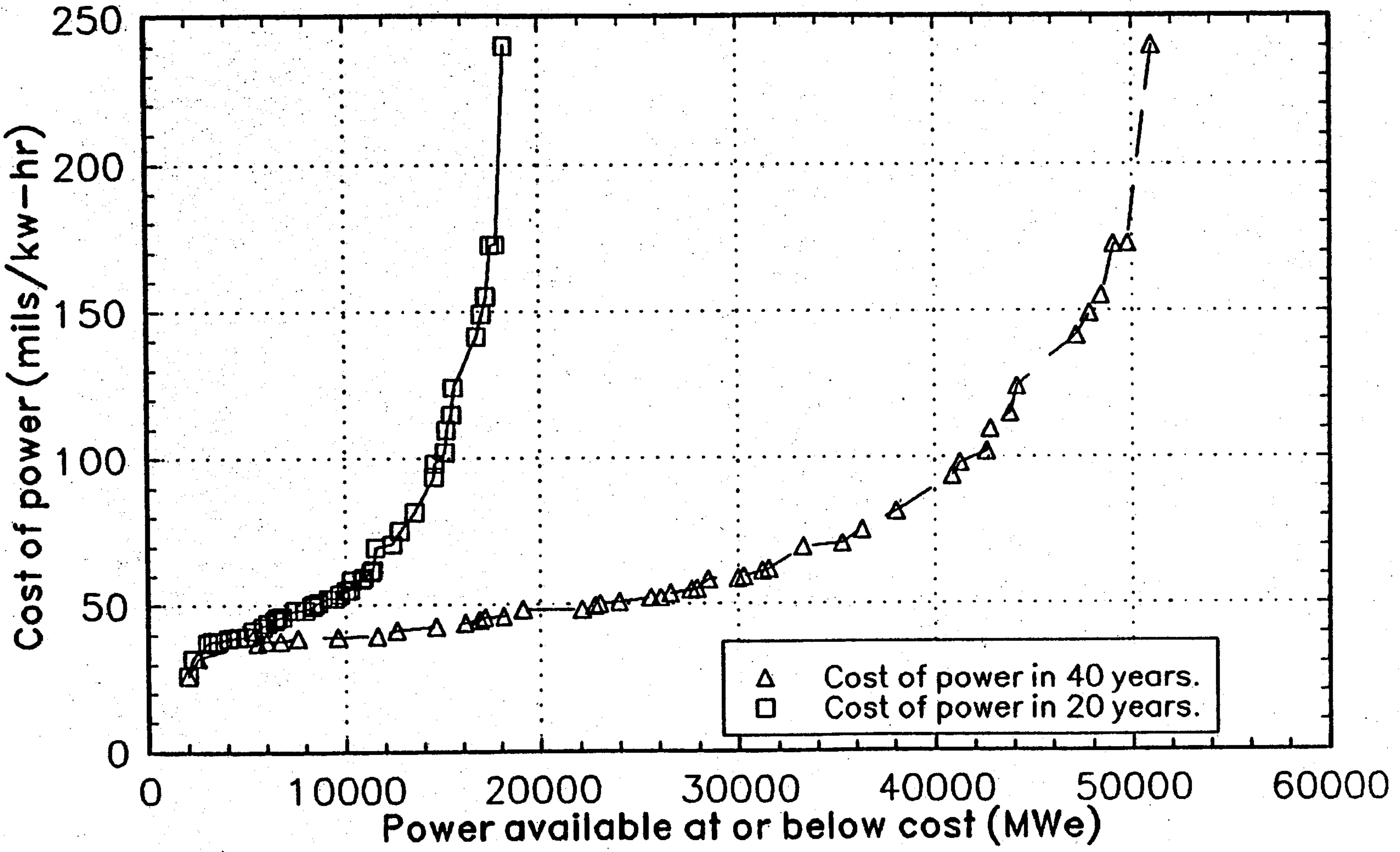



SUPPLY OF GEOTHERMAL POWER AT COST
Regions 6, 8–10, current technology, unidentified resources included.
Cost of Power (mil/kw–hr)
0
25
50
75
100
125
150
175
200
225
250
Power available at or below cost (MWe)
0
10000
20000
30000
40000
Cost of power in 20 years.
Cost of power in 40 years.
SP Consulting


SUPPLY OF GEOTHERMAL POWER AT COST
Regions 6, 8–10, increased technology, identified resources only.
Cost of Power (mil/kw–hr)
250
225
200
175
150
125
100
75
50
25
0
0
5000
10000
15000
20000
25000
Power available at or below cost (MWe)
Cost of power in 20 years.
Cost of power in 40 years.
SP Consulting

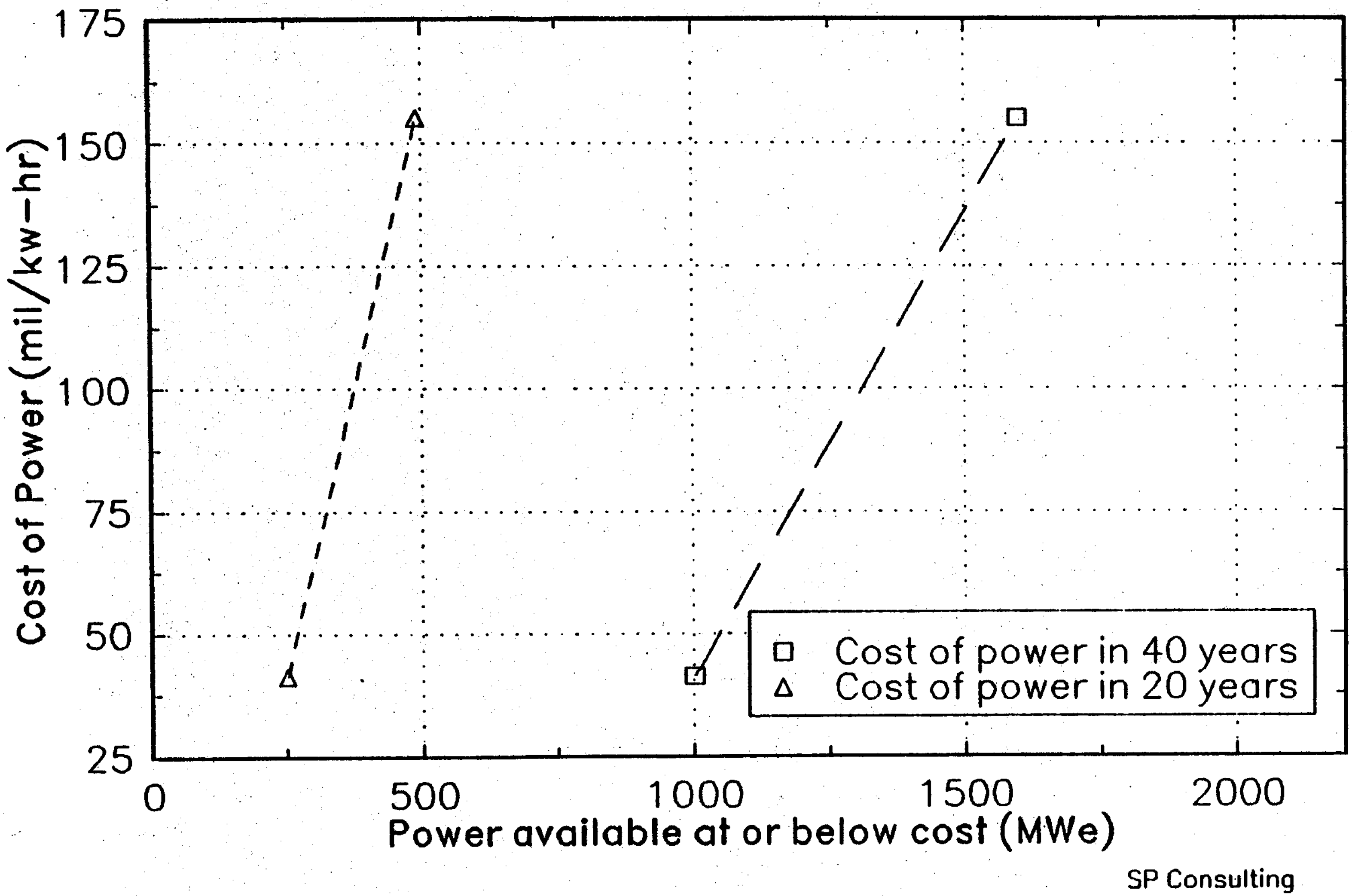
SUPPLY OF GEOTHERMAL POWER AT COST

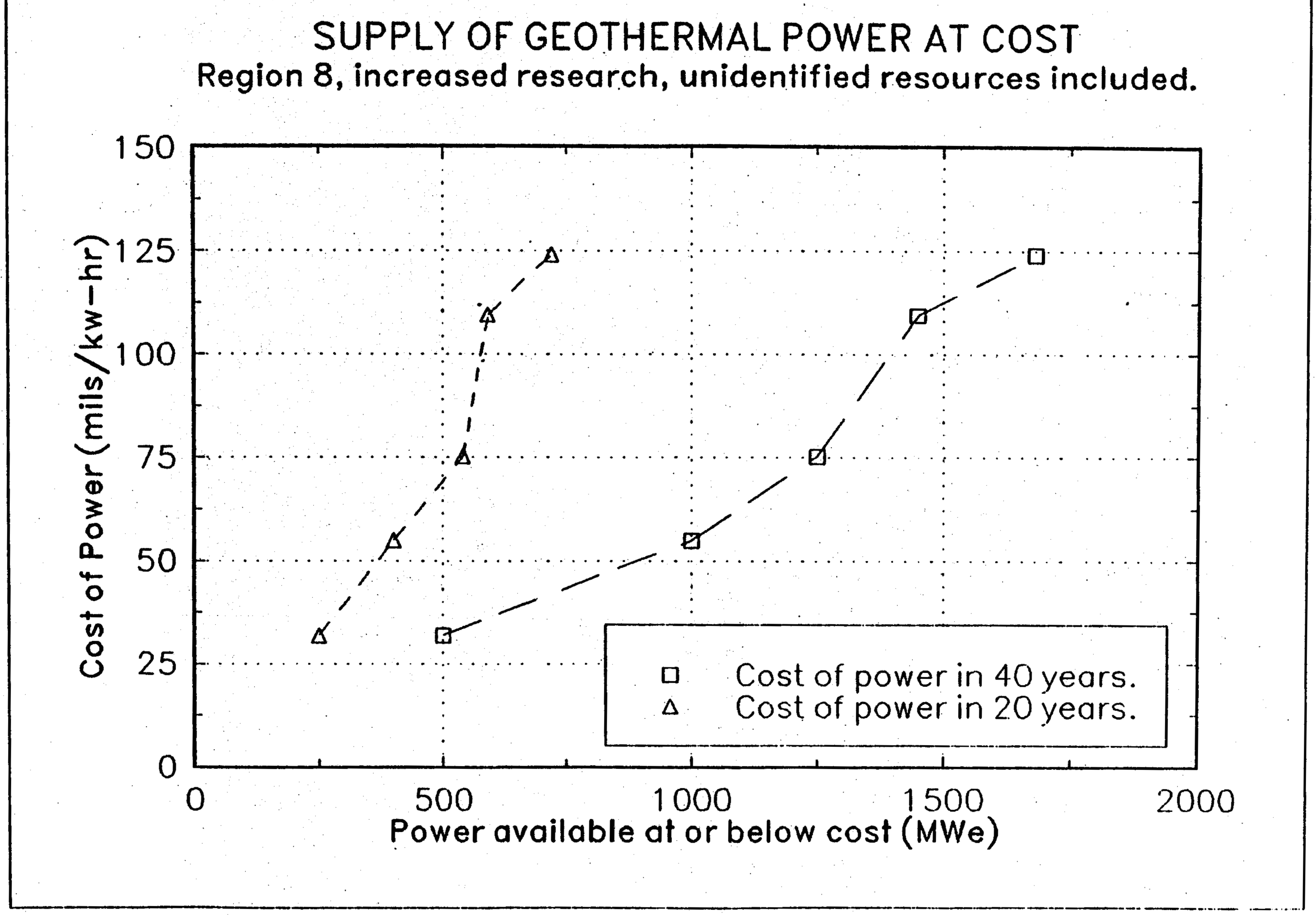
Regions 6, 8–10, increased technology, unidentified resources included.



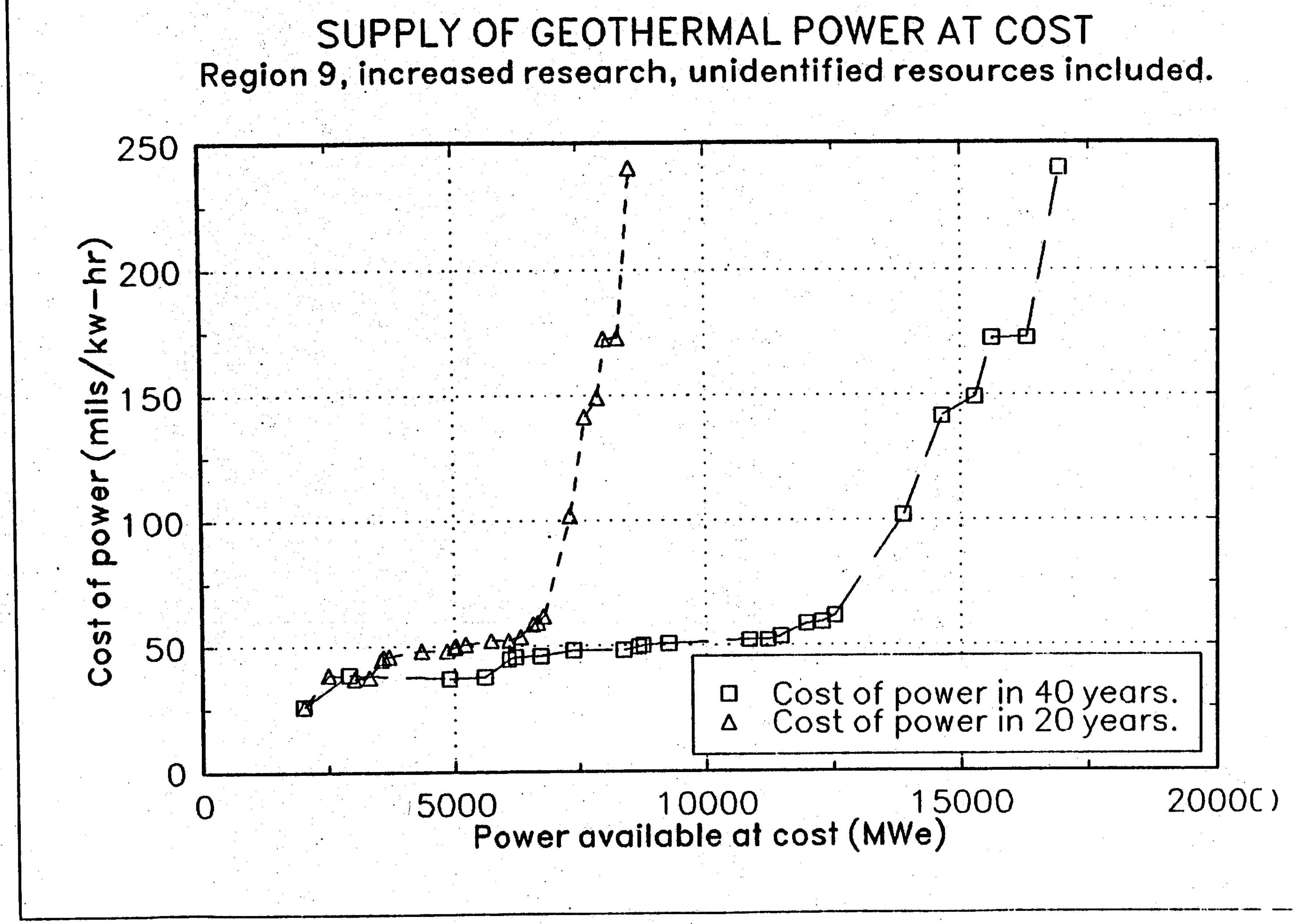
SUPPLY OF GEOTHERMAL POWER AT COST

Region 6, increased research, unidentified resources included.



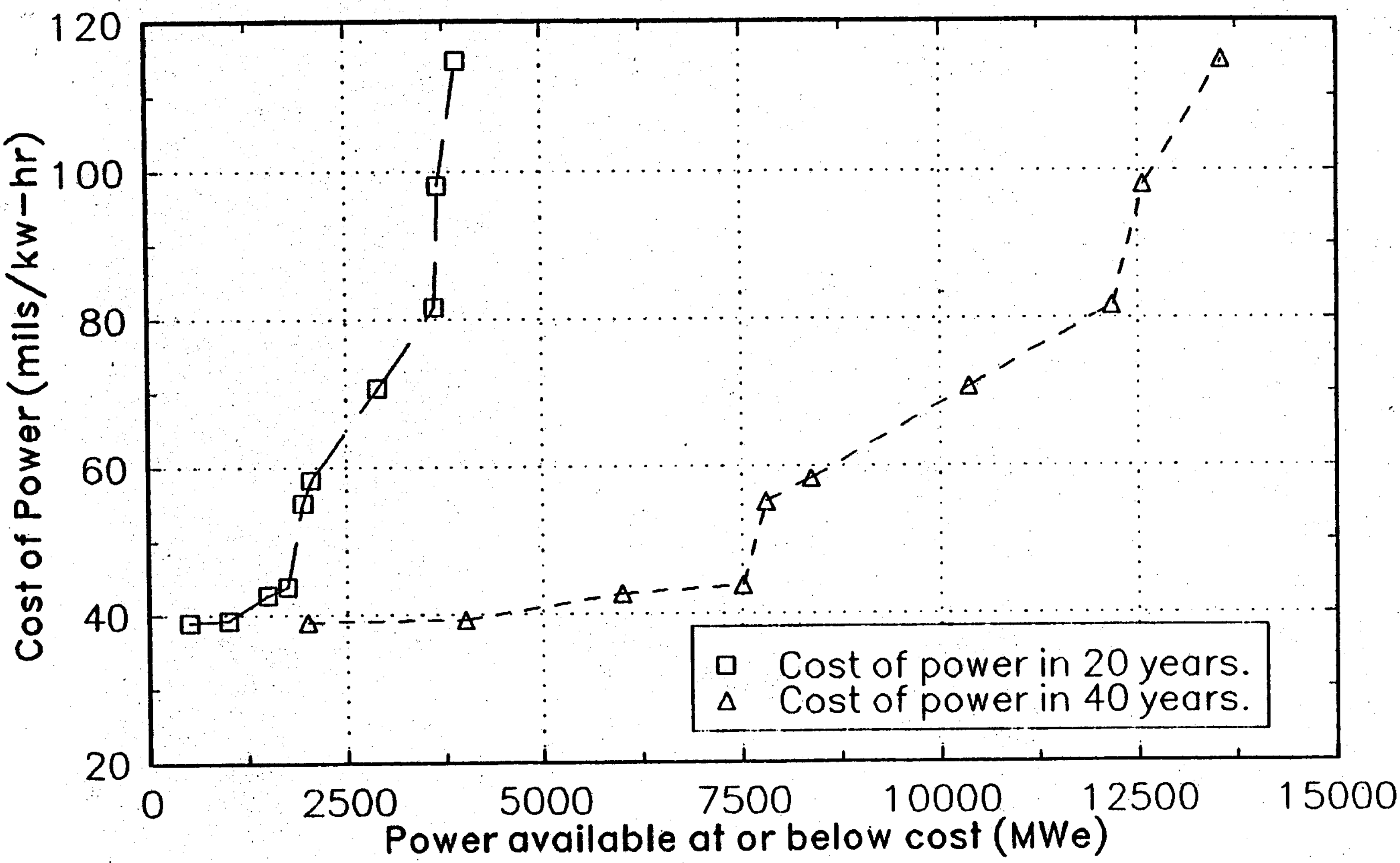


SUPPLY OF GEOTHERMAL POWER AT COST
Region 8, increased research, unidentified resources included.
Cost of Power (mils/kw-hr)
150
125
100
75
50
25
0
0
500
1000
1500
2000
Power available at or below cost (MWe)
Cost of power in 40 years.
Cost of power in 20 years.


SUPPLY OF GEOTHERMAL POWER AT COST
Region 9, increased research, unidentified resources included.
Cost of power (mils/kw-hr)
Power available at cost (MWe)
250
200
150
100
50
0
0
5000
10000
15000
20000
Cost of power in 40 years.
Cost of power in 20 years.

SUPPLY OF GEOTHERMAL POWER AT COST

Region 10, increased research, unidentfied resources included.



APPENDIX D

RESERVOIR DATA FOR COMPOSITE SITES:
Input for IMGEO Calculations

RESOURCE	TEMP deg. F	SIZE MW	DEPTH feet	FLOW RATE
SURPRISE VALLEY	320		4000	600,000
Now		25		
20 Years		500		
Total		1490		
LASSEN (Outside park)	420		3500	350,000
Now		0		
20 Years		116		
Total		116		
CLEAR LAKE Saline liquid	650		10,000	300,000
Now		50		
20 Years		500		
Total		900		
LONG VALLEY Low temperature	350		1000	600,000
Now		50		
20 Years		250		
Total		500		
LONG VALLEY High temperature	500		6000	400,000
Now		0		
20 Years		500		
Total		1600		
COSO	550		5000	550,000
Now		300		
20 Years		650		

Total		650		
RANDSBURG	340		1600	500,000
Now		10		
20 Years		50		
Total		84		
SALTON SEA	613		7500	550,000
Now		500		
20 Years		2000		
Total		3400		
WESTMORLAND	455		8000	350,000
Now		25		
20 Years		150		
Total		1710		
GEYSERS	400		6000	150,000
Now		1988		
20 Years		2000		
Total		2000		
BRAWLEY	525		11000	500,000
Now		150		
20 Years		350		
Total		640		
EAST MESA	350		3500	750,000
Now		60		
20 Years		100		
Total		360		
HEBER	350		4000	500,000
Now		150		
20 Years		350		
Total		650		
COVE CREEK/ CRANE CREEK	325		3500	500,000
Now		10		

20 Years		200		
Total		300		
REXBURG	450		11000	HDR
Now		0		
20 Years		0		
Total		500		
ISLAND PARK	450		7500	500,000
Now		0		
20 Years		250		
Total		3000		
RAFT RIVER/ other similar	280		6000	500,000
Now		10		
20 Years		30		
Total		53		
BLACKFOOT LAVA FIELD	450		10000	HDR
Now		0		
20 Years		0		
Total		250		
MEDICINE LAKE	550		4500	1000000
Now		50		
20 Years		500		
Total		2000		
STEAMBOAT	400		3000	600,000
Now		25		
20 Years		55		
Total		350		
DIXIE VALLEY	500		9500	750,000
Now		60		
20 Years		150		
Total		250		

FALLON AREA	375		5000	250,000
Now		10		
20 Years		100		
Total		660		
DESERT PEAK	430		6000	400,000
Now		10		
20 Years		100		
Total		750		
BEOWOWE	425		5000	400,000
Now		15		
20 Years		50		
Total		130		
NEWBERRY	470		3000	450,000
Now		0		
20 Years		200		
Total		1500		
ALVORD DESERT	350		3000	500,000
Now				
20 Years				
Total				
KLAMATH FALLS AREA	360		650	750,000
Now		0		
20 Years		100		
Total		676		
ROOSEVELT	510		4000	850,000
Now		30		
20 Years		250		
Total		500		
COVE FORT	400		8000	750,000
Now		10		
20 Years		100		
Total		500		

KLAMATH FALLS	360		650	750,000
Now		0		
20 Years		100		
Total		576		

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Geothermal Division
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Alan Jelacic
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Geo Hills Associates
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Los Altos Hills, CA 94022

Steve Pye
Unocal Geothermal
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Los Angeles, CA 90017

B. J. Livesay
Livesay Consultants, Inc.
126 Countrywood Lane
Encinitas, CA 92024

Susan Petty
Susan Petty Consulting
654 Glenmont Avenue
Solana Beach, CA 92075

Meridian Corporation (2)
Attn: Dan Entingh
Kathy Manger
4300 King Street, Suite 400
Alexandria, VA 22302-1508

Jim Disbrow
Energy Information Administrator
EI-531
U.S. Department of Energy
1707 H Street NW
Washington, DC 20585

William P. Long
Carlin Gold Company, Inc.
1240 East Main Street, Suite 3
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John Geyer
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