

Clean and Diversified Energy Initiative



WESTERN GOVERNORS' ASSOCIATION



Geothermal Task Force Report

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Western Governors' Association Clean and Diversified Energy Initiative

Geothermal Task Force Report

The Western Governors' Association's Clean and Diversified Energy Advisory Committee (CDEAC) commissioned this task force report in February 2005. Members of the Task Force are listed below. This is one of several task force reports presented to the CDEAC on December 8, 2005 and accepted for further consideration as the CDEAC develops recommendations for the Governors. While this task force report represents the consensus views of the members, it does not represent the adopted policy of WGA or the CDEAC. At their Annual Meeting in June, 2006, Western Governors will consider and adopt a broad range of recommendations for increasing the development of clean and diverse energy, improving the efficient use of energy and ensuring adequate transmission. The CDEAC commends the Task Force for its thorough analysis and thoughtful recommendations.

Members of the Geothermal Task Force

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Quantitative Working Group

The quantitative working group was created by the CDEAC to compare the analysis of data among task forces in order to ensure consistency in assumptions across the reports.

The following members contributed to this report:

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The Task Force would like to acknowledge the contributions of Alyssa Kagel Geothermal Energy Association; Nathanael Hance Geothermal Energy Association; and Pat Laney Idaho National Laboratory.

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Western Governors' Association
Geothermal Task Force Report
Executive Summary

A. Introduction

The Geothermal Task Force of the Clean and Diversified Energy Initiative reviewed geothermal resources of the states in the Western Governors' Association region. On July 25, 2005, two dozen members of the geothermal community met in Reno, Nevada, to assess the potential for commercial development of roughly 140 known geothermal sites. The Task Force also estimated the economics of developing these sites for commercial power production for projects that could be on-line in a timeframe extending to 2015. Finally, the Task Force compiled a profile of recommendations for interstate policy and regulatory frameworks to induce Western States' renewable energy development by 2015. The options for policy and regulatory direction outlined in this report provide a rich opportunity to set a common, strategic energy development. In summary, the Geothermal Task Force offers these conclusions to the CDEAC and WGA:

- The Western States share a capacity of almost 13,000 megawatts of geothermal energy that can be developed on specific sites within a reasonable timeframe. Of these, 5,600 megawatts are considered by the geothermal industry to be viable for commercial development within the next 10 years, i.e. by about 2015. This is a commercially achievable capacity for new generation and does not include the much larger potential of unknown, undiscovered resources.
- The 5,600 MW is estimated to be developable at busbar costs in a range of levelized costs of energy (LCOE) of about 5.3 to 7.9 cents per kilowatt-hour (kWh). This assumes commercial project financing conditions and the extension of a production tax credit (PTC) consistent with current federal energy law. Lacking a PTC to catalyze renewable energy development, LCOE values would be 2.3 ¢/kWh higher. (See graph on page 6)
- If actual future markets were to sustain costs up to 20 ¢/kWh, or the risk and cost of development reduced substantially, the Task Force estimates that known resources could support new capacity of about 13,000 MW.
- The Task Force recommends policy and regulatory initiatives that will (1) broadly strengthen and expand the renewable energy market; (2) facilitate timely leasing and permitting; (3) lead to the expansion of the transmission infrastructure; and (4) support key state and federal technology research to expand energy capacity.
- Geothermal power can be a major contributor to the power infrastructure and economic well-being of the Western States. New geothermal power capacity of 5,600 MW could add nearly 10,000 jobs, and also generate about 36,000 person-years of construction and manufacturing business. Geothermal power is a reliable, continuously available (24 hours per day – 7 days per week) baseload energy source that typically operates at 90 to 98 percent of the time. Insulated from conventional fossil fuel market volatility, geothermal power supports energy price stability and boosts energy security because it is a domestic resource. Geothermal power can help fulfill Renewable Portfolio Standards (RPS) that strive to diversify the states' and nation's energy supply. Geothermal energy is a clean electricity source, discharging far less emissions, including greenhouse gases, than equivalent fossil-fueled generation.

B. Benefits of Geothermal Power Generation

Geothermal energy is the heat from the earth of which only a small portion has been tapped for either electrical generation or direct use. It has a wide range of benefits that policymakers should consider as detailed below.

Reliable Electricity at Stable Prices

Geothermal power plants supply baseload power, i.e., electricity that is available 24 hours per day, seven days per week. Except for short outages to repair equipment and conduct overhauls every few years, these facilities have very high availability and capacity factors. Most facilities are also capable of load following if preferred by the power system. Geothermal's high reliability compares favorably to conventional power plants.

Geothermal power plants protect against volatile electricity prices because their lifetime fuel is secured at the initiation of the project. The resource is secured through long-term leases with private, state, or federal landowners, and the costs to drill the resource in advance of plant start-up are capitalized. This transfers the future fuel cost risk from the consumer back to the developer and/or operator. The acquisition of a long-term power purchase agreement from a utility further stabilizes the long-term electricity price and supports the financing and operational costs of a project.

Diversity of Resources for Utilities' Renewable Portfolio Standards

Geothermal can help utilities meet state RPS. Currently 20 states and the District of Columbia have an RPS. Geothermal energy is one of the only renewable resources that can provide baseload power. Geothermal power plants, ranging from 10 to over 200 megawatts depending upon the resource, can supply enough electricity to meet the needs of 10,000 to 200,000 homes accordingly. And, since geothermal resources are developed locally, geothermal power can reduce our dependence on imported energy resources. Additionally, geothermal plants can lower homeland security risks: they do not rely upon unstable international energy sources, nor are they terrorist targets. Also, geothermal facilities are local and smaller than large fossil or nuclear plants.

Economic Development Potential

Geothermal resources provide economic development opportunities for states, bringing jobs to rural areas as well as tax and royalty income. Based upon the findings of a recent industry employment survey (*Geothermal Industry Employment: Survey Results & Analysis*, Cedric Nathanael Hance, September 2005), achieving 5600 MW of geothermal production would result in 9,580 new full-time jobs from geothermal power facilities, and an additional 36,064 person-years of manufacturing and construction employment. An economic multiplier effect would increase these numbers further. New power facilities would also increase state and local tax and royalty income. In 2003, The Geysers Geothermal Field in California, with almost 1,000 MW of geothermal power generation capacity in place, paid \$11 million in property taxes to two counties, while royalty revenues added several million dollars more to state and county revenues.

Clean Electricity

Geothermal energy is one of the cleanest resources for generating electricity. Compared to fossil fuels, geothermal utilizes less land, consumes and discharges less water, has fewer air emissions, and generates fewer wastes. Geothermal particularly stands out when the relative air emissions from geothermal plants and fossil fuel plants are compared. In contrast to fossil fuel plants, geothermal plants only emit small amounts (if any) of carbon dioxide (a greenhouse gas), particulate matter, sulfur dioxides (acid rain) and nitrogen oxides (smog). Standing as a testament to this point, the air basin downwind of the largest geothermal field in the world, The Geysers, is the only air district in California to be in attainment with all federal and state ambient air quality standards for over 18 years.

New Technology

Although geothermal power plants have been producing electricity for decades, only a small fraction of geothermal potential has been tapped. With new technology and rising energy costs, geothermal resources that historically have not been economical to develop will become increasingly more attractive to investors and utilities. New geothermal technologies for direct use, such as for greenhouses, district heating, and fish farms, can also play an important role in reducing a community's overall need for other energy supplies.

C. Siting - Where are the Geothermal Sites?

The state-by-state capacity subtotals are listed in GT-I.2. This listing reflects a consensus of diverse experts in geothermal technology, development, and power generating operations. Appendix A discusses the generation of this profile of resource data.

Table GT-I.2
**Summary of Western States' Near-Term
New Geothermal Power Capacity**

	Capacities (in Megawatts)	Number of Sites
Alaska	20	3
Arizona	20	2
Colorado	20	9
California	2,400	25
Hawaii	70	3
Idaho	860	6
Nevada	1,500	63
New Mexico	80	6
Oregon	380	11
Utah	230	5
Washington	50	5
Total	5,630 MW	138

NOTE: The capacity of Wyoming, Montana, Texas, Kansas, Nebraska, South Dakota, North Dakota was not analyzed during the July 25 Geothermal Task Force Sub Group meeting on Supply. This information will be incorporated into this report once available.



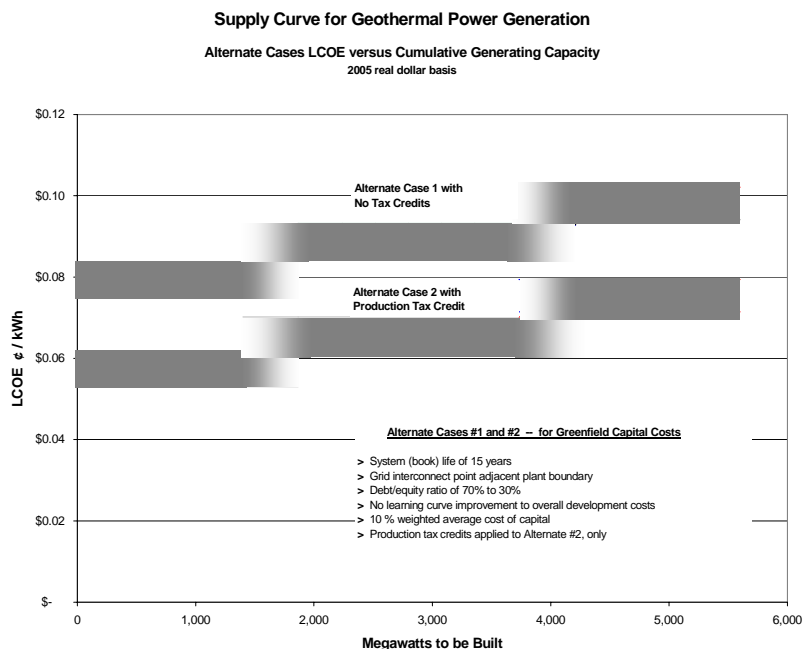
D. Cost Curve Information – How Many Megawatts Can Geothermal Generate?

The WGA Geothermal Task Force bases the projections for geothermal power capacity and economics contained in this report on specific, identified geothermal resource capacities and on current development economics in the WGA region. A detailed description of the cost curve is available in Appendix A of this report.

The projected capacity for electrical power generation for the WGA region is phased over two time spans and four cost

levels, as listed in the table below. Geothermal resources considered to have good commercial potential are designated as preferred development prospects by year 2015 at levelized costs of energy (LCOE) of up to 8 cents per kilowatt-hour ($\text{¢} / \text{kWh}$). The supply curve for geothermal resources represents the potential energy supply from specific, identified sites at current development economics using existing technology. (Note: These projections do not consider advances in technology or any learning curve effects that could reduce costs or expand available production.)

The U.S. Geologic Survey is in the process of updating assessment data for geothermal resources as mandated by The Energy Policy Act of 2005. That information, when available, should provide additional insight into the long-term potential for geothermal resources to meet the West's energy needs.



E. Geothermal Priority Recommendations

Market Development- The marketplace needs to support the continued development of geothermal resources.

1. Federal and state tax credits are important to reduce the risk and high capital cost of new projects. The federal production tax credit (and clean renewable bonding authority) should be made permanent, or at least extended ten years.
2. State laws and regulations should promote a continuing series of opportunities for power purchase agreements between developers and utilities. Whether generated through Renewable Portfolio Standards, Integrated Resource Planning, or other mechanisms, power purchase contracts are fundamental drivers of the market.
3. Federal and state laws and regulations should provide incentives for utilities and others to enter into long-term contracts for renewable power. Accounting and regulatory standards should treat renewable power contracts as benefits instead of liabilities, and power purchase contracts should have the backing of the government to ensure their credit worthiness.

Timely Permitting and Environmental Reviews- Geothermal projects should be prioritized to ensure that permitting, leasing, and environmental reviews are completed in a timely and efficient manner.

1. Federal, state, and local agencies should coordinate resources and requirements. Agencies should be designated to take the lead on specific issues to avoid duplication, and once issues are resolved they should not be revisited without cause.
2. A critical path for new projects should be defined as part of this cooperative effort, and timeframes for key agency decisions along the pathway should be established.

Transmission Access and Adequacy- The Western Governors should lead the process to ensure that adequate transmission is available for the identified resources.

1. There should be consistent western state policies on inter-connection to the grid that facilitate new geothermal (and other renewable) power development.
2. A fee to support the cost of new transmission could be set that would spread the cost across all states, parties and technologies on a capacity basis.
3. Both inter- and intra- state transmission is needed to support the identified resources should be fast-tracked for permitting and environmental reviews.

Federal Program Support- Continuing support from key federal programs is needed to achieve the 2015 goals. Federal programs should be coordinated with state agencies.

1. As the National Research Council concluded (*Renewable Power Pathways, 2002*), given the enormous potential of the resource base, geothermal research by the US Department of Energy should be increased, particularly into technologies that can reduce risk, reduce costs, or expand the accessible resource base.
2. Better resource information is needed. The USGS' new resource assessment and DOE's cost-shared drilling and exploration technology efforts should be priorities.
3. The US Department of Energy's *GeoPowering the West* initiative should continue to support state and local governments, Indian Tribes, and others seeking to utilize the West's untapped geothermal resources.

II. Introduction

A. Introduction

The Geothermal Task Force of the Clean and Diversified Energy Initiative reviewed geothermal resources of the states in the Western Governors' Association region. On July 25, 2005, two dozen members of the geothermal community met in Reno, Nevada, to assess the potential for commercial development of roughly 140 known geothermal sites. The Task Force also estimated the economics of developing these sites for commercial power production for projects that could be on-line in a timeframe extending to 2015. Finally, the Task Force compiled a profile of recommendations for interstate policy and regulatory frameworks to induce Western States' renewable energy development by 2015. The options for policy and regulatory direction outlined in this report provide a rich opportunity to set a common, strategic energy development. In summary, the Geothermal Task Force offers these conclusions to the CDEAC and WGA:

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III. Cost Curve

A. Cost Curve graphs

Figures III-1 and III-2 are, respectively, supply curves for a geothermal Base Case and Alternate Cases #1 and #2. These represent the economic analyses for geothermal generating power potential in the WGA region, addressing commercially attractive resources that could be developed during approximately the 10-year time frame to 2015. Data used to generate these curves are presented in Appendix A.

Figure III-1

Base Case Geothermal Supply Curve

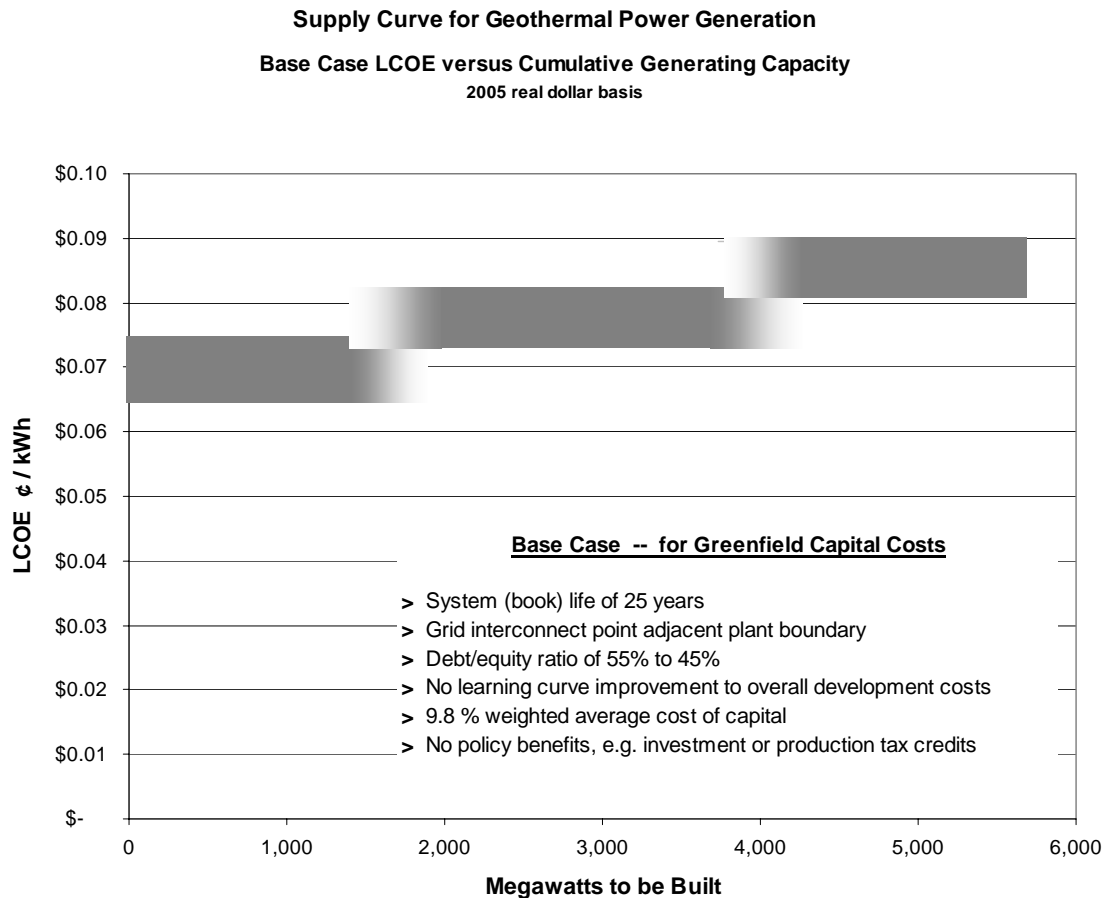
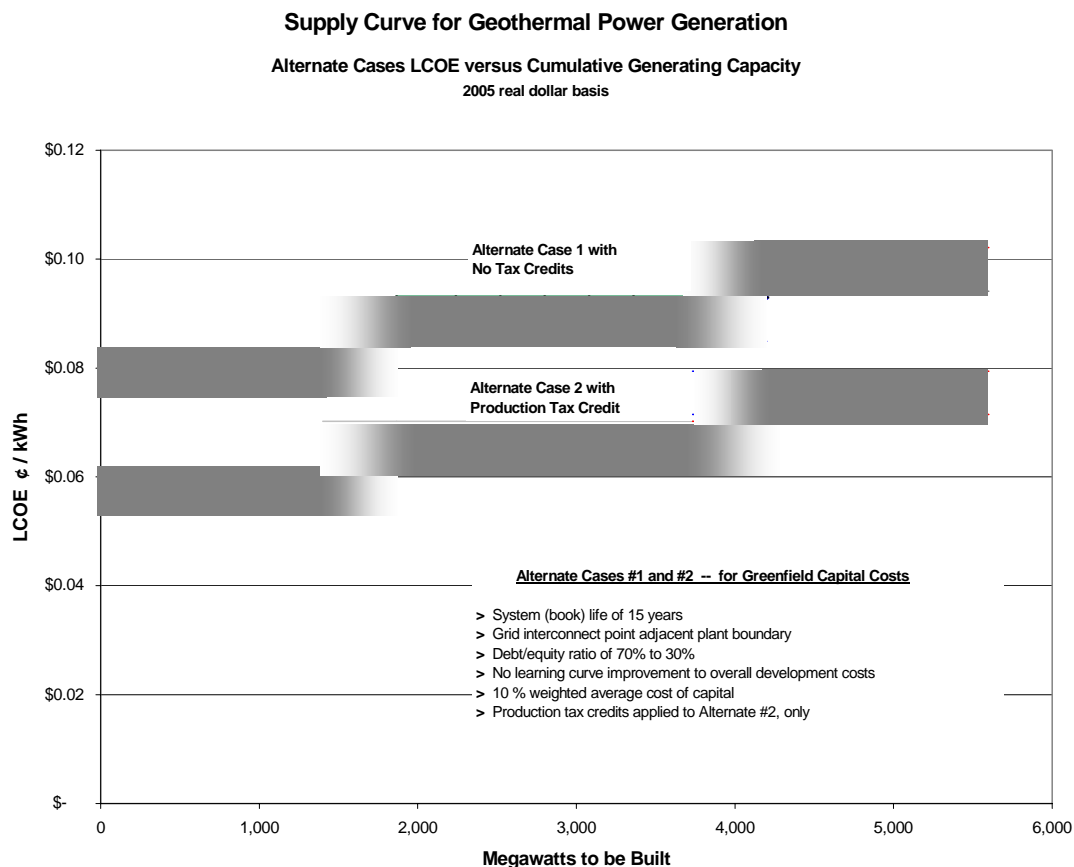


Figure III-2
Alternate Cases #1 and #2 Geothermal Supply Curves



B. Methodology

The geothermal task force applied an economic model developed by the WGA Quantitative Work Group (QWG). This model uses a profile of economic and physical parameters to predict the performance of business projects such as development programs for energy resources. The details of the method and how the geothermal task force applied it are described in Appendix A.

The QWG method uses discounted investment and operating cash flow to solve for annuitized lifecycle product costs -- i.e. the levelized cost of energy (LCOE), in year 2005 dollar values. This analysis estimates a future cost of developable geothermal power that compares directly to prices we experience today.

The QWG method applies a standardized profile of economic terms to calculate a Base Case LCOE result. The Base Case economic terms are not realistic for development of commercial geothermal power ventures, nor, for that matter, for the other energy technologies considered in the WGA Initiative.

C. Description of Cost Curves

The geothermal supply curves in Figures III-1 and III-2 depict a Base Case and Alternate Cases #1 and #2. The meaning of the Base Case is summarized in the preceding section. The two Alternate Cases approximate real-world economic conditions that geothermal power development projects must address. The main difference between the Base Case and the two alternates is a reduction in the "book life" of the project from 25 years to 15 years, corresponding to the typical debt repayment term for financing such projects. Amortizing the debt capital over a shorter term better represents the geothermal industry as compared to a 25-year term, which would be more characteristic of large, public utility projects.

The Alternate Cases also use a different debt/equity ratio than the Base Case: i.e. 70/30 versus 55/45, respectively, expressed as percentages of total capital cost.

The Base Case and Alternate #1 both represent costs of energy with NO tax benefits applied. Alternate #2 includes the effect of a Production Tax Credit (PTC) to illustrate the impact of such policy options.

The Geothermal Task Force conducted a workshop to estimate very current capital and operating and maintenance (O&M) costs. The workshop produced estimates that apportion development prospects into three capital cost categories. This produces the step-function nature of the "curves," corresponding to three defined unit capital cost values: \$3000/\$3500/\$4000 per kilowatt of installed capacity for all potential developable projects. Each curve has three overlapping cost bands that fade in the overlap zones. The shaded ends of the cost bands graphically depict uncertainty about where the quantities of capacity may actually fall on the cost curves. The shaded band sections anticipate the possible capacity distribution from low to high may be 1/3-1/3-1/3, or 1/4-1/2-1/4; many other schedules of cost distribution are possible. Notice also the height of the three cost bands in each figure. The height reflects a range of potential O&M costs of \$0.018 to \$0.026 per kWh. In combination the O&M uncertainty and the capacity uncertainty indicate the uncertainty in what total capacity may come in at a specific capital cost level. The O&M cost incorporates an ongoing wellfield construction cost for progressively replacing wells to keep the resource producing at power plant design capacity.

D. Description of Alternative Cases

The cases presented in this report apply specifically to "greenfield" project developments, with no allowance for a "learning curve." There could be two forms of learning curves. One form would reflect reduced LCOE results obtained through advances in technology, such as improvements in rates of drilling, reduced costs of construction materials for highly corrosive geothermal resource conditions, or improvements in the efficiency of power plant conversion of thermal energy to electrical power. A second form of learning curve might more appropriately be described as invoking economies of scale. For example, as geothermal resources are progressively developed to expand the extraction of thermal energy from the earth, it would be expected that marginal capacity would incur reduced unit costs per kilowatt installed. This reflects savings attainable because of support infrastructure previously constructed, and reduced unit O&M costs as staffing for an operating systems would be expected to grow less quickly than its capacity.

The WGA Geothermal Task Force anticipated that marginal costs under expansive system development as outlined here may fall in a range 10 to 15 percent less than the greenfield costs cited in Section II-C, preceding.

E. Geothermal Development Timetable

Because WGA has asked for predicted energy levels by 2015, one key question regarding renewable energy goals is “what is the lead time required to develop the operating projects”? For geothermal energy projects, as for other renewable technologies, the answer can be complicated. The initial elements that create the critical mass for a successful geothermal project development may be summarized as follows:

1. The potential geothermal resource has been identified and is under the control of the developer.
2. The developer has sufficient financial resources to initiate development.
3. Any unusual environmental, regulatory or permitting difficulties can be overcome.

If, the answer to all of the above questions is a clear yes, then the overall development timetable may reasonably be assumed as encompassing some 36 months. If the above assumptions prove difficult, long delays may extend this timeframe.

The “Critical Mass”

The development and financing of geothermal projects is not much different from the financing of other energy projects. First and foremost, it is about the allocation and management of risks among the parties, with a few notable exceptions. The assumptions relating to achieving the “critical Mass” are as follows:

a) The Developer

A key issue is the ability of the developer to assemble a committed team with the skills needed to develop and manage the geothermal field power plant effectively. The major operators in the geothermal industry have in-house talent including geologists, reservoir engineers, power plant engineers and other technical personnel, which they supplement with specialized consultants. Assembling and structuring this team is a process that at a minimum encompasses a six (6) to twelve (12) month process.

b) Site Control

Anyone who has drilled geothermal wells would agree that the geothermal resource is THE key to the success of a geothermal project. Among the resource issues that need to be addressed are:

1. Who owns the land? Most projects are developed on land that is leased either from the federal government (i.e., Bureau of Land Management) or private land owners.
2. Resource delineation: Most active geothermal prospects in play today have had some preliminary exploration performed in the past or have manifestations such as geological structures or hot springs.
3. Financial: In order to develop a financially project the developer must obtain site control through a geothermal lease or a fee land purchase of the entire geothermal resource. This is to preclude competing interests from negatively impacting projects sharing a resource.

This site control may be as simple as acquiring an existing resource area from a private owner, or winning a competitive bid in a BLM auction of Known Geothermal Resource Areas (KGRAs). In both of those instances site control may be accomplished in a relatively short time period. If non-competitive BLM, or state lands, lease applications are the site acquisition mechanisms, then the period for processing including performing NEPA studies can stretch for years if not decades. Negotiating geothermal leases with a group of private landowners can also be a tedious time consuming process. In summary, site control should be a three (3) to twelve (12) month process.

c) Permitting and Regulatory Issues

This can be the most complicated of the initial issues. Rather than deal with all the possible problems relating to these issues, we should assume that an experienced consultant can define a roadmap for permitting a particular project (see section on Barriers and Impediments in Environmental Review and Permitting Processes). If this roadmap does not allow for the project to be developed over a nominal 36 month period, unless there are very special circumstances, it may not be practical to consider such project in the WGA CDEAC planning process. In particular a partial list of site conditions which would result in material project environmental and permitting delays are:

- The presence of Native American sacred sites or sensitive areas.
- The presence of an endangered species on critical portions of the site, however, these can usually be mitigated.
- The need to use wetlands areas for site access or construction, although these can usually be mitigated using wetland banks if available.
- A site with large existing residential areas in close proximity. It is important to be proactive with a community early in the process.

d) A Developer with Access to Sufficient Capital Resources

Experience shows that on average the development of a geothermal project, after site acquisition, takes three years from start to commercial operation. The developer needs the capital and the commitment to go through the exploration and resource delineation processes, which many times do not yield a project at all. This equity contribution, which is usually in the order of \$3M to \$5M, is pure risk capital, and is the most difficult and expensive to obtain. The developer either has these financial resources or may well expect to spend a long frustrating period raising these funds. For planning purposes we can assume a six (6) to twelve (12) month period.

Project Execution

The new geothermal projects that will be developed to meet the WGA goals will probably range in capacity from 5 MW to several hundred MW. However, the most likely project size will be in the 20 to 50 MW range with an estimated 36-month development timeframe.

IV. Siting

A. Map of the Resource

These sites may be found in tabular format under table A.5.

B. The Siting Process

The Geothermal Energy Association (GEA) organized a workshop Reno, Nevada, on Monday July 25, 2005, in order to review existing resource potential and development cost estimates of known geothermal sites. The first objective of this initiative was to provide better information to the Western Governors' Association (WGA) Clean and Diversified Energy Initiative, notably by gathering data needed to build a geothermal supply curve. The workshop also aimed to gather ideas and identify options for the US-DOE Geothermal Program and the USGS to proceed to a more extensive review of the existing data and ensure their update on a regular basis.

Resource Potential

The morning session reviewed the resource capacity estimates of the geothermal resources located in the western states. The list of existing sites was based on the USGS Circular 790 (resources with $T > 150\text{ }^{\circ}\text{C}$), EIA data and the recently published "New geothermal site identification and qualification" (GeothermEx-CEC, 2004).

The review process focused on the list to correctly identify valid sites and to review and assess the power potential for each site.

Two different values were sought:

- The first power capacity estimate corresponds to the incremental new power capacity that could be built at each site within the next 10 years for a price of power less or equal to 8 ¢/kWh (price of power excluding transmission costs and considering the availability of a 10 year Production Tax Credit or PTC).
- The second resource potential estimate investigated the power capacity that could be built at each site with the best currently available technology when price and timeframe constraints were relaxed. No timeframe limit was provided and the indicative power price limit was 20¢/kWh.¹

Where little information was available about the resources, some sites were lumped together within a single power capacity estimate (e.g. "Cascade volcanoes" or "other Nevada sites", etc.).

Site Location and Maps

The resultant preliminary maps are provided below.

¹ It is important to note that this second power capacity values correspond to either (1) sites that would need more than 10 years to be developed (even if power production cost could be lower than 8¢/kWh) and/or (2) sites that would need power price above 8 ¢/kWh (and up to 20¢/kWh) to be developed.

(suite of footnote 1) A great deal of uncertainty characterizes at least part of these estimates since little information is known about sites where minimal exploration had been completed. Sites where little information data is available were particularly affected by the 10 years timeframe constraint as venture capital needed to fund exploration activities is very difficult to attract (exploration investment is quite risky) and potential prospects may thus require a lot of time to come online. Given the time needed to develop a geothermal project (*time required to secure lease, to gather funds need for exploration and explore the site, to obtain permits and confirm the power potential of the resource*), most projects considered developable within the next 10 years are already well-known resources.

- Requires firm transmission

Within the Western Interconnect, geothermal resources need *dedicated* transmission capacity - which generally means new construction to support their near 100% capacity factor. If there were long-term capacities available on existing corridors then dedicated access to these corridors would be sought on a firm contract basis from the existing transmission providers; however, the existing transmission infrastructure does not support large-scale geothermal development. Additionally large geothermal energy pockets are remotely located requiring major interconnection transmission development. As the number of transmission stakeholders involved in new transmission projects increases (for both geothermal and other needs) the unit cost of transmission goes down for all. Significant economies of scale can be achieved if the geothermal plants and transmission are sized to their maximum capability.

In parts of the Western Interconnection, transmission construction has come to a virtual standstill. The CAISO operates under its FERC approved tariff and does not offer price or operational certainty, which discourages joint participation projects in California and at its seams. (Congestion charges, curtailments, possible rotating blackouts, and one year transmission bidding processes are all part of the ISO environment). Public Power, which has over 40% of the transmission in the Western Interconnect, has developed very aggressive renewable portfolios. Unfortunately many geothermal resources are currently unattainable – as previously identified there is minimal existing transmission today that can be used and the prospect of new joint projects (under existing rules in some areas of the Western Interconnect) is dim because of a lack of transmission with cost and operational certainty. This has discouraged joint transmission projects not only with Public Power but also with other IOUs (outside the ISO) in the Western Interconnect. The PPIW initiative offers a resolution to the problem wherein the two different models (the financial model (of ISOs/RTOs) and the physical model of the other control areas) can coexist and yet, jointly build major transmission projects. In addition the PPIW initiative promotes participation by others through the “Open Season” process in order that any of these projects could maximize the economies of scale. It can easily be seen that the areas of the Western Interconnect where this would have the most positive effect would be those regions that interface with the ISO. This initiative was sponsored by many Publics in the Western Grid, is supported by many other IOUs in the Western Grid, and is simple to implement. Therefore implementation of this initiative and other similar cooperative initiatives would surely accelerate transmission projects in areas needing it most.

The WGA could establish a fee to support the cost of new transmission spread equitably across all states, parties and technologies on a capacity basis to support the costs of new transmission needed for geothermal and other clean and renewable technologies identified as a result of this process.

Joint ownership projects have played a vital role in the growth and development of many Southwest utilities, and the West in general, for over 50 years. The result is a highly integrated transmission and distribution system that has fostered extensive cooperation and coordination among owners.

V. Benefits of Geothermal

The heat within the earth is a vast but largely untapped energy source. Just below the surface the temperature never deviates far from 55°F, but deeper beneath the surface temperatures are hot enough to make hot water or steam. There are three ways to use this heat from the earth: by generating electricity, through direct use applications, and by using a geothermal heat-pump. Only a small fraction of geothermal's true potential has been tapped. State policymakers should consider the following benefits of geothermal energy:

Geothermal energy has the ability to:

- provide reliable electricity at a stable price;
- help states diversify the mix of fuels they use to produce electricity;
- transfer the future fuel price risk from the consumer to the geothermal developer/operator;
- generate electricity in a manner that produces minimal environmental impacts and emissions;
- help states meet renewable portfolio standards;
- generate economic development opportunities, especially in rural areas;
- provide heat for agricultural, industrial and space heating applications;
- provide baseload power.

Reliable Power

One of the principal benefits of geothermal power plants is that they provide baseload power. Baseload power plants provide power all or most of the time and contrast with “peaker” plants which turn on or off as demand rises, or peaks, as dispatched. Geothermal plants contrast with other renewable energy resources like wind and solar energy that generate power intermittently, or hydro whose availability peaks seasonally. New geothermal plants in the United States are available to operate over 95% of the time. Such high percentages make them compare favorably with fossil fuel and nuclear power plants and geothermal's additional benefits (outlined below) make geothermal a highly favorable option for energy production

Geothermal resources can provide power for many years. The Geysers geothermal field for example, which began commercial production in 1960 in Northern California, had the first domestic geothermal power plant. Nearly half a century later, the 21 power plants operating there generate power for approximately one million households in California. The key to successful long-term sustainable geothermal production lies in efficiently managing the resource. Technological advances—such as water injection, continue to be developed and allow developers to maximize resources and minimize drilling.

Electricity at Stable Prices

Using geothermal resources for power can help protect against volatile electricity prices. For any power plant, the price of the fuel used to generate power influences the price of the electricity produced; if the price of fuel is unpredictable, the price of electricity is unpredictable. Unlike traditional power plants that require fuel purchases, geothermal power plants secure their fuel supply before the plants begin operating by capitalizing the costs of the geothermal wells. This in essence transfers the future fuel cost risk from the consumer back to the geothermal project developer and subsequently to the project operator.

Since the price of geothermal resources will not change, it is possible to know what the price of electricity generated at a geothermal power plant will be over time. The price of electricity from

new geothermal power plants ranges from between \$0.06 per kWh and \$0.08 per kWh. Once capital costs for the projects are recovered, the cost of producing of power usually decreases. Fossil fuels have traditionally generated power for less, but the price of these fuels can suddenly increase to a level that is more expensive than geothermal electricity. For example, the price of natural gas is nearly three to five times what it was throughout the 1990s.

On a life-cycle cost basis, when all fuel costs and risks are considered, geothermal plants are a good investment. The fuel costs for a geothermal power plant are not dependent upon fuel volatile markets. Electricity price from geothermal power plants is predictable and stable over the life of the project.

Diversify Mix of Resources

Renewable energy resources like geothermal can help states diversify the mix of fuels they rely on for power and heat and protect customers from price volatility. In contrast, the price of other fuels may be volatile and difficult to predict accurately. In addition, using domestic renewable resources can help states reduce the amount of fuel they import from nearby states or overseas.

Clean Electricity

Air Emissions

One of the most significant environmental benefits of geothermal energy is clean air, which translates into fewer respiratory health problems for the U.S. population. Compared to conventional fossil fuel plants, geothermal facilities emit very small amounts of particulate matter, sulfur dioxide, carbon dioxide, and typically no nitrogen oxides. Mercury and hydrogen sulfide emissions are typically minimal due to improvements in abatement technology. When comparing an average coal plant to an average geothermal flash plant, the coal plant emits 24 times more carbon dioxide, about 11,000 times more sulfur dioxide, and 4,000 times more nitrous oxides per megawatt hour than a geothermal steam plant. Lake County, downwind of the world's largest geothermal field known as "The Geysers," is the only air district in California that has been in compliance with all state and federal air quality standards for 17 years.

Water Use

In many areas of the country, especially the western United States, water resources need to be conserved. Geothermal power plants use less freshwater resources than many other forms of electricity production. For example, comparing two recent power plant applications in California, a new geothermal flash plant would use 5 gallons of freshwater per megawatt hour, while a new gas facility would use 361 gallons per megawatt hour. Alternatively, a binary, air-cooled geothermal facility would consume no water. Also, the fluids used to generate geothermal power are kept separate from drinking water and are continuously recycled through the geothermal system, so they are not depleted through geothermal use. (*A Guide to Geothermal Energy and the Environment*, Kagel et al, April 22, 2005, pages 43-47.)

Other Environmental Benefits

- **Minimal noise pollution:** Normal geothermal power plant operation typically produces less noise than the equivalent produced "near leaves rustling from breeze," according to common sound level standards, and thus is not considered an issue of concern.

- **Minimal land use:** Over 30 years, the period of time commonly used to compare the life cycle impacts from different power sources, a geothermal facility uses 404 square meters of land per gigawatt hour, while a coal facility uses 3632 square meters per gigawatt hour. (*A Guide to Geothermal Energy and the Environment*, Kagel et al, April 22, 2005, pages 48-55; Environmental Advantages to the Utilization of Geothermal Energy, Paul Brophy, *Renewable Energy*, Vol 10:2/3, Table 3, pp. 374; *Environmental Aspects of Geothermal Development*, Kevin L. Brown, International Geothermal Association, Pisa, Italy, May 1995, Page 13.)

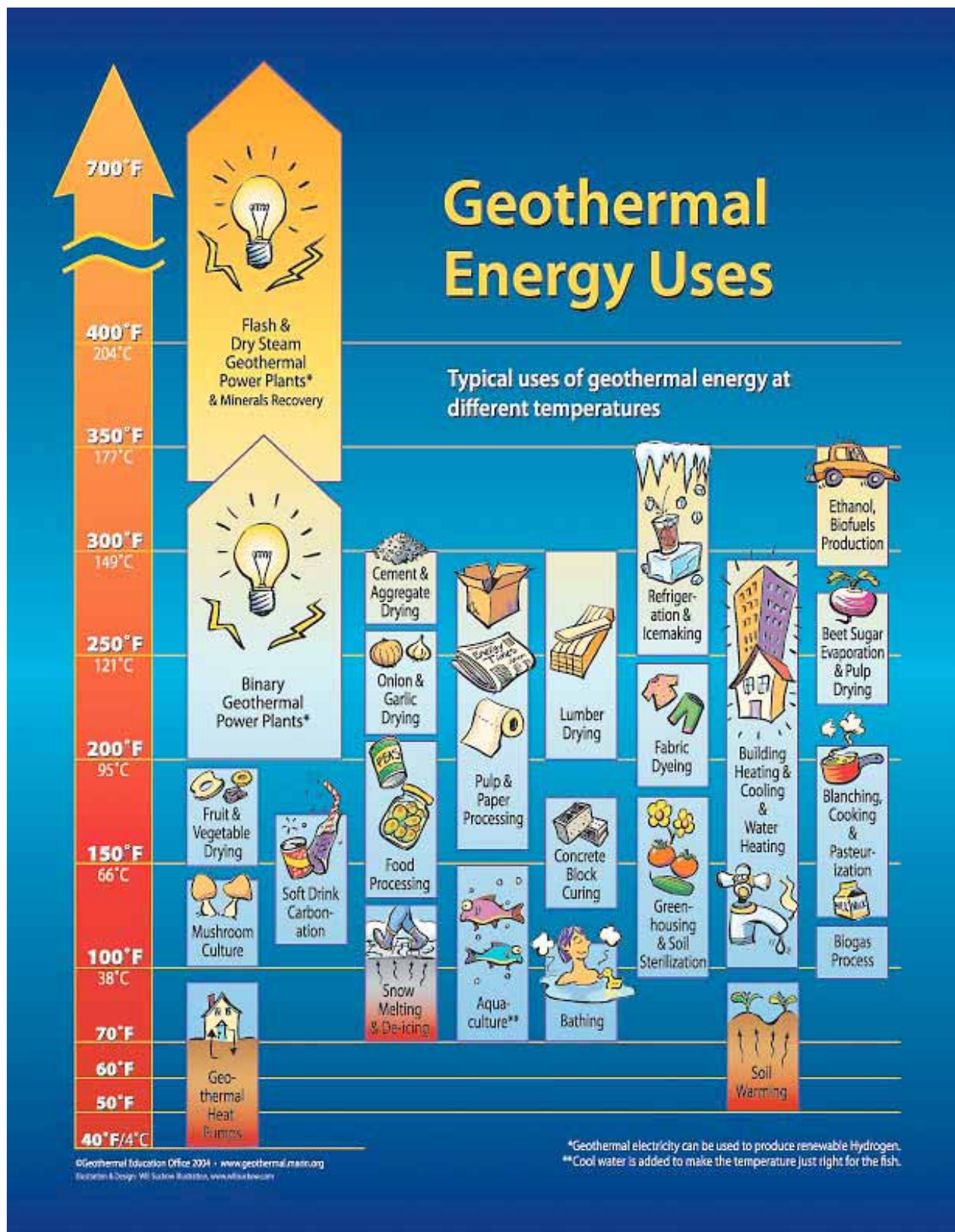
Meet Renewable Energy Standards

Twenty states and the District of Columbia now have some sort of renewable portfolio standard (RPS) that requires power providers to supply a certain amount of their power from renewable resources by a specific year. In many of these states, electricity generated from geothermal can count toward meeting the standard.

Economic Development Potential

Using geothermal resources can provide economic development opportunities for states in the form of property taxes, royalty payments and jobs. Geothermal power plants are among the largest taxpayer in every county where they exist. The 21 geothermal power plants at the Geysers Geothermal Field in California can generate almost 1,000 MW of electricity and have been an important source of revenue and jobs for Lake and Sonoma counties for many years. These power plants employ approximately 425 people full-time plus an additional full-time equivalent contract work force of 225. In 2003, property tax payments to the two counties totaled more than \$11 million.

Another revenue stream flows from royalties that developers pay in exchange for the right to tap resources on federal, state or private lands. These are similar to severance taxes that states charge for extracting fuels or minerals. In 2003, operations at The Geysers generated a total of \$6.15 million in federal royalties and \$4.1 million in royalties to the State of California. Local county governments share in both the federal and state royalties.



Top Reasons Why the West Benefits From Geothermal Energy

<p><u>Geothermal energy is clean energy</u></p> <ul style="list-style-type: none"> • It is a statute-recognized renewable resource that qualifies in most states' Renewable Portfolio Standards (RPS) • Geothermal plants produce minimal pollutant emissions compared to traditional fossil fuel plants, with some types of geothermal plants producing no air emissions at all • Geothermal plants conserve freshwater resources • Geothermal energy eliminates the mining, processing, and transporting required for producing electricity from fossil fuel sources • Geothermal energy uses less land than other energy sources, according to the U.S. DOE <p><u>Geothermal energy provides diversity</u></p> <ul style="list-style-type: none"> • Geothermal resources do not present a fuel risk • Geothermal helps to diversify the mix of fuels used to generate electricity, and can help meet RPS requirements • Geothermal resources are scattered throughout the Western states (see map) • As a local or regional resource that uses a renewable, reliable, and indigenous fuel source, geothermal offers security and does not rely upon unstable outside markets • Geothermal energy reduces the need for customer fuel cost adjustments <p><u>There is a vast geothermal resource</u></p> <ul style="list-style-type: none"> • The heat beneath the earth is a tremendous, but largely untapped energy source • Geothermal resources can deliver energy and power for decades • The heat flows continuously from earth • There are thousands of locations where geothermal resources are known to be developable throughout the West • Many additional locations are yet to be found <p><u>Geothermal energy is reliable</u></p> <ul style="list-style-type: none"> • No intermittent resource with geothermal--it operates 24 hours per day, 7 days per week, 365 day per year • Geothermal power plants provide steady and predictable baseload power • Not dependent on out-of-state or out-of-country fuel 	<ul style="list-style-type: none"> • Geothermal power plants operate at the highest capacity factors • A geothermal power plant will use most of its reserved transmission capacity most of the peak hours. Other energy sources, e.g. wind, do not typically use the reserved transmission capacity reliably at peak hours. <p><u>Geothermal energy can stabilize prices</u></p> <ul style="list-style-type: none"> • New geothermal power plants generate electricity between 5 and 8 cents/kwh • Because geothermal plants rely on a stable source of fuel, prices do not fluctuate like natural gas prices • Once the capital costs have been recovered, the cost to produce geothermal power will decrease • On a levelized basis, it is competitive with any new generation • On a risk basis, it is competitive with any new generation • On an environmental cost basis, it is competitive with any new generation <p><u>Geothermal Energy helps develop the economy</u></p> <ul style="list-style-type: none"> • In terms of economics, one acre of a geothermally heated greenhouse is comparable to a megawatt of power production • It generates economic opportunities, especially in rural areas • It provides heat for agricultural, industrial, and space heating applications • Geothermal energy creates jobs • Geothermal energy supports minority communities • Geothermal power plants are often the largest taxpayer in the county where they are located • The counties share in the royalties <p><u>Geothermal heat can be used directly</u></p> <ul style="list-style-type: none"> • It is an enabling technology, especially in times of high natural gas prices • It provides heat for agricultural, industrial, and space heating applications • Direct use applications create construction, operation, administrative, and maintenance jobs • Direct use applications use widespread lower temperature geothermal resources • There are limitless clever direct use applications, from aquaculture to agriculture.
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Table V.1. Comparative Air Emission Benefits of Geothermal vs. Coal

Emission		Nitrogen oxide (NO _x)	Sulfur Dioxide (SO ₂)*	Particulate Matter (PM)	Carbon Dioxide (CO ₂)
Sample Impacts		lung irritation, coughing, smog formation, water quality deterioration	wheezing, chest tightness, respiratory illness, ecosystem damage	asthma, bronchitis, cancer, atmospheric deposition, visibility impairment	global warming produced by carbon dioxide increases sea level, flood risk, glacial melting
Geothermal Emissions (lb/MWh)	Binary	0	0	0	0
	Flash	0	0.000215	negligible	60
	Steam	0.00104	0.35	negligible	88.8
Coal emissions (lb/MWh)		4.31	10.39	2.23	2191
Emissions Offset by Geothermal Use (per yr)		32 thousand tons	78 thousand tons	17 thousand tons	16 million tons

For more detailed information about the environmental aspects of geothermal energy, please access Geothermal Energy Association's (GEA's) *Guide to Geothermal Energy and the Environment*, available at <http://www.geo-energy.org/Facilities/Links/GeothermalGuide.pdf>.

Other Opportunities

Direct Use

In addition to generating electricity, the heat in geothermal fluids can be used directly for such purposes as growing flowers, raising fish and heating buildings. There are a number of basic types of direct use applications: aquaculture, greenhouses, industrial and agricultural processes, resorts and spas, space and district heating, and cooling. Generally, direct use projects use fluids with temperatures of between 70°F and 300°F. Direct use systems in the United States currently provide approximately 600 thermal megawatts of heat, enough to heat approximately 115,000 average homes. (The power from direct use systems is measured in megawatts of heat as opposed to power plants that measure power in megawatts of electricity.) Some geothermal projects “cascade” geothermal energy by using the same resource for different purposes simultaneously such as heating and power. Cascading uses the resource more efficiently and may improve the economics of a project.

Four commercial greenhouses in southern New Mexico, which at times have employed up to 400 people, occupy more than 50 acres and use geothermal heat to grow plants. In 2002, these projects generated nearly \$23 million in sales and paid more than \$6 million in payroll. A large greenhouse in rural Utah that grows flowers employs between 80 and 120 people at different times throughout the year.

Opportunities to Use Geothermal Resources to Improve Energy Efficiency

Like many natural resources, there is no end to the number of clever things that can be done with geothermal energy. There is a danger, therefore, of neglecting other potentially significant

opportunities, perhaps with as great of potential to that of geothermal generation. Although these are not directly related to the electric utility sector, they contribute to energy efficiency and need to be considered if the overall strategy is to be both comprehensive and adaptive. As the thermal market is dependent on natural gas and other fuels, geothermal resources offer potentially large energy and economic advantages.

Geothermal Heat Pumps

Another opportunity is offered by ground source heat pumps, taking advantage of the fact that subsurface temperatures at very shallow depths remain relatively constant year-round. Using closed-loop piping systems buried beneath the earth, these systems can be used almost anywhere to reduce heating costs in winter and cooling costs in summer.

The geothermal heat pump is a highly efficient renewable energy technology that is gaining wide acceptance for both residential and commercial buildings. Geothermal heat pumps are used for space heating and cooling, as well as water heating. Its great advantage is that it works by concentrating naturally existing heat, rather than by producing heat through combustion of fossil fuels.

The technology relies on the fact that the Earth (beneath the surface) remains at a relatively constant temperature throughout the year, warmer than the air above it during the winter and cooler in the summer, very much like a cave. The geothermal heat pump takes advantage of this by transferring heat stored in the Earth or in ground water into a building during the winter, and transferring it out of the building and back into the ground during the summer. The ground, in other words, acts as a heat source in winter and a heat sink in summer.

Engineered Geothermal systems

Engineered geothermal systems (EGS) are reservoirs created to produce energy from geothermal resources deficient in economical amounts of water and/or permeability. Enhanced geothermal technology will increase the productivity and lifetime of those reservoirs. The U.S. Department of Energy (DOE) estimates that the application of enhanced geothermal technology can significantly expand the extent and amount of geothermal resources used in the West.

Using Oil and Gas Infrastructure to Enhance Geothermal Resources and Vice Versa.

Nearly 2/3 of all oil discovered in the U.S. is still in place. With conventional technology, that is all we can extract from most oil fields and still make a profit. Also, the cost of electricity to operate oil fields is the most important factor determining the economic life of those fields. New technologies, such as enhanced oil recovery techniques and drilling microholes with less expensive rigs, can be combined with measures to reduce electrical costs, like utilizing renewable resources (wind, solar, and geothermal), to significantly increase the percentage of oil recovered and proportionately reduce the need for foreign oil. These advances must be tested under real world conditions before they will be adopted by a risk-averse oil industry.

A company has been recently formed to pursue its patented idea for converting nearly-depleted oil and gas fields into geothermal assets using several proven technologies in unique combination. Initially, solar energy is transferred as heat to aging oil and gas reservoirs in a pattern designed to increase the recovery of remaining oil and gas, at the same time building up

the heat content of the reservoir. Ultimately, the banked solar energy would be extracted utilizing naturally occurring brines to drive geothermal power plants and local heating systems.

The cost of drilling to develop geothermal resources is often the most decisive factor in determining the economic viability of proposed geothermal power plants. Yet the thousands of oil and gas wells that are typically drilled to even greater depths (accessing even hotter zones) have scarcely been considered for use in geothermal systems. If only 5% of the 600,000 wells that have been drilled in Texas could be used for geothermal extraction, that would mean 30,000 wells available for electrical power generation. As a conservative estimate, if each well had an average production of 2 megawatts, we could have as much as 60,000 megawatts of electrical power generated out of Texas alone. This potential applies as well to the deep sedimentary basins of the western U.S.

Taking Care of the West's Vast Rural Areas

In the west most of the territory is rural. These rural areas not only have significant political clout but are also the areas where the most significant increases in population, and therefore in energy services, are anticipated. Geothermal energy resources are widely distributed across the West and can serve as sustainable economic drivers for rural communities. Powerplants can provide lasting local income and jobs, direct use applications can support schools, farms and business, and geothermal heat pumps can provide economical heating and cooling. When rural economic development are also recognized, the benefits to the Western States of geothermal energy are even greater

VI. Barriers and Policy Recommendations

This section is divided up into four parts: the first addresses federal issues; the second state and local issues; the third transmission-related issues; and finally, issues related to direct use. The Task Force believes that Governors can play an important role at each of these levels to make geothermal an important part of the western states' energy portfolio.

Introduction

This area reviews key issues that affect geothermal development, both benefits and barriers, and how the barriers might be addressed through federal or state legislation, memorandums of understanding (MOUs), regulation, or policy recommendations. Additionally, the National Geothermal Collaborative (NGC) recently published a document entitled "Geothermal Outreach Principles and Comment Analysis Report" that reviewed 8 geothermal projects around the West and found that the same concerns are raised by the public and regulatory agencies regardless of where the project is located -- whether in a forest or desert, a rural area or near a community. Similarly, a survey the Geothermal Energy Association (GEA) distributed to geothermal developers across a number of states found that many barriers are rated as most significant regardless of location. These concerns and the mitigation measures that are known to work are addressed in this report as well as actions the WGA could take to meet their goal of expanding geothermal development by 2015. Some of the recommendations are state specific while some involve the federal government, as many of the known geothermal resources are located on federal lands. Fortunately there are other reviews of federal laws and regulations currently in process that may link well with the task force recommendations outlined in this report.

Additionally, the recent passage of the Energy Bill provided much needed incentives and directives for geothermal energy.

A. Federal Issues

The federal government needs to be a major partner in achieving the energy goals of the west, and its policies and programs need to support expanded use of the region's geothermal resources. Here is a quick summary of recommendations related to the Congress and federal agencies, followed by a more extensive discussion of each.

Key Recommendations:

- The Governors should urge Congress to extend the placed in service date for the Production Tax Credit to December 31, 2015 and provide more flexibility in meeting the deadline for technologies that have longer construction times. They should also urge Congress to extend the deadline for issuance of new "Clean Renewable Energy Bonds" in a similar manner.
- The WGA should urge the Department of the Interior to expeditiously implement recent changes to the Geothermal Steam Act and implement BLM's new Strategic Plan. BLM efforts are central to the federal government's role in geothermal development, and the Department needs to recognize this in setting priorities and budgets.
- WGA should support the work of the National Task Force on Improving NEPA, and otherwise support and pursue improvements in federal processing that reduce cost, reduce delays, and ensure timely decisions without substantive changes to the environmental protections sought by underlying laws.
- The Governors should support strong, continuing geothermal research and outreach efforts by the Department of Energy. In addition, WGA should ask the Secretary of Energy to expand DOE's support for exploration and exploratory drilling and examine whether existing federal loan guarantee authority in law can be used to supplement these activities to reduce risk and encourage development in new resource areas.
- The WGA should urge the Administration and Congress to review Executive Orders established by the Clinton administration, (EO 13007 and 12898), and the underlying law to improve its administration and seek to facilitate resolution of conflicts and provide direction on how to balance competing values when there are irreconcilable differences.

Issue: the Energy Policy Act of 2005 Fell Short of What is Needed

The Energy Policy Act of 2005, HR 6, builds upon the amendments Congress made last year in the FISC-ETI bill to extend the Production Tax Credit and improve its equitable treatment of all renewable technologies. The legislation expands the renewable technologies covered to include incremental hydropower, and expands the credit period from five to the full ten years for all

technologies. As a result, the federal production tax credit is poised to be a significant incentive for new geothermal power production.

However, while the Western Governors supported a longer extension, HR 6 only extends the "placed in service date" for geothermal and other renewable technologies by two years. This gives developers 29 months to have their facilities on-line. Only new power plants placed in service by December 31, 2007 will qualify for the PTC under this bill.

HR 6 takes major new strides in providing cooperatives and public power new reasons to invest in renewable power technologies. Cooperatives and public power entities provide significant electric services in the West, so these new provisions will greatly assist in achieving the CEDEAC goals.

First, the new law provides pass through of Section 45 for cooperatives, allowing eligible cooperatives to elect to pass any portion of the renewable electricity production credit to their patrons. An eligible cooperative is defined as a cooperative organization that is owned more than 50 percent by agricultural producers or entities owned by agricultural producers.

Second, HR 6 creates new Clean Renewable Energy Bonds ("CREBs"). CREBs are defined as bonds issued by qualified issuer if, in addition to other requirements, 95 percent of proceeds are used to finance capital expenditures incurred for facilities qualifying for tax credit under section 45. Qualified issuers include governmental bodies (including Indian tribal governments) and mutual or cooperative electric companies. This provision is effective for bonds issued after December 31, 2005 and before December 31, 2007 and is limited to a total of \$800 million.

These are very significant provisions, and together they will lead to an expansion in new renewable power development in the West. Congress should be applauded for including these important renewable energy tax incentives in the Energy Policy Act of 2005.

However, the West still needs a long term federal policy to encourage new renewable energy development. For both the Section 45 credits and the new clean energy bonds, Congress has limited them to facilities placed in service (or bonds issued) in the next two years. Other technologies, such as clean coal and new nuclear power, are provided much longer timeframes. While this may be due to the expectation that clean coal and nuclear power plants will take longer to build, renewable technologies also need and deserve policies with duration of more than two years. The limited horizon Congress has provided for its renewable energy incentives will hamper their ability to contribute to meeting the CEDEAC goals and create substantial uncertainty for investors, utilities and the Western States.

It's important to recognize that for all renewable projects, initial siting and permitting can take several years. Once this is completed, construction can take from less than a year for a wind or solar facility to three to five years for a geothermal or biomass plant. Thus, even in the best cases -- where all permits are in hand today -- geothermal and biomass developers will have a very limited time to take advantage of the PTC without facing unacceptable risks.

Recommendation: The Western Governors recognized the need for longer-term policies when they urged Congress to adopt an extension of the Production Tax Credit of at least five years. This would have provided the time-horizon needed to stimulate investment in the full range of renewable technologies and bring many new projects on-line. The federal tax incentives are an important complement to on-going state level initiatives to promote new renewable technologies, such as renewable portfolio standards. Together they will provide the policy basis needed to ensure vigorous growth in these industries, but this policy foundation is incomplete.

WGA should urge Congress to address this shortcoming as a high priority, either in legislative opportunities still coming up in this Session or in future Sessions. In the remaining months of this Session of Congress, the Budget Reconciliation package and other tax bills could provide an opportunity to extend the PTC deadline or to modify its strict treatment of placed in service. While HR 6 made great progress, without these changes many of the renewable projects that WGA's CEDEAC process is examining would suffer.

Congress should address the critical need for a long-term federal policy to encourage new renewable power development. It should make the Section 45 tax credit permanent or extend the placed in service date to 2015. Congress should also consider modifying its approach to placed in service for technologies that have longer lead times and construction periods. We would urge Congress to consider allowing such facilities to qualify for the PTC once they have secured a power sales contract and have begun construction. At this stage, projects have cleared all of the major hurdles and reached the point where developers must make the most significant financial commitment. To ensure that developers proceed to completion with all diligence, Congress could require that construction be completed within a reasonable period of time say two or three years.

Issue: Federal Agencies Represent Major Barriers (results from GEA survey)

Geothermal Energy Association (GEA), the trade group for the geothermal industry, distributed a survey in 2005 to new developers and other geothermal industry members assessing the significance of a range of barriers to geothermal energy production. The following are some key results from that survey:

- *Of the more than 60 barriers listed in the GEA survey, the Bureau of Land Management was rated as one of the most significant barriers, often due to lack of adequate funding and staff.*
- *Of the eight barrier categories listed in the GEA survey, "Procedures and Decisions of Federal Agencies" was rated second most often as one of the top three barriers (after financing).*
- *Respondents to the GEA survey reported up to 25 years of delays, often due to a backlog of leasing and permitting applications and drawn out environmental reviews. In addition, they rated "Lack of clear administrative procedures" as one of the most significant barriers.*
- *"Lack of clear timeframes" was rated one of the most significant barriers in the GEA survey.*

- *Two barriers rated most significant, according to the GEA survey, were “Lack of coordination between state & federal policies” and “Lack of coordination among federal agencies.” See enclosed chart of existing MOU between the BLM and USFS.*
- *“Obtaining permits” was rated as one of the most significant barriers for geothermal developers, according to the GEA survey. (See chart developed by BLM)*

The results of this survey simply reconfirm other studies conducted by NREL and others of the problems that developers face on federal public land. It should be noted that many of the barriers identified in GEA’s survey have been addressed or identified as priority actions in BLM’s Geothermal Strategic Plan. As previously mentioned, BLM has processed more than 200 geothermal lease applications over the past 5 years. Land use planning on BLM and Forest Service lands remains the single biggest barrier to processing leases. BLM and the Forest Service are using available resources to prioritize and amend land use plans to enable geothermal leasing, but these resources need to be sustained and a timeline compatible with the 2015 target established.

Recommendations: When the Geothermal Steam Act Amendments of 2005 and the BLM 2005 Strategic Plan are fully implemented some of these recommendations will have been addressed. However, timely implementation is critical to their success and support of geothermal development to meet the WGA’s goals.

Therefore, as a first order of business, the Department of the Interior should work to expeditiously implement the changes to the Geothermal Steam Act and implement BLM’s new Strategic Plan. BLM efforts are central to the federal government’s role in geothermal development, and the Department needs to recognize this in setting priorities and budgets.

In addition, we recommend that the Department consider undertaking the following specific actions, in cooperation with the Western states:

- Establish federal and state “SWAT” teams to perform the environmental reviews and to ensure that all permits from respective agencies are issued in a specific time frame for geothermal projects. Identify one lead federal agency for NEPA (i.e. BLM) and one state agency (i.e. CDOGGR in California for CEQA) to facilitate a coordinated yet thorough review process. These SWAT teams should be given decision authority and should be held accountable for their actions, through, for example, reporting their progress on pending applications to either Congress or the Governors’ respectively. Funding provided to the BLM through the Geothermal Steam Act (GSA) Amendments of 2005 can finance a program such as this allows the Department of Interior to transfer funds to the US Forest Service for geothermal related actions. The BLM royalties that go back to states with geothermal could be used to facilitate the states’ staffing needs for this type of directive. Under the GSA 50% of the BLM royalties go back to the state of origin.
- Establish federal and state statutory timelines for completion of environmental reviews and permitting of no longer than 4 months for an exploration project (if it’s not already Categorical Exempt) and 12-months for a power plant project once a complete application is received. Require strict adherence to the timeframes established for public

review of an environmental document or permit, for example 45-days for a draft EIS. Scoping of projects need to be as thorough as possible to facilitate these timelines and the agencies must take control of the process throughout the entire review. Implement Executive Order 13212 signed by President Bush on May 18, 2001. These statutory timelines could be recommended to Congress by the National Task Force on improving NEPA.

- Establish procedures to expedite or limit administrative appeals and judicial review of agency decisions. Templates for this type of review are contained in the Healthy Forest Restoration Act and the Warren Alquist Act in California among others.
- Insure implementation of the MOU between the USFS and BLM for coordination on federal lands as outlined in the Steam Act Amendments of 2005 (HR 6). If necessary, include other federal agencies in order to facilitate the SWAT team process and recommended timelines. This MOU is also required to set forth administrative procedures for lease processing which will reduce the backlog of least applications by 90% within five years.
- Simplify permitting for geothermal drilling rig engines (off-road engines) as a portable source allowing flexibility to move rigs as needed for this temporary operation.
- Prepare a Programmatic Agreement for Section 106 under the National Historic Preservation Act to address all geothermal energy resources in the United States. Assume a possible effect and require appropriate mitigation measures to avoid cultural resources.
- If a federal land management agency's land use plan is in conflict with possible geothermal leasing or utilization, allow any amendments to the plan to be addressed in the NEPA document for the project.
- As required by the BLM Strategic Plan (June 2005), update and prioritize operations that are considered Categorically Exempt under NEPA. This should also be completed in California under CEQA. Geothermal exploration projects, including well testing operations (up to and including full size well exploration projects), should be categorically exempt from NEPA and CEQA.

Issue: NEPA Review on Federal Lands

There is a lengthy, costly, and complicated maze to develop any resource, including geothermal, located on federal lands. Depending upon which agency is the landowner-- the US Forest Service, Bureau of Land Management (BLM), military or a combination-- the agency must perform an environmental review under the National Environmental Policy Act (NEPA). These agencies then interact or consult with other agencies that may have oversight given a specific issue of concern. For example, it may be necessary to consult with the US Fish and Wildlife Service (USFWS) if a federal listed endangered or threatened species has habitat or may live in the project area (Section 7 Consultation). Suffice it to say, there is a lack of a defined method for coordination between the federal agencies, even those within the same agency. For example,

the directives and objectives of agencies within the Department of Interior, including the BLM and the USFWS, differ. The BLM is to manage and utilize resources, whereas the USFWS's directive is protection. Additionally, the federal land management agencies such as the USFS and BLM have different regulations and procedures for implementing NEPA. Their land management plans may also differ as to priorities in the management of resources. All the clean and diversified resources need to be identified in all the agency management plans to facilitate development; however, these land management plans can take years to update as they also are reviewed under NEPA.

There has recently been established by the House Resources Committee a National Task Force on improving NEPA. It is chaired by Congressman Cathy McMorris from Washington State and Ranking member Tom Udall from New Mexico. They held their first public meeting in Spokane on April 23 to collect information on how NEPA has been implemented and is working in the Pacific Northwest. The question of this task force is "Is NEPA meeting the original intent of the law passed in 1969?" Although the timeline of the task force may not meet with the timeline of the recommendations of the WGA, it is very possible that many of the recommendations will align not only with the Geothermal Task Force but also with those from other Task Forces.

Recommendation: The WGA should support the work of the National Task Force on Improving NEPA, and otherwise support and pursue improvements in federal processing that reduce cost, reduce delays, and ensure timely decisions without substantive changes to the environmental protections sought by underlying laws.

Issue: Research Needed To Achieve Full Potential of Geothermal Resources

The analysis supporting this report indicates that there are substantial geothermal resources which have been specifically identified in the West. In addition, it is expected that even more resource potential remains undiscovered. But, the cost and risk of current development preclude utilization of this vast resource. The federal government has taken the lead in supporting development of new technologies for exploration, resource verification, drilling, efficient production and utilization, and advanced concepts like enhanced geothermal systems and its support for these efforts is critical to the future of geothermal energy use in the West. The Department of Energy has also coordinated its efforts with state activities, and made significant outreach through its Geopowering the West initiative. These programs need to be continued, and expanded to address key needs particularly in resource identification and confirmation.

Recommendation: The Governors should support a strong, continuing geothermal research effort at the Department of Energy that addresses the full range of technical problems encountered in achieving full production from the identified and undiscovered resources in the West. They should also support continuation of advanced technology programs and outreach through GeoPowering the West. In addition, WGA should ask the Secretary of Energy to expand DOE's geothermal program in critical areas, particularly the identification and development of new resources. WGA should urge the Department to expand its support for exploration and exploratory drilling and examine whether existing federal loan guarantee authority in law can be used to supplement these activities to reduce risk and encourage development of new resource areas.

Issue: Need for Combined Technology Research

The best forecasting and planning is often overcome by unforeseen developments. Historically, technology development has proceeded independently in each energy resource area. However, for the first time in our history, predominantly used fossil fuels face increasingly severe shortages and environmental limitations, creating the necessity for integration of all our resources into energy portfolios. Potential advances from combining technologies may be significant, changing our thinking about how best to proceed.

Recommendation. It is recommended that the WGA actively support research into promising new geothermal technologies and combinations of energy technologies, particularly those that may enhance a transition from increasingly limited fossil fuel resources to clean renewable resources.

Also, DOE should expand its efforts use oil and gas infrastructure to enhance geothermal resources and vice versa. Nearly 2/3 of all oil discovered in the U.S. is still in place. With conventional technology, that is all we can extract from most oil fields and still make a profit. Also, the cost of electricity to operate oil fields is the most important factor determining the economic life of those fields. New technologies, such as enhanced oil recovery techniques and drilling microholes with less expensive rigs, can be combined with measures to reduce electrical costs, like utilizing renewable resources (wind, solar, and geothermal), to significantly increase the percentage of oil recovered and proportionately reduce the need for foreign oil. These advances must be tested under real world conditions before they will be adopted by a risk-averse oil industry.

The cost of drilling to develop geothermal resources is often the most decisive factor in determining the economic viability of proposed geothermal power plants. Yet the thousands of oil and gas wells that are typically drilled to even greater depths (accessing even hotter zones) have scarcely been considered for use in geothermal systems. If only 5% of the 600,000 wells that have been drilled in Texas could be used for geothermal extraction, that would mean 30,000 wells available for electrical power generation. As a conservative estimate, if each well had an average production of 2 megawatts, we could have as much as 60,000 megawatts of electrical power generated out of Texas alone. This potential applies as well to the deep sedimentary basins of the western U.S.

Issue: Recognize Energy Development as Rural Economic Development in the West's

Because of where the bulk of the population is located, much of our current thinking derives from energy developments in the eastern U. S. We need to be careful in applying that thinking to the west. For example, in the east the population is concentrated in large urban areas with relatively little rural country in between. In the west, much more of the territory is rural. These rural areas not only have significant political clout but are also the areas where the most significant increases in population, and therefore in energy services, are anticipated.

Recommendation: It is recommended that the WGA not simply focus on solving our problems in urban areas but, consistent with our extensive rural areas, promote energy development policies that balance urban and rural needs. A sound western strategy may differ from eastern strategies.

For example, the U.S. Department of Energy, through its Geothermal Technologies Program (GTP), is seeking to replace diesel generators in use at a remote location in Alaska that currently consume over 125,000 gallons of diesel fuel annually for power generation by using domestic geothermal resources from local hot springs. DOE has teamed with an industrial partner and the Chena Hot Springs Resort (CHSR) to validate that a power plant can be installed for \$1000/kW rather than the >\$2500/kW current average plant cost, and that the operating and maintenance costs will be <1 ¢/kWh, thereby demonstrating the feasibility of generating power at less than 5 ¢/kWh from a very low temperature geothermal resource.

Issue: Process and Assumptions for Addressing Cultural Concerns Need Revision

It is very likely that every geothermal hot spring in this country has been used by Indian Tribes and is considered sacred. The Section 106 consultation under the National Historic Preservation Act can create significant delays and controversy, while not necessarily providing new information on the hot spring or area and not facilitating resolution of all tangible issues. It may be impossible to completely mitigate perceived concerns on the effect the development of the geothermal resource may have on the surface features or spirituality of the area, but the law and its regulations provide little guidance on how to balance historic or cultural needs with national energy, security or environmental priorities.

Recommendation: The WGA should urge the Administration and Congress to review Executive Orders established by the Clinton administration, (EO 13007 and 12898), and the underlying law to improve its administration and seek to facilitate resolution of conflicts and provide direction on how to balance competing values when there are irreconcilable differences.

B. State and Local Issues

State Policy Options for Promoting Geothermal Energy

This section focuses on policies that the Western Governors can use to encourage the development of geothermal energy for electric generation. This document is divided into two sections. The first section features a brief description of 13 policy options the governors could support to expand geothermal development in their own states. The second section is a graphic representation of these same policies and features some pros and cons associated with each. For further details on state renewable energy policies visit the National Geothermal Collaborative at www.geocollaborative.org and the Database of State Incentives for Renewable Energy at www.dsireusa.org.

State Policy Options

This section includes a list and a brief description of various renewable energy policy options governors can support in their own states and is divided into economic incentives and regulatory mechanisms.

Economic Incentives

Grants and Loans
Property Tax Incentives
Sales Tax Incentives

Regulatory Mechanisms

Renewable Portfolio Standards
Green Pricing Programs
State Renewable Purchases

Investment Tax Credits
System Benefit Charges
State Production Tax Credits
Royalty Payments

Disclosure & Certification Programs
Interconnection Requirements
Transmission Policy
Integrated Resource Planning

Economic Incentives

Grants and Loans

States have grant programs to support renewable energy in the commercial, industrial and government sectors and for schools and utilities. Some programs focus on research and development, but most aim to encourage the purchase and installation of equipment. Programs vary in the amount offered—from a few hundred dollars up to \$1 million — and some states set no limit. Twenty-two states, including Kansas, New Mexico, Oregon and Wyoming, offer grants like these.

It also is possible for states to provide a loan guarantee on financing for renewable energy projects. Banks and lending institutions that have no experience financing such projects may be hesitant to do so. However, if a state were to guarantee a loan, it could facilitate renewable energy development by decreasing the risk for the lender and helping projects gain easier access to capital. Eighteen states, including Alaska, Idaho, Montana, Nebraska and Oregon, have loan programs such as these.

The California Energy Commission's Geothermal Program promotes geothermal energy in the state by extending financial and technical assistance to public entities for planning, project impact mitigation, and direct use projects. It also provides financial assistance to private entities for research, development, mitigation and commercialization projects. The funding comes from royalties that developers pay the federal government tied to geothermal energy production on federal leases in California. Typically, this program provides grants and loans each fiscal year.

Property Tax Incentives

Property tax incentives usually come in the form of exemptions, exclusions and credits. Many tax exemptions are structured so that any additional value that a device adds to the property is not included in the value of the property for taxation purposes. Because property tax is collected locally, some states give local authorities the option of providing special property tax incentives or exemptions to lure project developers. Twenty-five states, including California, Kansas, Montana, North Dakota, Nevada, Oregon, South Dakota, and Texas, either have property tax exemptions or allow localities the option to exempt renewable energy systems from property tax.

Sales Tax Incentives

Sales tax incentives usually exempt equipment and labor used to construct a renewable energy facility from the state or local sales taxes. These exemptions can save developers money especially on critical upfront capital expenditures; although property tax incentives usually produce greater savings over the life of the project. This incentive is available in 17 states including Arizona, Idaho, North Dakota, New Mexico, Nevada, Utah, Washington and Wyoming.

Investment Tax Credits/Corporate Tax Incentives

State investment tax credits can help encourage investment in renewable technologies that are typically more expensive than conventional technologies. The federal government offers a ten percent tax credit for businesses that invest in equipment used to produce, distribute or use geothermal energy. Corporate tax incentives allow corporations to receive credits or deductions ranging from 10% to 35% against the cost of renewable energy equipment or installation costs. In some cases, the incentive decreases over time. Some states allow the tax credit only if a corporation has invested a specific amount into a given renewable energy project. In most cases, there is no maximum limit imposed on the amount of the deductible or credit. Fifteen states, including California, Hawaii, Montana, New Mexico, North Dakota, Oklahoma, Oregon, Texas and Utah, feature this incentive.

System Benefit Funds

States use system benefit charges (also known as public benefit funds) to support renewable energy, energy efficiency and energy assistance programs. These funds are collected through a consumption-based charge (typically a fraction of a cent per kWh) that all electricity customers pay. States use them in a variety of ways, including identifying their domestic renewable resources; for rebates to customers who purchase renewable energy systems; or for energy education programs. A few states now allow certain non-governmental organizations that specialize in energy programs to administer the funds. Fifteen states have such funds including Arizona, California, Montana and Oregon.

State Production Tax Credits

This option provides a tax credit (usually around 1 cent per kWh) for electricity generated from renewable resources. This is essentially a state version of the federal production tax credit. Such production-based incentives are useful not only because they reduce the price of electricity from renewable sources, but especially because they encourage developers to actually generate electricity rather than just install equipment. This is useful only in states that assess property tax. Also, a state production tax credit may offset some value associated with the federal production tax credit. Maryland, Minnesota, New Mexico and Oklahoma offer production tax credits.

Royalty Payments

Developers generally pay royalties to state, tribal or federal governments based on a percentage of their revenue that comes from using geothermal resources on leased land. For geothermal projects on federal lands, the federal government collects a royalty of 3% of the gross revenues from electricity sales at geothermal power plants. (For the first 10 years the royalty is assessed at 1.5%.) Of this amount, 25% goes to the county and 50% to the state. The remaining 25% goes to the Bureau of Land Management who uses it to facilitate geothermal leasing on federal lands. The federal model serves as an example of how states could assess royalties for geothermal projects located on state lands.

Regulatory Mechanisms

Renewable Portfolio Standards (RPS)

This policy requires electricity providers in a state to ensure that a specific percentage of the total power they sell comes from renewable resources. A carefully crafted RPS can be an effective way to greatly expand the use of renewable energy. Nineteen states have some form of RPS and nearly a dozen more have considered them in recent legislative sessions. Table 2 lists the states

that have an RPS and the amount of renewable energy that the policy requires.

Note: The following Western states explicitly include geothermal in their RPS: California, Colorado, Hawaii, Montana, New Mexico, Nevada and Texas.

Just as each state's energy situation is unique, so is each RPS policy. States can craft these policies to encourage development of the resources they choose. The standards in Arizona and Nevada are written to encourage solar power. Similarly, states with strong geothermal resources can structure their RPS to encourage geothermal development. Although an RPS can boost the development of renewable resources, this policy alone does not address other impediments to geothermal development such as the siting and permitting of projects or issues regarding transmission lines.

Figure VI.2. States With Renewable Portfolio Standards

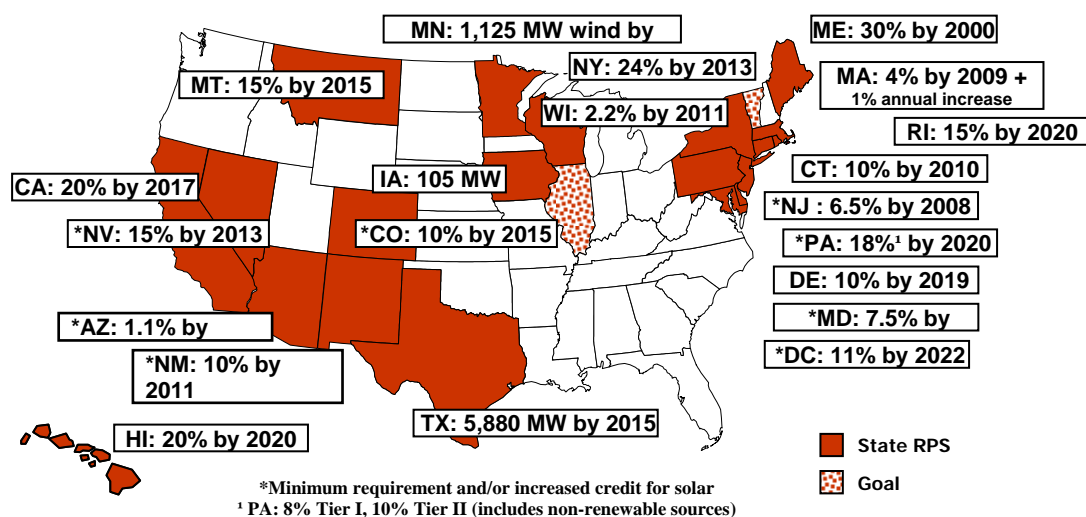


Table VI.2. Advantages and Disadvantages of RPS Policies

Advantages	Disadvantages
Can create a market by ensuring that there are buyers and sellers for the power.	Complex and difficult to design.
Can be applied in regulated and competitive energy markets.	Exact cost cannot be determined in advance but can be limited.
Can give incentives to specific resources, depending on the state's priorities.	The RPS is a mandate.
Relatively low administrative cost to the state.	Fairly new policy and experience is limited.

Source: The National Conference of State Legislatures, 2004. For more detailed information on state renewable portfolio standards see the report "Evaluating State Renewable Portfolio Standards" at www.geocollaborative.org/publications.

Green Pricing Programs

Through green pricing programs, power providers offer a menu of different renewable—or "green"—products to customers. An example would be a program that allows customers to

support renewable technologies by purchasing 100 kWh blocks of electricity generated from renewable resources for \$2 to \$3 per month. The utility itself can administer and market these programs to customers or it could contract with another company that specializes in providing these marketing services. Thirty-two states have regulated green power programs that are available to customers through utilities. However, anyone can support green power through buying renewable energy certificates through a retail provider.

State Renewables Purchases

State government can elect to purchase a certain amount of its energy from renewable sources for use in state-owned facilities. Since state agencies are significant energy users, this commitment can help support the renewables market in the state; it also gives the government an opportunity to be a model for other power customers. Individual large cities like Seattle and Chicago also participate in these programs. These purchases can be made through existing utility green pricing programs or, in some cases, through negotiation with the power supplier. Nine states in the eastern United States have committed to purchasing a renewable energy. Several large municipalities in the west purchase renewables this way but not any western states.

Disclosure and Certification Programs

These programs require electricity retailers to display on a customer's bill the mix of fuel sources that are used to generate electricity. The aim is to provide a sort of "truth in advertising" for electricity retailers. Polls have shown that consumers want more of their power to come from renewable sources and that many will pay a premium. Demand for green power may increase as more customers see the actual amount of energy that is generated from non-renewable sources. This effort is under way in 25 states including Arizona, California, Colorado, Montana, Nevada, Oregon, Texas and Washington.

Interconnection Requirements

Geothermal developers typically must connect their power plants to the existing network of power transmission lines to get their product to market. In most cases, the allocation of the associated interconnection costs is determined in accordance with Federal Energy Regulatory Commission requirements. In some limited situations, state policymakers also regulate interconnection to the power grid.

Transmission

The many challenges associated with siting, permitting and paying for power lines can hinder the development of renewable energy in many states. Many of the nation's best renewable resources are located in remote areas; using them often requires building new lines to deliver the power to customers. States can examine their laws governing how transmission lines are sited and financed in order to determine if these processes impede renewable energy development. Kansas recently passed legislation streamlining the process for siting transmission lines and allowing the issuance of bonds to finance them. In Minnesota, the Public Utility Commission recently approved four new transmission lines for one utility with the condition that it acquire new renewable energy projects at the same time as the new lines. (The utility is allowed to recover costs associated with these specific lines.) This may help guarantee that the renewable energy projects will have transmission capacity available.

Integrated Resource Planning (IRP)

An integrated resource plan essentially details a utility's process for meeting customers' energy needs into the future (often a 20 year planning horizon). The plan evaluates the full range of possibilities including building new power plants (renewable or other), purchasing power through a contract, energy conservation and efficiency measures. Some state IRP processes also consider risk factors like resource diversity, reliability and dispatchability.

IRP processes are expanding from focusing only on cost to considering risks to customers associated with an energy plan that is too heavily dependent on one energy resource. Many investor-owned utilities across the west are addressing the risk of future carbon regulation by placing a value on tons of carbon dioxide emissions. States are implementing IRP processes again in light of the halt of utility restructuring efforts. An IRP process can be the basis for determining whether to offer power purchase agreements or other contract opportunities for new renewable power development.

In some states, IRP includes a means for considering environmental damages caused by electricity supply/transmission and identifying cost effective energy efficiency and renewable energy alternatives. IRP has become a formal process prescribed by law in some states and under some provisions of the Clean Air Act Amendments of 1992, and is encouraged by provisions of the Energy Policy Act of 1992.

(Adapted from From WAPA <http://www.wapa.gov/es/about/faqirp.htm>, Duke Power <http://www.duke-energy.com/company/energy101/glossary/I.asp>, and other sources)

Western Renewable Energy Generation Information System (WREGIS)

WREGIS will track and verify wholesale renewable energy generation in the west. The purpose is to expand the marketplace for renewable energy generated in the west, to increase consumer confidence in renewable energy markets and increase the liquidity and efficiency of those markets. In June 2002, the Western Governors' Association adopted an amendment to its resolution, "Western States' Energy Policy Roadmap," creating an independent system to track and verify renewable energy generation in the region covered by the Western Electricity Coordinating Council. The Western Governors' Association and the California Energy Commission are working collaboratively to develop the system. WREGIS is expected to be operational by early 2007.

Table of State Policy Options

Energy policy options are numerous and might best be applied in combinations, which likely will vary in their details from state to state. The Geothermal Energy Taskforce advising the Western Governors' Association CDEAC initiative recommends a focused subset of policy options that would help catalyze the growth of economically viable geothermal power development projects. And in order to help put those recommended options in context of a total range of policy choices available for public sector enactment, the table below features 13 policy options on a single sheet. This is designed to provide an at-a-glance view of how the policy parts fit together. The table lists the names of policy options as economic incentives and regulatory mechanisms, and qualifies their general impacts in terms of drivers toward or against enactment.

Table VI.3. Options for Renewable Energy Policy Relative to Geothermal Power Generation		
General Note: This table summarizes 13 policy options as economic incentives and regulatory mechanisms that states could enact, either individually or as joint measures, to catalyze commercial development of renewable energy sources. Many of the options could have Federal counterparts, as well. For example Federal Production Tax Credit (PTC) legislation is pending in the U.S. Congress. The WGA could, for example, approach joint policy agreement by providing recommendations and support for Federal legislation.		
<u>Economic Incentives</u>	<u>Enactment Drivers</u> <u>Toward Enactment</u>	<u>Against Enactment</u>
Grants, Loans, Loan Guarantees -- cited in 23 states, most to encourage systems procurement, and some R&D.	<ul style="list-style-type: none"> • Motivates investment by developers. • Reduces risk perceived by financing sources. • (See Royalty Payments, below) 	<ul style="list-style-type: none"> • Spreads price-control costs as broad-based tax burden. • Incurs public financing risk.
Property Tax Incentives -- cited in 25 states.	<ul style="list-style-type: none"> • Excludes incremental value from tax base of a development, yielding recurring annual savings. • Improves investment competitiveness. • Optionally state or local implementation. 	<ul style="list-style-type: none"> • Affects government revenue shortfalls, and/or spreads price-control costs as broad-based tax burden.
Sales Tax Incentives -- cited in 17 states.	<ul style="list-style-type: none"> • Reduces front-end burden of capital cost payments. • Improves investment competitiveness. • Promotes business growth to boost tax revenues, replacing deferred revenues of the incentives. 	<ul style="list-style-type: none"> • Affects government revenue shortfalls, and/or spreads price-control costs as broad-based tax burden. • Typically less savings than via property tax incentives.
Investment Tax Credits -- e.g. federal 10% tax credit; applicable to production, distribution (transmission), and use.	<ul style="list-style-type: none"> • Encourages investment in technologies costing more than "conventional" energy sources. • Improves investment competitiveness. 	<ul style="list-style-type: none"> • Affects government revenue shortfalls, and/or spreads price-control costs as broad-based tax burden. • May be susceptible to abuse if technology is inferior.
System Benefit Charges (or Public Benefit Funds) -- cited in 15 states; typically less than 1¢ per kWh.	<ul style="list-style-type: none"> • Promotes option to consume energy from higher-cost sources. • Used to raise awareness of alternative energy benefits. 	<ul style="list-style-type: none"> • Defacto tax on consumption to users at large.

State Production Tax Credits -- cited in 4 states, typically at 1¢ per kWh. Federal PTC -- the 2005 Energy bill extended the term to 10 years.	<ul style="list-style-type: none"> Improves investment competitiveness (i.e. geothermal production and power plant infrastructure) by reducing delivered COE. Motivates productivity, efficiency. 	<ul style="list-style-type: none"> Affects government revenue shortfalls, and/or spreads price-control costs as broad-based tax burden.
Royalty Payments	<ul style="list-style-type: none"> Based on energy derived from leased resources, with flexibility to encourage development thereof. Federal resource royalties ploughed back into development, production, and green pricing programs to support power competitiveness (e.g. California's program for grants, loans to geothermal programs). 	<ul style="list-style-type: none"> Affects government revenue shortfalls, and/or spreads price-control costs as broad-based tax burden.
<u>Regulatory Mechanisms</u>	Implementation Drivers <u>Toward Implementation</u>	
	<u>Against Implementation</u>	
Renewable Portfolio Standard (RPS) -- requires that power sales comprise a percentage from renewable sources; cited in 20 states.	<ul style="list-style-type: none"> Promotes consumption of renewable generation. Motivates generators, purchasers, and marketers. Invokes economy-of-scale costing trends. Can target local/state/regional resources. 	<ul style="list-style-type: none"> Raises energy costs (initially, at least); perceived as mandate. Does not address siting, permitting barriers. Assuring fulfillment of RPS targets needs to be addressed. (1)
Green Pricing Programs -- cited in 32 states at nominal rates of 1-3¢ per kWh.	<ul style="list-style-type: none"> Motivates purchasers and marketers, promoting consumption of renewable generation. Benefits ratepayers via favorable discounts 	<ul style="list-style-type: none"> Spreads price-control costs to non-participants as higher energy costs. Limited subscriptions available, typically.
State Renewable Purchases -- cited in 9 states, with participation in various cities independently of their states.	<ul style="list-style-type: none"> Adds volume consumption of renewable generation. Motivates investors and generators. State acts as consumer model. 	<ul style="list-style-type: none"> Spreads price-control costs as broad-based tax burden.

Disclosure and Certification Programs -- cited in 24 states.	<ul style="list-style-type: none"> • Requires generators and marketers to publicize their acquisition of power from renewable resources. • Promotes awareness to motivate purchasers. <p>(2)</p>	<ul style="list-style-type: none"> • Perceived as punitive motivation to generators and marketers.
Interconnection Requirements	<ul style="list-style-type: none"> • Motivates transmission grid owners/investors to help facilitate geothermal power development. • States may regulate allocation of connection costs to selectively benefit resources. 	<ul style="list-style-type: none"> • Spreads price-control costs to non-participants as higher energy costs.
Transmission Policy	<ul style="list-style-type: none"> • Addresses typical need for site-specific tie-in lines. • Addresses permitting and financing hurdles. • Motivates transmission grid owners/investors to help facilitate geothermal power development. 	<ul style="list-style-type: none"> • Spreads price-control costs to non-participants as higher energy costs.
<p>Notes: (1) Fulfillment of a statutory or regulatory RPS mandate isn't necessarily a given. Therefore, such policy should be formulated by considering, for example, what kinds of enforcement mechanisms would be needed <u>and</u> effective? If a government designates cost penalties for failure by utilities to deliver a quota of green power, the result may be to simply collect penalties, with little, if any, green power resources actually coming on line. That would hardly be a satisfactory outcome of an RPS mandate.</p> <p>(2) Imposing a requirement on generators and marketers to disclose and certify the quotient of their power generated from renewable energy resources actually has three potential benefits: i.e., as stated above, such a policy explicitly requires power suppliers to declare their generation or acquisition of renewable power for sale, and therefore make it available. The disclosure alerts the public to the availability of renewable energy. Implicitly, the public awareness aspect of the policy also may induce a snowball effect in demand, whereby the more the public is aware of a (good) thing, the more they will want of it.</p>		

State Incentives for Geothermal Heat Pumps

Eight of the 18 states in the WGA have incentive programs for the installation of Geoechange or closed-loop geothermal heat pump systems in residential and commercial applications. They are Hawaii, Idaho, Montana, Nebraska, Nevada, North Dakota, Oregon and South Dakota. The incentives include income tax credits and deductions, investment tax credits, rebates, low-interest loans, property tax exemptions. It is important that Geothermal heat pumps (also called ground source heat pumps or geoechange systems) be included in renewable incentive programs for new construction as well as retrofit.

Geothermal Awareness needs to be strengthened

Issue Geothermal resources and technology capabilities are largely unknown by energy professionals in state governments and utility sector policy areas. This clean and enabling resource has not been developed at levels consistent with its potential.

Recommendation. It is recommended that the WGA encourage state energy officials become familiar with geothermal resource areas in both power generation and direct use. This will include communication of geothermal maps and databases, and ensuring that state government energy officials as well as economic development officials are made aware of the benefits and potential.

C. Transmission-Related Issues

The Geothermal Task Force is recommending that the Western Governors:

- Facilitate and promote integrated resource planning of base load resources that require firm transmission. Additionally incentives should be made available for entities pursuing integrated geothermal resource plans. This position would promote economies of scale by sizing geothermal plants and transmission correctly;
- Support and promote Transmission development by implementation of simple individual principles. Through the Western Interconnect there are different regional obstacles. The WGA should support generically sound principles that resolve discreet regional problems. One such principle that the WGA should specifically support is the PPIW (Public Power Initiative of the West) Transmission Initiative which encourages joint transmission projects in areas subject to tariff obstacles;
- Promote socialization of geothermal transmission costs such that the actual energy user pays for the transportation costs.

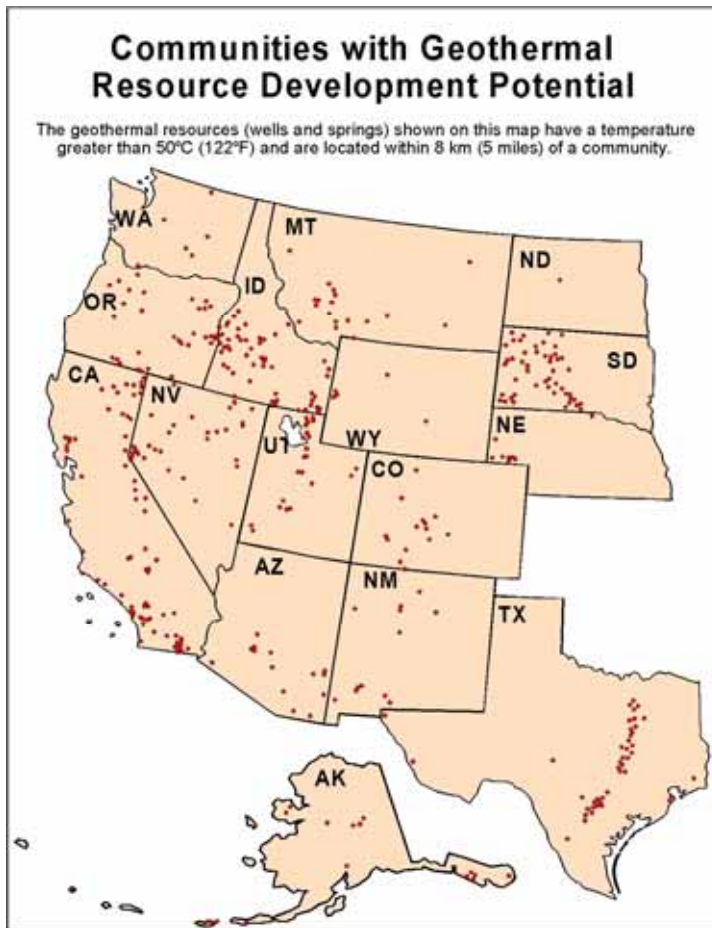
In addition to the above recommendations it is recommended that the WGA direct the Transmission Task Force to assess the industry to incorporate any other resources, including other renewables that complement the geothermal effort. The reason geothermal energy should be the preference green renewable is that it is a base load resource that requires the firm transmission (highway) system.

Additionally it is requested that the WGA direct the Transmission Task Force to implement a multitude of solutions and not concentrate on any one generic action plan. Having a portfolio of planned approaches affords a greater possibility of success, by limiting the risk that comes with only pursuing one option. A diversified approach would encourage entities, such as Public Power, to minimize risk, and avoid unintended consequences.

D. Direct Use Issues

Low-temperature geothermal resources exist throughout the western US, and there is tremendous potential for new direct-use applications. A recent survey of 10 western states identified more than 9000 thermal wells and springs, more than 900 low- to moderate-temperature geothermal resource areas, and hundreds of direct-use sites.

The survey also identified 271 collocated sites – cities within 5 miles (8 kilometers) of a resource hotter than 122 degrees F (50 degrees C) – that have excellent potential for near-term direct use. If these collocated resources were used only to heat buildings, the cities have the potential to displace 18 million barrels of oil per year.



Stand Alone Direct Use Applications

Geothermal reservoirs of low-to moderate-temperature water – 68°F to 302°F (20°C to 150°C) – provide direct heat for residential, industrial, and commercial uses. This resource is widespread in the U.S., and is used to heat homes and offices, commercial greenhouses, fish farms, food processing facilities, gold mining operations, and a variety of other applications.

Direct use of geothermal energy in homes and commercial operations is much less expensive than using traditional fuels. Savings can be as much as 80% over fossil fuels. Direct use is also very clean, producing only a small percentage (and in many cases none) of the air pollutants emitted by burning fossil fuel.

District and Space Heating

The primary uses of low-temperature geothermal resources are in district and space heating, greenhouses, and aquaculture facilities.

In the U.S., more than 120 operations, with hundreds of individual systems at some sites, are using geothermal energy for district and space heating. District systems distribute hydrothermal water from one or more geothermal wells through a series of pipes to several individual houses and buildings, or blocks of buildings. Geothermal district heating systems can save consumers 30% to 50% of the cost of natural gas heating. Space heating uses one well per structure. In both types, the geothermal production well and distribution piping replace the fossil-fuel-burning heat source of the traditional heating system.

Greenhouse and Aquaculture Facilities

Greenhouses and aquaculture (fish farming) are the two primary uses of geothermal energy in the agribusiness industry. Thirty-eight greenhouses, many covering several acres, are raising vegetables, flowers, houseplants, and tree seedlings in 8 western states. Twenty-eight aquaculture operations are active in 10 states.

Most greenhouse operators estimate that using geothermal resources instead of traditional energy sources saves about 80% of fuel costs – about 5% to 8% of total operating costs. The relatively rural location of most geothermal resources also offers advantages, including clean air, few disease problems, clean water, a stable workforce, and, often, low taxes.

Industrial and Commercial Uses

Industrial applications include food dehydration, laundries, gold mining, milk pasteurizing, spas, and others. Dehydration, or the drying of vegetable and fruit products, is the most common industrial use of geothermal energy. The earliest commercial use of geothermal energy was for swimming pools and spas.

Cascaded Use

Spent fluids from geothermal electric plants can be subsequently used for direct use applications in so-called "cascaded" operation. This provides added value to the generation operation and more efficient use of the geothermal resource.

Conclusion

There are substantial untapped geothermal resources in the Western United States that can be developed to meet power, heat and other energy needs. The resource base could support a five-fold increase in power production and perhaps even greater proportional increases in direct-use and geothermal heat pump applications. The energy, environmental, and economic benefits of achieving the use of these resources would be tremendous.

Federal and state efforts to support the development and use of geothermal resources are needed. Both federal and state tax, regulatory, transmission, research, and outreach policies need to be improved and sustained.

VII. Appendix

A. Cost curve data

On July 25, 2005, a group of 26 individuals with diverse expertise related to geothermal resources and geothermal power production participated in a workshop at the University of Nevada, Reno, to review and evaluate a compilation of historic and contemporary data. The workshop was facilitated under the auspices of the geothermal task force of the WGA Clean and Diversified Energy Initiative.

The results of the workshop assessment of resource capacities are summarized in Tables GT-1.1 and GT-1.2 in Section I, and supporting details are described in this Appendix. The data quantify geothermal resource capacities and the economics of developing power production from them at utility scale. The individuals who contributed their knowledge and effort at the workshop came from commercial geothermal energy developers and operators, geothermal professional associations, various academic institutions specializing in the geothermal field, the office of United States Senator Harry Reid, the U.S. Department of Energy (DOE) Geothermal Technology Program, and the U.S. Department of Interior Geological Survey (USGS). The names and affiliations of the workshop participants are listed in Table A-1. (Additional parties provided input outside of the workshop format.)

Table A-1
Workshop to Review and Estimate Geothermal Resource Estimates
Monday, July 25, 2005

	<u>Last Name</u>	<u>First Name</u>	<u>Organization</u>
1	Allman	Ellen	Caithness
2	Benoit	Dick	Sustainable Solutions
3	Box	Tom	Calpine Corp.
4	Brown	Peggy	Great Basin Center for Geothermal Energy (UNR)
5	Clutter	Ted	Geothermal Resources Council
6	Combs	Jim	Geo Hills Associates
7	Coolbaugh	Mark	Great Basin Center for Geothermal Energy (UNR)
8	Erikson	Jody	RESOLVE, Inc.
9	Escudero	Arsenio	Senator Harold Reed's Office
10	Garside	Larry	NBMG
11	Hance	Nathanael	Geothermal Energy Association
12	Hulen	Jeff	EGI
13	Hill	Roger	Sandia Laboratory, U.S. Department of Energy
14	Johnson	Elizabeth	CA Div. of Oil, Gas, & Geothermal Resources

Table A-1
Workshop to Review and Estimate Geothermal Resource Estimates
Monday, July 25, 2005

	<u>Last Name</u>	<u>First Name</u>	<u>Organization</u>
15	Laney	Patrick	Idaho National Laboratory, U.S. Department of Energy
16	Lovekin	Jim	GeothermEx
17	Mink	Roy	U.S. Department of Energy
18	Munson	Steve	Vulcan Power Co.
19	Petty	Susan	Black Mountain Technologies
20	Price	Jon	NBMG
21	Pritchett	John	SAIC
22	Reed	Marshall	U. S. Department of Interior, Geologic Survey
23	Renner	Joel	Idaho National Laboratory, U.S. Department of Energy
24	Schochet	Dan	ORMAT
25	Shevenell	Lisa	Great Basin Center for Geothermal Energy (UNR)
26	Vorum	Martin	National Renewable Energy Laboratory

B. In depth discussion of cost curve methodology

WGA Economic Analysis Approach

The WGA Quantitative Work Group (QWG) developed a comprehensive economic analysis guideline for the WGA Clean and Diversified Energy Initiative. The guideline defines:

- a modeling logic for economic analysis,
- a set of variable input factors with which to model diverse cases, and
- a set of common Base Case values for the input factors.

This methodology affords the CDEAC board a unified analytical framework shared by economic studies coming out of all technology task forces working on the WGA Initiative. The QWG also provided a spreadsheet that implements the guideline methods and reference data for all of the subject technologies. This provides all task forces a common calculation engine to standardize and automate the mathematical processing of economic cases.

As a result, the following describe the perspective for interpreting economic results for the Initiative, and in particular for the geothermal power technologies:

- The economic logic is standardized and applies equally to all energy technologies being considered by the various WGA task forces.
- The economic logic uses a simplified, discounted cash flow approach for which capital expenditures occur at one time by default, but which can be modified to simulate timed investments using future value input values.
- The guidelines require task force analyses to apply the Base Case input values in order to establish at least one economic result for each task force that rests on a common definition of economic terms.

Common Bases for Economics

The use of levelized costs² enables direct comparison of alternatives utilizing different technologies, scales of operation, and operating lifetimes. This accounts for the initial capital investment in a system, fixed and variable costs associated with operating and maintaining a system over its life, and fuel costs required to produce energy.

Base Case Parameters

The following parameter list defines the QWG economic analysis profile. The values of these terms can be revised to generate technology-specific cases over wide ranging conditions. The Base Case prescribed by the QWG assigned values as follows:

- System book life (debt financing term) of 25 years
- 5-year accelerated depreciation with half-year convention (MACRS)
- Discounting with a weighted average cost of capital of 9.8% (based on 55%/45% split of debt and equity to finance capital costs, with 6.5%/16.7% discount rate and return rate, respectively)
- Current costs and capacity factors (i.e. no cost and performance improvements over time)
- Inflation rate of 2.5% annually
- Federal corporate tax rate of 35%
- State corporate tax rate of 0%
- Combined property tax and insurance rate of 2% of initial investment
- Fixed O&M cost of \$20/kW-year for power distribution costs.
- Variables costs associated with electricity transmission not included
- State-level credits or incentives not included
- Federal investment tax credit of 10%, per policy prior to Energy Policy Act of 2005³ (not used)
- Federal production tax credit of \$.019/kWh, 10 years duration as of Energy Policy Act of 2005 (note used for Base Case)

As noted above, the Base Case criteria are defined in common for all technologies being considered for the WGA Initiative. This provides an apples-and-apples economic comparison so that policy analysts have the distinctive economic characteristics of each technology plainly called out. The selection of policy to foster energy development

² The levelized cost is that cost that, if assigned to every unit of energy produced over a system's life, equals the total life cycle cost of the system discounted to the base year.

³ Current investment tax credit does not appear to be altered by Energy Policy Act of 2005, except as to term of application.

should consider both the Base Case results and the technology-specific Alternate Cases, below, in order to determine a profile of incentives that will balance the relative economic strengths of desired renewable energy sources.

Geothermal Economic Case Studies

Geothermal power project economics reflect economic risks and productivity factors that are unique to both the technology and the challenges of energy resource accessibility. Some key characteristics of geothermal energy distinguish it from all other energy sources, both conventional (e.g. fossil) and other renewables (e.g. solar, wind, biomass), as follows:

- Geothermal resources are "hidden," requiring major speculative expenditures for exploration to identify and prove resources as commercially viable.
- Geothermal energy is available at relatively very low density (BTU's per pound of produced energy bearing material, for both water and steam) compared to other mineral energy forms such as coal, gas, and oil.
- Geothermal energy is characterized by relatively fixed ongoing fuel costs since, once accessed, a geothermal resource continues producing energy into the future without the risk factor of market volatility characteristic of conventional mineral fuels.

These factors influence the manner in which geothermal power projects evolve as investments, and also the trends of future variable cost changes under evolving market conditions.

Alternate Case Analysis Parameters

Reflecting the unique economics of geothermal power development projects, the following parameter values are specific to the Alternate Cases for geothermal power:

- Debt financing term of 15 years
- Federal production tax credit is applied (\$.019/kWh, 10 years duration - policy per the Energy Policy Act of 2005.
- Debt/equity ratio of 70/30, with WACC set at 10 %.

Discussion of Alternate Case Definitions

Table A-2 below lists parameters used to calculate the cost of energy by the guideline of the Quantitative Work Group (QWG) of the WGA support teams. Their method yields technology results with which to construct supply curves expressing levelized cost of energy (LCOE) versus cumulative electrical generating capacity.

The QWG guideline calls for submitting, at a minimum, a Base Case economic profile with supply curve. The Base Case values listed in Table A-2 are a hypothetical profile that the QWG defined to put all generating technologies under the WGA initiative on equal arithmetic footing. This reveals the relative economic posture of each technology, but the context of the Base Case is not realistic in business terms. The QWG recognized this, and their guideline invites "alternate" economic cases to show realistic technological and economic conditions that necessarily move away from the Base Case scenario.

Table A-2
Bases for Economic Amortization Calculations
for Geothermal Power Technologies

	Base Case	Alternate Cases	Notes
		Geothermal Task Force Entries	
Construction Period, years	3	3	Not used in LCOE calculation-- model applies one-time investment payment.
Equivalent annual payments during construction	3	3	Not used in LCOE calculation-- model applies one-time investment payment.
Book life, years	25	15	As per 7/25/05 workshop
Tax life, straight line (SL) depreciation recovery period, years	25	15	Not used -- model applies DB/MACRS, below
Tax life, declining balance modified accelerated cost recovery system (DB/MACRS) recovery period, years	5 / 6	5 / 6	
MACRS depreciation system	GDS	GDS	
MACRS Declining Balance (DB) depreciation percent	200%	200%	
Federal corporate tax rate	35%	35%	
Property tax and insurance	2%	2%	
Nominal Return on equity	16.7%	note	Base Case combined discount rate values are equivalent to 9.8 % weighted average cost of capital (WACC). Alternate Cases apply a WACC of 10 %, per 7/25/05 workshop
Nominal interest on debt	6.5%	note	
Equity share	45%	30	As per 7/25/05 workshop and 08/04/05 draft review meeting, this may range from 25/75 to 35/65 -- apply the median value. This is superseded by setting WACC = 10%, per above.
Debt Share	55%	70	
Real discount rate	6%		Not used - apply weighted average cost of capital.

Table A-2
Bases for Economic Amortization Calculations
for Geothermal Power Technologies

	Base Case	Alternate Cases	Notes
			Geothermal Task Force Entries
Inflation rate, annual	2.5%	2.5%	
Plant capital cost, 2005 \$ / kW	note	note	All cases: \$3,000 / \$3,500 / \$4,000 per kW installed capacity
Fixed O&M, 2005 \$ / kWh	n/a		
Variable O&M, 2005 \$ / kWh	note		Treated as fuel term, e.g. for biomass technology. For geothermal install O&M cost range as per 7/25/05: Sites allocated: 1.8 / 2.2 / 2.6¢ / kWh
Heat rate in 2004, MMBTU / kWh	n/a	n/a	Not pertinent to this model for geothermal
Distribution cost (fixed O&M adder), 2005 \$ / kW-year	\$20	\$20	
Grid connection capital cost, 2005 \$ / MW-mile	\$1,000	\$2,000	Application pending determination of distance bases by Transmission Task Force
Capacity Factor (CF), Variant 1 -- 2005	0.86		
Capacity Factor (CF), Variant 2 -- 2010	0.95	0.95	All geothermal cases use 0.95
Capacity Factor (CF), Variant 3 -- 2025	0.95		
Plant Nameplate Capacity, MW	50	50	delete question in prior draft in this cell
Distance to nearest grid connection, miles	0	0	Per 8/3/05 conference call, zero this value in alternate cases, pending Transmission Task Force feedback
State annual corporate tax rate, percent	0%	0%	
Federal investment tax credit, % per year			
Federal production tax credit (PTC), ¢ / kWh / year	n/a	Alt. 1 – n/a Alt. 2 – 1.9	
Transmission cost (variable adder), 2005 \$ / kWh	0	0	

Analytical Background

The remaining text is copied from the QWG “Guideline for Economic Analysis of Renewable Energy Sources,” July 12, 2005. Following are the terms outlining the QWG method of calculating LCOE for the WGA support process.

Base Case Supply Curve Calculations with Transmission Costs

1. Each task force shall develop a base case supply curve based on the above financing rules and methods as outlined below to calculate \$/MW-hr as a function of added capacity.
 - Where applicable, scenarios shall be developed for fuel price variations, and include low, medium, and high fuel price cases. EIA forecasts may be referenced, or published alternatives.
2. Task forces develop "busbar +" resource costs by using bus bar costs plus \$1000/MW-mile to nearest existing transmission line. Transmission calculations shall:
 - Exclude obvious restricted areas like national parks, etc., and assume current land use exclusion policy.
 - Use 2005 costs, midpoint power class capacity factors, no ancillary service adders.
3. Supply curves shall then be developed with two transmission system assumptions.
 - Assume 0% transmission capacity availability to nearest load center(s). That is, the supply curve must include new transmission and associated costs. Utilize \$1000- MW-mile as the assumed transmission cost.
 - Assume 20% transmission capacity availability to nearest load center. Once the 20% capacity is allocated, assume new transmission must be built to carry additional supply to the nearest load center. Utilize \$1000- MW-mile as the assumed transmission cost.
4. Generation MW and “ISO-price” contour maps¹
 - Use IRP, RPS, sub-regional plans and announced developments as additional inputs in selection (not only least cost from supply curves).
5. Following receipt and review of the base case supply curves, and additional analysis, if offered to the CDEAC, the following steps will be conducted:
 - CDEAC integration subcommittee will select diverse energy scenarios of generation fuels and locations from task force inputs for transmission modeling, based upon the base case supply curve modeling and maps.
 - Transmission costs will be modeled and evaluated for each scenario by the Transmission Task Force. No attempt to allocate costs to individual generators or technologies (see section below).
 - Distribution costs added, delivered cost total (with distributed technology getting appropriate credits for avoided T & D).
6. Per CDEAC instructions, the task forces are to provide emissions estimates for criteria pollutants and carbon as well as other important environmental indicators and impacts (e.g., land use, water use).

Specifics for Base Case Economics:

1. All costs in \$2005 dollars

2. 25 year life times for levelized cost of energy calculations
3. Present analysis with and without Federal production tax credit incentives
4. State assumptions of when plants are built and capital costs.
5. Include fixed “adder” for Distribution costs of \$20/kW-yr.²
6. Assume weighted cost of capital is constant over life of plant
7. Use EIA AEO 2005 stated capacity factors (Table 73 or equivalent)
8. Use EIA AEO 2005 cost and performance characteristics (Table 38) for overnight capital, fixed O&M, variable O&M, heat rate OR state assumptions and rational for differences to EIA values.
9. Use 2005 Federal tax depreciation schedule with straight line or MACRS (General Depreciation System [GDS] method with declining balance) with half-year convention³
10. Do not include “ancillary services” surcharge
11. Escalation rate on variable O&M is equal to inflation

Optional Analyses—Alternate Cases

1. Each task force may present alternative analyses that indicate the impacts of other assumptions such as:
 - Cash flow models vs. Fixed Charge Rate as described below and used for base cases.
 - Fuel price variation.
 - Federal credits, such as the PTC.
 - State credits.
 - Policy Recommendations.
2. Deployment Scenarios - All task forces should consider whether future levels of technology deployment might reduce costs of generation due to learning curve impacts. Where such deployment cost reductions are expected, task forces should present analysis and optionally develop an additional set of supply curves based on a low and high projected level of future deployment and the projected cost reductions associated with this deployment. Clearly state assumptions.
3. Ownership and Financing Variations – Showing how the impacts of alternative ownership structure and financing mechanisms affect generation costs.
4. Others Identified by the Task Forces – Each task force may choose develop additional scenarios that they deem relevant and useful.
5. If desired, clarify and separate any proposed “externality” benefits from electricity generation/delivery economics.
6. If desired, separate and clarify any analysis that proposes “capacity value” enhancements and show ranges of possible values as function of critical variables. Task forces must supply load/supply shape curves in support of capacity value analysis.
7. If desired, separate and clarify any analysis that proposes “alternative sales” enhancements such as liquid fuels or other products and show ranges of possible values as function of critical variables.

Other

- Base case analysis shall be conducted on a WGA Regional basis, not state specific.
- Plant siting recommendations shall be based on adequate energy resources (wind, solar, geothermal, etc) and/or access to fuel transportation (road, rail, pipeline, etc.), water, and other critical elements.

Analysis of Avoided Costs

This does not pertain to commercial, large-scale geothermal systems. It is for customer-sited renewables such as on-site PV or biomass generation that displace “end of the line” consumption of power from other generators such as utilities.

BACKGROUND INFORMATION ON RESOURCE CAPACITIES AND ECONOMICS

The Geothermal Energy Association (GEA) organized a workshop at the University of Nevada at Reno on Monday July 25, 2005 to review existing resource capacity potential and development cost estimates of known geothermal sites. The objective of this workshop was to provide updated information to the Western Governors’ Association (WGA) Clean and Diversified Energy Initiative, notably by gathering data needed to build a geothermal supply curve.

RESOURCE POTENTIALS

Workshop participants reviewed resource capacity estimates of geothermal resources located in the western United States. The review targeted a list of existing sites based on the USGS Circular 790 (resources with temperatures nominally greater than 150 °C), a database from the Information Administration (EIA) of the U.S. Department of Energy, and a recently published “New geothermal site identification and qualification” (GeothermEx-CEC, June 2004).

The review process considered two different values of a power potential for each site:

- A first power capacity estimate cites new power capacity that is considered to be commercially attractive to be developed at each site within the next 10 years at a price of power up to 8 cents per kilowatt-hour (¢/kWh). This price excludes supplemental transmission costs, i.e. for tie-in carriers to transmission corridors.
- Second, the workshop considered resource power potential estimates that might be built at sites, using currently available technology, when price and timeframe constraints were relaxed. A nominal target power price limit was 20¢/kWh, and an approximate time frame of 2015 to 2025 was a basis for development projections.

The methodology employed for the workshop to evaluate resource potentials was as follows: A set of spreadsheets listing existing site-specific resource potential values was circulated among workshop participants before the workshop for review and the source documents identified. During the workshop, the resource potential estimates were debated. Consensus was obtained for each site. In cases for which workshop participants provided a review for a site, the discussions began with this value. When a value was not

available from the participants, the discussion began with the GeothermEx-CEC value. And last, the EIA and USGS values were used as a starting point for discussion when no reviewed or CEC data were available.

Where little information was available about individual resources, some sites were lumped together with a combined power capacity estimate (e.g. “Cascade volcanoes” or “other Nevada sites”). Some sites were removed from the list that were considered not to be developable or the information was deemed otherwise not reliable.

Significantly, the second, longer-term power capacity values correspond to either (1) sites that would need more than ten years to be developed (even if power production cost could be lower than 8¢/kWh), or (2) sites that would be viable only at power prices above 8 ¢/kWh and up to about 20¢/kWh. Substantial uncertainty characterizes some resource estimates for sites where little exploration has been completed. Such sites would be commercially questionable development candidates within the 10-year (2015) time frame, as venture capital would be difficult to secure to fund the inherently risky exploration phase of development. These prospects would thus require added time to guide them through commercial proving and bring them online. Given the time needed to develop even proven geothermal resources (i.e. to secure leases, to obtain permits, and to confirm practically achievable power potentials), most projects now considered developable within the next 10 years are, in reality, already well-known resources.

DEVELOPMENT ECONOMICS

Workshop participants did not provide any cost review before the workshop, but all agreed that existing cost estimates are dated and likely inaccurate. In order to gather enough information of sufficient detail to build a supply curve, most of the session on economics was used to discuss a methodology that would attribute reasonable cost estimates to the sites, collectively.

As a result, the first objective of the economic discussion aimed to review the major capital cost components of geothermal power projects and to assess updated values for each component. A second objective was to consolidate those values in aggregated capital cost figures and agree on a tactic by which to allocate the new values to replace existing capital cost figures. This task was applied only to those sites considered developable within the next 10 years at a power price of 8¢/kWh or lower.

A. Capital Costs:

Eight general capital cost components may be defined for geothermal projects:

1. **Early development** -- The early development phase includes all activities that are financed with venture capital. This encompasses leasing mineral properties, exploration, permitting, and confirmation well costs to prove resource capacity and project economics, in order to secure commercial financing.

2. **Infrastructure** -- A substantial cost component for greenfield projects entails developing infrastructure to support a field construction and operation program, e.g. roads, water supply, utilities installation, etc.
3. **Production well field drilling** -- The drilling cost component encompasses the drilling of all complementary wells required to supply the power plant during its initial commercial operations. Confirmation of a resource's capacity for development (item 1, above) is estimated to provide 25 percent of the wellhead capacity required for a generating capacity. A minimum total wellhead capacity of 105 percent of design power plant capacity is typically installed to provide a contingency to maximize steam supply stability. Therefore, production well field drilling consists of installing the production well balance equivalent to 80 percent of the design plant capacity.
4. **Steam and brine gathering system** -- A steam and brine gathering system is a network of above-ground pipes connecting production wells arrayed over an area that can range to several square miles for a power plant. It was decided that components of the steam gathering system would exclude any components inside the battery limits of a power plant, and would also include downhole pumps, as needed. The gathering system includes typical fluid handling equipment such as steam/brine flash separators, but excludes unusual equipment characteristic of systems for handling very aggressive brines, such as are found at Salton Sea installations.
5. **Power plant** -- The power plant costs include all equipment located within the battery limits of the energy conversion systems, i.e. for actual power generation, cooling systems, emissions abatement subsystems, etc. This cost component also includes the electrical substation that conditions power for transmission.
6. **Interconnection** -- The interconnection cost assumes that greenfield projects will incur an average interconnection cost corresponding to a 230 kV transmission line to link the power plant substation to a transmission corridor. Pending a determination of locations and allocations of those corridors by the transmission task force, economic analyses will be provided to characterize costs for an average distance for the interconnection run.
7. **Soft costs** -- Soft costs are incurred by developers during the project development, for example interest during construction, developers' fees, overhead costs, financing costs and fees, legal and additional environmental costs, etc.
8. **High-brine handling system** -- Power plants using resources with very aggressive, hyper-saline brines typically need specialized and costly "high-brine handling systems." They include crystallizer-clarifier technology to blunt the scaling and corrosive properties of brines as produced; the scope of specific components is highly site-specific. In the US, the only resource known to need such equipment routinely is the Salton Sea area.

Cost estimates for individual cost components developed during the economic discussion are presented in Table A-2. All cost values are assumed to correspond to a greenfield power project of 50-megawatts (MW) generating capacity. Table A-3 gives the costs as unit values, i.e. converted to values as dollars per kilowatt of plant capacity.

Table A-3: Major capital Cost Components of Geothermal Power Projects

Basis: 50 MW generating capacity

Capital Cost Component: (\$ Millions)	Low	Average	High
Early Development	12	15	20
Infrastructure	1	2	2.5
Drilling	60	75	90
Steam Gathering System	20	30	50
Power Plant	50	65	75
Interconnection costs	6	8	10
Soft Costs	8	10	15

Table A-4: Unit Cost Components of Geothermal Projects Capital Costs

Basis: 50 MW generating capacity

Capital Cost Component: (¢/kWh)	Low	Average	High
Early Development	240	300	400
Infrastructure	20	40	50
Drilling	1200	1500	1800
Steam Gathering System	400	600	1000
Power Plant	1000	1300	1500
Interconnection costs	120	160	200
Soft Costs	160	200	300

These values represent ranges of cost values for geothermal power projects for contemporary technology and raw material prices. The low, average, and high component cost estimates cannot be summed to obtain the low, average and high total capital cost figures of power projects. Most projects will have cost profiles representing case-specific blends of the line-item components in the tables. Particularly competitive prospects would be expected to favor low-cost component ranges. The high end of the cost estimates is related to the current market conditions. In most cases, this value would rise corresponding to higher power prices (i.e. higher demand and/or scarcer conventional energy fuel sources). This would lead to developers' interest and fiscal ability to commercialize some of the more difficult, geotechnically challenged resource prospects.

As the low, average, and high value ranges were examined, the workshop participants agreed that a low-end capital cost value for greenfield projects should be \$3,000/kW, and a high-end value should not exceed \$4000/kW. An average value of \$3,500/kW was assigned.

Expansions are projects built to expand resource production and generating capacity on a resource already supporting a geothermal power plant -- i.e. they are built as expansions of previously developed greenfield projects. Since project expansions benefit from significant cost savings in exploration, infrastructure, and connection costs, their capital cost values were estimated to be in a range of 10 to 15 percent lower than the capital cost estimates of greenfield projects.

Finally the workshop allocated capital cost estimates to each geothermal resource appearing on the list of sites considered developable within the next 10 years, as follows: This methodology attributes to each prospective resource site a capital cost estimate in the range of \$3,000 to \$4,000 per kilowatt plant capacity. The allocations are based on existing capital cost estimates. A three-tiered cost category breakdown was used:

- Low Capital Cost figure: \$3,000 per kilowatt capacity (\$/kW)
- Average Capital Cost figure: \$3,500 / kW
- High Capital Cost figure: \$4,000 / kW

The capital cost estimates were assigned to each site according to their position in a range of existing capital cost estimates. For those sites for which GeothermEx-CEC capital cost figures were available, these were used to assign the new WGA estimates by relative ranking in the GeothermEx-CEC database. For sites not addressed in the GeothermEx-CEC study, EIA cost data were used for allocating the range of WGA values. Finally the average capital cost figure of \$3500/kW is assigned to sites where no previous capital cost estimate is available.

B. Operation and Maintenance (O&M) Costs:

Similar methodology was adopted to allocate O&M costs, based on relative standing in a range of EIA database estimates of O&M costs for a selection of sites. Sites included in these categories received O&M cost figure of 1.8, 2.2, and 2.6 ¢/kWh respectively, in relative rank order. Sites that had no previous O&M cost estimates were allocated the median 2.2 ¢/kWh value.

C. Make-up Drilling Costs:

Make-up drilling costs are estimated at 5 percent of the initial well field drilling costs, applied as an annual, variable O&M cost factor. Considering the average initial drilling cost figure provide in Table 1, i.e. \$1,500/kW, this suggests that a levelized make-up drilling cost would be 0.9 ¢/kWh. This is equivalent to \$75/kW annually at a capacity factor of 95 percent. It is assumed that this cost is included in the above O&M cost values.

An alternative methodology would consider that initial drilling cost represents 36% of initial capital costs. Annual make-up drilling cost base on the project's capital cost correspond to 1.8% of the project capital costs.

D. Detailed Resource Capacity Information

Table A-5 lists the sites that were assessed to estimate their developable capacities during the above-cited workshop of geothermal experts on July 25, 2005. Shown here are the estimated capacities that were allocated for the prospective 10-year and 20-year development time frames. Sites that are considered to have expansion potential are coded with the letter "e." The table lists capital costs and operating and maintenance costs values allocated by the workshop.

In the process of estimating capacity values to assign to all the sites, the workshop determined that it would assign values of no more than two significant figures. However, the summation of state subtotals and the WGA regional total are not rounded off in Table A-5. Tables GT-I.1/2 use the rounded summations.

Table A-5						
Detailed Geothermal Resource Capacity and Cost Allocations						
<u>Resource Names ad State</u>		<u>Resource Capacity Values</u> <u>Megawatts</u>		<u>Expansion</u>	<u>Cost Allocations</u>	
		<u>Near-Market</u> cost up to 8 ¢/kWh online within 10 years	<u>Longer-Term</u> cost up to 20 ¢/kWh online within 20 years		<u>Capital</u>	<u>O & M</u>
					\$ / kW	¢ / kWh
CALIFORNIA ---->		2,375	4,703			
Subtotal						
Border	CA		30		\$3,500	2.2
Brawley	CA	200	463		\$3,750	2.45
Calistoga	CA	10	20		\$3,500	2.2
Clear Lake Volcanic Field area	CA	20	50		\$3,000	2.2
Coso area	CA	75	150	e	\$3,500	2.45
Dunes	CA		10		\$3,750	2.2
East Mesa	CA	50	100	e	\$4,000	1.95

Table A-5
Detailed Geothermal Resource Capacity and Cost Allocations

<u>Resource Names ad State</u>		<u>Resource Capacity Values Megawatts</u>		<u>Expansion</u>	<u>Cost Allocations</u>	
		<u>Near-Market cost up to 8 ¢/kWh online within 10 years</u>	<u>Longer-Term cost up to 20 ¢/kWh online within 20 years</u>		<u>Capital</u>	<u>O & M</u>
					\$ / kW	¢ / kWh
Glamis	CA		10		\$4,000	2.6
Heber	CA	20	50	e	\$3,250	2.6
Honey Lake & Wendell & Amidy	CA	10	10		\$3,250	2.2
Kelly HS	CA		10		\$4,000	2.6
Long Valley caldera	CA	120	240	e	\$3,000	2.2
Medicine Lake	CA	480	480		\$3,400	1.8
Morgan Springs-Growler Springs (includes parts of Lassen not in the National Park)	CA		50		\$3,500	2.2
Mount Signal	CA	25	25		\$3,250	2.2
Niland	CA	75	150		\$3,500	2.2
Randsburg area	CA	10	40		\$3,000	1.95
Salton Sea area	CA	860	2,000	e	\$3,500	2.2
Superstition Mountain	CA	25	25		\$3,500	2.2
Surprise Valley / Lake City	CA	25	50		\$3,500	2.2
The Geysers	CA	150	300		\$3,200	2.2
Westmorland	CA	50	100		\$3,500	2.45
Truckhaven	CA	25	50		\$3,500	2.2
Mount Shasta - Military Pass Road area	CA	120	240		\$3,500	2.2
East Brawley	CA	25	50		\$4,000	2.2
NEVADA ----> Subtotal		1,488	2,895			
Aurora	NV	120	240		\$3,500	2.2
Baltazor Hot Springs	NV	15	30		\$4,000	2.2
Beowawe Hot Springs	NV	50	100	e	\$3,750	1.8
Blue Mountain	NV	30	90		\$3,000	2.2
Brady Hot Springs	NV	10	20		\$3,500	1.95
Colado	NV	30	60		\$3,750	2.2

Table A-5 Detailed Geothermal Resource Capacity and Cost Allocations						
<u>Resource Names ad State</u>		<u>Resource Capacity Values Megawatts</u>		<u>Expansion</u>	<u>Cost Allocations</u>	
		<u>Near-Market cost up to 8 ¢/kWh online within 10 years</u>	<u>Longer-Term cost up to 20 ¢/kWh online within 20 years</u>		<u>Capital</u>	<u>O & M</u>
					<u>\$ / kW</u>	<u>¢ / kWh</u>
Desert Peak area	NV	20	50	e	\$3,000	1.8
Dixie Valley	NV	70	70	e	\$4,000	1.8
Sulfur Hot Springs (Double - Black Rock)	NV		50		\$4,000	2.2
Fallon / Carson Lake	NV	50	150		\$3,500	2.2
Fish Lake	NV	50	75		\$3,750	2.2
Fish Lake Valley - Emigrant	NV	50	100		\$3,750	2.2
Fly Ranch (Granite Ranch)	NV	10	20		\$3,500	2.2
Great Boiling Springs (Gerlach)	NV	30	60		\$3,750	2.2
Hawthorne	NV	20	40		\$4,000	2.2
Hazen (Black Butte)	NV	10	20		\$3,500	2.2
Hot Sulphur Springs (Tuscarora)	NV	20	40		\$3,500	2.2
Hyder Hot Springs	NV	10	20		\$4,000	2.2
Kyle Hot Springs (Granite Mtn.)	NV	15	30		\$3,500	2.2
Leach Hot Springs	NV	18	36		\$4,000	2.2
Lee & Allan Hot Springs	NV	30	60		\$3,750	2.2
McGee Mountain	NV	10	20		\$3,500	2.2
New York Canyon	NV	35	70		\$3,250	2.2
North Valley / Black Warrior Peak	NV	37	49		\$3,250	2.2
Pinto Hot Springs	NV	29	58		\$3,250	2.2
Pirouette Mountain	NV	23	46		\$3,250	2.2
Pumppernickel Valley	NV	30	60		\$3,750	2.2
Pyramid Lake Indian Reserve	NV	25	50		\$3,500	2.2
Rye Patch (Humboldt House District)	NV	15	30		\$3,500	1.95
Salt Wells	NV	50	50		\$3,000	2.2

Table A-5 Detailed Geothermal Resource Capacity and Cost Allocations						
<u>Resource Names ad State</u>		<u>Resource Capacity Values</u> <u>Megawatts</u>		<u>Expansion</u>	<u>Cost Allocations</u>	
		<u>Near-Market</u> cost up to 8 ¢/kWh online within 10 years	<u>Longer-Term</u> cost up to 20 ¢/kWh online within 20 years		<u>Capital</u>	<u>O & M</u>
					\$ / kW	¢ / kWh
San Emidio Desert area (Empire)	NV	13	20		\$4,000	2.6
Shoshone-Reese River	NV	18	36		\$3,250	2.2
Silver Peak	NV	50	100		\$3,250	2.2
Soda Lake area	NV	20	35	e	\$3,000	1.95
South Hot Springs	NV	10	20		\$3,750	2.2
Steamboat Springs	NV	50	100	e	\$3,000	1.95
Stillwater area	NV	30	60	e	\$3,000	1.95
Sulphur Hot Springs (Hot Sulphur Springs)	NV	15	15		\$3,500	2.2
Trinity Mountains	NV	50	75		\$3,250	2.2
Wabuska	NV	10	20	e	\$4,000	2.6
Wilson Hot Springs	NV	10	20		\$3,250	2.2
Cressent Valley	NV	50	100		\$3,500	2.2
All other NV sites together: in part, Hot Creek Canyon, Smith Creek, McCoy Mine, Adobe Valley, Antelope, Battle Mountain, Big Smokey Valley, Dry Lake, Dyke, Eleven Mile Canyon, Excelsior, Fireball Ridge, Fox Mountain, Lockwood, Mcfarlanes, Rose Creek, Shoshone, Southern Pacific, Sulphur Hot Spring, Shoshone-Reese River, Black Rock Desert.		250	500		\$3,500	2.2
OREGON ----> Subtotal		380	1,250			
Newberry Caldera	OR	240	480		\$3,250	1.8
Crump's Hot Springs	OR	20	40		\$3,500	2.2
Three Creeks Butte	OR	20	40		\$3,250	1.8
Mickey Hot Springs	OR	25	50		\$3,500	2.2
Trout Creek area	OR	10	20		\$3,500	2.2

Table A-5						
Detailed Geothermal Resource Capacity and Cost Allocations						
<u>Resource Names ad State</u>		<u>Resource Capacity Values Megawatts</u>		<u>Expansion</u>	<u>Cost Allocations</u>	
		Near-Market cost up to 8 ¢/kWh online within 10 years	Longer-Term cost up to 20 ¢/kWh online within 20 years		<u>Capital</u>	<u>O & M</u>
					\$ / kW	¢ / kWh
Neal Hot Springs	OR	25	50		\$3,500	2.2
Lakeview ~ Hot Lake area	OR	20	20		\$3,500	2.2
Summer Lake	OR	20	50		\$3,500	2.2
3 sisters	Cascade					
Mt Rose (east)	Volcanoes		500		\$3,500	2.2
Mt Hood (excluding Park)	together					
WASHINGTON ----> Subtotal		50	600			
Mt Baker	WA	50	100		\$3,500	2.45
Mt Adam area	Cascade					
Wind River area	Volcanoes		500		\$3,500	2.2
Mt St Helen	together:					
Mt Rainer						
ALASKA ----> Subtotal		20	150		\$3,500	2.2
Hot Springs Bay Autau	AK					
Bell Island Hot Springs	AK					
Circle	AK					
Unalaska	AK					
ARIZONA ----> Subtotal		20	50		\$3,500	2.2
Clifton	AZ					
Gillard	AZ					
COLORADO ----> Subtotal		20	50		\$3,500	2.2
Waunita Hot Springs	CO					
Routt Hot Springs	CO					
Cottonwood Hot Springs	CO					
Mt Princeton Hot Springs	CO					

Table A-5						
Detailed Geothermal Resource Capacity and Cost Allocations						
<u>Resource Names ad State</u>		<u>Resource Capacity Values Megawatts</u>		<u>Expansion</u>	<u>Cost Allocations</u>	
		<u>Near-Market cost up to 8 ¢/kWh online within 10 years</u>	<u>Longer-Term cost up to 20 ¢/kWh online within 20 years</u>		<u>Capital</u>	<u>O & M</u>
					\$ / kW	¢ / kWh
Poncha Hot Springs	CO					
Wagon Wheel Gap	CO					
Orvis	CO					
Ouray	CO					
Pagosa Springs	CO					
HAWAII ----> Subtotal		70	400			
Kilauea SW Rift	HI		100		\$3,500	2.45
Puna (including Kamaili & Kapoho)	HI	50	250		\$3,500	2.2
Maui	HI	20	50		\$3,500	2.2
IDAHO ----> Subtotal		855	1,670			
Crane Creek-Cove Creek area	ID	25	50		\$3,500	2.2
Raft River	ID	50	100		\$3,500	2.45
Big Creek Hot Springs	ID	10	20		\$3,500	2.2
Rexburg	ID	20	100		\$3,500	2.2
willow springs	ID	100	200		\$3,000	2.2
China Cap	ID	100	200		\$3,000	2.2
Other ID sites		550	1,000		\$3,500	2.2
NEW MEXICO ----> Subtotal		80	170			
Lower Rio Grande Rift (including Tortuga Mtn & Ricon)	NM	50	100		\$3,500	2.6
Lightning Dock		20	40		\$3,500	2.2
Radium Springs	4 sites together	10	10		\$3,500	2.2
McGregor						
San Diego			20		\$3,500	2.2

Table A-5 Detailed Geothermal Resource Capacity and Cost Allocations						
<u>Resource Names ad State</u>		<u>Resource Capacity Values Megawatts</u>		<u>Expansion</u>	<u>Cost Allocations</u>	
		Near-Market cost up to 8 ¢/kWh online within 10 years	Longer-Term cost up to 20 ¢/kWh online within 20 years		<u>Capital</u>	<u>O & M</u>
					\$ / kW	¢ / kWh
Lower Frisco						
UTAH ----> Subtotal		230	620			
Cove Fort-Sulphurdale	UT	50	200	e	\$3,500	2.2
Roosevelt Hot Springs (McKeans)	UT	100	250	e	\$3,500	1.8
Thermo Hot Springs	UT	50	100		\$3,500	2.2
New Castle	UT	10	20		\$3,500	2.2
Other (Monroe, Mineral Mountain, etc.)	UT	20	50		\$3,500	2.2
WYOMING ----> Subtotal		0	0			
TOTAL CAPACITIES: Western		5,588 MW	12,558 MW			