October 8, 2009

Subject: Transmittal to ISEA Council of the Geothermal Resources Report

Dear Council Members:

The purpose of this letter is to transmit to you a report summarizing issues, opportunities, and suggested actions to address the State of Idaho energy objectives, outlined in the Legislature's 2007 Idaho Energy Plan. The report attached is focused on Geothermal Resources.

The Board of Directors (Board) of the Idaho Strategic Energy Alliance (ISEA) recognizes and thanks the Geothermal Resources Task Force, one of more than a dozen expert groups working as part of the Alliance, for their development of this report. The ISEA Task Forces are comprised of volunteer experts, including energy engineers, developers, private and academic researchers, regulators, and policy experts who have come together in the interest of Idaho citizens to develop and analyze options, provide information and build partnerships necessary to address Idaho's energy challenges and capitalize on Idaho's energy opportunities. The reports produced by these Task Forces present an understanding of the current status and potential path forward for each resource, and as such, provide a first step in executing the Legislature's 2007 Idaho Energy Plan.

The core of this report is the identification of barriers and challenges to, and the development of options for, expanding development of geothermal electric resources in Idaho. The conclusions and recommended options are not intended to be exhaustive, but rather, form a starting point for informed discussions.

As you know, it is the Board's responsibility to evaluate the potential benefits and costs of the recommended options developed by ISEA Task Forces. Our initial review comments on the Geothermal Task Force report are summarized in this transmittal. The Board believes that an adequate policy assessment of individual reports cannot be made, however, until all of the Task Force reports and options have been evaluated together, including considerations of Economic Development & Finance, Energy Transmission, and Communications. In this respect, both this report and the Board's comments should be viewed as "living documents" that will be updated as significant new information and/or perspectives emerge.

<u>Summary of Task Force Recommendations</u>

The Task Force recommendations, including actions and implementing suggestions, are summarized below, and in greater detail in the body of the report. In some instances, the ISEA Board concurred completely with the Task Force recommendations. In other instances, there was conditional or no consensus. In all cases, we as a Board feel that it is valuable for you to have an understanding of the recommendation, its potential benefits and downsides.

The recommended options in this report are grouped in three categories:

1. ***Incentives for Power Generation***

1. Establish a feed-in tariff. (No Consensus) Importantly, there was recognition that the details of a tariff were most critical. And, there is Board interest in asking the IPUC to conduct a process to evaluate the efficacy of the proposed tariff.
2. Allow utilities to include geothermal development costs in rates. (No Consensus) We recommend this proposal be evaluated in the same review as the feed-in tariff (above).
3. Increase the output limit under Idaho's PURPA rule. (No Consensus) This option received support from the IPUC, however, utility interests argue that this could increase costs to consumers. It would clearly be the discretion of the Commission, if they decided to carry this discussion forward, to decide whether to increase the PURPA limit.

2. Incentives for Transmission Development

1. Offering development incentives in Renewable Energy Zones. (Supported with Conditional Agreement)
2. Accelerated recovery of transmission costs. (No Consensus) Some parties believed there was already adequate flexibility in utility interconnection rules to accommodate a need for accelerated recovery, but others believe existing rules are inadequate. The Board sees value in asking the IPUC to consider evaluating this option in a subsequent process.

3. ***Education and Training***

1. There were several recommendations in the area of Education and Training. (Supported)

Proposed Action Items

In addition to commenting on recommended options, the Board believes it is helpful to suggest the organizations to which the Governor's Office or the Legislature might consider assigning the responsibility for evaluating, and possibly implementing recommended options. This evaluation would include, as appropriate, development of an implementation plan and timeline. In addition, we offer members of the Board and the Task Force as a resource to the reviewing organizations during the initial review and scoping of the recommendation, as well as during the evaluation and implementation. The Board's recommendations are presented below.

- ***Idaho Public Utilities Commission***
  1. Feed-in tariff
  2. Utilities including qualified geothermal costs
  3. Raising the PURPA limit
  4. Accelerated recovery of transmission reinvestment

- ***Office of Energy Resources***
  1. Evaluate renewable energy zones

- ***Idaho Department of Water Resources***
  1. Interagency task force on geothermal regulation and management

- ***Idaho Geological Survey***
    1. Geothermal resource data gathering,

- ***State of Idaho***
    1. State investment to reduce exploration and development risk
    2. State training engineers and scientists.

Again, the Board is pleased to commend the work of the Geothermal Resources Task Force and is pleased to submit their report to Council members for your review.

Steven E. Aumeier,

Chair, ISEA Board of Directors

<u>Idaho Strategic Energy Alliance Board Members</u>:

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Larry La Bolle, Avista
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Jim Kempton, Idaho Public Utilities Commission
Michael Louis, Center for Advanced Energy Studies/Energy Policy Institute
Ric Gale, Idaho Power Company

Recommendation	Page		Explanation	Comments from Team
Priority: Establish a feed-in tariff for geothermal	6, 27	Pro:	*Recognizes the long lead time & high upfront capital costs for geothermal, providing long term economic incentive to developers to take the investment risks of exploration drilling*	
		Pro:	*A feed-in tariff (possibly, at the level mentioned in the report) would likely add stimulus to geothermal resource development in Idaho. While the tariff would not remove all of the risk of exploration and development from the resource developer, it would significantly increase the likelihood that a developer could secure capital and operate profitably. A question the State would have to address, when considering the policy question of establishing a feed-in tariff, is whether to offer the tariff to the range of resources the State would like to promote (e.g. wind, biogas, etc.), and whether the tariff price should be uniform or established at varying levels depending on the resource type and value.*	
		Con:	*Adoption of the proposed feed-in tariff would represent a significant policy decision by the State of Idaho on behalf of its electric consumers. Implementation of the proposed feed-in tariff, dependent, of course, on the price established by the Idaho Public Utilities Commission for electricity sales from the resource, could unreasonably shift the risks associated with resource development to Idaho consumers. The report states that the feed-in tariff does not shift the risk and upfront cost of development to the ratepayers, however, we disagree. On one hand, the report authors are correct in asserting that a developer who is unsuccessful in siting a resource in Idaho will not pass on any development costs to ratepayers under the proposed tariff. And, that would also be the case if there were no feed-in tariff. But, the proposed tariff, again dependent on the established price, does allow a successful project developer who has significant development costs (i.e. costs that would have otherwise made their resource output uncompetitive in the electricity market) to push some or all of those "above market costs" costs onto consumers. The art in setting the tariff price, should the state decide to implement such a policy, would be to balance the benefits to Idahoans associated with development of geothermal resources with the costs that would otherwise have been paid by Idahoans for a similar resource (baseload, carbon free) that could be developed with less risk.*	If the State is not going to make any significant policy decisions, all the work of the task forces was a waste of time, & Idaho will likely fall behind neighboring states who recognize & accept RPS (renewable portfolio standard) & incentives. Details of how a tariff or other incentive is negotiated are obviously critical; a balance must be struck between ratepayers, taxpayers, utility & developers, but common sense tells us this is possible if the political will is there & good people are involved. Other things like an RPS or carbon tax would be useful, but they were viewed as too controversial for Idaho's political climate, so were not included. But it is possible that the public is more progressive than policymakers and might welcome more homegrown renewable energy.
	6,27	Con:	*The quoted 150 mills per kilowatt hour is approximately twice most utilities avoided cost.*	see above. The task force did not have time/expertise to research all details, but it recommends that someone do so.

Recommendation	Page		Explanation	Comments from Team
Priority: Allow regulated utilities to add "qualified" geothermal development costs to rate base.	7, 28	Pro:	*Recognizes the long lead time and high upfront capital costs for geothermal and allows regulated utilities to invest in early stage geothermal energy development and be assured of any rate based cost recovery.*	
		Pro:	*The benefit of this proposal is the same as for number one above, in that it would likely add stimulus to geothermal resource development (by utilities) in Idaho. The recommendation correctly recognizes that utilities are not incented to invest in the development of risky resources. Another significant benefit of allowing utilities to include geothermal resource development costs in their rates, is that these resources would then be available to serve Idaho customers' loads for the life of the resource and at the cost of production – not a market rate.*	
		Con:	*Adoption of the proposed feed-in tariff would represent a significant policy decision by the State of Idaho on behalf of its electric consumers. Implementation of the proposed feed-in tariff, dependent, of course, on the price established by the IPUC for electricity sales from the resource, could unreasonably shift the risks associated with resource development to Idaho consumers. The report states that the feed-in tariff does not shift the risk and upfront cost of development to the ratepayers, however, we disagree. On one hand, the report authors are correct in asserting that a developer who is unsuccessful in siting a resource in Idaho will not pass on any development costs to ratepayers under the proposed tariff. And, that would also be the case if there were no feed-in tariff. But, the proposed tariff, again dependent on the established price, does allow a successful project developer who has significant development costs (i.e. costs that would have otherwise made their resource output uncompetitive in the electricity market) to push some or all of those "above market costs" costs onto consumers. The art in setting the tariff price, should the state decide to implement such a policy, would be to balance the benefits to Idahoans associated with development of geothermal resources with the costs that would otherwise have been paid by Idahoans for a similar resource (baseload, carbon free) developed with less risk*	

Recommendation	Page		Explanation	Comments from Team
Priority: Allow regulated utilities to add "qualified" geothermal development costs to rate base. (cont.)	7,28	Con:	The allowance for the inclusion of costs in the rates of utility customers has the same potential to drive up resource costs, above what they might have otherwise been if the same investment had been made in other, more-certain resources.	More-certain resources, such as coal and natural gas or hydro also have issues, especially if cap and trade or other carbon tax is included. Ignoring externalities and true environmental costs of hydro and coal has long kept prices artificially low, but that seems unlikely to continue.
Priority: Raise MW limit on PURPA	7, 28	Pro:	*More in step with typical geothermal field potentials*	
		Pro:	*This proposal would likely help stimulate the development of electric resources, especially at times when the published PURPA rates exceed the price that could be obtained through negotiations in a competitive market, such as through a competitive bidding process.*	
		Con:	*Implementation of this proposal may result in Idaho consumers paying more for electricity from a project in the range of 25 – 30 aMW, than they would have otherwise if (as is the case today) the project developer were to sell the output at a price established through a competitive market. The published PURPA rates are intended to improve the viability of small projects whose developers may have fewer technical and legal resources available to participate in the sometimes extensive negotiations and analyses associated with a competitive market transaction. Increasing the limit may also have the potential of reducing a utility's ability to acquire geothermal resources through a competitive bidding process, since developers would be able to arbitrage their offerings against the PURPA rate.*	Task force did not have time/expertise to examine all details. Presumably PUC could figure out some safeguards.
Priority: Invest in technologies to reduce exploration & development risk & promote education	7, 28	Pro:	*Reduces exploration and development risk encouraging further geothermal development*	

Geothermal Task Force: Pros / Cons

Recommendation	Page		Explanation	Comments from Team
State should establish a $10 million fund for initial investigation of geothermal prospects	9,30	Pro & Con:	Establishing a $10 million fund for initial investigation of geothermal prospects would represent a sizable investment of dollars by the State of Idaho. The State would have to decide at a policy level that this investment would be a priority over all other types of investment that could be made to encourage development of renewable and other energy projects. The proposed repayment of the fund by developers is a very attractive and mitigating feature of the financial impact of this proposal.	
State should invest in scientific information and technologies to reduce exploration/development risk	28	Pro:	Funding the acquisition and evaluation of basic scientific data would likely help encourage development of geothermal resources in Idaho.	
State should promote education on needs for alternative energy sources & financing	28			
State should support Section 45 federal production tax credits (so these credits can be bought and sold)	28			

Recommendation	Page		Explanation	Comments from Team
Support changes to BLM leasing rules regarding reservoirs underlying adjacent BLM blocks.	28	*Pro:*	*Could protect reservoirs that underlie contiguous BLM lease blocks*	
Priority: Reimburse developers for transmission related capital costs over 5 years	8, 28-29	*Pro:*	*To help connect more remote projects to the grid; a special accelerated recovery of the transmission –related costs would provide developers an added incentive to make the initial investments necessary to connect renewable projects to the grid.*	
		Pro:	*Adoption of this proposal could help foster resource development by reducing risk to the developer and improving the economics of their projects. In the best case, where a resource developer remains solvent over the amortization period of the network transmission upgrade, there would presumably be only a modest rate impact to utility customers as a consequence of accelerated repayment.*	
		Con:	*The proposed accelerated repayment of transmission investment improves the economics of a project by transferring near-term cost and risk from the developer to Idaho consumers (assuming Idaho customers have the investment return included in their rates). Utilities already provide several different processes for developers (depending on the characteristics of each project) to secure interconnection and transmission service. The processes include variability in the determination of the term of the repayment period for developers' network transmission investments. We believe Idaho customers' interests are best protected when developers follow the FERC-established OATT process.*	If the current procedure works so well, then why are the utilities crying for transmission lines? The utilities need to pay more attention to siting and regulatory procedures, as indicated by recent news. This suggestion should help the utilities as well as independent developers of major lines, and ultimately future consumers. One radical idea is to charge some rental fee so that powerlines going through Idaho benefit Idaho taxpayers/consumers, not just California or whoever gets the power.

Recommendation	Page		Explanation	Comments from Team
Priority: Provide statewide renewable energy zones, including incentives esp. for transmission development	8, 29	Pro:	*Special zones can provide tax incentives necessary to help attract investment in geothermal development.*	
		Pro:	*Adoption of this proposal could have the effect of spurring energy investment, but only if the renewable energy zone included the geographic and other attributes that provided a premium to energy development, and was defined enough that construction of a transmission line was truly a benefit to the developer.*	
		Con:	*All of the cost of investment and the risk of recovery for the transmission development is placed on the utility's consumers (providing the investment is not covered by other funds made available by the State of Idaho or other body). We believe this cost and risk to be unreasonable.*	The idea of a statewide incentive zone is that some of the cost/risk is borne by taxpayers - not utility consumers though they constitute most of the taxpayers. A zone is not unique to any one company but companies can compete. Implementation should be only after additional study of how other states do such things.
Priority: Develop state interagency task force on geothermal	8, 29	Pro:	*Could improve the efficiency of the permitting and regulatory process*	
Priority: Compile all available geothermal data into a database	8, 29	Pro:	*Could identify data gaps. Would be publicly accessible. Would provide a central location for all relevant geothermal data.*	

Recommendation	Page		Explanation	Comments from Team
Priority: State should fund study of geothermal potential	9, 30	Pro:	*Would provide basic scientific data to the public that is site specific to Idaho's geothermal resources*	
		Pro:	*Funding the acquisition and evaluation of basic scientific data would likely help encourage development of geothermal resources in Idaho.*	
		Con:	*Establishing a $10 million fund for initial investigation of geothermal prospects would represent a sizable investment of dollars by the State of Idaho. The State would have to decide at a policy level that this investment would be a priority over all other types of investment that could be made to encourage development of renewable and other energy projects. The proposed repayment of the fund by developers is a very attractive and mitigating feature of the financial impact of this proposal.*	
Priority: Coordinate Idaho universities on renewable energy programs /workforce training	9, 30	Pro:	*There is a shortage of engineers and scientists needed by industry to explore, develop, and produce geothermal resources. We need to develop programs in our universities to supply the next generation of geothermal professionals.*	
		Pro:	*Could both help Idaho's energy future and employment.*	
Governor & Congressmen should encourage federal support for geothermal & renewable energy	30	Pro:	*Increased financial and technical support for geothermal and other energy options, reasonable multiple-use land management policies, and increased support of science and engineering education.*	
Improve permitting & communication process	8, 29			

Geothermal Task Force: Pros / Cons

Recommendation	Page		Explanation	Comments from Team
Provide knowledge & training for state agency personnel & regulators regarding geothermal	8,26, 29			
Provide education & outreach to the public	26			

8/1/2009

GEOTHERMAL

IDAHO STRATEGIC ENERGY ALLIANCE

Geothermal Task Force | Initial Mandate - Draft Report

Geothermal Task Force Membership

The membership of the Geothermal Task Force is comprised of representatives of utilities, geothermal engineers and developers, educators, regulators and researchers. One of the members is part of the staff at the Idaho Public Utilities Commission and has provided the Task Force with a review of this report but has been careful to recognize that the recommendations made in this report may require the action by the commission which may result in a conflict in his interest and responsibilities so has asked to be excused from providing support to the task force recommendations.

The Idaho Strategic Energy Alliance Geothermal Task Force has prepared this report in response to identified issues facing the development of geothermal projects in Idaho. The report is based on task force discussions and recommendations with an aim of removing some of the obstacles to geothermal energy development and enabling Idaho stakeholders to obtain the full potential of geothermal energy.

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Table of Contents

Executive Summary

Idaho's energy future will benefit from policies and actions of the same vision and courage our forefathers used to build some of America's largest hydroelectric dams which now provide us with long term supplies of low cost electricity. The very high initial cost of constructing large hydroelectric dams required private and public entity involvement and leadership. The Snake River flowing through Idaho presented a tremendous natural resource to harness for power generation.

Today we see the tremendous geologic endowment that Idaho holds in geothermal potential. At the same time we see ever higher energy costs are inevitable and the cost of fossil fuel based electricity generation carries serious uncertainties as to sustainability and the environment. A vision of Idaho's energy future should include taking a national leadership role in geothermal power development. The vision should embrace planting seeds for the growth of geothermal energy. It may take a decade or more to fully reap the benefits of seed investments made today by Idaho investors that include her electricity ratepayers and taxpayers who support the annual State agencies budgets. The investments and support will attract new businesses and opportunities into Idaho and make our state a leader in clean renewable and sustainable geothermal power. With the use of legislative policies that shift the emphasis to long term and sustainable energy solutions that tap into Idaho's abundant natural resource endowment, Idaho's energy future can lead the nation in geothermal power development.

Idahoans have long used geothermal energy for direct heating purposes, decreasing their use of other types of energy such as natural gas and electricity. Direct heating is still a key use for Idaho's geothermal resources and should be encouraged and expanded. Today we have office buildings, homes, greenhouses, fish farms and other facilities in Idaho that utilize the earth's hot geothermal fluid for energy. The Boise geothermal heating district is a valuable source of operational know-how and experience.

In addition to direct heating uses, geothermal fluids in select, very special locations are hot enough to be of use for generating electrical power. Over the past 30 years, technological advances have made electrical generation more feasible in a greater number of areas, but it is still possible only in very special circumstances. Currently Idaho has only one geothermal power plant: Raft River Unit 1 in Cassia County (Figure 3). This plant is designed to provide 13 megawatt ("MW") of capacity and is currently producing at about 11.5 MW. The project is investigating the possibility of adding more well capacity to bring the plant up to the full 13 MW. The Raft River project expects to add two more 13 MW power plant modules in the coming years and may one day produce up to 100 MW or more from the site. Exploration activity in the Raft River valley is expected to increase in the years ahead as multiple developers start to invest in drilling and development there.

Like gold, oil, good cropland, or a valuable gemstone, geothermal resources, especially the higher temperature ones, are found only in a few, very special locations with favorable geology. Because of its history of recent volcanic and tectonic activity, Idaho ranks high among the states in its potential for geothermal resources. The Western Governor's Association Geothermal Task Force report (p. 65) estimated that Idaho contains 855 MW of near-market, reasonably-priced geothermal power potential. Only California and Nevada rank higher. Idaho has a number of sites that, along with Raft River, can probably be developed for geothermal power generation. The most advanced site appears to be in the Crane Creek area near Weiser in Washington County. Roystone Hot Springs near Sweet and Magic Reservoir near Hailey may be candidates for development of electrical generation in the near future. Thermal springs and geothermal resources located in Blaine, Owyhee, Lemhi, Valley, Bannock and Camas counties may provide future power generation development opportunities for Idaho given sufficient exploration. Until the last few years, expensive exploration for geothermal energy ceased in the 1980's as high oil costs gave way to low-cost carbon-based fuels (and hydropower) for a number of years. Those times of low-cost energy are over, and development of alternatives to coal and hydrocarbons are critical to Idaho's future. While the exploration and development of geothermal power is expensive, the actual operational costs are among the lowest of all power sources (see full discussion in "Factors in Geothermal Project Economics", including Fig. 5a).

Are there downsides to utilization of geothermal energy? Not many from a scientific and technical point of view. The most serious non-financial constraint is the geographically limited availability of geothermal reservoirs, particularly those suitable for power production. In that sense, it is similar to an oil field or gold deposit. But as noted, Idaho is indeed privileged to be among the leading states in geothermal resource availability. Still, within our boundaries, geothermal energy must be prospected for and transmission facilities constructed to proven localities. Megawatt potential at any one site may be less than for coal or nuclear plants, but with numerous sites, that difference can be made up. Plus, more regionally developed sites allow for local distribution and generation, given appropriate regulatory and infrastructure requirements. As for extraction and environmental considerations, here geothermal energy production also has minimal drawbacks, especially if proper attention is paid to reservoir engineering, reinjection, etc. Poor management or design can lead to problems such as depletion of the resource, and some well field chemistry leads to pipe scaling and corrosion, but these can be addressed with proper engineering and technical fixes. Binary cycle plants, because they extract only the heat and not the fluid, tend to minimize these potential problems. Conversely, the more futuristic EGS (engineered geothermal systems) will potentially pose additional issues related to seismic triggering and water usage, which will have to be addressed as the technology becomes more feasible. Traditional geothermal extraction methods of electrical power generation have been in use since 1904 when the first plant at Lardarello, Italy was built. Binary geothermal plants have been used for over 25 years.

Environmentally, geothermal plants pose no chance of a massive flood as if a hydroelectric dam leaks; there is no huge plume of carbon dioxide from the smokestack, no waste piles of coal dust or fly as; and they have no radioactive waste released. Geothermal energy is among the greenest energy available, and it may be the friendliest to local fauna and flora.

The substantial benefits of geothermal energy include reliable Base Load 24 x 7 power generation, sustainable low operating costs, and superior online availability, along with minimal environmental impact. This is a renewable, long-lasting power source, if properly managed. But the location and amount of that geothermal power is determined by nature, though its development in Idaho or elsewhere depends on a number of man-made regulatory, economic, engineering, logistical and political factors. A geothermal power plant can provide millions of dollars of local spending each year. Geothermal power plants built in Idaho will provide sustainable and sensible energy sources that can become a significant portion of Idaho's energy portfolio.

Financially, geothermal energy, compared to most other generation sources, requires higher upfront capital costs per megawatt and a higher-risk investment because the development is in essence a "mining project" as well as an engineering and construction project. Unlike damming a river or buying a ton of coal or natural gas, developing the power first requires finding a subsurface resource that may not be visible on the land surface. Depths to the resource vary in each location, but are typically thousands of feet, requiring expensive drilling technology to investigate each site. As in mining or drilling for water, not all holes will be productive, regardless of how good the science. In Idaho, financing such a high-risk enterprise has proved daunting. It is no accident that commercial development of the Raft River plant was facilitated by prior work by the federal government. Currently, specific barriers to additional development include the high cost of exploration wells, lack of drilling incentives, regulatory patchwork, high-risk resource discovery, long lead times, capital-intensive development, transmission grid access and capacity limitations, along with associated permitting and multiple public and private land issues. Geothermal resources offer Idaho a highly prospective potential for a low cost, sustainable energy source. In order to develop it, additional transmission, exploration, infrastructure and economic incentives are needed to move from the category of "potential" to "actual."

Other states are already implementing some of these measures, including geothermal energy in renewable energy zones. It is hard to imagine any future long-term scenario that does not have higher real prices (including all environmental and other hidden costs) for energy, and Idaho, its policymakers, and the ratepayers need to recognize that.

Action Items

Economic Incentives: To help move geothermal development from its great potential in Idaho to actual and tangible power generating facilities requires specific incentives for the geothermal industry. While it was recognized and recommended that federal subsidies or incentives were highly desirable, the state has little influence there. The task force concentrated on issues under state control and designed its recommendations accordingly. The task force's key recommended power generation incentives are summarized as follows:

- **Recommendation 1** – Establish a "feed-in tariff" power price for geothermal development that addresses the long lead time and high upfront capital costs for projects in Idaho. For example, the tariff should have an eligibility period of 10 years and the accompanying power purchase agreement (PPA) should have a term of 20 years. The contracted power price should also provide some inflationary protection (for example, a 1 to 2% annual escalator). The terms and conditions related to performance bonds and plant output requirements would recognize the specific thermodynamic characteristics of each development site. A committee, including representatives from the PUC, developers, customers, the utility, and an independent technical consultant selected by all participants would develop the economic model to terms, conditions and price. Some countries in Europe have used this concept which allows a utility to charge higher rates initially to recoup capital expense.

Some people suggest that a feed-in tariff shifts the risk and upfront cost of development to the ratepayers but that is not the case (see page 34 and 35 for a more detailed discussion on feed-in tariff and a recommended tariff structure for Idaho). A feed-in tariff provides a long term economic incentive to developers to take the investment risks of exploration drilling. If their drilling is not successful the Idaho ratepayer bears no expense whatsoever. If their exploration drilling successfully discovers a commercial reservoir and the economics are positive then the ratepayer will only pay for power produced by the project and benefit from the project coming on line. A typical feed-in tariff will be much higher than the current power rates because the rate needs to cover the costs and ensure a commensurate profit for the exploration and development risks undertaken. For example in Germany the rate for geothermal power is 180 euros per megawatt hour. The rate is paid to any project over the next 10 years that comes online and begins delivering the power to the grid. The developer has already experienced the risks and costs of development. The rate is paid for renewable power delivered to the grid for projects coming on line over a limited period of time. The rate is part of a predetermined PPA and allows the developer to have a reliable set of terms and conditions to increase the bankability of the project.

- **Recommendation 2** – Allow Idaho's regulated utilities to immediately add "qualified" geothermal development costs to their rate bases. These qualified upfront costs incurred in geothermal development are higher-risk investments for reservoir resource discovery and development. The upfront costs of geothermal exploration and development have long lead times between the incurrence of the cost and the return on the investment. Currently the regulated utilities are not able to invest in early stage geothermal energy development and be assured of any rate based cost recovery. Compromises, such as risk-sharing between utility and ratepayer, might be a solution. State-backed bonds repaid by proceeds of later development are another potential financial vehicle that could be examined. A study of what other countries or states are doing could generate additional financing alternatives.

- **Recommendation 3** – The task force strongly recommends a implementation of a feed-in-tariff to stimulate risk taking activities related to exploration and development of geothermal energy but if one is not implemented, then raise the

MW limit on Idaho's PURPA contracts for baseload renewable energy to something more in step with typical scales for economically viable projects, perhaps 25-30 MW.

- **Recommendation 4** – Along with similar recommendations, listed below, invest in scientific information and technologies to reduce exploration and development risk and promote education on needs for alternative energy sources and financing.

Transmission: The lack of feeder lines and near capacity main lines in electrical transmission are major barriers to most renewable energy projects, including geothermal. Idaho should focus on creating a fast-track method to promote more inclusive planning by utilities and developers for transmission improvements within our state and to support federal level improvements outside our state. The key recommended transmission incentives are summarized as follows:

- **Recommendation 1** – To help connect more remote projects to the grid, geothermal (and perhaps other renewable energy) developers should be reimbursed for their transmission-related capital costs on a priority basis over a five year time period. Whether or how rate-payers (in-state and out-state) fund this was not discussed. Because geothermal projects already have a higher front end cost for development, the added burden of transmission-related costs can be difficult for the project to bear. A special accelerated recovery of the transmission –related costs would provide developers an added incentive to make the initial investments necessary to connect renewable projects to the grid.

- **Recommendation 2** – Create state renewable energy zones and economic incentives to spur utility investment in transmission to upgrade, extend and add new lines. Models exist in nearby states, such as Utah and Oregon, and should be investigated. Special zones can provide tax incentives necessary to help attract investment in geothermal development.

Public Education: The State should develop and implement an aggressive public education campaign regarding energy, renewable energy and the benefits of geothermal energy. Funding should be allocated to education and improving the technical database. The energy industry is facing a shortage of domestic and Idaho students interested in technical fields relevant to geothermal and other energy operations.

- **Recommendation 1** – Form an Inter-Agency Task Force. Led by the Idaho Department of Water Resources, each of the several state and local agencies that participate in the regulation and management of Idaho's geothermal and related natural resources should be funded to form a task force for improving efficiency of the permitting and regulatory process. This would only be effective if the task force members have directors/legislative/executive support for significant change in agency responsibilities and procedures. It could assist with federal issues through some type of joint review process as was done in minerals permitting some years ago.

- **Recommendation 2** – Geothermal Resource Data Gathering. A comprehensive program is needed to acquire and make available to the public all relevant geothermal data. The database developed by this process will help with exploration, regulation, education, and will also help identify key data gaps. A team would compile an update of the geologic, geophysical, hydrologic and technical data related to Idaho's geothermal resources. All of these data should be publicly accessible and include, to the extent possible, private company data, particularly those obtained with public funding. The Idaho Geological Survey (IGS), Idaho Department of Water Resources (IDWR), and Idaho universities would need to be involved with this effort and it should be collaborative with similar efforts by the Association of American State Geologists, U.S. Geological Survey, the Intermountain West Geothermal Consortium and others. Federal funding can jumpstart some of this, but the State needs its own in-house experts and budget to adequately direct, update, and maintain data beyond a three-year, single-site federal project. Management details and funding would need further discussion and authorization by the legislature/executive.

- **Recommendation 3 -** Geothermal Resource Data Acquisition. The state most likely lead by IDWR and IGS and the Universities, with support of OER, should find ways to fund acquisition of additional technical data for Idaho's geothermal hot springs such as testing to determine geo-thermometer data. At sites where it is warranted, such as known geothermal resource areas and locations with high potential, the state could acquire key data by funding lower cost geological and geophysical studies, such as mapping and magnetic and gravity surveys. Again, federal grants may provide some data but these are often very narrow in focus, highly competitive, and rarely allow statewide assessments. Such programs would provide basic scientific data to the public that is site specific to Idaho's geothermal resources. Creative sources of state funding could be something like having the State of Idaho establish a $10 million fund to be utilized for the initial investigation of geothermal prospects that have high resource potential, as determined by the Idaho Strategic Energy Alliance or another appropriate select committee of experts. The expended funds would then be reimbursed to the Fund by the developer under an "Over Riding Royalty" or at a later date "Project Financing" scenario. Other countries or states would have models for government-industry partnerships, carbon taxes or renewable portfolios, and other ways to encourage renewable energy exploration. Idaho needs to decide how serious it is about planning for the future.

- **Recommendation 4** – Train Geothermal Professionals. The shortage of engineers and scientists needed by industry to explore, develop, and produce geothermal resources is a key concern nationally and locally. We need to develop programs in our universities to supply the next generation of geothermal professionals. Idaho universities should be encouraged and supported to train students in specific, interdisciplinary courses covering the broad-based skills and knowledge needed in the geothermal industry. Relevant disciplines include engineering, geosciences (including geophysics), hydrology, exploration, energy conservation, business, etc., that could be combined in a "geothermal energy specialist" certification, perhaps in a geosciences department or an energy engineering program. Using a "home-grown" industry for their laboratory, such a program could both help these graduates find employment and become part of Idaho's energy future.

This report was written and researched by a volunteer committee. It is not intended to be exhaustive in its conclusions and recommendations, but only a starting point for discussion. The committee was not tasked with, nor did it consider, totally re-organizing state government or the relevant economic/regulatory entities. The committee was not tasked with, nor did it have authority, to decide who should pay for implementing some of the recommendations. However, it is clear that enhancement to Idaho's energy infrastructure and future supply, whether geothermal or other types, will require investments (i.e. funding and time) in both personnel and programs, whether in state government or industry. Policy discussions and legislative/executive actions must recognize and incorporate that if they wish to promote improvement to Idaho's energy picture.

Vision of Idaho's Energy Future

Idaho's energy future will benefit from policies and actions of the same vision and courage our forefathers used to build some of America's largest hydroelectric dams which now provide us with long term supplies of low cost electricity. The very high initial cost of constructing large hydroelectric dams required private and public entity involvement and leadership. The Snake River flowing through Idaho presented a tremendous natural resource to harness for power generation.

Today we see the tremendous geologic endowment that Idaho holds in geothermal potential. At the same time we see that higher energy costs are inevitable and the cost of fossil fuel-based electricity generation carries serious uncertainties as to sustainability and the environment. A vision of Idaho's energy future should include taking a national leadership role in geothermal power development. The vision should embrace planting seeds for the growth of geothermal energy. It may take a decade or more to fully reap the benefits of seed investments made today by Idaho investors that include her electricity ratepayers and taxpayers who support the annual State agency budgets. The investments and support will attract new businesses and opportunities into Idaho and make our state a leader in clean, renewable and sustainable geothermal power. With the use of legislative policies that shift the emphasis to long term and sustainable energy solutions that tap into Idaho's abundant natural resource endowment, Idaho's energy future can lead the nation in geothermal power development.

Idaho's First Geothermal Power Plant

(Source - U.S. Geothermal Inc.)

Geothermal - A Remarkable (and Challenging) Source of Renewable Energy

Geothermal is a practical source of energy for both direct use (e.g., heating greenhouses or buildings) and electrical power generation. This report focuses on the development of geothermal energy for electricity generation.

Among the types of renewable energy, geothermal is distinctive for a variety of reasons, including that it readily provides base load power, defined as generation capacity available 24 hours per day, 7 days per week. The distinctiveness of geothermal energy also presents a particular set of challenges for its development, including formidable financial and scheduling risks that arise from inherent uncertainties related to locating and tapping large reservoirs of hot geothermal fluids. The benefit of overcoming these upfront challenges is a long term, low cost supply of energy for Idaho.

In most, if not all cases, the hot groundwater, which is the geothermal fluid, travels along discrete pathways deep underground. Typically, as along the Boise Front or Warm Springs Geothermal System, the hot fluids are circulating in fractured rock associated with a specific fault zone, at a specific depth. A geothermal developer may have clues from surface hot springs, old hot spring terrace deposits, geochemical analyses, existing water wells with hot temperatures, etc., that there is a likelihood of hot fluids at depth. But until the resource is sufficiently drilled, one does not know for certain the depth and exact location and temperature and flow rate of the hot fluid. A drill hole that is a mile away from the favorable structure, fault, or aquifer, may be barren (i.e. not have a temperature sufficient for use). On the other hand, a drilling program can delineate a productive trend that could dictate the difference between a viable and nonviable resource.

The discovery and development of geothermal resources is expensive and to a degree speculative; higher financial risk is associated with the early phase of the projects. Geothermal power plants by nature have higher risk capital investment compared to other generation sources. Idaho needs to offer attractive appropriate incentives and accessibility to investors of this capital to entice developers into the state.

The potential for geothermal energy development in Idaho is considerable due to its geology. This is most simply seen from national maps of geothermal resources (Figures 1 and 2), which are essentially maps of measured heat flow Southern Idaho especially has a higher heat flow from the Earth due to its recent volcanic activity across the Snake River Plain. Also apparent and well-known are the large number of commercial and recreational hot springs, primarily concentrated in southern Idaho (Dansart, et al., 1994, "Geothermal Resources of Idaho," 1:1,000,000 map and prior compilations with several hundred springs identified). However, tapping this potential is neither easy nor foolproof. Like any exploration project it will require engagement with a suite of issues. For any near-term energy development, perhaps the most important single issue will be the initiation of a set of economic incentives tailored specifically for the geothermal industry. The main benefit is an Idaho-based and Idaho-controlled baseload power supply with long-term sustainability to augment existing power sources as the population and energy demand grow within our state. But the lead time is long.

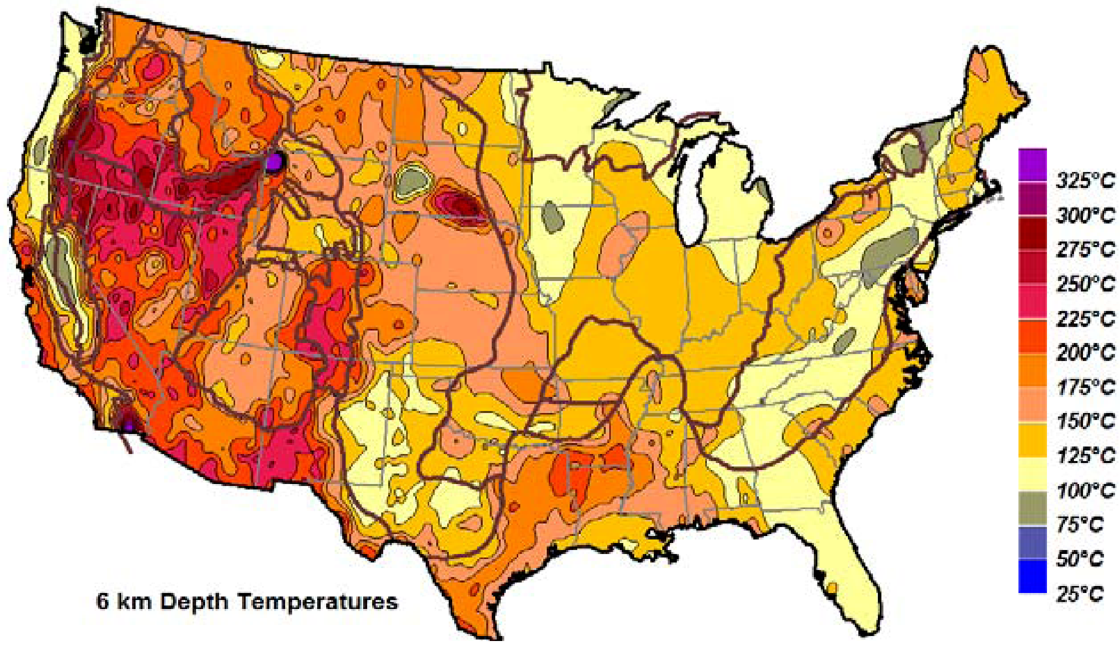

Figure 1. *Temperatures estimated at 6 km depth below land surface in conterminous United States. Map from SMU Geothermal Laboratory, cited in Blodgett and Slack, eds., 2009, report of Geothermal Energy Association. Note some of the hottest temperatures lie under the Snake River Plain in Idaho.*

Geothermal power plants built in Idaho will provide sustainable and sensible energy sources that can become a significant portion of Idaho's energy portfolio. The exact size of Idaho's geothermal potential remains to be seen, but has been estimated in the Western Governor's Association Geothermal Taskforce Report at 855 MW of near-term geothermal power potential. As explained in a later section, much of that is projected with little subsurface data. Still, that could amount to something like 30% of the state's power requirement, an enviable amount.

The locations of some potential viable geothermal reservoirs are obvious –there are surface hot springs, and heat above usually means heat below. However, other resources have few surface manifestations that signal their location, size, temperature and usability for power generation. Furthermore, once a potential underground resource is identified and delineated, it must be fully evaluated before full-scale investment can be made in its development and construction. Thus, geothermal energy, compared to most other generation sources, requires higher upfront capital costs per megawatt and a higher-risk investment. The good news is that once the resource is on line and power plants are installed and connected, geothermal energy can supply clean, reliable baseload power for decades with little or no exposure to fuel price risk and an affordable $/kWh cost over the project's life cycle. For example geothermal power plants can cost $4.5 to $5.5 million per megawatt of capacity to build, including drilling wells. Gas plants can cost only $1.5

to $2.5 million per megawatt of capacity to build. However, with respect to power production, a geothermal power plant can cost only $15 to $20 per megawatt hour of capacity to run the plant whereas a gas or coal plant can cost $50 or more per megawatt hour to operate due to the requirement to purchase fuel. For geothermal plants, the "fuel" is essentially locked up and paid for up front whereas gas and coal plants must continually purchase fuel at open market prices.

Like in any energy-producing activity, there are some technical challenges to operating efficiently over the long-term. Some, but not all, geothermal fluids contain sufficiently high concentrations of metals for scaling in pipes to be a problem, particularly in steam plants. High gas concentrations are found in some geothermal areas; extremely corrosive fluids may simply not make suitable geothermal prospects. And like any groundwater resources, over pumping leads to reductions in pressure and water levels. Managing a geothermal field to a sustainable production level typically requires careful monitoring and injection wells, plus good engineering during operations. In spite of these issues, a number of geothermal fields have been operated continuously and productively for many decades. The modern use of binary cycle plants avoids some of these issues by being a closed loop in which the heat is extracted but the fluid itself is sent back into the bowels of the earth. The management of each reservoir requires attention to production and injection and a potential decline in the reservoir temperature over time. These declines are often about 1 to 1.5 % per year. Over long time frames the reservoirs may decline in heat value.

In summary, geothermal offers Idaho the potential for a low cost, sustainable energy source but it requires the infrastructure and incentives to move from the category of "potential" to "actual." A 2007 report by the California Energy Commission (cited in Blodgett and Slack, GEA, 2009) notes that a "levelized cost" for various power types puts geothermal energy at a "lower levelized cost ($/MWh) than many other types of merchant owned power plants including: Natural Gas Combined-Cycle, Wind, Biomass Combustion, Nuclear, Solar Thermal, and Photovoltaic." The actual cost to the consumer is heavily dependent on market and regulatory factors as well as the actual cost of generating the power itself. In its cost structure, geothermal is somewhat similar to hydropower, in so far as it requires a large upfront, capital-intensive, well-engineered investment with subsequent low yearly operating costs and carbon-friendly technology. That is a model Idaho ratepayers and policymakers are familiar with.

The substantial benefits of geothermal energy include reliable baseload 24 x 7 power generation, sustainable low operating costs, and essentially carbon-free availability. It is also a renewable, long-lasting power source. As development in Idaho proceeds, these geothermal power plants will be distributed in different locations across the State according to where the resources are found, contributing to the employment and tax base in numerous local communities. At many sites, after the first plant is developed and producing electricity, there will be an opportunity to conduct further exploration, expand the reservoir yield, and add to the inventory of wells. As more plants are built on a single expanded resource, the combined total annual operating costs are reduced. Some costs can be spread over a wider base.

A January 14, 2009, editorial in the New York Times describes geothermal energy and cites conclusions of a recent study:

"*To most people the word "geothermal" means hot springs and geysers — like parts of Iceland or Yellowstone National Park where water is heated by the presence of magma near the surface of the earth. But the earth's heat lies below everywhere, and it offers a virtually untapped energy reserve of enormous potential with a very short list of drawbacks. In 2006, a panel led by the Massachusetts Institute of Technology surveyed the prospects for electricity production from enhanced geothermal systems. Its conclusions were conservative but very optimistic. The panel suggested that with modest federal support, geothermal power could play a critical role in America's energy future, adding substantially to the nation's store of renewable energy and more than making up for coal-burning power plants that would have to be retired.*"

Idahoans have long used geothermal energy for direct heating, offsetting demand for other types of energy utilization. But only recently have Idaho's natural geothermal riches been utilized for electrical production. Elsewhere in the world, as determined by geologic factors, geothermal power plants have long supplied electricity. In fact, only in areas of favorable geology, usually manifested by active or recent volcanic systems and hot springs, is sufficient heat flow available to make geothermal energy development likely. Idaho is one of those places (see Figures 1, 2, 3 and 4).

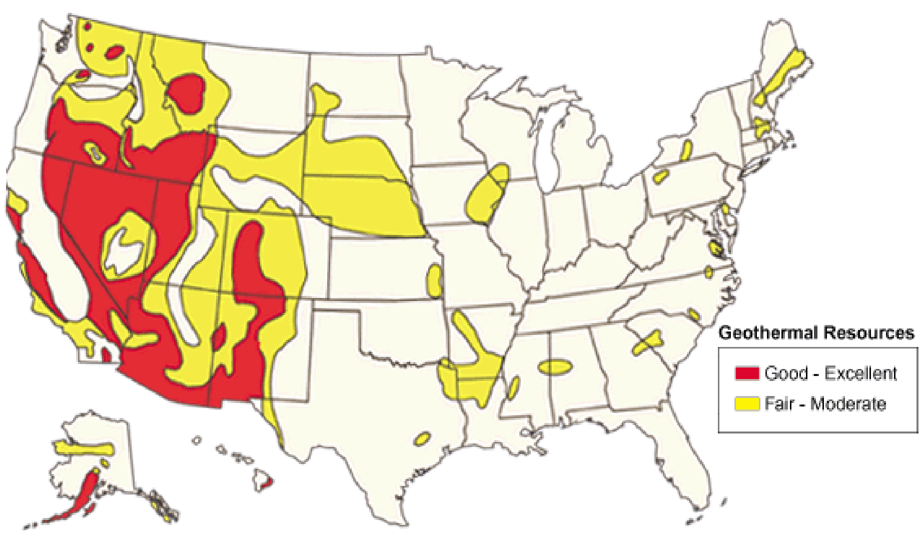

Figure 2. *Geothermal resources of the United States (Source U.S. Department of Energy)*

The deep interior of the earth is extremely hot, and heat energy moves inexorably from the hot interior to the cooler surface. In certain locations, heat energy can be accessed in extraordinary amounts. Volcanoes are surface expressions of this heat movement, since volcanism is caused by the activity of magma, or molten rock. Hot springs are other physical manifestations of that heat. Where sufficient geothermal fluid is in place and able to circulate, a geothermal reservoir of hot fluid – often extremely hot – forms and it can be tapped by drilling wells. The geothermal industry utilizes this hot fluid to generate electricity, heat buildings, crop drying, aquaculture, and provide industrial process heat. Currently less than one-half of one percent of the United States electrical power comes from geothermal sources. According to Geothermal Energy Association data, in 2007, geothermal was the fourth largest source of renewable energy in the U.S. Today the U.S. has about 3,000 MW of geothermal electricity connected to the grid. Geothermal energy generated 14,885 gigawatt-hours (GWh) of electricity in 2007, which accounted for 4% of renewable energy-based electricity consumption in the U.S. (including large hydropower). The U.S. continues to produce more geothermal electricity than any other country, comprising approximately 30 percent of the world total.

There are three general types of geothermal plants in common use. Typically, the plant technology is selected to provide a good functional match to the temperature of the underground geothermal resource:

1. Dry steam plants utilize steam from underground to directly turn a turbine and generator in what is – except for the absence of a boiler and its fuel –a conventional power generation cycle. The dry steam plant is the oldest kind of geothermal generation; the largest single geothermal development is the Geysers field in northern California producing about 725 megawatts of power. Steam-dominated reservoirs such as the Geysers resource are rare.

2. Another type of geothermal generation technology is the flash steam plant. In a flash plant, superheated fluid is drawn from wells. When the superhot fluid is depressurized, it flashes partly to steam. This steam can be used to turn turbines-generators.

3. The third type of geothermal generation is the binary cycle plant. The binary geothermal plant uses moderately hot fluid pumped from the earth. Unlike its dry steam and flash cousins, a binary plant uses the heat from the geothermal fluid to heat a secondary fluid such as pentane, which boils at room temperature. The pentane, contained in a closed loop, absorbs much of the heat from the geothermal fluid through a heat exchanger; the added heat causes the pentane to boil or flash into a vapor. The expanding vapor is used to turn the turbine piped into the closed loop of working fluid. In the binary cycle the pentane is then cooled back down to a liquid phase using an evaporative cooling tower with circulating cool water, or using air cooling with radiators similar to those beneath the hood of a car. The spent geothermal fluid is returned to the reservoir to be reheated by the earth.

In some areas, there may be high amounts of heat underground, but the rock does not have sufficient pathways (typically fractures) through which fluid can circulate and become heated – it is, in effect, a hot, dry rock. Because of the lack of opportunities for circulation, such rock formations, though hot and widely distributed, have frustrated efforts to recover the tantalizing heat energy reserves through conventional geothermal methods. Hence the recent surge in interest in the advancement of EGS technology.

An enhanced geothermal system (EGS) is one that takes into the account the local geology of "hot, dry rocks." If the local geology has heat and no fractures, then the fractures are engineered (manmade, using technologies adapted from the oil and gas industry), enhancing the fluid flow and allowing the heat to be retrieved through wells. Typically, fluid has to be injected into such EGS reservoirs. It will require significant research and engineering expenditures to realize the commercial potential of this approach, but it potentially could expand the geographic area of geothermal energy availability.

In another and more modest form of EGS, the permeability of an existing geothermal field is enhanced to increase the production of hot fluid. The basic concepts are the same for this as for hot-dry-rock EGS systems, but generally the engineering and construction costs for this more modest style of EGS are lower, and thus this form of EGS may well represent a more viable possibility for increasing power output of a geothermal field in the near term.

An EGS is a type of geothermal resource extraction approach and should not be confused with a type of geothermal generation. It is likely that if an EGS system was developed it would incorporate one of the types of surface generation facilities discussed above.

Geothermal energy rights are owned by private individuals, the federal government and in some cases the state. The rights are similar to mineral and water rights but in Idaho they have a special nature. If the hot water from the earth is greater than 212F then the fluid is characterized as geothermal energy and owned as a geothermal energy right. If the water is less than 212 F it is characterized as water and is own as a water right. If a person wants to seek geothermal energy rights on federal lands there is a nomination process that leads to a public auction of the parcels. The auction process results in the person who bids the most to pay a "bid premium" per acre for the right to the lands. The successful bidder then enters into a 10 year lease and agrees to pay a production royalty from any future energy produced from the parcel. The bid premiums in the past several BLM auctions has ranged from less than $100 per acre to more than $10,000 per acre depending on it location and proximity to existing geothermal reservoirs. Most leases have renewal rights so long as there is power production for the parcel then the lease can be renewed.

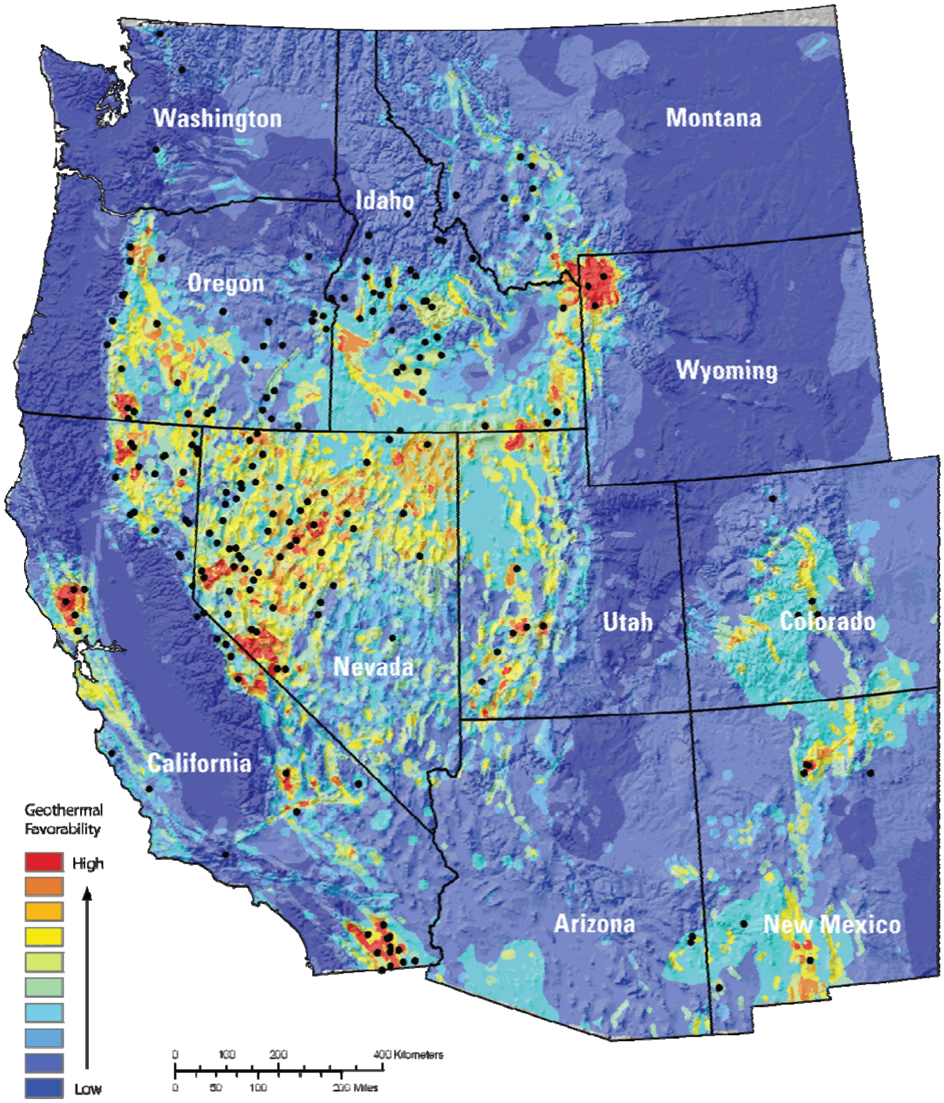

Figure 3. *Geologic potential for geothermal in western states shows Idaho's very high potential (Source U.S. Department of Energy)*

Advantages of Geothermal Energy for Idaho

The advantages of geothermal energy to Idaho are many. As noted in a number of studies, geothermal energy is one of the "greenest" sources of electricity, and there are also many economic and social advantages to its use:

- Geothermal power plants are long-term, secure power sources with minimal fuel supply risk, which can be managed by good engineering.

- Geothermal power plants provide baseload generation – power is generated 24 hours a day, 7 days a week.

- Geothermal plants produce few or no greenhouse gas emissions during operations, with some power plants able to scrub naturally occurring gases present in certain reservoirs. Binary geothermal power plants have essentially no emissions. Particulate emissions to the environment are virtually zero from geothermal plants.

- Geothermal plants involve modest use of land for power plant and piping system footprints. Geothermal plants have low visual impact.

- Geothermal power plants are distributed in smaller sizes over a wider geographic area so prove more transmission grid stability in the event one unit goes down.

- Geothermal generation operations have low overall environmental impact. A properly designed and built project will have minimal impact on wildlife or the landscape. Projects are usually designed to be sustainable with a geothermal fluid injection system that helps to stabilize and renew the reservoir.

- With geothermal plants, the day-to-day price of power production decreases with time as capital debt falls off the balance sheet. Geothermal projects acquire their lifetime "fuel supply" up front, and typically show low power production prices over their service life cycles.

- Geothermal plants add skilled, good paying, long term jobs to Idaho.

- Geothermal plants will advance the objective of energy independence and security of supply for Idaho.

- Geothermal plants increase the tax base for remote and rural-dominated counties that host them.

- Geothermal plants enhance local economies through the spending flywheel effect as employees spend and as plant supplies and miscellaneous commodities procurements are made locally.

- Newly enacted competitive BLM leasing rules provide state and local governments with proceeds from public auctions held for geothermal energy rights leasing.

These benefits are balanced by the fact that for successful geothermal energy development, very specific geologic and hydrologic environments have to be discovered and defined through geologic and geophysical investigations. To explore for, discover and drill a geothermal field requires substantial upfront financial expense and risk. The advances in binary cycle power generation technology are allowing more areas with lower temperature reservoir potential to be candidates for power generation.

Geothermal exploration and development is a specialized, risky, and expensive venture, contrasting sharply with the construction of conventional hydrocarbon-based technologies. A large coal-fired power plant and buying known coal reserves is a currently viable and known process, but it is not a "green" source of energy, and one which many Idahoans may not want built in their communities. Likewise, a natural gas-fired power plant and contracts for a predictable, but possibly expensive, supply of natural gas may be appealing today but natural gas, like coal and oil, contain uncertainties of future supply availability and carbon costs. From a geologist's perspective, Idaho's geothermal endowment is most likely greater than its supply of coal or natural gas, though those are abundant in neighboring states.

Figure 4. *Well Drilling and Flow Testing at Raft River 2007 (Source: U.S. Geothermal)*

Factors in Geothermal Project Economics

Growth in the U.S. geothermal energy industry is being driven by a number of factors including these:

- Widespread interest in development of "green" energy resources.
- Widespread interest in development of domestic energy resources.
- Widespread interest in development of renewable resources to displace U.S. dependence on supply-limited fossil resources.
- Commercial opportunities resulting from the adoption of renewable portfolio standards (RPSs) in many U.S. states.
- Commercial opportunities arising from the evolution of financial incentives and risk reduction strategies intended to level the playing field for domestic renewable power development.
- Technology advancements for exploration, drilling and energy conversion.

Despite recent vicissitudes in global productivity and growth, it is clear that over the long term, fossil fuel scarcity and global economic and population growth are contributing to a rapid increase in world energy costs. According to the International Energy Agency (IEA), from 2000 to 2005, the average global cost of fossil fuels used to generate electricity increased by 67%. This increase has highlighted the need to develop new sources of energy that are not only economical but also renewable.

Improved Technology

Several areas of geothermal development have advanced over the years, making geothermal power production economically feasible at lower temperatures and greater depths.

- *Drilling Technology* – A major source of capital cost for geothermal power development is well drilling. Innovations in well drill technologies have allowed developers to access resources more expeditiously and with a higher success rate. Moreover, drilling improvements are allowing deeper and more difficult resources to be economically accessible.
- *Turbine Efficiency* – Turbine improvements have been gradual but important. With higher turbine efficiency, more power may be generated per energy input.
- *Process Improvements* – The development of the binary cycle was a critical step for generating electrical power from more abundant, lower temperature resources. In the process, lower temperature geothermal fluid vaporizes a

fluid with a lower boiling point, allowing vapors from the secondary fluid to drive the turbine. Recent advances in binary technology have made this technology significantly more capable and versatile for low-temperature resource utilization.

Resource Assessment Criteria

To be successful at development the following physical characteristics need to be assessed to classify the requirements of a feasible project:

- *Well Temperature and Depth* – Typically, shallow geothermal resources are more desirable for development due to the increased cost of development associated with increased depth. Deep well drilling results in increased capital costs, which may render a project economically infeasible. Accordingly, shallow resources with high well temperatures signify excellent resource potential and economic viability.

- *Presence of a Sustainable Hydrothermal System* – A geothermal resource is commercially viable when the system supports continuous flow of geothermal fluid and/or steam as a medium to transfer the heat energy from the reservoir to the surface.

- *High Permeability* – Geothermal resources are most accessible when contained in rocks with high permeability, which facilitates the movement and subsequent heating of subsurface geothermal fluid within the resource necessary for sustainable power production.

- *Geographic Location* – Projects closer to transmission grids with available capacity are more desirable for development because it reduces capital costs and allows immediate access to the market to sell the power. Due to their renewable portfolio standards and other incentives, certain states offer better advantages for geothermal development than other states. Such states are more desirable to developers because power prices and incentives for renewable energy may be greater in those states.

- *Environmental Considerations* – Project locations in areas that do not contain fragile ecosystems or other environmental considerations are more desirable than other locations because of the cost of environmental mitigation and the long lead times required for permitting in those areas.

- *Additional Aspects of Development* include current congressional changes to the renewable energy market through legislation, such as favorable extensions of the production tax credits, adjustments to investment tax credit and adjustments to the capital cost recovery rate.

Federal and State Initiatives

Geothermal development in the U.S. is being driven by state initiatives requiring utilities to purchase some of their power from renewable resources, as well as federal and state tax credits and tax incentives that enhance the economics of renewable power projects.

- *Renewable Portfolio Standards (RPS).* A number of states have instituted renewable portfolio standards (RPS) that require utilities to purchase a minimum percentage of their power from renewable sources. For example, RPS statutes in Nevada, Montana, and Colorado require 20%, 15%, and 10% renewable energy, respectively, by 2015. California currently requires 20% renewable by 2010, but is considering an even higher goal of 33% renewable by 2020. Oregon recently passed a RPS requiring that utilities with at least 3% of Oregon's total retail electric sales must procure 5% of their energy from renewable resources by 2011, followed by 15% by 2015, 20% by 2020, and 25% by 2025. In addition to this, according to the Department of Energy's Office of Energy Efficiency and Renewable Energy, utilities in 34 states nationwide are providing their customers with the opportunity to purchase green, renewable power through premium pricing programs. Thus, other states with favorable geology and more advanced RPS programs are competing for the interest of geothermal development in the western states. In addition, there has been talk of federal renewable energy portfolio requirements.

- *Production Tax Credits (PTCs)*. The federal renewable energy production tax credit provides a 2.1 cent/kWh (inflation-adjusted) benefit for the first ten years of a renewable energy facility's operation. Such production-based incentives are useful not only because they reduce the price of electricity from renewable sources, but also because they encourage developers to generate electricity rather than just install equipment. At present, unless extended, the deadline for receiving PTCs for the operation of newly constructed facilities is December 31, 2013. Similar to the federal PTCs, certain states provide a tax credit (usually around 1 cent/kWh) for electricity generated from renewable resources.

- *Investment Tax Credits(ITC) / Corporate Tax Incentives*. State investment tax credits can help encourage investment in renewable technologies that are typically more expensive or higher risk than conventional technologies. The U.S. federal government offers a 10% 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. Fifteen states offer this incentive. It should be noted, however, that ITCs cannot be used in combination with PTCs.

As noted earlier, operating costs for geothermal power plants are in the low range, compared to other types of renewable energy technology. Figure 5 compares some of these costs. The upfront capital requirements and high risk of a geothermal exploration and development are far more significant than the actual operating costs once a plant is built.

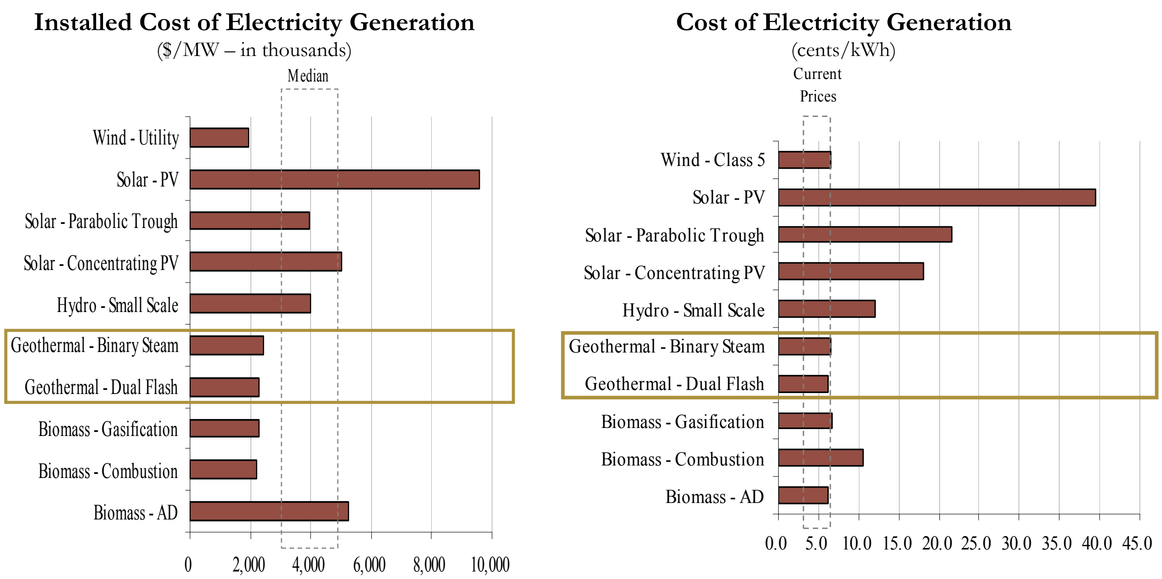

Figure 5a.   *Comparison of Costs of Renewable Energy. (Source California Energy Commission December 2007)*

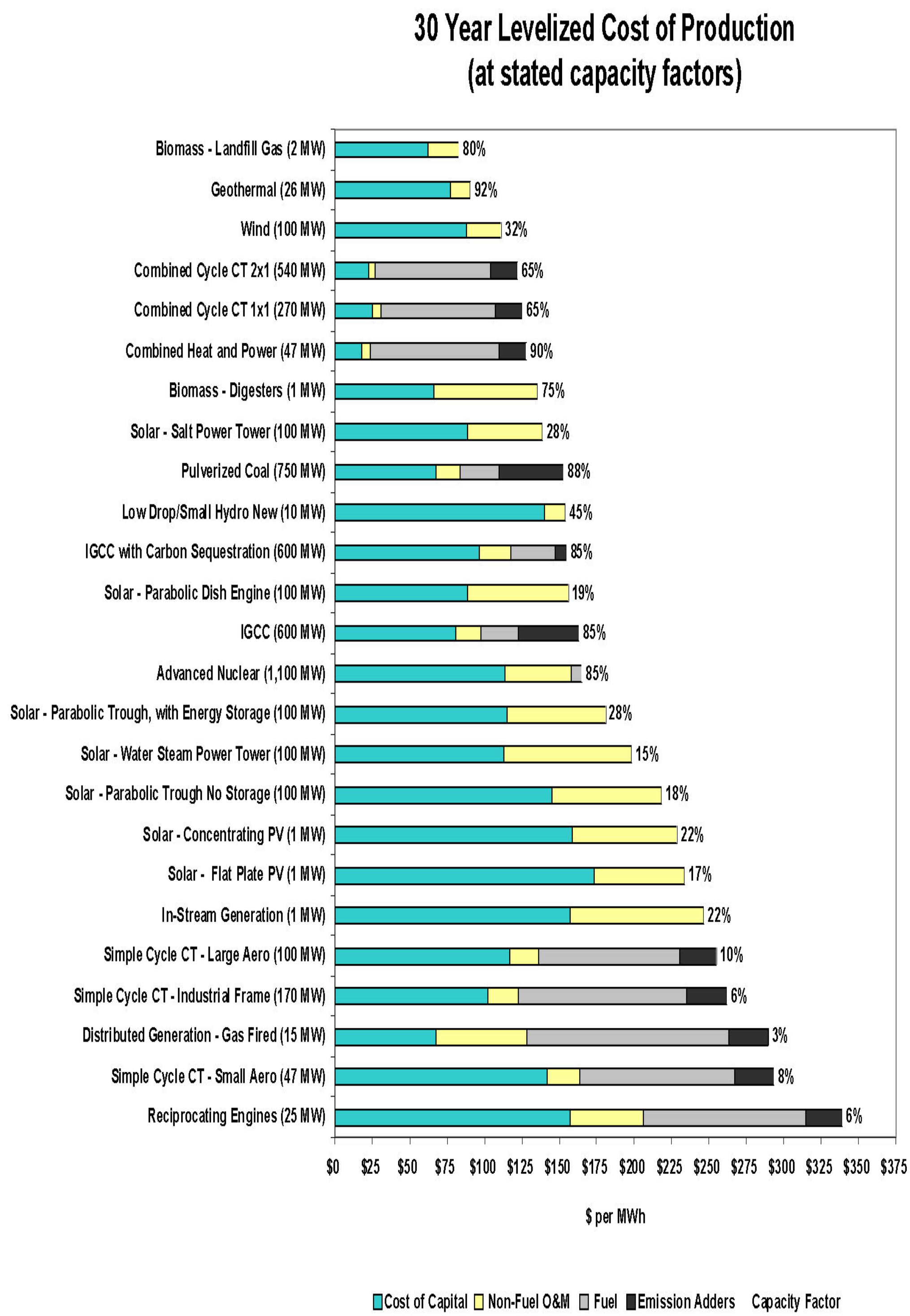

Figure 5b. *Comparison of Costs of Energy Production (Source Idaho Power Company 2009 Integrated Resource Plan December 17, 2008 Presentation).*

A Discussion of the Development of Idaho's Geothermal Resource Potential *(by Daniel Kunz)*

A high temperature steam geothermal resource that would be commercially viable for power generation has not yet been discovered in Idaho. To date, the geothermal resource potential exists in the low to medium temperature range utilizing binary cycle power plants. Binary cycle power plants in Idaho will cost between $4.5 million and $5.5 million per MWhr of capacity to develop and build. Between 25 to 40% of that cost goes into drilling and reservoir development. Transmission costs included in the following discussion are limited to a reasonable transmission line cost, and projects more that 10 to 15 miles from a interconnect point are excluded. Idaho has potentially three or more types of reservoir development that will occur. Most of the exploitable temperatures of two of the three types are expected to be between 265^{o}F and 325^{o}F. Three reservoir systems are discussed.

In Idaho, geothermal projects will be developed after successful exploration within volcanic rock sequences hosting geothermal prospects that contain large aperture fractures (>1-foot wide geofluid filled void space) in normal fault zones at relatively shallow depth (1500' to 2500'). These resources each could result in 15 to 20 MW of power production potential. Costs to develop these resources would be at the low end of the range, or $4.5 million per megawatt of capacity. If there are 10 of these sites discovered in Idaho then the power potential is 150 to 200 MW from the shallower resources and would cost between $675 and $900 million to develop.

The next types of geothermal resources that can be developed are ones geologically similar to Raft River. There the reservoir is deep at about 6,000 feet and hosted in fractures and permeable zones contained within layers of sedimentary and metasedimentary rocks. These resources can potentially produce more than 50 MW per development but will be fewer in total number. Perhaps 4 sites will produce 200 MW within the Raft River area. Assuming that two additional such sites are found within Idaho (three sites in total), the potential of this resource type could be 600 MW. Costs to develop these resources would be at the high end of the range, or $5.5 million per MWhr of capacity with $3.3 billion required to develop 600 MW.

The third type of geothermal resource potential hosted in Idaho is much more important to the future. Idaho has significant potential to host Engineered Geothermal Systems (EGS) particularly in the eastern part of the State. EGS requires that hot rock in the earth is found relatively close to the surface and is used to boil water in an underground chamber into steam that can be used to make electricity. Idaho should expect that one or more EGS power projects can be build in the state. These will likely be 500 MW stations ultimately and will have the potential to scale. It is difficult to put a current cost on these projects because development timing requires major government support up front to help develop a prototype project. It is probable that the costs of development will decline to be competitive with other major power sources once the first major plant is operating. Using $8 million per MWhr of capacity as a placeholder value, a 500MW plant would cost $4 billion to build.

How long will this all take? Exploration activities will start once the economic incentives are in place. Results then may take two to four years of exploration activities prior to development. It is imperative that Idaho establish an incentive now to reduce development time. More power plants can be developed at Raft River in the near term. With an aggressive drilling program at Raft River, there could be 50MW developed within 5 years. Another 25 MW can be considered during those same 5 years coming from the shallow fracture types. Then 50 to 100 MW could come online in the next 5 years and then 200MW or more in the following 5 years. Within 15 years it is possible that Idaho would host a 200 MW EGS site.

Status of Geothermal Development in Idaho

Direct Heating

Idahoans have long used geothermal energy for direct heating purposes, decreasing their use of other types of energy for heating such as electrical and natural gas consumption . Direct heating is still a key use for Idaho's geothermal resources and should be encouraged and expanded. Today we have greenhouses, fish farms and other facilities in or near Idaho that utilize the earth's hot water for energy. The Boise Geothermal Heating District is a valuable source of operational know-how and experience. Idaho should work to promote and expand local development of geothermal resources in Idaho for direct use and to export our expertise to create value for Idahoans.

Electrical Generation

Idaho's geothermal riches have only recently been utilized for electrical production. Elsewhere in the world, in locations determined by specific geologic factors, geothermal power plants have long supplied electricity. In fact, only in areas of favorable geology, usually manifested by active or recent volcanic systems and hot springs, is sufficient heat flow available to make geothermal energy into electricity using customary technology. Idaho is one of those places. The 2006 Western Governor's Association geothermal Task Force set Idaho at having 855 MW of near term power generation potential and ranked Idaho as the 3rd best state for geothermal potential.

Currently Idaho has only one geothermal power plant: Raft River Unit 1 (Figure 6). This plant is designed to provide 13 MW of electrical generating capacity and has been in commercial operation since January 2008. The Raft River project is slated to add two more 13 MW power plant modules in the coming years and may one day produce up to 100 MW or more from the site. Exploration activity in the Raft River valley and other geothermal areas across Idaho is expected to increase in the years ahead as multiple developers start to invest in drilling and development.

Idaho has a number of other sites that can achieve development. The most advanced site appears to be in the Crane Creek area near Weiser. Roystone Hot Springs near Sweet has an existing well and Magic Reservoir near Hailey has temperatures and other conditions that make them candidates for development of electricity generation. Big Creek, China Cap, Rexburg and Willow Springs were also named as

Figure 6. *U.S. Geothermal's Raft River Power Plant, 2008*

Currently Active - Idaho Geothermal Power Developers

The Raft River geothermal power plant was originally developed under a 10 MW PURPA contract between Idaho Power Company and US Geothermal Inc. The contract was priced at a rate that reflected the advanced nature of the Raft River site with existing production wells and a proven reservoir. The power prices allowed US Geothermal to make a significant investment in development and attract a tax-equity partner to monetize the federal tax benefits available to renewable energy projects. US Geothermal intended to develop three separate 10 MW power plants at Raft River using the PURPA contract format and pricing. Subsequently, Idaho Power released an RFP for geothermal power under its Integrated Resource Plan (IRP) process. US Geothermal bid its projects into the RFP, including two of the Raft River units and its Neal Hot Springs project in Oregon. This process resulted in Idaho Power and US Geothermal agreeing to convert one of the 10 MW PURPA contracts into a negotiated Power Purchase Agreement (PPA) outside of the requirements of the PURPA rules.

Another company, Agua Caliente LLC, is seeking to conduct early stage exploration activities in Idaho in at least two locations: Raft River and Crane Creek. The Northern Band of the Shoshone Nation also holds geothermal lease interests in Idaho identified and formerly owned by Idatherm.

National Geothermal Development Forecasts

Global geothermal expansion has occurred steadily, driven by capital attracted to projects with strong economic fundamentals. The United States continues to be the world leader in online capacity of geothermal energy and the generation of electric power from geothermal energy.

According to U.S. government energy data, in 2005, geothermal energy provided approximately 16 billion kilowatt hours (kWh) – 0.37% of the electricity consumed in the U.S. The Geothermal Energy Association ("GEA") notes that as of August, 2008, geothermal electric power was generated in seven U.S. states: Alaska, California, Hawaii, Idaho, Nevada, Utah, and New Mexico with combined capacity rated at 2957.94 MW. The U.S. Geological Survey shows the potential of Identified Geothermal Systems as ranging from 3,675 MWe (95% probability) to 16,457 MWe (5% probability).

However, estimated US geothermal potential is much higher as indicated below. Incentives or policies implemented to develop geothermal energy could result in significantly higher capacity than that currently estimated.

NREL Estimated US Geothermal Potential

Shallow – Identified…….……….….…….30,000 MW
Shallow – Unidentified………….…..…..120,000 MW
Co-production & Geo-pressure….……>100,000 MW
Enhanced Geothermal Systems….….13,000,000 MW

Source: National Renewable Energy Laboratory

Barriers to Geothermal Development in Idaho

Geothermal development faces a number of significant upfront barriers to successful development.

Initial identification of a potential geothermal resource is usually based on a combination of public data and proprietary data acquired or generated by the company, individual or entity doing the exploration. Once mineral and/or property rights are acquired, geologic, geophysical and hydrologic assessment continues until the prospect is ready to enter the development stage. This early work may include core drilling and other relatively expensive activities. These data are usually proprietary, and are important components for attracting investment capital. The geologic model developed by these activities is used to postulate the size and location of the geothermal reservoir, and is the basis for designing the development drilling phase. The geologic model also helps the drilling phase by allowing investigators to hypothesize the physical conditions within the reservoir and how a drilling program may best confirm properties of and access into the reservoir.

The intellectual property stage of geothermal development leads to the discovery and development stage which can only be accomplished by drilling. Drilling of geothermal production and injection wells is generally more expensive on a per-foot basis than oil and gas drilling because the necessary well diameter is so much larger in order to get the required geothermal fluid flow rate to the surface and back again. The drilling is also more costly because specialized blowout prevention equipment, drilling mud chilling, and special engineering and tools for directional drilling are often involved. A single production well can easily cost between $2.5 and $5.0 million, and between 20 and 100 lower-cost exploration drill holes are often required before a resource discovery is confirmed.

The direct economic incentives need to be specifically tailored for the unique nature of geothermal development. The State of Idaho provides a sales tax rebate to renewable energy projects larger than 25 kW that is available after the costs are incurred; this does help. For example, the $54 million Raft River geothermal project recently was rebated about $0.9 million of Idaho sales tax incurred by the construction of the project in 2006 and 2007. This represented 1.7 % of the total capital expended and is very helpful, but the project still requires significant prior funding for exploration and development costs. The sales tax rebate alone is not enough to attract the long-term capital associated with higher risk geothermal resource exploration. There is a substantial gap between the investment date and the date when the investor can earn the state sales tax rebate.

The risky and expensive drilling stage of geothermal development needs the greatest economic incentive by the federal and state governments to stimulate this industry. Consequently, Recommendation Area 1 in the next section of this report includes several specific suggestions to address financing incentives.

Specific Barriers to Idaho Geothermal Development

Project Economics:

- Lack of drilling incentives
- Regulatory patchwork
- High-risk resource discovery
- Long lead times
- Capital-intensive

Transmission Facilities:

- Grid capacity
- Permitting and patchwork of public and private lands
- Access to existing (and future) grid
- Long lead time

Regulatory and Government:

- Permitting on state and federal lands
- Disclosure via nomination for federal lands

Education and Information:

- Need improved Idaho database for geothermal-related information
- Knowledge and training for state agency personnel and regulators
- Enhanced education and opportunities for students in geothermal-related fields in universities
- Better acceptance and outreach to general public on geothermal and renewable energy

Options to Enhance Geothermal Development in Idaho

The Geothermal Task Force identified the following options that if implemented collectively would allow substantial development to move forward rapidly. The Federal stimulus bill may help address the next few years of geothermal development, but we believe Idaho needs to address these options at the state level to help secure the long term future of geothermal development here.

Recommendation Area 1 – State-based Financial and Economic Incentives and Regulatory Changes

Economic Incentives: To help move geothermal development from its great potential in Idaho to actual and tangible power generating facilities requires specific incentives for the geothermal industry. While it was recognized and recommended that federal subsidies or incentives were highly desirable, the state has little influence there. The task force concentrated on issues under state control and designed its recommendations accordingly. The task force's key recommended power generation incentives are summarized as follows:

- **Recommendation 1** – Establish a "feed-in tariff" power price for geothermal development that addresses the long lead time and high upfront capital costs for projects in Idaho. For example, the tariff should have an eligibility period of 10 years and the accompanying power purchase agreement (PPA) should have a term of 20 years. The contracted power price should also provide some inflationary protection (for example, a 1 to 2% annual escalator). The terms and conditions related to performance bonds and plant output requirements would recognize the specific thermodynamic characteristics of each development site. A committee, including representatives from the PUC, developers, customers, the utility, and an independent technical consultant selected by all participants would develop the economic model to terms, conditions and price. Some countries in Europe have used this concept which allows a utility to charge higher rates initially to recoup capital expense.

  Some people suggest that a feed-in tariff shifts the risk and upfront cost of development to the ratepayers but that is not the case. A feed-in tariff provides a long term economic incentive to developers to take the investment risks of exploration drilling. If their drilling is not successful the Idaho ratepayer bears no expense whatsoever. If their exploration drilling successfully discovers a commercial reservoir and the economics are positive then the ratepayer will only pay for power produced by the project and benefit from the project coming on line. A typical feed-in tariff will be much higher than the current power rates because the rate needs to cover the costs and ensure a commensurate profit for the exploration and development risks undertaken. For example in Germany the rate for geothermal power is 180 euros per megawatt hour. The rate is paid to any project over the next 10 years that comes online and begins delivering the power to the grid. The developer has already experienced the risks and costs of development. The rate is paid for renewable power delivered to the grid for projects coming on line over a limited period of time. The rate is part of a predetermined PPA and allows the developer to have a reliable set of terms and conditions to increase the bankability of the project.

Idaho does not have a renewable portfolio standard quota system like other states. It is likely that a national quota scheme will be instituted in the coming years requiring Idaho to meet certain quota criteria for renewable energy. The main problem with a quota system is the lack of any real certainty for geothermal power development over the long term. As quotas are met, geothermal developers face the prospect of becoming an uneconomic source of power as natural gas, coal and other power sources are used to fill in the power shortages. These shorter term power pricing changes that favor non renewable power sources can cause geothermal development business in Idaho to collapse. There is reluctance by investors to take the capital investment risks that require long term investing. Thus short term speculators may get involved and work against the stable development of geothermal. A feed-in tariff ("FiT") offers developers and Idaho the most effective method to assure the development of this kind of renewable power. Feed-in tariffs have a consistent history of providing all willing investors and developers the opportunity to produce and sell renewable energy thereby stimulating rapid development of this power source. Next to the direct investment subsidiaries they provide, European governments use feed-in tariffs as the most widely available means of creating renewable energy growth (13).

In the effort to combat climate change, the increased deployment of renewable energy sources is regarded by many as critical. One major obstacle to this adoption is the retail price of electricity generated from renewable sources, which is typically more expensive than the retail price of electricity generated from installed generation fossil fuel sources. A FiT is a revenue-neutral way of making the installation of renewable energy more appealing. The electricity that is generated is bought by the utility at above market prices. For example, if the retail price of electricity is 10¢/kWh then the rate for green power might be 40¢/kWh. The difference is spread over all of the customers of the utility. For example, if $100,000 worth of green power is bought in a year by a utility that has 1,000,000 customers, then each of those customers will have 10¢ added on to their bill annually.

Thus, a small annual increase in the price of electricity per customer can result in a large incentive for people to install renewable energy systems. This is the essence of a FiT: it is a mechanism to instigate a change in the way power is produced, gradually shifting from present polluting means to non-greenhouse methods. It is normally phased out once the change has occurred. In California it covers the first 500 MW of generation only. In Germany the FiT for roof top solar photovoltaics is reduced by 8% in 2009 and 2010 and then by 9% annually from 2011 onwards, instead of by 5% per year.

The main benefits of adopting a feed-in tariff for Idaho will be to help address global climate change, develop more local and domestic sources of energy, advance the development of geothermal-related technologies to become a leader in the sector, provide local jobs and a stronger tax base, and reduce our dependence on fossil fuels. A major drawback to the adoption of the FiT is the fact that the retail price of electricity generated from geothermal sources is initially more expensive than the prevailing retail price of electricity generated from installed facilities which today generally carry no cost component for carbon emissions. A FiT is a revenue neutral way of attracting investment in geothermal by spreading the higher costs of geothermal power sources over a wider base of customers. So a small increase in the overall price of electricity paid by Idahoans can result in a large incentive for developers to explore, engineer, finance and develop geothermal energy.

Terms of the Proposed Feed-in Tariff

The Idaho Feed-In tariff in cents per kWh for geothermal energy

- 15 ct/kWh for the first 12 years of project's production life then reduced to 8.5 ct/kWh thereafter for next 13 years of contract
- Tariff rates escalate by 1.5% each year from base date 2009
- Any geothermal power generation project qualifies
- Feed-in tariff guaranteed for 25 years – 25 year Power Purchase Agreement
- Tariff eligibility period open 10 years – to qualify for tariff project must come online within 10 years
- Tariff covers first 250 MW of geothermal generation only
- Terms of PPA based on current Raft River agreement

This kind of FiT structure would provide developers incentive to explore for and develop power geothermal generation in Idaho. It will help the state find out just how much geothermal energy will be developed and the resulting impacts on the state economy.

- **Recommendation 2** – Allow Idaho's regulated utilities to immediately add "qualified" geothermal development costs to their rate bases. These qualified upfront costs incurred in geothermal development are higher-risk investments for reservoir resource discovery and development. The upfront costs of geothermal exploration and development have long lead times between the incurrence of the cost and the return on the investment. Currently the regulated utilities are not able to invest in early stage geothermal energy development and be assured of any rate based cost recovery. Compromises, such as risk-sharing between utility and ratepayer, might be a solution. State-backed bonds repaid by proceeds of later development are another potential financial vehicle that could be examined. A study of what other countries or states are doing could generate additional financing alternatives.

- **Recommendation 3** – Raise the MW limit on Idaho's PURPA contracts for baseload renewable energy to something more in step with typical scales for economically viable projects, perhaps 25-30 MW.

- **Recommendation 4** – Along with similar recommendations, listed below, invest in scientific information and technologies to reduce exploration and development risk and promote education on needs for alternative energy sources and financing.

Recommendation Area 2 – Transmission

Transmission: The lack of feeder lines and near capacity main lines in electrical transmission are major barriers to most renewable energy projects, including geothermal. Idaho should focus on creating a fast-track method to promote more inclusive planning by utilities and developers for transmission improvements within our state and to support federal level improvements outside our state. The key recommended transmission incentives are summarized as follows:

- **Recommendation 1** – To help connect more remote projects to the grid, geothermal (and perhaps other renewable energy) developers should be reimbursed for their transmission-related capital costs on a priority basis over a five year time period. Whether or how rate-payers (in-state and out-state) fund this was not discussed. Because geothermal projects already have a higher front end cost for development, the added burden of transmission-related costs can be difficult for the project to bear. A special accelerated recovery of the transmission –related costs would provide developers an added incentive to make the initial investments necessary to connect renewable projects to the grid.

- **Recommendation 2** – Create state renewable energy zones and economic incentives to spur utility investment in transmission to upgrade, extend and add new lines. Models exist in nearby states, such as Utah and Oregon, and should be investigated. Special zones can provide tax incentives necessary to help attract investment in geothermal development.

Recommendation Area 3 – Public Education, Technical Assistance, and Training

Public Education: The State should develop and implement an aggressive public education campaign regarding energy, renewable energy and the benefits of geothermal energy. Funding should be allocated to education and improving the technical database. The energy industry is facing a shortage of domestic and Idaho students interested in technical fields relevant to geothermal and other energy operations.

- **Recommendation 1** – Form an Inter-Agency Task Force. Led by the Idaho Department of Water Resources, each of the several state and local agencies that participate in the regulation and management of Idaho's geothermal and related natural resources should be funded to form a task force for improving efficiency of the permitting and regulatory process. This would only be effective if the task force members have directors/legislative/executive support for significant change in agency responsibilities and procedures. It could assist with federal issues through some type of joint review process as was done in minerals permitting some years ago.

- **Recommendation 2** – Geothermal Resource Data Gathering. A comprehensive program is needed to acquire and make available to the public all relevant geothermal data. The database developed by this process will help with exploration, regulation, education, and will also help identify key data gaps. A team would compile an update of the geologic, geophysical, hydrologic and technical data related to Idaho's geothermal resources. All of these data should be publicly accessible and include, to the extent possible, private company data, particularly those obtained with public funding. The Idaho Geological Survey (IGS), Idaho Department of Water Resources (IDWR), and Idaho universities would need to be involved with this effort and it should be collaborative with similar efforts by the Association of American State Geologists, U.S. Geological Survey, the Intermountain West Geothermal Consortium and others. Federal funding can jumpstart some of this, but the State needs its own in-house experts and budget to adequately direct, update, and maintain data beyond a three-year, single-site federal project. Management details and funding would need further discussion and authorization by the legislature/executive.

- **Recommendation 3 -** Geothermal Resource Data Acquisition. The state most likely lead by IDWR and IGS and the Universities, with support of OER, should find ways to fund acquisition of additional technical data for Idaho's geothermal hot springs such as testing to determine geo-thermometer data. At sites where it is warranted, such as known geothermal resource areas and locations with high potential, the state could acquire key data by funding lower cost geological and geophysical studies, such as mapping and magnetic and gravity surveys. Again, federal grants may provide some data but these are often very narrow in focus, highly competitive, and rarely allow statewide assessments. Such programs would provide basic scientific data to the public that is site specific to Idaho's geothermal resources. Creative sources of state funding could be something like having the State of Idaho establish a $10 million Fund to be utilized for the initial investigation of geothermal prospects that have high resource potential, as determined by the Idaho Strategic Energy Alliance or another appropriate select committee of experts. The expended funds would then be reimbursed to the Fund by the developer under an "Over Riding Royalty" or at a later date "Project Financing" scenario. Other countries or states would have models for government-industry partnerships, carbon taxes or renewable portfolios, and other ways to encourage renewable energy exploration. Idaho needs to decide how serious it is about planning for the future.

- **Recommendation 4** – Train Geothermal Professionals. The shortage of engineers and scientists needed by industry to explore, develop, and produce geothermal resources is a key concern nationally and locally. We need to develop programs in our universities to supply the next generation of geothermal professionals. Idaho universities should be encouraged and supported to train students in specific, interdisciplinary courses covering the broad-based skills and knowledge needed in the geothermal industry. Relevant disciplines include engineering, geosciences (including geophysics), hydrology, exploration, energy conservation, business, etc., that could be combined in a "geothermal energy specialist" certification, perhaps in a geosciences department or an energy engineering program. Using a "home-grown" industry for their laboratory, such a program could both help these graduates find employment and become part of Idaho's energy future.

Funding Mechanisms

The following model may be a potential way to fund geothermal research and education within Idaho. The following paragraph is from the website of the California Energy Commission (http://www.energy.ca.gov/geothermal/index.html):

The California Energy Commission's Geothermal Program was created by Assembly Bill 1905 (Bosco) and has been in operation since 1981. During the first decade, it promoted California geothermal energy development by extending financial and technical assistance to public entities to support direct uses, planning, and mitigation projects. In 1992, the program was expanded to include financial assistance to private entities for research, development and commercialization projects. The funding source is revenue paid to the United States government by geothermal developers from production on federal leases in California. Typically, there are funds available each fiscal year in the Program's Geothermal Resources Development Account for awards to qualifying applicants, and are provided as grants or loans.

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Appendices

APPENDIX A

Idaho's Development Opportunities

Geothermal development requires long lead times, even for development of existing known resources. To accelerate development of geothermal resources for electricity development for the next 10 years, Idaho needs to encourage development of its existing resources. Thermal springs and geothermal resources located in Blaine, Owyhee, Lemhi, Valley, Bannock and Camas counties may provide near term power generation development opportunities for Idaho. Exploration for steam resources in the counties that make up the eastern Snake River plain and most of eastern Idaho could yield significant energy supplies.

To the extent that existing reservoirs and resource areas have been analyzed and can support power generation, then the development of production wells and reservoir capacity is the single largest challenge in development. To develop support for drilling in Idaho, additional geological and geothermal exploration information could be acquired with the help of state or federal incentives. The most recent assessment of geothermal development potential is included in a 2007 Idaho Department of Water Resources report titled Geothermal Power Generation in Idaho. An Overview of Current Developments and Future Potential. Following is a summary and excerpts from some of the various reports available regarding geothermal development in Idaho.

An Assessment of Geothermal Resource Development Needs in the Western United States (Geothermal Energy Association)

In Idaho, most of the promising areas identified as having near-term electric power production potential are located in the Basin and Range Province and the Snake River Plain. The Snake River Plain is a crescent-shaped rift zone characterized by young volcanism and containing geothermal and cold-water aquifer resources that extends across south-central Idaho.

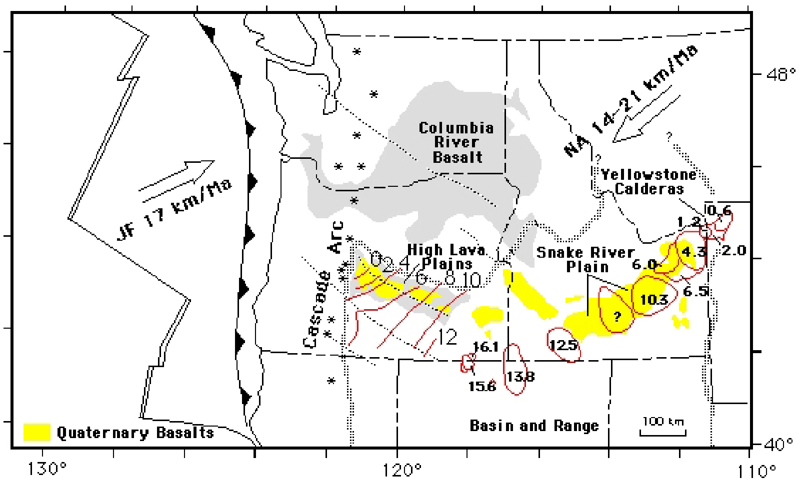

Figure 7 - *Geologic interpretation of "hot spot" and volcano tectonics (Source- USGS)*

The Basin and Range Province extends into southern Idaho south of the Snake River with its largest section in the southeast and south-central part of the state. Both the Snake River Plain and the Basin and Range Province reflect a geologic setting with abundant faults, fractures, and inherent high crustal heat flows – features that are important for the generation of geothermal systems.

There is also geothermal electric power potential in the Idaho Batholith region, a large mountainous area covering approximately 15,400 square miles stretching from the Boise National Forest to the Bitterroot Mountains. Thermal springs are common in this region, where researchers assert that anomalous heat results partly from "the decay of radioactive elements contained in many of the minerals which commonly occur in the granitic rocks…" and "are also the result of deep circulation of ground water in fault zones"[1]

According to the WGA Geothermal Taskforce Report, it is estimated that there are 855 MW of near-term geothermal power potential in Idaho[2] – enough baseload energy to provide nearly 30% of Idaho's current energy needs if sold entirely in-state[3]. However, in the report, there are 305 MW of new electric capacity possible at identified locations and 550 MW at "other Idaho sites". This differs from the analysis of other states in the report because so much of the supposed economical resource in Idaho was not specifically identified. According to researchers, the primary reason for this is that many of Idaho's presumed sites are near hot springs where high heat flow has been recorded at the surface, but little to no subsurface exploration has been performed. However, heat energy at these hot springs areas and shallow emanations of hot groundwater may be able to be captured using the type of low-resource-temperature plant installed at Chena Hot Springs in Alaska. These units (or a similar type of technology) may be applicable at a multitude of Idaho's shallow geothermal aquifers and hot springs.

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[1] Source – DeTar, Robert E. "Thermal Waters". Idaho State University: http://imnh.isue.edu/digitalatlas/hydr/thermal/thermal.htm

[2] See Western Governors Association Geothermal Task Force Report (January 2006): http://www.westgov.org/wga/initiatives/cdeac/Geothermal-full.pdg (page 65)

[3] Source – Energy Information Agency: http://www.eia.doe.gov/cneaf/electricty/epa/fig7p2.html
Take 90% availability for a geothermal power plant and the number is over 30.9 percent based on 2005 numbers for retail sales in Idaho.

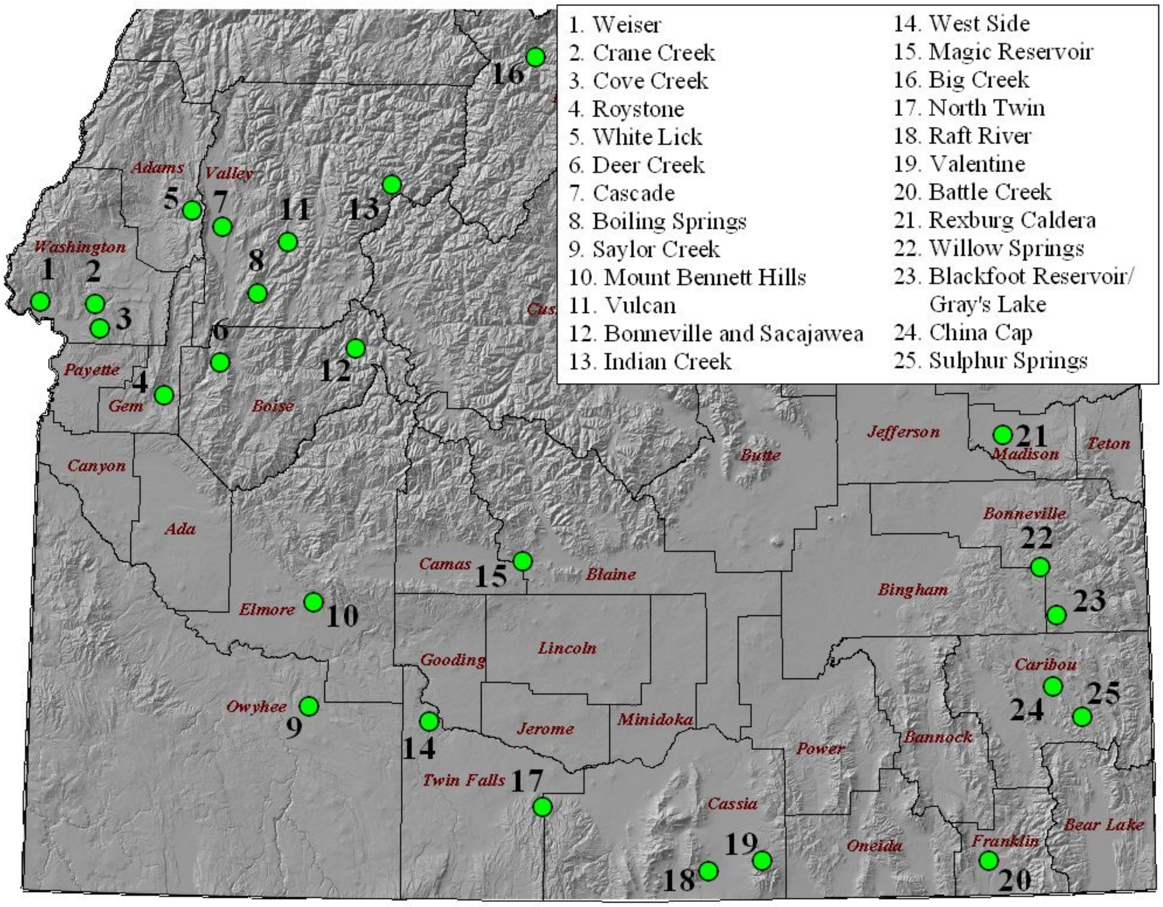

Figure 8. *Geothermal Potential of Idaho (Source: Idaho Department of Water Resources)*

Five Well-Known Potential Sites for Geothermal Power Generation in Idaho

The following section describes some of the better known and more prospective geothermal properties known in Idaho, based on a 2006 report from the Geothermal Energy Association (written for and partially funded by the U.S. Department of Energy), and on information compiled by the Idaho Department of Water Resources (St. Marie, Mink, and Neely, 2002, IDWR report "*Examination and Evaluation of Geothermal Sites in the State of Idaho with Emphasis Given to Potential for Electrical Generation or Direct Use*" available at: **http://energy.idaho.gov/informationresources/renewableenergy.shtml**).

Previous studies on Idaho geothermal generation possibilities have centered on a small number of sites in the state which have the potential for electrical generation. These sites are considered to have potential based on their surface temperature, as well as estimates of the temperature of the reservoir using geochemical analyses. Sites examined for this study included the following:

- The Crane Creek Hot Springs area east of Weiser in Washington County
- The Raft River area southeast of Burley in Cassia County
- The Big Creek Hot Springs area west of Salmon in Lemhi County
- The Vulcan Hot Springs Known Geothermal Resource Area (KGRA) east of Cascade in Valley County
- The Magic Reservoir area in Camas and Blaine Counties

1. Crane Creek Hot Springs area (Washington County)

Overview

The Crane Creek Hot Springs area of Washington County is located 12 miles east of the city of Weiser in a predominantly agricultural area (Figure 1). The area was formerly designated as a KGRA with an approximate size of seven square miles. The springs' surface temperature has been reported at various times ranging from 74° to 77° C. Measurements at the Crane Creek Hot Springs in 2002 yielded a surface temperature of 81° C and an approximate discharge of 30 gallons per minute (gpm). McClain (1979) reported the discharge to be approximately 50 gpm, and that both the silica and Na-K-Ca geochemical thermometers suggest the reservoir temperature is 166° to 176° C. There are at least two other lower-temperature hot springs in the immediate vicinity. A watering hole for cattle has been excavated over at least one spring to the west of Crane Creek Hot Springs, and another spring is being used on an adjacent property to the southwest of Crane Creek Hot Springs.

The rocks underlying the Crane Creek area are faulted and gently folded by a north-south trending fault zone (Dansart et al., 1994). In general, the geology consists of tilted blocks of older metavolcanic and metasedimentary rocks with infillings of Miocene basalt and interbedded arkosic sandstone. The aquifer supplying Crane Creek Hot Springs is likely fracture-dominated, and a combination of these different rock formations. Bloomquist et al. (1985 vol.2) calculated the aquifer volume to be 9.3 cubic miles (mi^3). A previous geophysical (audio-magnetotelluric) study by the USGS (Hoover et al., 1976) indicated the presence of a shallow conductive zone under Crane Creek Hot Springs (Young and Whitehead, 1975). This may indicate that there is either a substantial reservoir of geothermal fluid containing significant dissolved ions underlying the area, or that there is a large deposit of conductive minerals, probably deposited by the geothermal system. Either of these scenarios is possible, but Young and Whitehead (1975) describe the geochemistry of the thermal spring waters at Crane Creek as being Na-Cl-SO42- with pH values of 7.1 to 8.0. It is unlikely that these waters would be responsible for large-scale metallic deposits, and so it is more likely that the conductivity anomaly below Crane Creek is due to the ionic nature of the reservoir. This study also indicated the presence of a structural “break” that trends roughly north-south, which is interpreted as a fault and is likely the conduit for the geothermal fluids.

McClain (1979) estimated the power potential to be 100 MW and Bloomquist et al. (1985, vol. 2) suggested 179 MW as the field’s potential. If these estimates are accurate, the development could require between 100 and 200 acres for the plant site; it is unknown if this much land is available for development. Additional geologic work will be required to determine the actual field potential.

Mitchell et al. (1984) et al. (1984) performed a δD/δ18O isotopic study that indicated the water in the springs may be of Pleistocene age. This could indicate a regional or intermediate groundwater recharge system and possibly slow recharge compared to the area’s non-thermal springs. If this is the case, the suitability of the reservoir may be brought into question.

Site Development:
The Crane Creek area is one of the best choices for a new geothermal power development project in Idaho. The location is convenient to major highways (I-84 and US-95) and to a well-developed power transmission system because of the proximity to the Idaho Power hydroelectric dams on the Snake River. The area is close to the Idaho Power electrical transmission lines coming out of the Hells Canyon dam complex. This is a series of 230kV lines emanating from the dam sites in Hells Canyon. These lines cross the region approximately seven miles to the west-northwest while running southeast from Brownlee Dam to the Boise metropolitan area. The closest transmission substation on this series of lines is at Midvale, 11 linear miles to the north-northwest of the Crane Creek Hot Springs. The closes transmission substation to the area is in Weiser, approximately 10 linear miles to the west-southwest. However, the operating voltage of the power lines at the Weiser substation is only 69kV and may not be sufficient for the electric power generated at Crane Creek.

Interwest Development owns 226 acres around Crane Creek Hot Springs, including water rights on Crane Creek. This area abuts BLM land which has no current geothermal leases or claims. Interwest is currently allowing the land to be used for grazing and hopes to use the land as a game bird hunting reserve. Interwest apparently has all of the access required for development, as well as the ability to purchase the adjoining private land. Interwest is strongly favorable to development of this site for electrical generation as well as some kind of cogeneration facility (e.g., ethanol production or food processing) (Leon Blaser, personal communication).

2. Raft River (Cassia County)

Site of US Geothermal Power plant. http://www.usgeothermal.com/index.aspx

3. Big Creek Hot Springs (Lemhi County)

Overview

Big Creek Hot Springs are located on United States Forest Service land in Lemhi County, approximately 24 miles west-northwest of Salmon, near the Frank Church River of No Return Wilderness. Access to the area is unimproved and primitive roads.

Big Creek Hot Springs is one of the hottest geothermal systems in Idaho, with a surface temperature of approximately 93° C, (the boiling point of water at the springs' elevation) and a discharge from 15 vents of approximately 75 gpm (McClain, 1979). Geochemical thermometers indicate that the underground reservoir temperatures are in the 137° to 179° C range (Dansart et al., 1994). Bloomquist et al. (1985 vol. 2) gave an aquifer volume value of 0.8 mi^3, based on the estimated area and thickness values used in that study, and as such, cannot be relied upon as a meaningful value. Significant research into the thickness and areal extent of the Big Creek aquifer would be required to determine a more reliable volume.

Site Development

There have been numerous estimates of the electrical potential of the Big Creek Hot Springs area, such as 11 MW (for binary cycle generation) given by Struhsacker (1981), 23 MW from Bloomquist et al. (1985), and according to McClain (1979), the field has a 50 MW potential. All of these figures probably fall into the category of "best estimates," and the sustainable power that the field might produce is unknown. Significant geologic work would be required to determine the size of the geothermal resource.

4. Vulcan Hot Springs KGRA (Valley County)

Overview

The Vulcan Hot Springs KGRA is located in a remote area of Valley County, over 20 miles east of Cascade. Access is by paved county highway, a Forest Service road, and a 0.75-mile hiking trail. The main vent at Vulcan Hot Springs discharges roughly 500 gpm at a surface temperature of 84° C, and 12 other nearby vents add 100 gpm (Dansart et al., 1994; McClain 1979). Geochemical analysis of the springs indicates a reservoir temperature of about 150° C (Mitchell and Young, 1973). The springs form a hot creek, which has been dammed with logs and tarapaulins at a number of points to create soaking pools.

The aquifer for Vulcan Hot Springs is Cretaceous granite of the Idaho Batholith, and flow is assumed to be fracture-controlled. Bloomquist et al. (1985 vol. 2) gives an aquifer volume of 0.8 mi^3, which is based upon a "best estimate" of the area and thickness since there are few data for this area.

McClain (1979) estimated the area's electrical potential at approximately 50 MW, although space limitations imposed by the area's rugged topography may limit development potential. The general lack of research data also adds uncertainty to this estimate.

Site Development

Development of the Vulcan Hot Springs KGRA would require a great deal of research and effort. This effort would require a great deal of research and effort. This effort would require geophysical study to determine the subsurface extent of the reservoir and the conduit structures which bring the geothermal fluid to the surface, geochemical study of the fluid to confirm reservoir temperature estimates, and well-drilling and reservoir testing to determine the suitability of the reservoir for electrical power generation. Some of this work, specifically the geophysics and drilling, would require the construction of an access road to the springs' discharge area, or would require that all necessary equipment be packed in or flown in by helicopter.

5. Magic Hot Springs Area (Blaine, Camas Counties)

Overview

According to Ross (1971), Magic Hot Springs previously discharged near the north edge of Magic Reservoir at 36° C with a discharge of 130 gpm. In 1965, a 259-foot well was drilled near the site of the springs, which discharge 74° C water at a rate of 15 gpm. The springs ceased flowing after the well was completed. Geochemical analysis of the water in this well indicated a reservoir temperature of approximately 149° C (Struhsacker et al., 1984).

Local rock types are basalt, rhyolite, and sediments. The flow water appears to be controlled by normal faults (Struhsacker et al., 1984). In general, wells drilled near major faults have higher temperature gradients and higher water yields (Dansart et al., 1994). The existence of a number of large geologic structures in the area may indicate the potential for a significant geothermal resource.

No estimates have been made with respect to the electric power potential of the Magic Hot Springs area. Additional geological studies and the drilling of at least one exploration well are needed to determine flow and geothermal gradient information.

The location of the former Magic Hot Springs is approximately two miles from the closest power-transmission line (rated at 138 kV) and owned by Idaho Power. The closest substation is also approximately two miles from the Magic Hot Spring location. Another power plant in the area is the Magic Dam hydroelectric project.

Site Development

The Magic Hot Springs area is close to power transmission lines and the capacity for additional generation exists. In addition to the generation facilities, the transmission lines necessary to connect the facility to the power grid would have to be erected.

APPENDIX B

Status of Current and Future Geothermal Technology

Except in areas close to Yellowstone Park, it appears that Idaho may have few steam-dominated resources at temperatures (>165 ° C, by rule of thumb) suitable to supply a flash facility. Until exploration changes this observation, it appears likely that the initial development of geothermal energy in Idaho will be through the utilization of the binary cycle power generation cycle, since low- and moderate-temperature resources occur more frequently and binary technologies are better suited for cost-effect generation.

The current and potential future technologies for converting geothermal resources into power are summarized briefly below.

Flash Generation Technology

Engineers for geothermal flash plants and dry steam plants sometimes amuse themselves by observing that their plants – which are essentially low-pressure steam turbine operations – are on the cutting edge of 19th Century industrial technology. This is a little bit true, though it should be noted that modern geothermal flash and dry steam turbines are exquisitely manufactured (usually in Japan) and painstakingly engineered to make the most of the low-pressure saturated steam encountered in these geothermal applications. The manufacturers continue to make incremental increases in efficiency and durability of these magnificent machines, but they represent a highly mature technology. This fact of maturity typifies much of what we can expect from technology development in flash plant systems. Because of their sophistication and the high capital concentration required to make them, these big turbines take a long time to make, between 1.5 and 2.5 years lead time, typically, and there are few specialists who manufacture them. For this reason, there is not a great deal of elasticity in the large geothermal turbine supply business, and projects that require them also require a lot of planning and forethought.

For energy extraction from high-temperature geothermal resources, flash and dry steam technologies are inherently more efficient than binary technologies. For this reason, flash plants have a secure place in the quiver of technologies developers have at their disposal to turn hot brine into electrical current. Flash plants are typically applied at delivered resource temperatures of 166° C and above, so a determination of where, and if, flash technology will find a home in Idaho will have to wait for discovery of a resource of appropriate quality and scale.

Binary Cycle Power Generation Technology

Increasing interest in geothermal resource exploitation in the U.S. is encouraging a great deal of attention to advancement of binary cycle technology for extraction of energy from low-temperature and moderate-temperature resources. The generic technology used in binary cycle power generation is proven – like refrigerators running in reverse – and about 25 years old. There are dozens of binary cycle geothermal plants worldwide, sporting many hundreds of MW in cumulative nameplate capacity and spanning a wide variety of plant sizes. Now there are advances being made in the equipment design, working fluid selection, plant configuration strategies, and commercial packaging approaches that are moving the binary cycle industry sharply toward a fiercely competitive design and supply market for low-temperature geothermal service. This field was once the nearly exclusive domain of one manufacturer/packager, Ormat. It is now seeing spirited application designs and commercial approaches from a wide variety of companies including United Technologies Corporation/Carrier, Turbine Air Systems, ElectraTherm, and others, as well as custom stick-built binary plant engineers and their clients.

The net result is that by selection of less familiar working fluids, such as industrial refrigerants rather than hydrocarbons such as pentane and isobutane, binary technology can be feasibly applied to lower-temperature geothermal resources. Experimentation with mixed working fluids may improve cycle efficiency and low-temperature range, as well, though it’s unlikely that the laws of thermodynamics will be amended to allow the binary application range to drop much lower than the limits now apparently in force.

The most salient improvements in binary cycle technology may well come from exploitation of economies of manufacturing, whether in cost or time, and in the canny application of reference designs to achieve optimal balances of efficiency, capital cost, and ultimate payback. The binary cycle geothermal business is fascinating and dynamic at the moment, and developers of geothermal resources in Idaho have a wholesome variety of competitive approaches to test on the ground.