National Geothermal Collaborative
Steering Committee
Second Review: Issue Briefs
Final Meeting Summary

April 19, 20, 21, & 23, 2004

Conference calls

Decisions Made:

Number	Decision
1.	***Issue Briefs:*** Changes and edits were accepted for the second review of six issue briefs – a few key agreements/decisions include (see sections for detailed changes): 1. Economic Impacts: (see section below for details) 2. Location Brief: The brief's will include two maps to reflect potentially producible resources – Department of Energy's map, from the Energy Efficiency Renewable Energy (EERE) website, showing heat flow at depth, and the Oregon Institute of Technology's (OIT) map showing location/uses of current development. 3. Environmental Impacts – The brief will accurately reflect the range of emissions from geothermal plants (air and water) from very little to none. This brief will also depict the source of a compound (in the air or water). 4. Common Questions: There was agreement that this Brief will answer affirmatively to the question of whether geothermal energy is renewable. 5. Siting 6. Technology and Cost: The Approximate Capital Costs for Various Power Plants Table will include an additional two columns (fuel costs and capacity factor) to paint a more accurate picture of the associated costs and advantages geothermal in comparison to other fuels. The group will review the possibility of including a table reflecting the costs over the life of the plant.
2.	The Briefs will include a cover sheet/introduction to explain the purpose, how the information was complied, sources of information, and the consensus process.
3.	Participants chose to review the Technology and Costs and Direct Use Briefs with the caveat that another call would be scheduled to increase participation.

Actions:

1. ***Location Brief*** – Karl Gawell will develop language for this brief about geothermal pressurized resources.
2. ***Location Brief*** – RESOLVE will research the cost of printing the maps in color.

3. ***Environmental Brief*** – RESOLVE will send this Brief to Jessica Alcorn, CERT, to specifically review terminology around tribes/tribal leaders that would include all native Americans (Alaskans and Hawaiians).
4. ***Siting Brief*** – Southern California Edison will review the language on eminent domain.
5. ***Technology & Costs Brief*** – GEA will draft a table of geothermal costs over the life of the plant.

Meeting Objectives:
To complete a second review of the Issues Briefs - to further refine the documents, focusing on those issues identified as potentially blocking consensus, or important to preserve and protect in order to reach consensus. This will cover substantive changes – elements or words that significantly alter the meaning of the sentence. The following Issue Briefs were reviewed in these meetings: page numbers for meeting summary included:

Brief	Refer to Meeting Summary Pages:
➢ Economic Development	(pps. 3-4)
➢ Location	(pps. 4-6)
➢ Environmental Impacts	(pps. 6-8)
➢ Common Questions	(pps. 9-12)
➢ Siting	(pps. 12-14)
➢ Technology and cost	(pps. 14-17)

(Benefits and Challenges and Policy Options completed second review on March 24, 2004).

Changes/Discussion
For a full account of the changes accepted, editorial and substantive, please refer to the revised documents (these will be circulated prior to the third, and final review). The following is an outline of each meeting and the key substantive discussions on each Brief, including agreements, editorial changes and the relevant marked up sections. Each description includes a copy of the section of the Brief being discussed, including the subsequent changes:

- **bold** text was added,
- ~~strikeout~~ text was removed).
- *** Denotes decisions on editorial changes accepted by the group.

April 19, 2004

Issue Briefs Reviewed: Economic Development and Location

In attendance:

Diane Bates - GEA	Mathew Brown - NCSL	Roger Hill - GPW
Liz Battocletti – Bob Lawrence and Assoc.	Jeanine Clayton – USFS	Charlene Wardlow - Calpine
	Troy Gagliano - NCSL	
Gordon Bloomquist – WSU	Karl Gawell - GEA	

Economic Development Issue Brief

Overall, there was a suggestion to reorder the sections so the most common contributing factors are first, and the newer and smaller contributing factors follow.

Introduction Paragraph – discussion centered on the terms remote vs. rural. The important point to convey is that when geothermal development is in rural areas it improves local economies – ***USE the term "rural." The concern about the property tax sentence was about the term "most"; it creates the image of geothermal paying everything – ***USE "major" or "leading".

> "Whether they are used to generate electricity or for direct-use applications, geothermal energy projects contribute to the economy of areas where they are located. Geothermal power plants ~~pay substantial property taxes~~**are often a major taxpayer in their**~~**pay the most taxes in the**~~ community. Royalties are another potential source of revenue, both for governments when development occurs on state or federal land and for individuals who lease their land to private developers. Using the heat of geothermal resources directly in commercial greenhouses or fish farming can help support a state's agricultural industry, even in areas that have poor farm land or where energy supplies are expensive or difficult to access. When geothermal resources are located in rural areas their development provides an opportunity to improve local economies. **The extraction of valuable minerals from geothermal resources is beginning to demonstrate additional economic benefits.** (p.1)"

Jobs Section – ***Quantify the term "temporary" construction - two-three years.

> "Geothermal power plants often are located in rural areas, which typically have chronic, high unemployment rates. Building a 49 megawatt (MW) geothermal power plant may create several hundred temporary **(two to three years)** construction and related development jobs and between 30 and 50 permanent, **highly skilled** full-time jobs **that pay well above minimum wage** at the facility. Considering the economic multiplier effect, this would mean at least 150 to 200 new full-time jobs in the community. Because of geothermal plants have long operating lifetimes, they can become a stable, reliable part of a community's economic base. (p.1)"

Lake County Project – the company involved has a preference to use the term "reclaimed water" - ***USE this term where appropriate and remove the term "wastewater" where possible.

> "In addition, Lake County is saving millions of dollars in ~~wastewater~~ disposal costs by piping treated wastewater **(reclaimed)** from the county into geothermal wells to create steam that the power plants use to generate electricity. The Lake County project, which began in 1997, currently uses approximately 8 million gallons of ~~processed wastewater~~ **reclaimed water** for this purpose each day; a similar project in Sonoma County injects about 11 million gallons ~~of wastewater~~ each day. (p. 1)"

Minerals Section – ***ADD an introduction sentence, similar to the other sections. There was concern about tracking statistical references and/or how to cite.

AGREEMENT: Participants agreed the best method would be to develop a coversheet/introduction to the series of Issue Briefs that explains the Briefs, the purpose, how the information was complied, the sources of information and the consensus process.

> "Selling valuable minerals-such as zinc, silica and manganese- that are present in geothermal fluids can make power plants more profitable and provide another base of

economic activity for communities. A 49 MW plant in Imperial Valley in southern California is expected to produce approximately 30,000 metric tons of zinc annually, presently valued at more than $1,200 per metric ton. As extraction technology develops, it also may be possible to recover silica, manganese, lithium, silver, gold, and other valuable minerals from geothermal reservoirs. Many of these minerals currently are imported, and some are critical for high-technology industries. Given these factors, it is possible that geothermal resources could become significant sources for future mineral production. (p. 3)"

Royalties Section – The correct distribution of royalties for the federal level is 50/50 state/federal. States have the authority to decide the disbursement of the state's share with counties. In California, the distribution is 50/30/20, federal/state/county. An additional element of note, California uses its royalties to expand the use of geothermal energy through providing grants or loans, thereby expanding geothermal development and increasing royalties. ***ADD language about how the ratios will change based on changes to the Steam Act.

"Royalties are based on a percentage of a developer's profits or revenues that come from using geothermal resources on leased land. These payments are similar to severance taxes that governments collect for leasing their land to private mining operations. In states where the federal government collects geothermal royalties, it gives back half of the total to the state in which the resource is located. This can generate significant revenue for states such as Idaho and Nevada, where most of the geothermal resources lie under federally owned lands. By 1997, geothermal power plants had paid a total of nearly $500 million to the federal government in royalties. In 1999 alone, Nevada received $2 million from its share of federal royalties from approximately 235 MW of geothermal electric generating capacity that provides 5.5 percent of the state's power. (p. 2)"

Direct use – clarify that the jobs created would be professional level, paying well above minimum wage.

"Using low temperature geothermal resources (between 70°F and 300°F) for agricultural purposes also generates revenue and creates jobs for some states. Four commercial **geothermal** greenhouses in rural, southern New Mexico employ nearly 200 people **and** 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 one million square-foot greenhouse in rural Utah employs between 80 and 120 people at different times throughout the year. These jobs pay nearly twice the minimum wage. Low temperature geothermal resources also support nearly 50 aquaculture operations (production and sale of farm raised aquatic plants and animals) in 11 western states and some southeastern states. (p. 3)"

Location Issue Briefs

Map

After much discussion the group agreed the map(s) in the Brief should provide a more accurate depiction, for decision makers, of where potentially producible resources are located. To do this the group agreed to use the EERE map, based on 1979 and other data, to show locations of possible sites based on heat flow and to use the Oregon Institute of Technologies map to show locations of existing geothermal development and uses. The EERE map also includes locations of geothermal pressurized resource.

AGREEMENT: Use the EERE and OIT map.

The maps need to include a note that gives some context, including such elements as: temperatures for electrical generation and direct use, elements necessary for development (water and permeable rock), and a caution about the depth of the resource. Maps should also include a background note.

> **"Background on the map - What is the potential for geothermal energy? The heat in the earth is a huge resource. Figure 1 shows the expected heat in the earth at a depth of 6 kilometers (19,685 feet). Existing geothermal power technology can produce electricity from resources at temperatures as low as 90degrees C. Oil and gas drilling technology has allowed successful drilling to depths of 6km and more, the drilling depth record for the Gulf of Mexico was 33,200 feet on January 2004 (Shell Oil.) Conventional geopressurized resources require an intersection of underground heat, water and fractured rock, which this map does not show. Enhanced Geothermal Systems technology seeks to develop the technology to engineer geothermal systems where natural conditions do not exist and expand the economically recoverable resource to depths approaching oil and gas."**

ACTION: Karl Gawell will develop language about geothermal pressurized resource.

Concerns about the maps included:

- fair representation - showing potential where there is none – in the existing map Washington is not adequately depicted, and Arizona shows potential but experts cannot confirm it.
- heat flow maps do not include other elements necessary for development – water or permeable rock
- need to reflects potential for a full range of uses
- depth of the temperatures on the map may be misleading – depth will affect accessibility
- Fahrenheit/Celsius consistency in the maps and text

The group discussed printing the maps in color for increased clarity.

ACTION: RESOLVE will look into pricing for color printing.

Introduction Section

- The introduction needs to more adequately reflect the inclusion and discussion about the EERE and OIT maps.
- Term 'purchase' – geothermal cannot be purchased – ***USE the terms "obtained" and "transported" – this is the reason geothermal is less costly than other resources.
- Transportation of heat – this is being done currently – ***USE the phrase "not generally practicable"
- ***ADD language that geothermal production facilities use and disturb less land compared to other resource production facilities.

> "Geothermal resources, which utilize the heat of the earth, are located throughout the planet's crust. Those closer to the surface are most commonly used however, because **geothermal** drilling costs are **currently** prohibitive ~~and technology is limited~~ below depths of between 10,000 and 15,000 feet. The hottest domestic geothermal resources are most easily accessible in the western United States, but

low temperature resources that are practical for direct use applications are more widespread. Geothermal power plants and direct-use projects must be built near the geothermal resource because it is not **generally practical** to transport steam or hot water over great distances. ~~However,~~ Since ~~the~~ **production occurs where the resource is located**, ~~geothermal reservoir is located on site~~ the costs associated with ~~purchasing~~ **obtaining** and transporting fuel to the plant are considerably less compared to a fossil fuel plant. **Compared to production from most other resources, geothermal energy disturbs less land.** Traditional power plants can be built over a wider range of areas but require constant fuel purchases and shipments over their lifetime.(p. 1)"

Power Generation Section

This section was edited to read more positively about new technologies (beyond drilling and energy conversion) that are bringing the usable temperatures down. ***ADD language that currently geothermal power is economically developed in four states – California, Nevada, Utah, and Hawaii - public policy and advances in technology are expected to expand this use.

"The darkest areas of the map **(figure 2)** indicate **highest** potential regions for electricity generation. Geothermal power plants generally **operate at resource temperatures (over 190°F), although lower temperature resources are becoming increasingly attractive with advances in technology**~~require resources with temperatures over 300F, although temperatures as low as 212F have been used~~. ~~Advances~~ **Power is currently being economically produced in four states- CA,NV,UT,HI. Public policy and advances in technology are expected to** ~~in drilling and energy conversion technology could~~ expand the use of geothermal power ~~plants to other states where resources exist by are too far underground to tap economically~~. (p. 2)"

April 20, 2004

Issue Brief Reviewed: Environmental Impacts

In attendance:

Diane Bates - GEA
Liz Battocletti – Bob Lawrence and Assoc.
Gordon Bloomquist – Washington State University
Janine Clayton – USFS
Paul Dunlevy - BLM
Troy Gagliano - NCSL
Karl Gawell - GEA
Cedric Nathanael Hance - GEA
John Nielson – Western Resource Advocates
Arlene Rocabado - SCE
Charlene Wardlow - Calpine

Environmental Impacts Brief

This Brief covers environmental impacts for power generations (direct use impacts are in the Direct Use Brief); therefore the title should reflect this –

AGREEMENT: RE-TITLE, Geothermal Power and the Environment.

Air Quality Impacts

There was a concern that this section draws disproportionate attention to particulate matter as a problem. The reason for including this section was because wet cooling towers emit water vapor which may contain particulate matter that is regulated and may require mitigation. Terminology needs to adequately reflect the amount of particulate matter emitted – ***USE "small amounts".

> "Geothermal power plants are considered a clean source of electricity because they emit almost no carbon monoxide, ~~some~~ **small amounts** of particulate matter (depending on type of facility), only very low levels of sulfur dioxide (SO_2) and carbon dioxide (CO_2) and typically no nitrogen oxides (NO_X). In fact, the NO_X and SO_2 associated with geothermal power plants results from capturing and incinerating the hydrogen sulfide that occurs naturally in geothermal resources. Geothermal plants that use steam emit mostly water vapor. **Wet cooling towers which emit water vapor, are regulated and may require mitigation for particulate matter.** Binary power plants, which transfer the heat of the water to another fluid that vaporizes at lower temperatures than water, **using dry cooling** produce virtually no emissions because the resource remains fully contained. (p. 1)"
>
> **"The chemical composition of each geothermal reservoir is unique but certain compounds are commonly found in these resources due to their volcanic nature such as arsenic and boron. Geothermal resources may contain mercury, however to date, most of the mercury associated with geothermal use comes from one specific reservoir in an area where mercury was mined for years. Mercury can be removed from geothermal steam easily and affordably. Add hydrogen sulfide. (p. 1)"**

Water Impacts

- There are only two plants that use other methods of disposal – Susanville, California discharges water onto woodchips prior to burning; Empire, north of Pyramid Lake, discharges spent fluid through an onion drying plant – ***REMOVE references to these two plants.
- The term disposal is viewed as a problem in the public arena - consider using a different term.
- Chemical Compounds - boron, arsenic, mercury and ***ADD hydrogen sulfide – the list of compounds for geothermal plants is comparatively small and can be mitigated. The compounds listed travel through the air – ***MOVE the paragraph to the air section. Mercury, specifically, only comes from one plant and is mitigated. These compounds come from wet cooling towers which emit water vapor, and virtually none from binary plants using dry cooling.
- Describe how water from geothermal plants is kept separate for other water sources – ***USE "well casing".

> "Maintaining the quality of nearby water sources **must** ~~is a concern during all~~ **be addressed throughout all** phases of geothermal development and operation. **The chemical composition of each geothermal reservoir is unique but certain compounds are commonly found in these resources due to their volcanic nature**. Geothermal fluids from deep underground can contain dissolved minerals and sediments **and other compounds such as arsenic and boron** that must **be disposed of and** kept separate from local water sources **through well casing, aboveground piping or other containment features**. Each geothermal reservoir is unique and must be analyzed to determine the best method of disposal. Reinjecting the fluids ~~back~~ into the reservoir is the preferred and most frequently used method of disposal ~~and only two small plants in the United States use a different method of disposal~~. Reinjection also acts to recharge the geothermal resource and extend the life of the reservoir."

Land Use Impacts

- ***USE "forested land" instead of "National Forest land"
- Micro-earthquakes – it is more accurate to say that they are usually imperceptible to nearby residents; most people never feel them and only know they occurred because their pictures are slanted.
- Term "tribes" – this term leaves out native Alaskans and Hawaiians.

ACTION: RESOLVE will have Jessica Alcorn, CERT, review the document and suggest alternative terminology.

- ***ADD – it is important that the public have adequate information about the proposed project and gather public input.
- Term "deep reservoir" – implies an underground pool which is misleading.

"Geothermal plants are typically compatible with agricultural, industrial and ~~National Forest~~ **forested** land uses and can easily be designed to blend in with surrounding areas. Geothermal power plants occupy very little land compared to other power plants, particularly coal and nuclear facilities that also require land for mining, transportation and storing fuels. When considering land use impacts for any type of power plant, it is important to also factor in infrastructure like roads and transmission lines. Just as with any form of development, using geothermal energy will have some impact on plants and animals. Since most geothermal resources are located in areas of seismic activity, there has been some concern that project-related production and injection activities can induce low magnitude earthquakes, or micro-earthquakes ~~that in some cases~~ **usually imperceptible** to nearby residents ~~may feel~~. Also, removing large amounts of fluids from the ground may result in some land subsidence.

~~Because of potential land use impacts,~~ Geothermal development on certain environmentally sensitive public lands or in areas with cultural or spiritual significance ~~to tribes~~ can be contentious and complex. In order to avoid conflict, it is important to first ~~survey a site~~ **provide accurate information about the proposed project to the public, including the identification of possible concerns,** and ~~allow sufficient time for~~**allow time to solicit** comment ~~on a proposed project~~. In some areas geothermal development will be inappropriate due to environmental and cultural conflicts. Tribal leaders, land management agencies, landowners, state historic preservation offices, environmental groups, **other interested parties** and members of the public should be able to identify these potential conflicts early on and ~~possibly~~ help **shape** mitigat**ion of** conflicts.(p. 2)"

Drilling Section

- The use of the term "steam" in the first sentence excludes binary plants - ***REMOVE the sentence.

"~~Geothermal power plants use steam (that either exists naturally or comes form vaporizing hot water) directly to spin a turbine generatory and generate electricity.~~ Geothermal ~~these~~ resources are located ~~in deep~~ underground ~~reservoirs~~ **and** ~~that~~ must be drilled into to bring the resources to the power plant ~~on the surface~~. The number of wells needed depends on the size of the power plant and on the ~~magnitude~~ **pressure and temperature** of the geothermal resource. Most drilling occurs before a power plant begins operations, but additional drilling is sometimes necessary to maintain the resource

over the life of the plant. The drilling process is ~~highly~~ regulated to protect the environment and the safety of workers. Potentially hazardous materials **used** at the site are contained and control systems monitor the process to prevent uncontrolled discharges of potentially hazardous fluids or gases.(p. 3)"

April 21, 2004

Issue Briefs Reviewed: Common Questions and Siting

In attendance:

Diane Bates - GEA
Liz Battocletti – Bob Lawrence and Assoc.
Gordon Bloomquist – Washington State University
Mathew Brown - NCSL
Janine Clayton – USFS
Paul Dunlevy - BLM
Troy Gagliano - NCSL
Karl Gawell – GEA
Roger Hill – Sandia/GPW
Martin Loutreau – WH Task Force on Energy Project Streamlining
Arlene Rocabado - SCE
Charlene Wardlow - Calpine

Common Questions Brief

Question #1 – Duration of the new PTC legislation is 10 years. There were questions about the range of prices for power generation; the number should include rationale – ***USE because capital costs are amortized.

"New geothermal power plants currently generate electricity for between $0.05 and $0.08 per kilowatt-hour (kWh). After about 10 years, these plants tend to generate power for between $0.03 and $0.05 per kWh **as the high initial capital costs are amortized.** Legislation pending in Congress would apply a production tax credit of $0.018 per kilowatt-hour to electricity generated at new geothermal power plants ~~for the first five years of operation~~. This credit has been a major factor in the growth of the domestic wind industry. (For more on this see Question 9). Most of the costs associated with geothermal power plants are related to ~~resource exploration~~ **exploring and defining the resource** and plant construction. Drilling for resources can account for as much as one-third to one-half of the total cost of a project. Geothermal power plants also have ongoing operating costs such as royalties paid for using the geothermal resource, property taxes and plant personnel. (p. 1)"

Question #2 - Clarification – heat pumps do use water/steam – ***REMOVE "do not use geothermal steam or water"

"Generating electricity using geothermal energy requires high-temperature resources that currently are most accessible in the western states. Advances in both drilling and power plant technologies could enable developers to more affordably tap geothermal resources in a larger portion of the ~~West~~ country and thereby expand the use of geothermal power.

Lower temperature resources that are sufficient for direct-use applications are located over a larger area and support agricultural activities such as fish farming, commercial greenhouses, ~~mining~~ **mineral extraction**, and space and district heating in various

western, southwestern and southeastern states. According to the Geo-Heat Center at the Oregon Institute of Technology, more than 400 communities in 16 western states are located within five miles of a geothermal resource that is suitable for district heating. Geothermal heat pumps that simply transfer heat between the ground and buildings are practical nearly ~~anywhere~~ **everywhere** ~~because they do not use geothermal steam or water~~. (p. 1)"

Question #4 - Reorder the sentences so that "the key to successful geothermal" is up front.

"Geothermal resources can provide electricity for decades~~if properly managed~~. **The key to successful geothermal development lies in managing the resource. Use of geothermal energy to generate electricity dates back 100 years.** The world's first geothermal resource developed to generate electricity was tapped in Italy in 1904, and that reservoir is still producing. The geothermal field at The Geysers, established in 1960 in northern California, powered the first geothermal plant in the United States. Although the pressure of that resource has diminished slightly, water reinjection techniques have stabilized the pressure, and the field now is expected to sustain current levels of production indefinitely. Using geothermal energy to generate electricity for many years would require replacing aging power plant equipment and may require drilling new wells if the productivity of older ones diminishes over time. ~~The key to successful geothermal development lies in managing the resource. Use of geothermal energy to generate electricity date back 100 years, and~~ **R**ecent technological advances—such as pressure stabilization and water reinjection—allow developers to maximize resources and minimize drilling.(p. 1)"

Question #5 - New Mexico Greenhouse – conditions change daily, need to pick a point in time and state that "at one time they employed 200 or up to 400 people." ***ADD language on Klamath Falls direct use, district heating and others from the Direct Use Brief.

"Certain low temperature geothermal resources are also practical for direct-use applications such as growing flowers, fish farming, and heating buildings. Four large commercial greenhouses in southern New Mexico **which at times have** employ**ed up to** ~~approximately 200~~ **400** people and use geothermal heat to grow a variety of plants. A one million square-foot greenhouse in rural Utah uses geothermal heat to grow flowers and employs between 80 and 120 people throughout the year. Geothermal-heated water also is used for fish farming operations in California, Colorado, Idaho, New Mexico and in some southeastern states from Georgia to Louisiana. **Major portions of Klamath Falls…direct use**."

"Direct-use systems in the United States currently provide approximately 600 thermal megawatts (MW) of heat, enough to heat 115,000 average houses. (The power from direct-use systems is measured in megawatts of heat; power plants measure power in megawatts of electricity.) Generally, direct-use projects use fluids at temperatures of between 70ºF and 300ºF."

Geothermal heat pumps, which are not considered a form of direct use, are practical across the country ~~because they do not use actual geothermal resources~~. ~~Instead~~ Heat pumps use the constant temperature of the earth at a certain depth to transfer heat to a

building in the winter, and from a building to cool it in the summer. More than 1 million geothermal heat pumps (with a total capacity to generate approximately 8,600 MW of heat) are operating in states across the country" (p. 2).

Question #6 - ***USE consistent language with the Environmental Impacts Brief – "small amounts" – the concern is the brief needs to reflect a range - very low emission to none, based on technology. Reference the Benefits Brief graph – the URL (hotlink for the version on line).

> "Geothermal energy is considered a clean source of energy because geothermal power plants**, depending on the technology,** emit ~~no~~ **at most very small amounts of** particulate matter, nitrogen oxides, ~~and, depending on the technology, at most very low levels of,~~ sulfur dioxide and carbon dioxide. Geothermal plants also are compatible with agricultural and industrial land uses, can be designed to blend in with surrounding areas, and occupy small amounts of land. The agriculturally productive Imperial Valley in southern California is home to several geothermal power plants, and the Mammoth **Lake** power plant, ~~in~~ **near** California's famous ski resort, is designed to blend into the scenery. The short-term effects of drilling include noise and the visual effects of the drilling equipment. In an operating power plant, noise is minimal under normal conditions. Finally, geothermal fluids contain dissolved minerals and sediments that are controlled to avoid contaminating local water resources. **(Refer to Issue Paper….website)**" (p. 2).

Question #7 - The group discussed the answer to this yes or no question and whether it should be answered in the affirmative. The concern was that although NGC participants, and those on the call, believe geothermal is a renewable resources, there others who do not. State and federal policies that recognize geothermal as a renewable: almost all state RPS recognize geothermal as renewable, and Executive order 13123, Greening the Government through Efficient Energy Management, considers geothermal renewable. The answer needs to clearly distinguish that the resource/heat is renewable and the medium can be renewable, if properly managed and replenished for sustainability.

Agreement: Answer is Yes. Include in the answer the reason others believe the medium is finite.

There is language to answer this question on the Texas State Energy Conservation Office website (http://www.infinitepower.org/resgeothermal.htm); the paragraph beginning "One question that commonly arises regarding geothermal energy is whether or not it is a renewable resource."

> "**Yes.** Geothermal energy refers to the constant heat of the earth **- this is limitless**; water or steam is simply the medium that transmits the heat. After it is used, the water is injected back into the ground where it is replenished with heat and used again. **Some consider geothermal resources more finite than other renewable resources because some systems were overproduced…of water use in the system. While the heat of the earth remains constant, the water or steam has to be replenished and effectively managed to ensure sustainability of production.** ~~Some consider geothermal resources more finite than other renewables resources because the productivity of individual wells may diminish after prolonged use. Resource management is critical, however, to ensuring the productivity of wells.~~ Experience at existing fields shows that production can continue indefinitely if resources are properly maintained.**GT is a recognized renewable resource in most states with an RPS.better to say all Western States…EO 13123**" (p. 2).

Question #8 – There was concern that the second bullet implies that oil and gas industry never drills a dry hole. They have just as difficult a time as geothermal locating the resource, but after a field has been determined there are not as many dry holes. The 80/20 statistic came from Department of Energy. ***Clarify the term "financing" - what it does and does not include.

> "The three main barriers to more widespread use of geothermal resources involve the location of resources, economics and permitting challenges.
>
> - "Geothermal resources that are suitable for power generation are limited to locations in most western states, Alaska and Hawaii. Resources that are practical for direct-use applications are more widespread, but also are located predominately in the west."
>
> - "Technology and public policy greatly influence the economics of geothermal energy. Locating geothermal resources is expensive and risky **just as in oil and gas exploration** ~~because the exploration technology is not as advanced as similar methods used to extract oil and gas~~. **However** the success rate of drilling for fossil fuels is more than 80 percent because many reserves are identified before drilling occurs. Geothermal exploration technology is not as ~~reliable~~ successful; productive wells are discovered approximately only 20 percent of the time **because the geology of geothermal systems is more complex**. Geothermal energy also remains more expensive because public policies, financing and research historically have not supported geothermal energy **development** as they have traditional energy sources ~~fuel sources~~" (p. 3).

Question #9 - PTC applies to price, not cost. The group discussed including the Accelerated Depletion Allowance, but since it is not listed as a classic tax incentive it will not be included in the Brief. RPS now exists in 14 states; Maryland just passed an RPS including geothermal.

> "A few financial and regulatory incentives promote the development of geothermal resources for power generation and direct use. The Database of State Incentives for Renewable Energy (www.dsireusa.org) describes many of them. The major federal incentive is a**n investment** tax credit of 10 percent ~~(up to $25,000 per year)~~ that is available to commercial businesses that invest in equipment used to produce, distribute or use geothermal energy. The federal production tax credit of $0.018 per kilowatt-hour (adjusted for inflation) currently **applies to wind and biomass but** does not apply to geothermal energy. This incentive has been a major factor in the growth of the domestic wind industry in recent years and, if applied to geothermal energy, would significantly **increase the incentive for industry by** decreas**ing** the ~~cost~~ **price** of electricity generated at ~~these~~ **geothermal** power plants. States offer a variety of incentives, including investment tax credits, sales and property tax exemptions, and grant and loan programs. States also can use geothermal energy to meet renewable energy portfolio standards (RPS). Currently, ~~13~~**14** states have an RPS that requires power retailers to sell a specific amount of power from renewable resources, and more states are considering implementing such a standard" (p. 3).

Siting Power Plants Brief

Siting Transmission Lines Section

- Authority needs to be clarified - on federal lands the federal authority has control, on private and non-federal lands local municipalities have the greatest authority.
- Eminent Domain – the concern was that there are different challenges based on who builds transmission; those with eminent domain authority have fewer challenges, although this does not include challenges in crossing federal lands.

> "The transmission system operates like a big, interconnected, interdependent machine. State policymakers, local governments and federal authorities all have some control over what is built where and who makes the investment in transmission infrastructure. Federal authorities wield the greatest authority over the rates that those who own transmission lines can charge others to send power over their lines. State ~~policymakers~~ **and local agencies on private and state lands** have the greatest authority over the process of issuing permits to build transmission lines and power plants. It is often challenging to secure a permit to build a new transmission line or expand existing ones. **Private parties or others without eminent domain authority find this process still more difficult.** Few people like the way the lines and transmission towers look, and, in many cases, the people who see the lines do not experience any direct benefit from the lines; they often are built to deliver electricity to people who live many miles away" (p. 1).

ACTION: Southern California Edison will review the eminent domain language.

Siting Guidelines Section

Guideline #5 **–** there was discussion on the terms siting, application and permitting processes – siting includes more than application and permitting is a phase of siting and a more accurate term. Many of the same problems/solutions were raised in discussion on the Impediments document – agencies need adequate resources (staffing, time, and money).

> "5. Address the issue of costs associated with ~~the application~~ **permitting transmission lines and power plants** process.
>
> "~~Inefficient siting~~ **A permitting** processes **with a clearly laid out timeline, that states how many and what type of studies are required can save time and help developers avoid unexpected costs** ~~can be excessively burdensome for permitting agencies and costly for developers. Developers expet that they will likely have to spend money on conducting environmental impact studies, for example. A review process that clearly states how many and what types of studies are required can save time and help developers avoid unexpected costs~~" (p. 2).

Guideline #6 – ***The concern was that most states with a centralized process for transmission siting require the connecting power plant to have a minimum production capacity in order to qualify. Most geothermal plants are below this threshold; and therefore cannot utilize a centralized process.

> "6. Provide a central place where applicants can obtain all the necessary permits **for transmission lines.**

~~All but six states do this for siting electricity transmission lines, and it is an important part of trying to provide oversight without unduly burdening the process.~~ **According to EEI, all but six states have some type of centralized permitting for siting electricity transmission lines, and it is an important part of trying to provide oversight without unduly burdening the process. Geothermal production does not qualify in all cases. Where states have such processes, they should consider making them applicable to the production capacity and types of geothermal generation.**

Lay out a set of considerations that can be used to determine if the facility should or should not be constructed. Avoid simple "not in my backyard" objections.

Arizona does this through statute, providing a set of approximately 10 items that can be considered in the siting review process. For example, environmental impacts, impacts on local affected communities, reliability benefits and security impacts are examples of the kind of considerations for such a list.

Guideline #10 – ***INCLUDE the USFS and BLM appeal processes and the state of California appeal process which goes to the State Supreme Court.

"State permitting laws and regulation almost always lay out an appeals process. Parties who disagree with the siting authority's decision can appeal to the courts, or in some cases, to the public utility commission itself. The appeals process is important in many states because it provides a clear and transparent way for all parties to understand who makes decisions. It can help avoid a situation in which aggrieved parties challenge a decision for extended periods of time through multiple forums. **By way of example, the DOI and USDA have different processes for the same decision. The State of California allows for appeals directly to the State Supreme Court. An efficient, coordinated appeals process is important at both the state and federal levels**" (p. 3).

April 23, 2004

Issue Brief Reviewed: Technology and Costs

In attendance:

Diane Bates - GEA	Janine Clayton – USFS	Roger Hill – Sandia
Mathew Brown - NCSL	Paul Dunlevy - BLM	Arlene Rocabado - SCE

AGREEMENT: Participants chose to review the documents with the caveat that another call would be scheduled with the intent of increasing participation.

Technology and Costs Brief

Overall, the use of the terms cost and price needs to be careful and deliberate, especially in comparisons and references to emissions – ***USE consistent language from the Environmental Brief.

"Geothermal energy provides an affordable, clean method of generating electricity and heating and cooling buildings. Geothermal power plants tap certain high-temperature resources (above 190°F) to generate electricity with~~out producing many~~ **minimal or no**

air emissions. Heat pumps and 'direct-use' applications, which rely on more common low-temperature resources (from as low as 70°F up to 240°F) are used throughout the country as an energy and dollar-saving alternative to traditional furnaces or natural gas-fired boilers. Two challenges for geothermal energy are that resources are difficult to locate and tend to be found in ~~remote~~ **rural** areas. Because of their location, issues associated with transmitting power can hinder development and limit potential direct-use applications" (p. 1).

Geothermal Electricity Production Section

"Geothermal power plants use the earth's heat— in the form of underground steam or hot water— to spin a turbine and generate electricity. Wells hundreds to thousands of feet deep are used to deliver the hot fluid to the power plant on the surface, where the heat is converted to electrical energy. The ~~cooled~~ water that is not ~~consumed in this process~~ **lost to evaporation in cooling towers** is piped to outlying wells where it is injected back into the reservoir to be reheated. Geothermal electricity production currently is limited to certain western states where the hottest resources are closer to the surface, but advances in drilling and energy conversion technologies could make it possible to expand the use of geothermal power plants to other states. The three types of **commercial** geothermal power plants are dry steam plants that use resources of pure steam, and flash steam and binary cycle plants that tap reservoirs of hot water."

- Dry Steam
  When resources produce pure steam, the steam is used to drive a turbine and generate power. However, these resources are rare; only five such fields have been discovered to date. The only commercially developed steam field in the United States is The Geysers, located in northern California, which began the commercial producing of electricity in 1960. The Lardarello, Italy, field began production in the early 20th century.

- Flash Steam
  Geothermal reservoirs that contain hot, pressurized water are much more common and provide energy for all domestic geothermal power production except The Geysers. Flash-steam power plants use resources that typically are hotter than 350ºF. Before fluids enter the plant, the pressure of the fluid is reduced until it begins to boil, or flash. This process produces both steam and water. The steam subsequently is used to drive the turbine; the water is injected back into the reservoir. These types of power plants operate in California, Hawaii, Nevada and Utah.

- Binary Cycle
  This rapidly expanding technology uses geothermal resources with temperatures as low as 190°F. Rather than flashing the geothermal fluid to produce steam, this type of power plant uses heat exchangers to transfer the heat of the water to another working fluid such as isobutane that vaporizes at lower temperatures. This vapor drives a turbine to generate power, after which it is condensed and circulated back to the heat exchangers. In this type of plant **which has superior environmental characteristics**, the hot water (which tends to contain dissolved salts and minerals) is never exposed to the air or to surface waters before it is injected back into the reservoir. The use of binary power plants has ~~increased rapidly from the~~ **were introduced in the** mid-1980s ~~to the present~~ and **are the fastest growing technology in this sector with** more than 350 MW of binary generation **that** exist in California, Hawaii, Nevada, New Mexico and Utah.

Enhanced Geothermal Systems Section

This section needs to be renamed Advanced Technology and the text split into Enhanced Geothermal Systems and Power Plant Development. ***ADD Language in the Power Plant Development section

about kalian cycles and using binary fluids – why they are being pursued (they will make the resource base larger, closer to load centers).

> **"Advanced Technology**
> ***"Enhanced Geothermal Systems***
> "~~Modern~~ **Geothermal** power plants need ~~high temperature resources~~ **heat, water, and porous rocks** located fairly close to the surface to generate affordable electricity. Researchers and geothermal developers in the United States, the European community and Australia are searching for ways to enhance the productivity of geothermal reservoirs and to **use areas with plenty of heat but little water**."
>
> *"**Power Plant Development***
> "Advanced power generation and drilling techniques may make it possible to generate electricity using much lower temperature resources and allow developers to tap valuable resources located deeper underground. If successful, these technical advances will enable the recovery of a much larger portion of the enormous thermal energy stored within the earth. **Add something about kalina cycles, and using fluid in binary systems- discuss why these are being pursued, b/c they will make resource base larger….to bring it closer to the load centers**" (p. 3).

Cost Challenges

Prices should be reflected in ranges, for example .03-.06 cents for wind. ***ADD the term price to the title.

> **"**Cost**, Price** and Challenges
> "Unlike traditional power plants that run on fuel that must be purchased over the life of the plant, geothermal power plants use a renewable resource that is not susceptible to price fluctuations. New geothermal plants currently are generating electricity for between $0.05 to $0.08 per kilowatt-hour (kWh). Geothermal plants that have operated for more than 10 years tend to generate power for as little as $0.03 per kWh to $0.05 per kWh**, because the capital costs are paid off**. By comparison, ~~some~~ modern wind turbines ~~are~~ generate power for approximately $0.03 **to $0.06** per kWh with the help of the federal production tax credit of $0.018 per kWh. Coal and nuclear power plants can generate cheap power **SOURCE?:** (below $0.03 per kWh), but a number of environmental and economic concerns are associated with these plants that do not relate to geothermal plants."
>
> "Most of the costs associated with geothermal power plants are related to resource exploration and plant construction. ~~Locating geothermal resources is expensive and risky because only about one in five wells yields a reservoir that is suitable for development~~ **Like oil and gas exploration, it is expensive and risky to locate geothermal resources, because only one in five wells yields a reservoir suitable for development**. ~~Because of this risk~~ Geothermal developers must prove that they have a reliable resource before they can secure **the millions of dollars required to develop geothermal resources**. In the United States, initial costs for large geothermal power plants (those with a capacity greater than 1 MW) generally are between $2,000 and $3,100 per installed kilowatt (kW), depending on the temperature and chemistry of the resource (see Table 1)" (p.4).

Approximate Capital Cost for Various Power Plants Table

There was a lot of discussion on how to present this information fairly and in a way that conveys the attributes of geothermal energy. Suggestions included: add columns (fuel costs and capacity factor), eliminate the comparison data and only show geothermal data, or eliminate the comparative table and replace it with a table that reflects geothermal costs over the life of the plant (case specific if possible). It was noted as important to keep the comparison to other fuels because the audience for the Briefs is decision makers who would want to know the comparative information.

"Table 1."

Geothermal	$2,000-$3,100 **2200-3400**	**0**	**95%**
Coal	$900-$1,200	**$2mbtu**	**90%**
Wind	$1,000 – **3300**	**0**	**30-40%**
Natural Gas	$500-$800	**$5.50mbtu**	**90%**

"Note: ~~These figures reflect the cost of constructing a power plant. They do not include costs fro resource exploration and drilling.~~ **For instance, while gt costs more initially than other technologies, it is available to produce electricity more than other technologies, and fuel is free/costs are zero in perpetuity**.

"Source: The National Conference of State Legislatures, 2004" (p. 4)

AGREEMENT: The group decided to add two columns (fuel costs and capacity factor)and at the next meeting discuss whether the chart above (with confirmed figures), a proposed table for cost over the life of a plant, or no chart best serves the purpose of the brief.

ACTION: GEA will develop a table of geothermal costs over the life of the plant for discussion.

Other

Briefs should reference other Briefs or cite websites for maps or select statistics; references will include the URL for access to the Brief or web site. For the Briefs on line, the reference will be a hot link (direct connection to the site or Brief).

Next Steps

The next Conference call, to complete the second review of the Technologies and Cost and the Direct Use Brief, will be scheduled in the second week of May. If possible, this review will include a FIRST review of the Jurisdiction and Authority brief.