GEOTHERMAL DEVELOPMENT NEEDS IN IDAHO

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Photo: Raft River Groundbreaking. Taken by Daniel J. Fleischmann

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Preface

Every state with geothermal resources faces different challenges in utilizing those resources to help meet its energy needs. The purpose of this report is to combine an analysis of relevant literature, and interviews with industry stakeholders in Idaho. These interviewees represent different perspectives, which help construct a balanced and objective understanding of what types of policies and actions public institutions can take to encourage greater development of Idaho's geothermal resources. For this report, there are interviews with over 50 professionals that are involved with the geothermal field in the United States, over 35 of which have worked specifically with geothermal resources in Idaho (including geologists, developers, home-sellers, utilities, regulators, consultants, direct use facility operators, clean energy advocates and university researchers).

This research includes information based on travel to Idaho to visit direct use facilities, the Raft River construction site, and to meet with industry stakeholders. It is aided by previous study on Utah released in June of 2006, subsequent studies on Arizona and New Mexico released in September of 2006, and an ongoing study on Nevada to be released in December of 2006.

During the course of the interview process, opinions differed from issue to issue. Ultimately, after taking into consideration the broad spectrum of opinions, this report represents a general consensus (or majority viewpoint) of what a diverse group of industry stakeholders believe are the overall needs to unlocking greater geothermal development in Idaho. The help received, whether informative, critical, or "filling in a gap" of information, was indispensable to the final product and I thank all who contributed time and effort to help bring this report to final publication.

Introduction

Photo: Warm Springs well, Boise, established 1892. Photo by Daniel Fleischmann

Geothermal resource development in Idaho is almost as old as the state itself. Admitted into the Union in 1890, residents of its capital city of Boise began using geothermal resources for district heating in 1892. Since then, the use of the Boise Front geothermal aquifer has expanded to include four separate systems that heat hundreds of buildings and residences. Development has occurred in other parts of the state where geothermal resources are used for thermal energy needs to serve homes, public buildings, recreation, and businesses.

However, years of low-cost hydroelectric power have limited extensive geothermal development. Geothermal resources provide only a small percentage of Idaho's heating and currently no electricity generation. With its population rising, energy prices soaring, and power markets reliant on out-of-state power facilities for 46 percent of its energy consumption, a new emphasis has been placed on developing Idaho's abundant geothermal resources[1]. Developers are en route to completing the first commercial geothermal power plant in the state, and other power generation projects are now under consideration. Once again the people of Idaho have an opportunity to pick up where they left off so many years ago.

To facilitate this effort, a workshop was held in May of 2001 at Boise State University focused on the role of geothermal development in Idaho's energy future. Following the workshop, an ad hoc steering committee was formed, and with the help of U.S. Department of Energy (USDOE) and its GeoPowering the West (GPW) program, the Idaho Geothermal Working Group was established. Select members of the working group drafted a Strategic Plan which reviewed the needs and barriers involved in the continued development of geothermal resources, and composed strategies and an action plan for the future. It was released it in the fall of 2002.

This report is focused specifically on Idaho's geothermal resources, and the role of policymakers and institutions in geothermal development. It follows up on the Strategic Plan and other relevant publications by updating the status of new geothermal development in the state. It is clear from the research that the opportunities for new development are significant, both for geothermal direct use applications and for geothermal power facilities. Although there are technological and economical challenges to this development, as well as limitations due to resource development restrictions, experts generally agree that policymakers in Idaho and Washington D.C. can help mitigate these challenges to facilitate an energy market that encourages geothermal development.

For the purposes of this document, "geothermal resources" have temperatures at least sufficient for direct use applications: >85°F (29°C) [although in many cases it is necessary to use higher temperatures]. The first part of the report addresses current development, future potential, and promising geothermal resource areas in the state and the efforts to develop them. The second part of the report addresses needs related to power production for the electric grid and distributed generation -- generally requiring temperatures greater than 212°F (100°C)[2]. The final part of the report addresses needs related to direct use applications.

This report is one of several examinations of obstacles and opportunities for geothermal energy on the state level being conducted by GEA. The final report will bring together these reports and offer cross-cutting analysis of the barriers and needs identified in different Western states.

Any opinions expressed in this report are those of the author, and do not necessarily reflect the views of the Department of Energy, the many individuals who contributed to this report, the Geothermal Energy Association or the members of GEA's Board of Directors.

Geothermal development trends in Idaho

On July 30th, 2006, a crowd of more than 100 assembled to witness the groundbreaking for the construction of Idaho's first commercial geothermal power facility in the heart of the Raft River Valley. In its first phase, the plant will produce a constant flow of 10 Megawatts (MW) of power to the electric grid, after which additional facilities expect to be built on the site. The momentous occasion for the new Raft River plant comes at a time when energy consumption has hit all-time highs throughout the western U.S.

Although recent studies and reports assert that Idaho is among the states with the largest potential for geothermal power production in the U.S., a quarter-century has gone by since geothermal power was first proven feasible in the state. At the same location as the new facility, the Idaho National Laboratory tested the world's first binary geothermal power plant at Raft River through a project funded by the USDOE. This demonstration plant had a nameplate capacity of 7 MW and ran from the fall of 1981 until June of 1982, achieving a net-output of 4 MW. While the project was declared a success, the plant was shut down because it was not economic for commercial production. The new plant, far more advanced and efficient than the original, will be competitive in today's market.

In addition to new power development, the installation of direct use applications is expected to increase as well. Because direct use applications do not require the intermediate to high-temperatures required for power generation, there are more resources available to exploit. By the mid-1990s, the Geo-Heat Center at the Oregon Institute of Technology (OIT) had identified 73 operating direct use facilities at over 40 separate resource areas in the state. Among these are greenhouses, aquaculture facilities, schools, hospitals, churches, hotels and resorts, using temperatures ranging from 85 to 200°F (29 to 93°C)[3]. OIT suggests that there are other sites in Idaho using geothermal direct use applications for space heating, greenhouses, and resorts that are not included in its records. This includes both installations that have come online since the mid-1990s and installations already existing that were not recorded at the time.

Despite the volume of existing installations, researchers say that the resource remains vastly under-utilized. Due to its northern latitude and the high elevation of many of its towns and communities, Idaho's winters are long and have large heating loads. The presence of geothermal resources throughout the state makes geothermal direct use applications a viable heating alternative to fossil fuels.

While most agree that direct use projects will increase, they expect that electric production is most likely to see the next wave of development. Once ignored by geothermal developers, Idaho is seeing a resurgence of new leases and project considerations. Raft River is only the beginning for geothermal power development in Idaho.

Idaho's Geothermal Potential

There is a general consensus among researchers that the full extent of Idaho's geothermal resource potential remains yet to be discovered. Many of the targeted prospects for geothermal resource potential have not been drilled to deep depths, and exploration efforts for these resources in Idaho and the western U.S. are still nascent compared to those for oil and gas (both in breadth and in technical experience). Even low-temperature geothermal systems capable of large-scale direct uses are poorly understood. Researchers say that there is reluctance by regulators and stakeholders to allow expansions of existing systems due to concerns that the heating capacity of the resource may be reduced. This assumption about reduced heating capacity in part reflects an insufficient understanding of the nature of these systems. Better understanding of resource potential could alleviate concerns and enable geothermal use in more communities.

Geography and Geology

While direct use geothermal systems are generally considered a heating alternative for local homes and businesses, resource areas with electric power potential are less understood because to confirm them generally requires drilling to deep depths. In addition, many resource areas with electric power potential are located in remote locations. However, despite these limitations researchers say there are several areas where developing a power plant may be realistic in the near-term with existing technology.

Idaho has an advantage over other western states in that geothermal power plants may operate more efficiently in its colder climate. The most promising areas for near-term electric power production 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 resources that extends across south-central Idaho (See Figure I). 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.

Unlike its neighbors to the east (in Montana, Wyoming, and Northeastern Utah) Idaho has not been a producer of oil and gas, although one natural gas well recently began producing near Rupert. Because Idaho lacks substantial efforts for oil and gas drilling, researchers have used hot springs as the basis for identifying active geothermal areas. In fact, 308 hot springs have been identified in the state, along with 745 geothermal wells (although most of these wells are shallow water wells without detailed subsurface data)[4]. Hot springs are not the only indicators of available geothermal resources, and developers say that many deep geothermal aquifers do not discharge at the surface.

Resource Assessments

Estimates of Idaho's geothermal potential have been made in several recent reports and studies. In January of 2006, the Geothermal Task Force of Western Governor's Association (WGA) estimated that Idaho has 855 MW of near-term economic potential resources (i.e. by 2015) and 1,670 MW of long-term potential (i.e. by 2025). The report gives 305 MW at six identified sites and 550 MW at "other Idaho sites" that are not named in the report[5]. 855 MW is enough base-load energy to provide nearly 30 percent of Idaho's current energy needs if sold entirely in-state[6].

This 855 MW is in contrast to the findings of the U.S. Geological Survey (USGS) in Circular 790, released in 1978. At that time, USGS Circular 790 reported a geothermal electric power potential from identified resource areas in Idaho at 366 MW; not including Island Park Known Geothermal Resource Area (KGRA), which was also named a major potential resource in the report[7]. Island Park is a large volcanic caldera, 18 miles long and 23 miles wide, situated roughly 15 miles southwest (edge to edge) of the Yellowstone Caldera. Studies indicate that the Island Park caldera is older (2.1 million years) than the Yellowstone Caldera (0.63 million years) and suggest that its original heat source has dissipated considerably[8]. Although researchers suggest there is electric power potential remaining in the caldera, (likely obtainable through Hot Dry Rock or Enhanced Geothermal Systems (EGS) in hot, low-permeability rock) at the time of this writing, drilling in the Island Park KGRA is restricted.

When USGS Circular 790 was drafted, the authors were only considering resources at or above 302°F (150°C) as viable for electrical generation due to then existing engineering and technological limitations to generate electricity from these temperatures. USGS Circular 790 estimated the reservoir temperature at Raft River to be just below 300°F (149°C). As a result, Raft River was not given an estimate for electric production in the report. However, three years later, in 1981, when binary technology tested at Raft River produced electricity, it demonstrated how quickly technological change can occur. Developers of the new Raft River facility plan to develop additional power units that may result in as much as 90 MW of installed capacity once the property is fully developed. The Raft River area, extending beyond existing leases, has been estimated to contain even more electric power potential, with most recent "high" estimates at 515 MW[9]. Despite the exclusion of the Raft River electric production estimates in USGS Circular 790, when considering both discovered and undiscovered resource areas, the report still estimated Idaho's total recoverable geothermal electric power potential at 13,916 MW[10]. Adding the previously excluded estimates for Raft River increases this number to 14,431 MW.

In contrast to USGS Circular 790, the WGA report had the benefit of 28 years further study of Idaho's resources. However, in the report, the 550 MW of new electric capacity possible at "other Idaho sites" differs from other states because so much of the supposed economical resource was not specifically identified. According to researchers, the reason for this, primarily, 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 exploration drilling has been performed.

A new USGS assessment is underway to update geothermal resource potential estimates presented in Circular 790. Researchers throughout the geothermal energy field have encouraged the new assessment in part because there is a broad spectrum of opinions about the size of the available resource. There is also a need for reliable information to guide new exploration based on advanced information technology and field data not available in 1978. When the USGS performed this assessment, no geothermal power plants existed in Idaho, and not much was known about the resources that had been discovered. In addition to leaving out projections for resource areas with estimated temperatures below 302°F (150°C) the authors only considered resources shallower than 9,842 feet (3,000 meters). However, at this time geothermal production is achieved at greater depths in other parts of the world. Researchers contend that in addition to deep convective resources, conductively heated hydrothermal resources may be available for production at deep depths throughout the state, depending on fluid, permeability, and the economics associated with development.

Additional Potential accessible through new technological applications
New technological applications have expanded the range of potential recoverable geothermal energy. For example, when the demonstration of binary technology was successful at Raft River in 1981, many more resource areas opened to development as a result. Binary technology is used today in power plants in California, Hawaii, and Nevada and was used at one time for power generation in New Mexico, Oregon, and Utah. The USDOE defines a binary geothermal power plant as a system that operates by using "the heat from the geothermal water to heat a secondary fluid, usually a compound with a lower boiling point. Vapor from the secondary fluid is created in a heat exchanger and is then used to turn the turbine. The geothermal water is injected back into the aquifer in order to maintain pressures in the aquifer system. The fluids are in separate closed-loop systems and do not contact each other directly"[11]. In addition to using lower temperature fluids, binary power plants emit nearly zero emissions of common pollutants or greenhouse gases.

Although binary power plants have made use of secondary fluids with a lower boiling point than water, the geothermal resource being tapped still required greater than boiling temperatures (212°F (100°C) or slightly lower at altitude). However, in 2006, a new technology was demonstrated to produce power from well below those temperatures. The first demonstration project is now up and running in Alaska at the Chena Hot Springs Resort; producing power from a geothermal aquifer with temperatures of 162.5°F (72.5°C). The plant is using Organic Rankine Cycle (ORC) technology, using a process similar to existing binary power plants. However, because the geothermal water at Chena Hot Springs never reaches the boiling point of water, a refrigerant, called R-134a, is used which has a much lower boiling point than water. The water is pumped at 480 gallons per minute (gpm) and passes through a heat exchanger where it transfers heat energy to the refrigerant. When the refrigerant boils, it vaporizes and is then routed to a turbine to generate power. The system runs in a closed loop and most of the water is injected back into the reservoir with the rest of the fluid being used for space heating. At the first plant, cooling water is siphoned from a shallow well close to a nearby creek using the natural gradient, or fall, of the property. A second plant will be installed at the resort using air-cooling[12].

Another technology, applicable for geothermal development, is engineering geothermal systems through Hot Dry Rock or EGS. While a number of deep wells in Idaho have measured intermediate-to high temperatures, several did not encounter adequate fracture permeability to deliver a continuous source of fluid. EGS is a process where geothermal aquifers with low permeability can be stimulated to create a conductive fracture network where the reservoir operates like a conventional hydrothermal reservoir. It was proven feasible by a demonstration project in Soultz-sous-Forêts, France. This process can serve to extend the margins of existing geothermal systems or create entirely new ones[13]. Hot Dry Rock targets a heat source that lacks both permeability and fluid, and proven technically feasible through a demonstration project at Fenton Hill (on the western rim of the Valles Caldera in New Mexico). These methods, while more expensive than used for conventional geothermal power projects, have potential for future application in the U.S. and Idaho[14].

Studies of potential resource areas
In addition to new technology, most agree it is essential to collect data on potential resource areas and to clarify near-term opportunities for development. In the Strategic Plan, there was concern expressed that data collection and analysis on Idaho's resources had stalled in the mid-1980s, and needed to be updated. Recent efforts by the USDOE and researchers in Idaho have begun to meet this challenge by providing funding to update databases, networking with businesses and communities, and engaging developers and potential investors. Although most agree that more

has to be done, the progress is evident in the volume of locations being considered for development.

The descriptions below provide an overview of Idaho's resource areas with electric power potential. While some of these areas have been covered in previous reports [including the "Overview of Geothermal Investigations 1980 to 1993" released by the Idaho Water Resources Research Institute (IWRRI) at the University of Idaho in December of 1994 and the "Examination and Evaluation of Geothermal Sites in the State of Idaho with Emphasis Given to Potential for Electrical Generation or Direct Use" released in September 2002 by the Idaho Department of Water Resources (IDWR) Energy Division] additional resource areas, not mentioned specifically in past reports, are considered here. Information about these additional resource areas is based on research and discussions with experts. The resource areas described below do not represent the only ones in Idaho with potential. There are likely many other potential resource areas that have yet to be identified, and there are potential resource areas that have been identified as prospects where information about them is not publicly available.

Areas with geothermal power production potential Idaho[15]

Figure I: Snake River Plain regional aquifer system: Source – USGS: http://capp.water.usgs.gov/gwa/ch_h/jpeg/H052.jpeg

Snake River Plain

The Snake River Plain contains many potential geothermal resource areas. As seen in Figure I, the Snake River Plain stretches from Eastern Oregon to eastern Idaho near the Montana and Wyoming border. Temperatures between 150 and 200°F (65 and 93°C) are common in hot springs and shallow wells in this region. This includes the Boise Front geothermal aquifer, which has been a significant source for geothermal direct uses. Although temperatures in the Boise Front geothermal system have not been considered sufficient for electric power production, intermediate-temperatures of up to 194°F (90°C) have been recorded there.

The technology used at Chena Hot Springs offers opportunities in Idaho to develop resource areas in the Snake River Plain with intermediate-temperatures. Although the power unit at Chena Hot Springs uses 162.5°F (72.5°C)-temperature fluid, designers say that has to do with climate conditions in Alaska, and that in Idaho advanced ORC units would likely require resources with temperatures closer to 200°F (93°C).

One of those promising areas is located near Hagerman on the south side of the Snake River, where a resort pipes geothermal water at just under 200°F (93°C) from a 200-foot (61-meter) well. Consideration for electric production in the area has been limited due to concerns over declining water levels and water availability; however there has been interest in drilling on the north side of the Snake River, near the resort. A cold-water aquifer may be located above the resource, masking accurate temperature gradient readings. Researchers suggest that more exploration is warranted to discover the source of the heat, and that a resource may be confirmed if deep drilling is performed. Even without deeper drilling, it is possible that the technology used at Chena Hot Springs could produce electricity from the existing resource if water availability issues can be resolved.

In addition to its abundance of intermediate-temperature systems, a number of locations in the Snake River Plain have demonstrated potential for higher temperatures suitable for utility-scale power plant development. Below are descriptions of these potential areas and their current status.

Barron's Hot Springs
Barron's Hot Springs is located 7 miles southwest of Fairfield in Camas County in a volcanic transition zone between the Snake River Plain and the Idaho Batholith. Its surface temperature measures 163°F (72°C). Reservoir temperatures are predicted to be 257°F (125°C) although temperature gradients on the east side of the fault in the vicinity of Barron's Hot Springs are estimated to have higher temperatures at depth. The surface springs are on private land, while the surrounding mountains are on Bureau of Land Management (BLM) land, and developing the resource would likely involve a federal lease. However, transmission infrastructure is located not far from the resource area along U.S. Highway 20. Researchers suggest further study is warranted to determine locations favorable for exploration drilling.

Magic Reservoir Hot Spring Area
The area seeing the most interest in the Snake River Plain for power development is the in the Magic Reservoir Hot Spring area on the border of Blaine and Camas Counties. In 1965, a 259-foot (79-meter) well was drilled near the site of the springs that discharged 165°F (74°C) water at a rate of 15 gpm. Geochemical testing of the well estimated a reservoir temperature of approximately 300°F (149°C). Active faulting is clear and present in the area, which shares traits of the Snake River Plain and the Idaho Batholith, with several localized granitic formations. Elevated temperature gradients occur along the west side of the reservoir, indicating other potential drilling locations. Two lease applications are currently under review on BLM and private land at the north end of Magic Reservoir near Hot Springs Landing, totaling 3,840 acres.

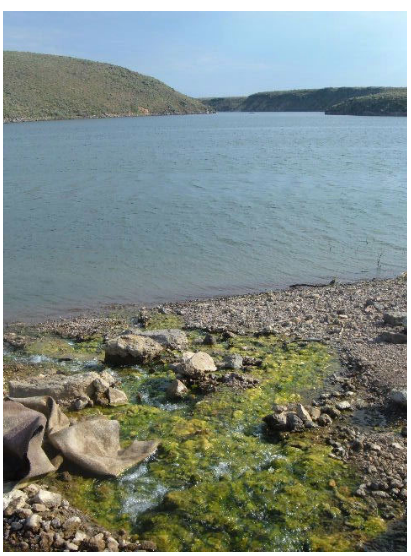

Photo: Hot water pours over the rocks near Magic Reservoir, situated in a valley of rolling hills south of the Smoky Mountains. A hot tub (not in the photo) sits to the side where swimmers still use the geothermal waters for soaking. Photo by Daniel Fleischmann, GEA

The Magic Reservoir Hot Spring area is promising due to its location near transmission lines and a substation. There are other non-geothermal power plants nearby Mountain Home, operated by Idaho Power. The site is located 15-20 miles south of the population centers in Hailey, Ketchum, and Sun Valley.

Mountain Home
Efforts have been made to study the resource around Mountain Home, particularly near the Mountain Home Air Force Base just north of the Snake River in Elmore County. The geologic setting in the area indicates the existence of geothermal resources. Direct use applications appear feasible for the base, based on studies of existing wells, although they do not make use of thermal water. In 1974, two wells encountered high-temperature rocks six miles northeast of Mountain

Home (described in the Mount Bennett Hills section below). These wells were the basis for the study at the Mountain Home Air Force Base. In 1986, a well was drilled at the base to a depth of 4,403 feet (1,342 meters) that measured maximum temperatures at just below 200°F (93°C). Available fluid from the well was at lower temperatures not economical for a geothermal heating project at the time. Results of geochemical sampling near the base combined with the findings of this well suggested that while high temperatures may be encountered at deep depths, the deep resource penetrated by the two nearby wells do not communicate with the resource measured in the 4,403-foot (1,342-meter) well.

While the costs of deep drilling reduce the economic viability of tapping the deep high-temperature resource in the near-term, there have been recent solicitations for geothermal energy exploration at the military base, due to ongoing National efforts by the U.S. Department of Defense (DOD) to develop on-site renewable energy at their military bases. Solicitations for interest at Mountain Home had many responses but were eventually cancelled due to administrative issues. The base houses nearly 10,000 people, and could greatly benefit from geothermal use. Efforts are still underway to find willing developers to explore the area.

Mount Bennett Hills[16]

The Mount Bennett Hills area is an east-west trending horst, or elevated fault-bounded block, along the northern margin of the west central Snake River Plain in Camas and Elmore Counties. Subsurface geology of the area shares traits common with the Snake River Plain and the Idaho Batholith (located to the north). The area is approximately 60 x 12 miles long bounded on the north by normal faults and the Camas Prairie Rift, and to the south by the Snake River Plain. It stretches from Mountain Home to the Magic Reservoir, running just south of U.S. Highway 20.

One of the most promising areas studied is south of Bennett Mountain in Elmore County just north of the Hot Springs Creek Reservoir. The reservoir is located north of the Snake River, and I-84, approximately six miles northeast of Mountain Home. In 1974, Union Oil drilled two deep geothermal wells in the area that measured high temperatures. Subsequent studies of the wells measured temperature gradients of 3.35 and 3.5°F/100 feet (61 and 64°C)/kilometer (km). The hottest well was called Bostic 1A and it measured a bottom-hole temperature (BHT) of 383°F (195°C) at a depth of 9,616 feet (2,931 meters). High temperatures were also recorded in the other well at 8,898 feet (2,712 meters).

According to a report released in 1982 by the Los Alamos National Laboratory, the area was considered a prospect for EGS or Hot Dry Rock due to the existence of Idavada Volcanics; silicic volcanic rocks underlying the area at depth. The report suggested that north of the Bostic Well, at the base of the Mount Bennett Hills, geophysics should be performed and temperature gradient wells drilled to better identify the resource. The Bostic well produced fluid at 1,000 gpm, but temperatures of the water measured 270°F (132°C), not suitable for electric power production in 1974. Since the report was released in 1982, there has been little follow up on the prospect to examine areas to the north or to examine the potential application of binary technology to use the 270°F (132°C) resource (although this would require new well drilling).

Locations throughout the Mount Bennett Hills area have measured higher than average heat flow values and temperature gradients (exceeding 5°F/100 ft (92°C)/km). While the Mount Bennett Hills has been mapped and existing well data analyzed, further exploration of the region is warranted. Much of the land is managed by the BLM, while some of the lands are on scattered state and private property. Due to its location close to I-84 and power transmission, the area is attractive for development.

Rexburg Caldera Complex

The Rexburg Caldera Complex is a promising region in eastern Idaho, in Jefferson and Madison Counties. The Rexburg area is situated along the northeast-trending boundary between the eastern Snake River Plain and the Basin and Range Province, and has geological characteristics common of both areas. One study of the region described the Rexburg Caldera Complex as a "coextensive with a complex of about eight calderas of Pliocene age. The calderas were the source of several major rhyolitic volcanic deposits present along the southeast margin of the eastern Snake River Plain."[17] The city of Rexburg has a population just over 17,000, and is located 30 miles northeast of Idaho Falls along U.S. Highway 20 and the Union Pacific Railroad.

A 3,943-foot (1,202-meter) well was drilled in 1980 at the edge of the town to heat large buildings, but temperatures were considered insufficient for the project. Elevated temperature gradients were recorded in wells drilled several miles to the southeast of Rexburg on a geologic feature commonly referred to as the Rexburg Bench. In addition, geothermometers calculated using water chemistry data from existing wells yielded estimated deep reservoir temperatures of up to 392°F (200°C). Reported temperature gradients in the area range from 2.6-4.6°F/100 feet (47.8-84°C/km). The Rexburg area was assessed in the WGA Geothermal Task Force Report in 2006 and by the Sandia National Laboratories in 1992. The range given by these assessments are 20 MW near-term (WGA 2006) and 500 MW long-term (Sandia 1992). Most of the promising resource areas, including identified thermal wells and springs, are on private land, although BLM land is located in its western boundary.

Basin and Range Province

The Basin and Range Province lies in southern Idaho and several promising discoveries have documented there, including Raft River. Unlike the Snake River Plain region, many of the resource areas in the Idaho portion of the Basin and Range Province are sparsely populated and remote. Researchers say that studies of these resources are still in their early stages, and require reconnaissance work and hydrological study.

Blackfoot Reservoir/Gray's Lake

Elevated temperature gradients and deep wells in the vicinity of Gray's Lake and the Blackfoot Reservoir in eastern Idaho have indicated potential for electric power production. A deep well drilled by Conoco in 1979 measured a BHT of 374°F (190°C) at about 3 km in a test well called Gentile Valley# 1-9. The well is located near the Little Valley Reservoir in Bonneville County just west of Gray's Lake and northeast of the Blackfoot Reservoir in Caribou County. Researchers suggest that this area "has been thought to have significant geothermal potential based on the geologic setting alone" (IDWR 1994) and further studies of this area have strengthened this conclusion. The area is sparsely populated, but is not significantly remote. Most of the land in the area is private, although it does contain scattered tracts of BLM land and U.S. Forest Service (USFS) land is located to the east of the targeted geothermal prospects. Researchers suggest that existing data should be followed up on, and geothermal rights in the area should be clarified to determine necessary permits that would need to be acquired to develop a power project.

China Cap

China Cap is part of a group of Pleistocene rhyolite domes located in a heavily faulted area near the Blackfoot River in northern Caribou County just south of the Blackfoot Reservoir (described above). The development site is on a mixture of private, state, and BLM land. A federal lease was issued to develop the prospect in 2004 and geophysics and environmental reviews were subsequently completed. The developer, Idatherm, LLC, discovered the resource through satellite imagery, finding that the mountains in the area contained an anomalous area of light snow cover in the winter months. While wells in the region have recorded elevated temperature gradients, no drilling has been done in the specific area of interest. However, the geology of the area is considered promising and the developer is seeking financing to drill a test well.

Raft River KGRA

The Raft River KGRA is located south of the Snake River Plain in Cassia County, approximately 40 miles southeast of Burley. Located in the Raft River Valley, it is generally considered part of the Basin and Range Province. The Raft River KGRA is by far the most studied resource in Idaho for power generation. It was first explored in the early 1970s after intermediate-temperature fluid was encountered in local irrigation wells. The discovery of these wells was not the first indication of geothermal resources in the Raft River Valley. Frazier Hot Spring, on BLM land near the location of the new facility, has measured temperatures at the surface as high as 203°F (95°C). In addition, low-temperature wells in the area had been used for many years for agricultural purposes, including heating for nearby greenhouses. Subsequent drilling to deeper depths measured resource temperatures below that of what were utilized in conventional flash plants and the demonstration binary plant became the first successful attempt to produce from temperatures below 302°F (150°C).

After the demonstration plant came online in 1981, it operated for eight months. As noted above, the power produced was not considered cost competitive and the plant went idle. The pumps, the electrical equipment, and the property were eventually sold off (with the plant itself eventually installed in Nevada). When originally built, 7 wells were drilled on the site (5 production wells and 2 injection wells) to utilize the resource, producing from temperatures from 275 to 300°F (135 to 149°C) at depths from 4,500 to 6,000 feet (1,371 to 1,829 meters). Nearly two decades after the initial plant was shut down, efforts to develop the site began again when the property was acquired by US Geothermal, Inc. With the help of grant money from the USDOE, well clean-up and a flow test program were performed and completed in 2004. Four of the seven original wells had to be re-drilled. The first power plant is under construction on 660 acres of private property and is expected to be online in the fall of 2007, producing 10 MW of energy. An additional 4,417 acres has been leased, and there are plans to expand the well field in the near future.

Estimates for potential on the existing leases range up to 90 MW. However, researchers assert that the Raft River geothermal system is extensive and potential exists in other areas nearby. There is interest in obtaining federal leases adjacent to the property. While the Raft River project benefits from prior testing and proximity to existing transmission infrastructure[18], the visibility that this project creates is critical to the success of the industry in the state.

Willow Springs

A highly promising area in Idaho is Willow Springs, in southeastern Idaho on the border of Bingham and Bonneville Counties. Willow Springs is west of the Caribou Mountains near Idaho Falls on a mixture of private, state, and BLM land, not far from Gray's Lake (discussed above). In 1978, Quasar, an oil and gas exploration company, drilled a deep well, hoping to find petroleum resources in eastern Idaho near its border within the oil-rich Overthrust Belt, taking the risk during the oil shocks at the time.

While petroleum was not found, hot fluid was discovered in shallower parts of the well, and at depth where temperatures exceeded 480°F (249°C). A federal lease was issued to the developer, Idatherm, LLC, in 2004, who has subsequently secured drilling permits and completed environmental reviews. The developer is seeking financing and venture capital to drill a new exploration well near the original well. Due to the temperature and other promising geologic data, developers suggest the resource is capable of producing as much as 100 MW when fully developed[19].

Other areas of interest in the Basin and Range
Several other areas in the Basin and Range Province of southern Idaho have also aroused interest, including a potential resource suggested, but not verified, south of Holbrook in the Curlew Grasslands area of Oneida County.

A promising area with verified data is located in southeastern Idaho, in Franklin County. Wells drilled near Battle Creek Hot Springs and Squaw Hot Springs discovered shallow geothermal aquifers with temperatures of nearly 230°F (110°C). A deep well in the area recorded a BHT of 250°F (121°C) at 8,000 feet (2,438.4 meters) and geothermometers suggest higher temperature aquifers may be located in the area. However, the shallow geothermal aquifers may have potential for small-scale electric power production with binary technology. Researchers suggest that the resource area should be revisited, and new testing performed. The area is located in between Banida and Preston on private land, not far from transmission or population.

Near Soda Springs in Caribou County is another potential area called Sulphur Springs. The area is located on a mix of private and federal land and has never been drilled. At the time of this writing, federal lease applications are under review to allow drilling in the area. Those familiar with the site suggest that it is favorable for development due to its location near transmission infrastructure.

Another area worth noting is Newdale, near the Wyoming border in southern Fremont County. In the early 1980s, two commercial geothermal wells were drilled near the community on private land. The resource was not deemed sufficient to produce power at the time, although the temperatures indicated that further study might be warranted. The two wells measured 190°F (87.8°C) at 2,920 feet (890 meters) and 180.5°F (82.5°C) at 3,358 feet (1,023.5 meters).

In southwestern Idaho in Owyhee County, Juniper Butte (in the Jordan Valley) is considered a promising area, based on the local geology. However, the area is located on BLM land and extremely remote.

Idaho Batholith
The Idaho Batholith is a composite mass of Cretaceous age granitic plutons[20] covering approximately 15,400 square miles in central Idaho. The Batholith stretches from the Boise National Forest to the Bitterroot Mountains. Thermal springs are common, particularly in the Boise National Forest where several hot springs and geothermal wells are used to heat homes, greenhouses, and resorts. According to study by geologists from Idaho State University, anomalous heat in the Batholith 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."[21]

Much of the land in the Idaho Batholith is federally managed, primarily by the USFS. There is concern in these areas over remoteness, available fluid, and the challenge of deep drilling in granitic rocks. However, there are several areas of immediate interest in this region with electric power production potential.

Big Creek Hot Springs[22]
Big Creek Hot Springs is located in Lemhi County, near the Montana border, on USFS land. Surface temperatures of approximately 199°F (93°C) result in the discharge of boiling water,

because of the high elevation (over 4,500 feet (1,372 meters) above sea level). This discharge occurs from 15 vents totaling approximately 75 gpm. Reservoir temperatures are estimated to be between 279-354°F (137-179°C) at depth. The resource is located along the Hot Springs fault, which researchers say may contain additional, concealed thermal anomalies with electric power production potential.

Big Creek Hot Springs is remote and limited access by roads and a lack of transmission lines in the immediate area have been barriers to development. In 1981, a feasibility study outlined how development of the resource could serve a nearby cobalt mine and local communities to the south. While the study found that the project was technically feasible, economics were not favorable at the time. Recently, there has been renewed interest in developing the site and federal lease applications are currently under review. The leases encompass 5,760 acres of USFS lands south of Shoup, just east of the Frank Church River of No Return (RONR) Wilderness.

Boiling Springs steam vent. Photo by Josh Laughtland webmaster@idahohotsprings.com: Used by permission

Boiling Springs

Boiling Springs is one of the hottest thermal springs in Idaho. Steaming water from the springs emerges at the surface at 185°F (85°C). The resource area is located 75 miles northeast of Boise, along the Middle Fork Payette River in southern Valley County. Six federal lease applications are under review to drill in the area on USFS land, totaling 12,160 acres. The site is located about two miles northwest of Silver Creek Plunge and roughly 20 miles north of Garden Valley.

Bonneville Hot Springs and Sacajawea Hot Springs

Potential intermediate-temperature resources may exist in Boise County on USFS land east of Lowman at Bonneville Hot Springs and Sacajawea Hot Springs. Bonneville Hot Springs has surface temperatures of 185°F (85°C) and Sacajawea Hot Springs has surface temperatures of 153°F (67°C). Geothermometers indicate that both Bonneville Hot Springs and Sacajawea Hot Springs have reservoir temperatures between 266-302°F (130-150°C) at depths from 2-3 km. Both areas are considered potential prospects for electric power production, and both are less remote than Boiling Springs. Researchers suggest that additional analysis should be performed to assess the feasibility and logistics of a geothermal power project.

Vulcan Hot Springs KGRA

Vulcan Hot Springs is located on the western edge of the Idaho Batholith on USFS land in Valley County. A 2002 report by the IDWR found that the resource is among the most likely areas in the state capable of electric power production. Surface temperatures measure 183.2°F (84°C), with a highest recorded temperature of 191°F (88°C). There are 13 springs in the area, with a combined discharge of 507 gpm. Based on geochemical testing of the area, reservoir temperatures are estimated at 297°F (147°C). Because it is located 20 miles from the nearest town, is 18 miles from the nearest transmission lines, and is a pristine recreation destination on USFS land, considerations for development have been limited. Researchers say that development of the resource would require additional access roads, and the sensitive environment of the area may pose further challenges. However, despite these limitations, there is currently interest by developers in examining the feasibility of a power project on the site.

Payette River Basin
Six hot springs in the Payette River Basin between Banks and Horseshoe Bend in Boise County were studied in the mid-1980s. Thermal springs in the area have measured surface temperatures as high as 186.6°F (86°C), and geothermometers indicate reservoir temperatures of up to 302°F (150°C). Reservoir volumes and temperatures are at least sufficient for localized direct use applications, and private land in the area has utilized the resource for that purpose. For example, a greenhouse at Banks uses geothermal heat from a spring with resource temperatures of 180°F (82°C) flowing at 240 gpm. Nearby Deer Creek Hot Springs, with a surface temperature of 176°F (80°C), lies to the east, closer to Lowman. These areas contain a mix of private, state, BLM, and USFS land. Geothermal power development in this area would most likely involve leasing USFS land.

Other areas of interest in the Idaho Batholith
There are several other promising locations in the Idaho Batholith region. For example, in Lemhi County, investigations of Owl Creek Hot Springs, several miles east of Big Creek Hot Springs, have estimated reservoir temperatures of 260°F (127°C) at depth. Southeast of Salmon in Lemhi County a temperature gradient of 4.6°F/100 feet (84°C/km) was measured in a deep hole in the Lemhi River Valley. In both these areas, no additional exploration has been performed to follow up on these results.

In northeast Valley County, there has been recent interest in development at Indian Creek Hot Springs, located near Big Baldy (9,705') in the Challis National Forest. Indian Creek Hot Springs has a surface temperature of 190°F (88°C)[23]. Recent exploration has been completed in the Cascade area of Valley County, with the help of Idatherm, LLC and Chevron Energy Solutions. Developers say that this initial exploration looks promising, with exploration drilling as the next step.

Another area of interest is in Idaho County in a remote section of the Bitterroot Wilderness along the Lochsa River. Here, the geochemistry of thermal springs, along with elevated temperature gradients, suggest temperatures of up to 338-392°F (170-200°C) at depths between three and four km (IDWR 1994). Development of this area, however, is unlikely due to its remoteness and its location on USFS lands.

Other areas of promise

Crane Creek Hot Springs
Crane Creek Hot Springs is located in Washington County, roughly 12 miles east of the city of Weiser in a predominantly agricultural area. It is considered one of the most promising resource areas in Idaho for near-term development, based on existing resource data, the geologic setting, and its location near transmission infrastructure.

The resource is situated in a confluence of several geological areas. This includes the transition zone between the Columbia River Basalt and the Idaho Batholith. It is also located along the west side of the north-south trending Idaho fault zone, which also marks the northern boundary of the Snake River Plain[24].

A recent measurement of the surface temperature was 178°F (81°C), with a discharge of 30 gpm. Geochemical thermometers suggest the reservoir temperature is 331-349°F (166-176°C). A geothermal exploration well drilled in 1981 measured a BHT of 325°F (162.8°C) at 7,998 feet (2,437.8 meters), but did not return sufficient fluid for electric power production. As advancements in drilling technology have taken place, and additional data on the resource has been acquired, most agree that subsequent drilling could be more productive. Estimates of the electric power production potential of the resource area range from 100 to 179 MW. (IDWR 2002)

Crane Creek Hot Springs is located near major highways (I-84 and US-95) and in the vicinity of high voltage Idaho Power electrical transmission lines coming out of the Hells Canyon Dam complex. According to IDWR, these lines cross the region approximately 7 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. (IDWR 2002)

The area is on a mixture of private and BLM land. Several developers have leased the private land area, and a federal lease was issued in July of 2004. Over the past few years, some exploration progress has been made. The developers have conducted geophysical and geological work; however additional funding is needed for exploration drilling.

Geothermal Power Development Needs

Since the demonstration project began producing power in Raft River in 1981, Idaho has not seen another power plant come online in the past quarter century. Geothermal direct use facilities have grown in the last decade, with new customers joining the Boise district heating system, geothermal space heating installed in new homes built near the Givens Hot Springs airstrip, and expansions of existing facilities and businesses. Extensive resource development, however, has been limited by multiple factors. Among these are the lack of past exploration drilling and the relatively low cost of fossil fuel electricity and heating rates over the past two decades. In addition, because Idaho residents receive nearly half their power from hydroelectric sources, their reliance on fossil fuels as opposed to renewable energy has not been as significant a concern as in neighboring states (such as Utah and Wyoming, which rely on fossil fuels for over 95 percent of their energy use). In addition, Idaho's history of regular air quality compliance has not led to significant regulation of its power plant emissions.

Until recently, heating and electricity rates in Idaho had been relatively low compared with rates in other parts of the country (particularly rates in California). However, the stability of energy prices has come into doubt in recent years, particularly amid concerns over the capacity to meet demand in some areas of the state. Findings from the 2002 Strategic Plan indicate that these concerns have been pressing at least since 2001 after the California energy crisis affected power markets throughout the region. With recent spikes in the price of natural gas and other conventional power sources, as well as salmon recovery issues affecting hydroelectric power sources, Idahoans are faced with the revelation that energy is no longer cheap and abundant. This creates an opportunity for geothermal resource development in the state. Most agree that when utilized, geothermal resources provide a clean, reliable alternative to fossil fuels and a hedge against high energy prices. For new development to occur, however, effective policies must be in place that address development needs essential to industry success. These include:

- The need for greater exploration and study of the resource;
- Regulatory needs;
- The need for adequate government incentives;
- The needs of the power market;
- The need to establish uses for distributed generation;

For each of these needs, the analysis below identifies key barriers and proposed policy alternatives that a general consensus believes can reduce constraints and will propel new exploration and development.

The need for greater exploration and study of the resource

To date, geothermal resource development in Idaho has been limited to direct use facilities, the demonstration power project in Raft River where a new power project is now underway. Outside of Raft River, however, deep geothermal exploration drilling has been minor, especially when compared with efforts in California and Nevada. Well data suggests that the number of wells drilled below 1,000 feet (305 meters) outside of the Raft River Valley is no more than a dozen[25]. While the geothermal resource in Idaho is considered very promising (in fact, Idaho ranks third, behind only California and Nevada, for near-term electric power production potential in the 2006 WGA Geothermal Taskforce report) it is poorly understood and lacks a history of substantial exploratory drilling for new developers to build upon.

Resource Identification

According to the Strategic Plan, Idaho faces a “lack of data and understanding on existing resources to support additional development”[26]. While there are Idaho geological maps that display the location of hot springs and wells, researchers consider these maps rudimentary. For Idaho’s geothermal prospects where there was geochemical and geological work, there has been little follow up exploration. Most of the existing data on areas that were drilled in Idaho dates back to the 1970s and early 1980s, and unlike in California and Nevada, drilling in these areas was usually limited to one or two wells. Developers say that with inexpensive power rates, even after prices climbed slightly during the 1980s, there was little incentive for developers to explore Idaho’s geothermal prospects in detail. In addition to having among the lowest energy prices in the country over the past three decades, Idaho also has far less oil and gas drilling than other western states. Researchers contend that without an extensive history of oil, gas or geothermal drilling, they lack critical knowledge of subsurface geology which increases development risks.

Old Hyndman (11,775’) and the Pioneer Mountains dominate the skyline of Hailey, where geothermal hot springs were first utilized for home heating nearly a century ago. Photo by Daniel Fleischmann, GEA

In general, exploration is a time-consuming process that generally involves significant upfront costs with high risks and uncertainties (only magnified in areas without prior subsurface exploration). Because geothermal resources are buried deep beneath the surface of the earth they cannot be verified without well drilling. Developers today contend that financing the first well drilled is usually their greatest challenge. According to an August 2005 report by GEA, exploration (including geological studies, drilling, and confirmation) is typically up to 1/3rd of the overall costs of a geothermal project. Drilling can be up to 1/4th of the overall costs -- considering the cost of a geothermal exploration well ranges from $1 million to $9 million -- depending on the depth, the type of material being used, and the current market for drilling rigs. According to the report, an average well “would probably be in the range of $2-5 million.”[27]

However, this does not take into account the costs of regulatory delays, and recent spikes in demand for steel and drilling equipment that are unpredictable and have increased markedly throughout the first six months of 2006 when oil prices escalated.

High upfront costs make it particularly difficult to drill in Idaho because it is hard to raise the required venture capital without a market to sell the power. This is especially difficult for sites that have never had a producing well (aka a "greenfield"). Developers say they lack the capital resources to pursue a project without confidence that the resource can be developed economically. According to the Strategic Plan, the geothermal industry has suffered from not having a "long enough track record on geothermal production" causing the financing industry to be skeptical and risk adverse towards geothermal projects[28]. Even the Raft River project, which was a proven energy-producer, faced nearly prohibitive risk factors when the property was initially acquired in 2002.

Government programs

Most agree that government programs, including grants and loans, can be effective at reducing the risks associated with high upfront costs. Investment in geothermal development can result in royalties, tax revenues, and energy savings, all of which could benefit the Idaho economy. The state has provided little financial assistance for geothermal studies, and currently provides no funds directly for geothermal research or exploration. This leaves the industry and the federal government to provide funding for these activities. Funding from the federal government has been limited in its scope in part due to the risks and uncertainties involved with development. Federal funding is often seen as a waste if it doesn't result in a completed project. As a result, most agree that the challenge for both the state and federal government is spending money effectively to get the most out of their investment and to demonstrate results.

The USDOE has assisted projects in Idaho in recent years through the Geothermal Resource Exploration and Development (GRED) program and other efforts, including GPW. Besides GRED and GPW, the primary benefactor of USDOE funding in Idaho has been the Idaho National Laboratory. The Idaho National Laboratory has a geothermal research office in Idaho Falls and has had a presence in the state for three decades. It is responsible for many of the reports and on-the-ground research that has helped lay out the framework for future study. While not everything the Idaho National Laboratory geothermal team does relates to Idaho's resources, most agree they provide critical expertise valuable to development efforts in the state.

More recently, the GPW, and the State Working Group it helped organize, have held conferences, performed outreach, created Internet resources, and released the aforementioned Strategic Plan. The Strategic Plan was developed through subcommittees working on issues brought up during the initial meetings. When the plan was released it contained a description of barriers and a detailed "Action Plan" that specified, among other items, the need for government action to spur industry growth. According to the Action Plan, the government needs to help:

- Increase technical knowledge and understanding of Idaho's geothermal resources and their uses;
- Promote financial assistance for geothermal energy projects;
- Promote innovative and broader use of geothermal energy; and
- Promote opportunities for geothermal electric power development[29].

This includes the need for federal and state programs that create awareness about multiple uses of geothermal resources (i.e. electric power, distributed generation, and direct use). The Action Plan suggested education workshops on these uses, resource assessments in promising areas, and working with universities, federal institutions and private industries to collaborate on research programs. All of these activities are currently being performed. It also suggested using federal and state cost-share programs and loan guarantees. So far, only GRED has addressed those suggestions.

Ultimately, the purpose of the Action Plan was to set in motion a network of support to enable groups who can use geothermal resources to do so; whether they are communities, local businesses, industries, rural electric cooperatives, or large Investor-Owned Utilities (IOUs). Furthermore, the Action Plan recognized that geothermal resources are a public good, and thus deserve incentives for their use[30].

Since the Action Plan was finalized, federal involvement in geothermal research in Idaho has seen increased activity. This includes the ongoing activities mentioned above, as well as funding for research at the IDWR Energy Division and research being performed at Boise State University, Idaho State University, and the University of Idaho. Both Boise State and the University of Idaho are participants in the Intermountain West Geothermal Consortium (IWGC). The IWGC is designed to conduct geothermal research throughout the West and is comprised of members from academic institutions in Idaho, Nevada, Utah and Oregon and geothermal research staff from the Idaho National Laboratory[31]. According to the director of the IWGC, Dr. Walter Snyder, the function of the IWGC is to target both on-the-ground research applicable to both exploration and development, and to provide new data, readily accessible to make use of this information easier and to maximize the impact of the research investment dollar.

Researchers say that for the IWGC to make real progress in Idaho, they need funding to perform exploration drilling. Most agree that the volume of geothermal prospects in Idaho (as described in the previous section) is impressive given the lack of subsurface exploration. Researchers say that the characterization of Idaho's resources is far behind states like California and Nevada, where previous exploration work exceeds that conducted in Idaho by an order of magnitude. The best guess by even the most knowledgeable researchers in the state is that Idaho could sustain anywhere from a handful of geothermal power plants to rivaling Nevada or even Southern California in recoverable resource. Where the resource falls between these two extremes depends on how much of the resource in Idaho contains fluid that can sustain substantial flow rates or whether high temperatures encountered in deep wells lack fluid, or rest in confined structures that are not accessible through conventional hydrothermal wells. Researchers classify this uncertainty as a lack of understanding of how geothermal systems in Idaho operate. However, most agree that because Idaho is not well defined, there exists a unique opportunity for new discovery. Researchers suggest that Idaho is a candidate for a deep drilling exploration program, similar to those that helped characterize the resource base in California and Nevada in the 1970s (leading to the nearly 40 geothermal power plants built in those states during the 1980s).

Federal budget

Because government programs have been essential to industry resurgence, continued support is critical for the industry to maintain its current momentum. One issue that has come up repeatedly is the importance of the USDOE Geothermal Technologies program in funding exploration, assisting new development, and fostering technological breakthroughs. High energy prices are fueling the demand for alternative energy, and planned geothermal power projects currently under development could represent an increase of over 67 percent in total geothermal energy capacity in the next 5 years alone[32]. However, despite the need for greater government support when the industry is re-emerging, funding for the program has declined significantly in recent years. In fact, the FY 2006 appropriation for the USDOE Geothermal Technologies program is 16 percent lower than the average budget from 1990-1999, even without accounting for inflation[33]. Of more pressing concern, at the time of this writing the FY 2007 is still uncertain, and might possibly be zeroed out.

Considering that the Bush Administration is attempting to reduce federal budget deficits, it is important to raise awareness on how geothermal resource development can help reduce these deficits by creating economic development and positive economic multipliers. For example, the Raft River project may not have come to fruition without federal funding, and most agree that the benefits of the project will far outweigh the initial federal expenditure, especially if its development spurs new power plant projects in the state.

Most agree that if research is combined with cost-sharing new developments, the federal government will help maximize their research dollars. Federal funding for demonstration projects for new technology, GRED, cost-shared drilling, and loan guarantees, have been successful in the past. A new round of loan guarantees for several alternative energy sources has recently been made available by the USDOE, although geothermal was not explicitly included, along with the other technologies listed, at the time of this writing.

College and university programs
Another point that has come up repeatedly is the importance of college and university research programs. Funding for these programs does more than improve technology and resource identification; it helps the industry continue to grow. Many experienced geothermal professionals are retiring and funding for college and university programs create opportunities for experienced geothermal professionals to share their knowledge with the next generation. Developers contend that a new generation is essential to make up for an experience gap in the industry and a lack of manpower available to work on new exploration and new projects. University research programs offer promising ways to perform exploration studies at low costs. For example, using new computer technology, several existing programs have enabled students to review satellite imagery of geothermal resource areas from on-campus computer labs.

Although federal funding is one way to keep these programs strong, there is a general consensus that state and private funding should be pursued, rather than depending solely on federal grants which may vary with each budgetary cycle. Both state grants and scholarships can be helpful as well as the pursuit of private endowments that can expand existing programs. Being that geothermal energy is a renewable power source, clean energy advocates assert there should be an impetus for private contributions.

Reviewing and updating existing data
In addition to on-the-ground exploration efforts and university programs, several interviewees point to the need to review and update existing data. For instance, well over a century of mining and mineral exploration, geological reports, documents, and studies are sitting in archives. At the time this information was compiled, the discovery of high-temperature fluid may not have been considered valuable, and thus was not publicized. Efforts to review these documents and update existing data are underway. For example, the Idaho Geological Survey (IGS) is digitizing and mapping the state's oil and gas wells (although the scope of this data is limited). Furthermore, after the establishment of the Idaho Geothermal Energy Working Group, key participant, the IDWR Energy Division, was awarded a $75,000 grant, of which part went to update the state's geothermal database. Researchers say that they would like to review even more archive data, but the necessary time and funding are not available.

In an effort to preserve and make more accessible previous geothermal studies, the Office of Scientific and Technical Information (OSTI) at USDOE has created a searchable internet database of existing reports, which includes geothermal studies. The OSTI database provides a valuable new tool to examine existing data throughout the website.

Outreach

Among government programs, both federal and state, the least expensive is outreach. Outreach requires no drilling, no leases, and no transmission lines. Both the state and federal government can be involved, as well as industry. The GPW program has been the major federal effort in this regard. They have engaged the state government and helped foster greater activity in networking and outreach to local communities. For example, in October of 2006, Odyssey Idaho was held in Boise with several sponsors, including the state government and Idaho Power, which discussed, among other things, renewable and sustainable forms of energy. In early November of 2006, the Idaho Geothermal Working Group held a meeting in Boise, preceded by a geothermal energy development workshop in Murphy in Owyhee County. A meeting was also held in Cascade on November 8th, which included a presentation by United Technologies (UTC), manufactures of the ORC unit at Chena Hot Springs.

Most agree these efforts are a good start, and must continue. The Strategic Plan asserted the need for the state to "institute, sponsor and/or coordinate educational programs, and activities (e.g., workshops, symposiums, etc.) to promote the uses of geothermal energy."[34] Several interviewees suggest encouraging K-12 science curriculum to study geothermal resources and organize field trips to existing facilities. In fact, the owner of Edwards Greenhouse in Boise regularly offers tours of her greenhouse facilities to elementary school students, however the effort is localized and not part of an organized state effort. Most agree that an organized state effort is important because Idaho businesses, as well as the public, are still relatively ignorant about the ability of geothermal resources to supply their power and thermal needs.

Regulatory needs

To develop a project requires more than a resource and a market for the power; it requires a regulatory environment that encourages development. The regulatory process for geothermal development varies from prospect to prospect. Some geothermal resources are located in remote areas, far from transmission. Some are located in areas near population centers where water rights and water uses are contentious.

Geothermal resources in Idaho are designated as separate from water and mineral resources. Geothermal resources are defined as those with ground water having a temperature of 212°F (100°C) or more in the bottom of a well. However, the state regulations further describe geothermal resources to be sui generis, "… being neither a mineral resource nor a water resource, but they are also found and hereby declared to be closely related to and possibly affecting and affected by water and mineral resources in many instances."[35]

Rights to use a geothermal resource must be obtained from the state, with the IDWR as the lead agency responsible for administering and enforcing these rules. If a power plant uses water-cooling (as will the Raft River power plant), additional water rights must be secured for consumption of the cooling water. Because of the value of water, geothermal developers generally pursue air-cooling for their power plants. For the most part, past demonstrations of air-cooling have resulted in less efficiency during the summer months. However, the trade-off has been reduced expense and complexity compared with water-cooling.

State and private land
While most agree that the regulatory process in Idaho for state and private lands are less prohibitive to electric power development than on federal land, there are measures that can be taken to improve the process. Developers' say that state land is perhaps the least complicated to lease, however, they have issues they would like to see addressed. For example, leases on state lands must be procured in one-section blocks at a size of one square mile. Leasing a section of state land cost roughly $2,000, so a developer may have to spend extra time and money leasing multiple tracts. Even if the developer is interested in a smaller piece of land, he or she may still have to pay a full section fee. In addition, royalty rates for state leases are higher than for federal leases.

On private lands the leasing of the land is subject to negotiation between the landowner and the developer. However, developers say that there may be concern over the complexity of land and resource ownership. In Idaho, this confusion creates a disincentive to explore, even on private land, because it is often unknown if landowners own the geothermal rights to their land. They also worry about lawsuits over water rights, especially during drought years. It is uncertain whether or not that issue will be addressed by Idaho's ongoing water adjudication process, which seeks to clarify water rights ownership throughout the state, including on federal lands.

One thing that is certain is that water is precious in Idaho and needs protection. Often there is concern from regulators that a geothermal operation may interfere with a nearby water right, drying up wells used for various purposes, such as hot springs, domestic water, or irrigation. Although such an occurrence is rare (and less common today with current technology) in an extreme case, this concern could cause a power plant to be shut down, even if no drying up of other wells were to take place. For this reason, most agree it is critical that funding is available to hire experienced regulatory staff qualified to work effectively with developers to prevent these issues from occurring.

Despite Raft River using water-cooling, researchers say the plant will use far less water than equivalent megawatt-hours (MWh) from conventional power facilities such as natural gas, coal, or nuclear. According to the Strategic Plan, water policies are critical to the success of geothermal projects, and the state should promote water policies that encourage the use and development of geothermal energy by:

a. Utilizing expertise from the Idaho Department of Water Resources to clarify rules and regulations of use to geothermal energy;
b. Identifying water policies that are a barrier to geothermal development; and
c. Formulating, proposing, and promoting changes to water policies[36].

Federal Lands
Acquiring federal lands has been a challenging prospect for developers in Idaho. For one thing, drilling for geothermal resources on federal land requires both state and federal permits. Requirements on these lands include obtaining federal leases, drilling permits, construction permits, commercial use permits, right-of-way grants for roads, pipelines, transmission lines, and communication sites, etc. along with accompanying environmental assessments. As in the state definition, geothermal resources on federal lands are not considered water resources. However, unlike the state definition, they are considered a mineral resource, and are treated as such in the federal regulatory process.

The federal government manages approximately 64 percent of the surface acreage and approximately 69 percent of the mineral acreage in Idaho. About 39 percent of Idaho lands are managed by the USFS, and about 22.5 percent of Idaho lands are managed by the BLM[37]. Many of the promising geothermal resources areas in Idaho would involve working with the BLM or USFS to develop. Developers contend that complicated permitting on federal lands has constrained investment in many of Idaho's most promising geothermal prospects.

While some exploration may take place without a lease, exploration well drilling will not due to the substantial risk of drilling on property without acquisition. Developers in Idaho say they had been reluctant in the past to take the risk to submit a lease and drill on federal lands without a guarantee that they will be able to complete the project in a timely manner. This has particularly been a concern on USFS land. The USFS and the BLM are in two different federal departments [USFS is part of the U.S. Department of Agriculture (USDA) and the BLM is part of the U.S. Department of Interior (USDOI)]. However, when developing on USFS land, projects are subject to regulations from both agencies. While the BLM ultimately processes a USFS lease, exploring for geothermal resources on USFS land may require changing a forest plan to incorporate geothermal development.

Many of Idaho's most promising resource areas include surface and/or mineral acreage managed by the USFS, including Big Creek Hot Springs, Boiling Springs, and Vulcan Hot Springs. Several others include surface and/or mineral acreage on BLM lands, including China Cap, Magic Hot Springs, Willow Springs, and part of the Crane Creek Hot Springs geothermal system. By February of 2002, there were no geothermal leases on federal lands in Idaho. However, as of August 2006, there were three federal leases issued and 12 pending lease applications under review in four of Idaho's most promising resource areas. According to regulators, part of the impetus for the change has been recognition of the value of the resource and intensified efforts towards securing renewable resources based on rising energy costs; issues that factored into the regulatory changes authorized by the U.S. Congress in the Energy Policy Act of 2005 (EPAct).

EPAct

In EPAct, several actions were taken to facilitate geothermal development on federal lands. EPAct authorized additional funding for regulatory agencies (including the BLM and USFS) to help them meet new requirements for processing leases and permits for geothermal prospects and projects, and requires all future USFS and BLM resource management plans to consider geothermal leasing and development in areas with high geothermal resource potential. Furthermore, these new regulations changed the royalty structure for power plants to send 25 percent to county governments[38]. Several interviewees touted this policy as an effective incentive for communities to pursue geothermal projects for economic development.

As for the USFS in Idaho, where several lease applications are now being processed, the policy changes in EPAct led to a Memorandum of Understanding (MOU) between the USFS and BLM. Regulators say that the MOU, signed in the spring of 2006, has already improved interagency coordination which had been virtually non-existent for years, with no leases for two decades prior.

Additional implementation needs

At the time of this writing not all of the changes authorized in EPAct have been implemented or received full appropriations. There is concern, particularly from developers, that delaying these changes will stunt some current development and planning. There is a general consensus that, in their existing capacity, regulatory agencies in Idaho (both state and federal) lack both the experience and the quantity of staff sufficient to handle a large increase in geothermal lease and permit applications. Educating staff is considered a priority. A geothermal 101 training to discuss the basics of geothermal development on USFS land is being considered, and would be valuable. One Idaho-based researcher submitted a proposal to the USDOI for that purpose.

Most agree that the MOU between BLM and USFS is a good first step. However, land use amendments are difficult to change. Regulators say they can be simplified if they allow for amending part of a plan to incorporate a geothermal project, instead of a whole plan affecting a large area, although even this takes considerable time and effort. To resolve this issue, there is consideration for developing a Programmatic Environmental Impact Statement (PEIS) that would cover all BLM and USFS lands in the Pacific Northwest and the Great Basin in order to conduct these efforts in a broader context. A similar effort was performed for wind development to clear the way for several new projects being constructed on federal lands in the Pacific Northwest, including Idaho. Similar to wind, a geothermal PEIS would evaluate the potential impacts associated with the developing geothermal resources including the adoption of policies and best management practices (BMPs) and the amendment of land use plans to address geothermal energy development[39]. There is concern that a PEIS would take longer than other methods, or might affect projects currently under development. However, regulations clearly specify that a PEIS should not impact these ongoing projects or lease applications currently under review. In addition, similar to the wind PEIS, there are efforts to streamline the permitting process to support the increased interest in developing geothermal resources on these lands.

The PEIS would be a joint effort of the BLM and the USFS. Most agree it is important for BLM and USFS to continue working together to ensure that leases are processed in a timely manner, and to return decisions on environmental reviews in such a way that impacts are understood and issues are resolved. This effort will help ensure that National Environmental Policy Act (NEPA) processing and compliance is fully funded. The PEIS is intended to create a predictable set of timelines for approval or disapproval of development plans, to reduce uncertainty and encourage investors to finance these projects.

The need for adequate government incentives

Although new regulatory changes have the potential to facilitate exploration and development, geothermal developers in Idaho say these changes need to be coupled with appropriate government programs and incentives to enable geothermal projects to become more competitive. In the past, government incentives were used to secure needed financing for geothermal projects. There is a general agreement that similar incentives could be applied today and produce a similar result in Idaho. The challenges, according to researchers, are economic, political, and cultural. However, federal and state incentives could complement outreach, education, and industry involvement to encourage more development opportunities. Researchers conclude that successful near-term development depends upon lawmaker action as much as upon the characteristics of the resource itself.

Federal incentives

The Raft River project is an excellent start for the geothermal power industry in Idaho and developers say that two policies have been essential to the project's success. The first (and most important) is the Federal Production Tax Credit (PTC), which provides a subsidy of 1.9¢ per kilowatt-hour (kWh) for 10 years. In EPAct, the PTC was extended until January 1, 2008, and based on the volume of new projects being developed in the U.S. and renewed interest in Idaho's resources, it is clear that the PTC extension immediately enabled more planned geothermal projects to move forward. However, developers say that for more geothermal prospects in Idaho to be cost-competitive, the PTC needs to be extended for a period that realistically covers the 3-5 year time frame for development of a geothermal project. The consensus is that an extended PTC, combined with effective government programs and outreach efforts, will reduce uncertainties and risks for developers and encourage more private investment.

The second policy that is essential to the Raft River project has been the rules designated by the Public Utility Regulatory Policies Act of 1978 (PURPA). Although PURPA is not considered an incentive, it helps create a market for small renewable energy projects by obligating regulated utilities to purchase the power, at rates equal to the utility's avoided cost (i.e., "the incremental cost to an electric utility of electrical energy or capacity or both which, but for the purchase from the qualifying facility, such utility would generate itself or purchase from another source")[40]. The implementation of PURPA regulations varies from state to state. In Idaho, avoided cost rates for facilities averaging 10 MW or less (like the Raft River plant) are based on the cost of a natural gas-fired combined cycle combustion turbine, which results in a higher value for the "avoided cost" than might be encountered in other states. These rates are adjusted periodically based on natural gas forecasts.

PURPA contracts are available for geothermal facilities up to 80 MW (unlikely to be exceeded in the near-term by new geothermal power plants in Idaho). The maximum length of a PURPA power contract in Idaho is currently 20 years. Developers say that PURPA has been relatively successful in Idaho, producing approximately 100 contracts for small renewable power facilities. Most of these facilities are small hydroelectric; however wood-fired, wind, and a landfill gas facility have also received PURPA contracts since its establishment. Because PURPA does not restrict where the facilities can be built, many of these facilities are located out-of-state, but serving Idaho customers. The primary incentive for developing projects in state is to avoid wheeling costs. Idaho customers pay for the costs of PURPA facilities through additional rate charges. Although PURPA has been recently amended on the federal level, Idaho regulators say this will not change existing regulations in Idaho.

State incentives

While most agree that PURPA has been effective based on Idaho's implementation of the policy, efforts towards passing a Renewable Portfolio Standard (RPS) have made little progress. Like PURPA, the RPS is not technically an incentive; however it facilitates a market for renewable power. Based on the geothermal potential in Idaho, in addition to the potential of wind, solar, and biomass clean energy advocates suggest that an RPS of 10 percent by 2020 (which matches the proposed federal RPS that passed the U.S. Senate in 2005) would likely be attainable (considering non-hydro sources)[41]. However, despite the feasibility of meeting this standard, those familiar with the political culture in Idaho say that support for an RPS is unlikely in the near-future.

Still, recent policy decisions indicate that Idaho legislators are warming to policies friendly to geothermal development. Although the Idaho state government has spent little money on geothermal exploration, research, or development, the legislature passed a sales tax exemption for equipment used in the construction of renewable power facilities in 2005[42] and a state renewable production tax credit of 0.5¢ per kWh passed through the legislature one year earlier, but was vetoed by the governor due to fiscal concerns.

As energy issues intensify, clean energy advocates say they expect more support for geothermal resource development to come. One reason for this is that over the past two decades Idaho's usage of hydroelectric power has declined. In the early 1980s, Idaho customers received nearly ¾ of their power from hydroelectric sources. As energy demand has grown, and the supply of hydroelectric power has not increased (especially during drought years), it now makes up a smaller piece of the pie. In 2004, for example, the state's largest utility, Idaho Power, relied on hydroelectric generation for only 45 percent of its power generation, relying mostly on out-of-state coal-fired generation for the rest[43]. As noted above, salmon recovery issues in the Pacific Northwest will likely limit future development of hydroelectric dams and may affect some existing facilities in the region.

In April 2005, the Idaho legislature enacted the Renewable Energy Project Bond Program to complement the creation of the Idaho Energy Resources Authority (authorized by the state legislature in March of 2005). The program has the authority to issue revenue bonds to help finance renewable energy projects. Because geothermal developers often have trouble obtaining financing, this program has the potential to support such projects, and do so at lower interest rates than private banks. As of September 2006, the Authority had yet to finance a project and receives no state funding. However, clean energy advocates say the creation of the program is still a step in the right direction[44]. They say that loan guarantees would be a further step that could encourage development, although it is more likely that loan guarantees substantial enough for power projects are a more feasible solution on the federal level.

What can Industry do?

While clean energy advocates working with the state legislature agree that there has been a great deal of recent interest and activity relating to geothermal energy over the past several years, they say that geothermal industry presence in Idaho has been too quiet. They assert that in order for geothermal resource development (both power production and direct use) to receive broader inclusion in future policy decisions, more outreach and a unified advocacy effort from the industry is essential to remain on the public and government radar. This includes working more closely with other clean energy advocacy groups on state legislative issues and working with community leaders, local businesses, and environmental and civic groups to coordinate on proposed projects.

One reason geothermal industry presence is needed in the state is because most clean energy advocates in the Pacific Northwest are located in Washington State and Oregon, where policies have been more favorable towards renewable development. The most active of these groups today is the Northwest Energy Coalition; however, even they have small representation in the state, and their Idaho office was established only in 2004. Advocates say that the geothermal industry can be a leader for the clean energy community in Idaho. The abundance of the resource and the presence of direct use facilities give them a noticeable position in Idaho's energy future. In fact, one clean energy advocate expresses surprise that the geothermal industry is not more organized to contend with the ongoing water adjudication process in Idaho that can affect both direct use and power projects.

Another issue most agree is critical for industry involvement is the State Energy Plan. Idaho has not updated its existing energy plan since 1982, and the new plan is expected to be completed in early 2007. Government agencies working on the plan say its impetus has been rising energy costs, load growth, and Idaho's increasing reliance on out-of-state coal generation. The plan, once completed, will focus on ways to better inform energy incentives, facility siting, transmission siting, and to deal with new challenges that have occurred in the past quarter-century. Clean energy advocates say they expect that out of the plan will be recommendations for several possible incentives and related programs to encourage and nurture new geothermal development. At the time of this writing, an Interim Committee on Energy, Environment, and Technology and its various sub-committees has already met several times in August, September, and October and has started developing policy recommendations to be submitted to the full committee for consideration. This includes looking closer at geothermal energy and how the state can help shape its future role through state energy policy. The directive from the legislature asking for an updated energy plan was sent to Governor Dirk Kempthorne in March of 2006 before he was appointed as the Secretary of the Interior. Action on the plan is not likely to take place until after Governor Butch Otter begins his Administration in January, 2007[45].

As the pressure towards reducing greenhouse gas emissions intensifies, it is unlikely that coal plants will be built in Idaho. Idaho Power currently operates three large out-of-state coal-powered generation facilities to meet most of their base-load power needs; located in Nevada, Oregon, and Wyoming. In fact, interim-Idaho Governor, Jim Risch, moved to bar coal-fired power plants from Idaho by directing state environmental regulators to opt out of a federal mercury trading plan under the federal Clean Air Mercury Rule. The impetus for this decision is, in part, due to the fact that Idaho already meets standards for coal emissions, since no coal-fired facilities are located in the state. In addition, significant water use requirements present a challenge to building coal as well as nuclear facilities in Idaho.

With the current limitations on building coal facilities in the state, four municipal utilities (in Burley, Heyburn, Idaho Falls, and Rupert) have considered buying into the Intermountain Power Project Unit No. 3, a coal-fired power generating station slated for construction near Delta, Utah. The decision to contract debt to acquire power from this facility was left to voters in these communities on November 7th, 2006 and the measure failed in every one, except for Idaho Falls.

The needs of the power market

In evaluating the potential for geothermal development, most agree the impetus to utilize renewable power in Idaho has traditionally been driven by the utility sector. Unlike oil, coal, and natural gas, geothermal energy cannot be shipped. Geothermal power plants must be built at the location where the resource exists, and the power transmitted to populations within the region. While the geothermal resource base in Idaho may be significant, it will not be developed unless it can be produce power that is economically competitive.

According to IDWR in 2002, criteria for successful prospects include the right location (i.e. proximity to markets and/or power grids and approximate population served) and the potential for electrical generation (i.e. water temperature, water flow rates, aquifer geology, and the sustainability of geothermal flows)[46]. These conditions will dictate the electricity rates sold by a geothermal project and the likelihood of utilities purchasing electricity from the project.

Transmission access issues

There is a general consensus that transmission access remains a barrier to geothermal development in Idaho. Procuring remote geothermal resources is limited by the capacity of Idaho's transmission infrastructure. Much of the infrastructure was built in the past 50 years, and as the state population has grown, some transmission lines have begun to reach capacity limits, (even with subsequent upgrades). Geothermal resources that are remote from loads add to the costs of any project under consideration. Because utilities are not required to cover the transmission costs for projects that they do not own, these costs fall on the developer.

While efforts towards transmission upgrades are included in Integrated Resource Plans (IRP) for utilities, transmission costs for developers depend on the distance of the resource from existing transmission infrastructure, whether the existing transmission lines in the area are at or near capacity, or whether power lines built to connect to the nearest transmission grid would have to cross federal lands (thus requiring NEPA analysis). Much of the transmission constraints for

Idaho customers exist outside of the state. Most of the transmission goes east-west across the Snake River Plain and is limited once the resource is far away from this primary transmission grid.

Investor-Owned Utilities (IOUs)
In Idaho, most of the load is served by IOUs. In 2004, its top three providers of retail electricity were IOUs. Idaho Power provided 57.7 percent, covering areas mostly in southern and central Idaho not served by cooperative and municipal utilities. Its largest customer-base is Boise and Treasure Valley -- both areas experiencing considerable load growth. The second largest IOU in Idaho in 2004 was PacifiCorp at 15.0 percent, serving eastern Idaho, including Arco, Montpelier, Preston, Shelley, and St. Anthony. Third was Avista at 14.8 percent, which serves Spokane, Washington and Idaho's northern panhandle. These three IOUs represented 87.5 percent of Idaho retail power sales in 2004[47].

According to utilities and utility regulators, IOUs are risk averse to projects that raise the costs for its ratepayers. Any utility that considers a geothermal project must go through the process of costs and benefits to determine the levelized cost of power versus other renewables and non-renewables. The PTC (discussed in the previous section) is considered the most important government policy affecting geothermal power acquisitions. For many projects, it is the difference between its success and failure. According to utilities serving Idaho, if the PTC is not extended, or it is only extended for two or three years, a more effective policy would be to change the placed-in-service date requirement so plants under construction by that date can get credit for years that the plant is online. This would mean, under the current PTC deadline, if a plant is under construction by December 31st, 2007, and comes online in 2008, it gets the credit for nine years; online in 2009, it gets credit for eight years; online in 2010, it gets the credit for seven years, etc. Utilities say this policy change would stop the "placed-in-service cliff" that occurs when the PTC expires; making the cost of power more predictable and encouraging investors and utilities to pursue more geothermal projects.

While the prospect of geothermal energy as "green power" has been a draw for utilities, developers say that efforts to acquire geothermal power projects are a recent phenomenon in Idaho. For example, in 2004 Idaho Power issued a Request for Proposal (RFP) for up to 100 MW of geothermal energy in Idaho by 2009 and in 2006, its proposed IRP has expanded that number to 150 MW, but over a longer time period[48]. In Idaho Power's 2004 RFP, it offers 20 year PPAs to projects of 30 MW or more and is considering 30 year PPAs. In 2005, Avista issued an RFP calling for the acquisition of 400 MW of wind resources, and 80 MW of "other renewable resources" by 2016. Utilities say that the drivers for these RFPs are the need for diversification and the recognition that geothermal power projects are becoming an attractive base-load alternative.

Idaho Power states that for its RFPs, projects must be cost-competitive, although no specification for the price per kWh is specified. It must be "located inside, or in close proximity to, the Idaho Power Company service territory providing first-call physically delivered electrical energy… [and]…the developer will be solely responsible for all transmission analysis associated with the initial bid submittals." Alternative contracts include ownership by the utility, transfer agreements, partnership arrangements, utilizing alternative financing, preferred maintenance agreements, sharing of commercial risks, or utilizing utility-provided land[49].

These utilities have also initiated green power programs. Avista has a "Buck a Block" program for wind energy, allowing customers to pay a minimum of $1 extra per month. PacifiCorp allows customers to sign up for its Blue Sky program for a minimum of $1.95 extra per month. Idaho

Power offers a green power program for a minimum of $3 additional per month. Each of these programs helps finance renewable power projects[50]. However, the growth of these programs are limited by the amount of customers who sign up, and how much extra they pay on their monthly bill. Despite the small surcharge, utilities say that the percentage of customers participating in these programs remains small. Clean energy advocates assert that utilities will only do so much marketing themselves and it is essential that other entities, including environmental groups and the state government, be involved as well. Furthermore, it is important to show actual projects these programs help finance to give customers an objective understanding of how their contribution makes a difference in the energy they use.

Rural Cooperatives and Municipal Power

While IOUs serve the majority of Idaho customers, many of Idaho's smaller communities are served by their local municipal utilities and rural co-operatives. Because many of Idaho's geothermal resources are located in rural areas, most agree it is prudent to consider the policies affecting these utilities that could encourage greater use of geothermal power.

Over the past couple decades many of these communities have been served by out-of-state hydroelectric power from Bonneville Power Administration (BPA). However, after drought has reduced hydro supplies to the region and higher energy costs in California have affected BPA's load growth, rate increases have affected customers being served by BPA all over the Pacific Northwest. Higher rates have not only initiated changes in how BPA may serve its customers in the future, it has also raised awareness of the potential to use local renewable resources to serve rising load growth in Idaho's small communities. The ORC units being utilized at Chena Hot Springs have created renewed interest in using small power units to serve local loads. For example, 1 MW of base-load geothermal can serve nearly 1,000 homes and many communities in Idaho have fewer than that.

One suggestion offered by several interviewees is for an analysis of geothermal resources located near existing transmission serving rural co-operatives and municipal utilities. This analysis could evaluate local hot springs and geothermal resources based on development potential of small power projects. Technological and resource parameters, the distance from transmission lines, and the potential price of power could be assessed. In addition, economic development potential and employment needs in the community could also be factored in to determine how this development might benefit the local area. This includes consideration of local industry and mining operations which may be located in rural areas, and can utilize small-scale power units[51]. Existing studies of geothermal resources in Idaho clearly indicate potential for these types of projects throughout the state.

Currently, the prospects for using small-scale geothermal power units depend, in part, on the outcome of ongoing regional dialogue between BPA and its customers. This dialogue will determine how the BPA load will be allocated, and whether or not utilities will be able to serve their own additional load using indigenous resources, like geothermal. Such development may be enhanced by the availability of federal Clean Renewable Energy Bonds (CREB) that encourages development of renewable resources by assisting municipal utilities and rural cooperatives in purchasing Renewable Energy Credits (RECs).

Role of Government

The state government can enact policies that encourage municipal utilities and rural cooperatives to pursue geothermal development. While keeping electricity rates low may be the most important criteria for power procurement by utilities, it is not the case for government. The government considers economic development, environmental quality, and the benefits of energy independence as well.

The Idaho Public Utilities Commission (IPUC) requires regulated utilities to prepare IRPs to forecast supply and demand, and specify options to meeting load growth considering cost reliability, long-term risks, and environmental impacts. Regulators say that geothermal has an advantage in the IRP process because of its low risk of fuel-price volatility and its environmental benefits, including low emissions of greenhouse gases. However, developers say that based on the near-term costs of geothermal power plants, and the risk adverse natures of utilities, these measures are not sufficient to drive the market.

For instance, in compliance with the IRP, Idaho Power runs a computer model called Aurora, which takes all inputs from the IRP, including environmental benefits, and calculates what they are worth to the utility, reflecting what the price it would pay for geothermal compared to other resources over the life of a power contract. In the model, 50 MW of new geothermal was one of the cheapest alternatives, even without the PTC[52]. However, most agree that these numbers, while promising, do not fully encapsulate the additional costs of transmission access, exploration, regulatory delays, and volatile drilling costs, not equivalent to cost factors for conventional fossil fuel plants.

To mitigate for these additional cost factors, several interviewees suggest that measures can be taken to help utilities recover the costs of purchasing renewable power projects. For instance, when utilities purchase power from an outside party (such as a geothermal developer) the power purchased becomes imputed debt. In several states, policies have been utilized that allow utilities to recover the incremental costs of purchasing renewable power. This includes rate flexibility mechanisms such as mark-ups and systems benefit funds, which allow utilities to increase rates that would go towards funding alternative energy projects. The success of these mechanisms depends on the existing price of renewable power and the political attitudes towards these policies. In Idaho, some utilities are dubious that such policies would make a significant difference, since they are adverse to raising rates in the first place.

On the federal level, there is a clear opportunity for a carrot and stick policy. As discussed before, government programs reduce risks for developers, while incentives like the PTC reduce the price of power to be sold to utilities. However, perhaps the largest unknown policy factor is the potential for carbon taxes or the use of renewable energy for carbon credits. Such policies not only adjust the market towards clean energy projects, but also raise the value of renewable power projects in utilities' energy portfolios.

Regional Transmission Organizations (RTOs)

Perhaps one of the most significant policies that can impact the power market in Idaho is the implementation of RTOs. Developers note that because a project is localized, in most cases they do not have the option of negotiating with utilities other than the one with the closest utility lines. Thus, proponents say that if RTOs are expanded throughout the western U.S., they might possibly reduce transmission tariffs to postage stamp transmission rates for electric generation traveling across utility wheels. Such a system might be structured to avoid rate pancaking across multiple owners, and enable a more transparent market conducive to broader, long-term planning needs for entire regions. RTOs may encourage coordination on transmission projects cost-shared by multiple partners to serve a larger volume of customers and disperse the costs and risks. In the existing non-RTO structure, a utility could charge a tariff even if generation travels through its system for less than the length of a football field.

For Idaho's resources, an RTO might more easily enable developers to sell to larger markets where clean energy is in greater demand and where the costs of renewable power is more competitive with conventional sources, such as California. In addition, an RTO might reduce economic hurdles in selling to nearby cities, such as Salt Lake City and Spokane. An RTO based on this model was first proposed in 2000, later called the Grid West RTO. Grid West defined its purpose as "creating a new, independent, non-profit corporation that plans and manages certain operational and commercial functions of the regional transmission grid." The RTO would have covered the Pacific Northwest and parts of the intermountain West (including Washington, Oregon, Idaho, Nevada, Utah and parts of Montana, Wyoming and California) and would have had authority to raise transmission rates and build infrastructure. While some say this was a revolutionary concept and there was considerable interest when originally proposed, as the project moved ahead there were concerns over bureaucracy and complexity, and after several years of negotiating between major utilities in the Pacific Northwest, the Grid West RTO was scrapped. More recently, a new RTO has been proposed called the "Columbia Grid" that would have less authority on rates and infrastructure, but would be able to help guide planning and centralize information[53].

The need to establish uses of distributed generation

There is a general consensus that distributed generation is one practical way to use Idaho's geothermal resources. Most agree that geothermal projects under 10 MW have generally had trouble negotiating a power contract with a utility, even with PURPA. However, new developments in the geothermal industry have made distributed generation a real possibility in Idaho. As discussed above, there are many potential opportunities to use a system similar to the one installed at Chena Hot Springs in Alaska. Researchers contend that while high-temperature geothermal resources [>302°F (150°C)] generally require deep drilling, 200°F (93°C) geothermal resources are more widely available at shallow depths.

Because geothermal power plants have high-upfront costs, a small project can take several years to recover these costs before a profit is made. However, if a distributed generation project makes a product instead of, or aside from, electrons onto the power grid, return on the investment may be recovered earlier, and profits may be higher. For example, several consultants point out that small power units can be used both to produce power and cascaded heat for multiple uses all in one integrated system. This is especially relevant to sites with existing direct use facilities (if sufficient temperatures are present). In addition to the project at Chena Hot Springs, this concept has been demonstrated before in New Mexico and Nevada. Such a system could be possible for existing power plants to use the resource for additional businesses. Researchers say power facilities being built at Raft River could possibly use re-injected water for cascaded heat for greenhouses, aquaculture, dairy processing, or other uses to produce additional revenues -- although such a project is not yet in the works.

Several consultants and researchers throughout the western U.S. note recent interest in using geothermal resources to produce alternative fuels, which are notoriously energy intensive to develop[54]. Proponents of these projects suggest that a large-scale ethanol, bio-diesel, or hydrogen development plant could use small-scale geothermal power units (5-10 MW). Furthermore, several of Idaho's most promising resource areas (including Crane Creek, Mountain Home, and Rexburg) are near rail lines and major interstate highways that can transport alternative fuels to emerging markets in California.

In general, proponents of distributed generation projects suggest the advantages of these units are: they can be off-grid; not requiring additional transmission lines or procuring a PPA; and they do not have to work through a lengthy utility regulatory process. Furthermore, because they produce a product to sell beyond electrons for the electric grid, they have the potential to provide more revenue and more jobs than a power plant of equivalent size. Those considering these projects point out that the capital costs of small power units might be more per-kWh than a utility would be willing to pay, but might still be lower than the retail power price the utility would charge.

Most agree that the range of possibilities for these technologies has not yet been fully considered. Developers say the challenge is in creating a market. For instance, they assert that in order to profitably produce small power units they need enough resource areas and enough willing buyers to enable mass-production. One challenge is whether these units will need to be custom made for each individual site, or whether they can operate (with only small adjustments) anywhere a suitable resource exists. However, considering its resource base, there is a general agreement that small power units represent a great opportunity to open up more of Idaho's geothermal resources to development.

Geothermal Direct Use Development Needs

The geothermal-heated Idaho State Capitol. Photo taken by Daniel Fleischmann, GEA

Idaho has a long history of using geothermal direct use. As discussed above, the first geothermal district heating system in Idaho established in Boise 114 years ago. Following its development, other facilities in Idaho were developed, particularly for recreation. In the 1970s (after the first energy crisis) additional exploration was done in Boise and elsewhere in order to expand the use of the resource. During the 1980s, several new areas in Idaho began using geothermal direct use applications and by the end of the decade, the use of the Boise Front geothermal aquifer was expanded from the original Boise Warm Springs Water District (BWSWD) system to include four separate systems.

According to a study released in April of 2006, existing direct use facilities in Idaho save the equivalent of an estimated 236.6 gigawatt-hours (GWh) per year with estimates of emissions offsets totaling 231 tons of nitrogen oxides (NO_x), 188 tons of sulfur dioxide (SO_2), and 109,008 tons of carbon dioxide (CO_2)[55]. It is likely that as energy prices rise and new projects come online the numbers above will increase significantly.

Despite a history of geothermal usage in Idaho as compared with surrounding states, researchers frequently express exasperation that these resources are vastly under-utilized. Besides energy savings, proponents of these technologies tout the contribution to economic development, particularly of geothermal-heated greenhouses, which currently employ several hundred workers in the state. In his July 11th, 2006 testimony in front of the U.S. Senate Committee on Energy and Natural Resources, IWGC director, Dr. Walter Snyder, said that the utilization of direct use applications "has allowed local business enterprises to flourish that would not have otherwise been possible."[56]

Much of Idaho's population resides along the Snake River Plain, a consistent source of geothermal heat, yet few communities have taken full advantage of their proximity to available resources. However, there is a general consensus that before geothermal direct use projects can become viable alternatives for more Idaho residents and businesses, the state must take a more active role in promoting them. There is no cohesive "direct use" geothermal industry in the state and there is little incentive to pursue these projects by communities and businesses beyond the energy savings themselves. In addition, most agree that direct use applications have primarily been used in areas where the resource is obvious, and that most of the available resource base is still unknown. The analysis below identifies three specific needs for policymakers to address to greater encourage geothermal direct use development in Idaho. These include:

- Regulatory needs;
- The need to establish markets; and
- The need to close the information gap.

For each of these needs, the analysis below identifies key barriers and proposed policy alternatives that a general consensus believes can reduce constraints and will propel new exploration and development.

Regulatory needs

The IDWR is the lead agency responsible for administering and enforcing the development of geothermal resources. There are separate definitions for a "geothermal resource", which is defined as "ground water having a temperature of greater than 212°F (100°C) at the bottom of the well" and a "low-temperature geothermal resource" defined as "…ground water having a temperature of greater than 85°F (29°C) and less than 212°F (100°C) in the bottom of a well…". Low-temperature geothermal resources used for purposes such as "greenhouse heating, warm water aquaculture, space heating, irrigation, swimming pools and spas, are administered by the IDWR and regulated in accordance with the rules and statutes governing groundwater appropriation and well drilling regulations". A developer "must acquire the resource by means of an application, permit and license procedure, provided that the low temperature geothermal resource is utilized primarily for heat value and secondarily for the value as water". These rules apply to drilling on all lands in the State of Idaho (except Tribal Reservation lands)[57].

Water

One of the main concerns for regulators in Idaho (both state and federal) is protecting scarce water resources. As noted earlier, water adjudication is ongoing in Idaho, currently focused on the Snake River Plain, and some direct use facility operators report that this may affect their use of the resource. Although most agree this effort is necessary, the consequence for some is that they are forced to spend money to hire legal representation to ensure their water rights are protected. Since this process is ongoing, those businesses and people considering new direct use projects may be hesitant to proceed until the adjudication process is finished.

According to a May 2006 report by the Government Accountability Office (GAO), "developers of geothermal resources for direct use face obstacles obtaining appropriations in the Snake River [Plain] of Idaho, which consists of much of the state below the panhandle, because groundwater is fully appropriated there and used predominantly for irrigation."[58] Water is critical for irrigation and the survival of agricultural industries. Water rights can be contentious, especially in years of drought. Water rights in Idaho are like property rights, in that they are granted through the principal known as the Doctrine of Prior Appropriation. This means "those who first made beneficial use of water are entitled to continued use in preference to those who came later." Water rights must also meet the definition of beneficial use. In Idaho, beneficial uses include "domestic use, irrigation, stock-watering, manufacturing, mining, hydropower, municipal use, aquaculture, recreation, fish and wildlife, among others."[59]

In general, unless a user is grandfathered in, the permitting of surface disposal of water may be limited, thus making it difficult for new homes to use geothermal without irrigating, re-injection, or using a down-hole heat exchanger and close-looped system (currently being utilized at Givens Hot Springs and Crouch). Re-injection is critical because in some cases, geothermal resource users from artesian wells have affected other users in the area. However, for existing regulations, re-injection may only be required in critical ground water areas. The IDWR and the Department of Environmental Quality (IDEQ) are the lead agencies in charge of administering and enforcing the various rules and regulations governing water use and water quality in the State of Idaho. IDWR is responsible for issuing water rights, well construction permits and underground fluid injection wells. The DEQ's Water Quality Division is responsible for administering surface disposal of wastewater, including geothermal fluids[60]. There has been an impetus to pass rules and regulations that encourage geothermal development; however, geothermal direct use receives less attention from these agencies when compared with other high-priority water issues.

Federal Lands
Of the numerous direct use geothermal facilities in Idaho, not one is on federal land or is using federal mineral resources. While much of the federal land in Idaho includes its remote southwestern desert and its vast forests and mountain wilderness north of the Snake River Plain researchers assert that federal lands in Idaho contain numerous prospects situated close enough to available markets to be attractive for development. The problem, according to developers, has been federal royalty regulations that discouraged many potential direct use geothermal projects throughout the western U.S. For example, in several other states developers who did attempt projects on federal lands found that the royalty rates were one of the highest costs of maintaining the project. Calculations were based on equivalent power usage, and in some cases would run higher than an electrical power plant would pay for the equivalent amount of energy use.

In addressing geothermal development issues, EPAct authorized changes to the royalty system (although at the time of this writing the final regulations are still under review). Once the new policy is enacted, it is understood that the royalty rates for projects on both BLM and USFS land will be changed to a small fee. This means that nearly 2/3rds of the land in Idaho will be potentially available for direct use projects. As noted above, while not all those lands are attractive for development, or without restriction, researchers suggest there are a multitude of areas that are promising. According to the Strategic Plan, geothermal resources on USFS land could be used for multiple applications, including using greenhouses heated by geothermal to grow seeds to replace fire-damaged rangelands[61]. Another option, suggest researchers, is in Boise National Forest (especially along State Route 21) where none of the numerous hot springs on USFS land are being tapped for geothermal heat, and all the existing direct-use facilities in the area are on private or state land.

Another promising area is between Boise and Mountain Home on I-84. The area is surrounded by BLM land and is virtually devoid of development. However, several interviewees suggest that the area has the primary components for good direct use sites. It rests along the Snake River Plain with abundant low-temperature geothermal systems likely in the area. It is near a large population center (Boise) along distribution pathways by rail and Interstate highway. Although ground water supply issues and the need for new exploration and drilling may be a limiting factor for development in the near-term, most agree the area should still be studied for resource potential[62].

The need to establish markets

Direct use geothermal systems replace thermal uses otherwise produced through electricity or boilers using conventional fuels. Direct use facility operators in Idaho are often passionate about their status as models on how to use sustainable renewable resources to benefit Idaho communities. For example, geothermal resources are used along the Snake River Plain (including facilities northwest of Buhl, and in Twin Falls) to produce flowers, heat buildings, raise fish, and even to raise alligators. Operations in Boise and nearby Boise and Owyhee counties use geothermal for the same purposes. Edwards Greenhouse, in northwest Boise, has been operating for over 75 years, and employs over 100 workers at the height of the growing season.

While the benefits of geothermal direct use have been clear for many years, rising energy costs have strengthened their impact. These energy savings are now more critical, particularly because Idaho has large heating loads throughout much of the year. Based on research data, there are two

prominent targets to consider regarding the need to establish markets. The first is the potential for expanding existing applications and resource areas; the second is extending direct use to new business applications and new areas.

Photo: Ward's Greenhouse, Garden Valley. Used by permission.

Expanding existing applications and resource areas

One challenge to developing geothermal resources is the cost of replacing existing infrastructure. Retro-fitting existing buildings is not as economic as designing new residencies or businesses for geothermal from the start of construction. However, in some cases, existing geothermal-heating infrastructure exists in the area, and can be expanded to cover new homes and businesses. There are several examples where such action can be taken that researchers say should be considered for potential new projects.

Ketchum

Ketchum is a community of just over 3,000 residents in Blaine County interested in expanding its use of geothermal heating. By the 1980s, roughly 60 homes were estimated to be heated by nearby geothermal resources. During the 1990s, many of the geothermal systems went off-line, and few still exist in the area. Hot springs are located in the region, the closest being Guyer Hot Springs which has surface temperatures ranging from 131-158°F (55-70°C) with discharges of 1,000 gpm. The community is currently negotiating with the owner of Guyer Hot Springs to expand the system once again[63].

Hailey

Roughly 12 miles south of Ketchum is Hailey, a growing community of over 7,500 residents also in Blaine County. Hailey Hot Springs, less than two miles west of the community, has surface temperatures as high as 138°F (59°C). They were once used to heat the Hiawatha hotel in Hailey. The system was installed in the early 20th century and operated until a fire destroyed the hotel in 1979. Studies have indicated that of the possible uses of the geothermal resource, "a city owned district heating system had the highest potential for economic success"[64]. Based on the prior use of the resource and the economics of today, most agree that the idea of installing such a system is worth revisiting.

Boise

In Boise, there are four existing district heating systems. The original BWSWD system is still running 114 years after its initial development, producing at the same temperatures. The other three systems all became operational in the 1980s. The State of Idaho geothermal system was completed in 1982, and currently supplies heat to nine buildings in the Capitol Mall complex, including the State Capitol, covering a total of about 1.5 million square feet. The smallest system is the Veterans Administration (VA) Hospital system. The VA in Boise drilled several wells in the mid-1980s and began serving VA buildings in 1988. The system is currently used to heat about 400,000 square feet in 22 buildings on the VA grounds[65].

The most rapidly expanding system has been the City of Boise system, which heats many of the large buildings downtown including City Hall, the Washington Mutual Building and the Merrill Lynch Building, which was located specifically to use the geothermal system. Several of these large buildings also use water-looped heat pumps that also provide cooling. Because these heat pump loops operate at a lower temperature than liquid to air heating coils, these buildings are able to extract a larger amount of heat out of the geothermal water. There are plans to expand the City of Boise system to provide heating for Boise State University, the largest single university campus in Idaho at over 18,000 students. Customers of City of Boise system currently pay rates priced at 30 percent below the cost of natural gas.

Altogether, these four systems provide heating to hundreds of homes and buildings; however, those familiar with the system say that based on the size of the city, no more than 1 percent of the actual square-footage is heated by geothermal.

Studies and modeling have been performed on the Boise Front geothermal aquifer throughout the years. In 2003, the IWRRI at the University of Idaho assessed the potential impacts of increased production. While the report concluded that planned expansions would not diminish the resource, researchers say there is still uncertainty on just how much heating the aquifer could provide, either with existing wells, or with new well drilling[66].

In Boise, one concern is how the resource will be affected if demand increases significantly. Until 1999, the water used for the City of Boise system was not injected back into the aquifer and the resource had therefore experienced a decline in aquifer pressure. Once re-injection wells were introduced, aquifer pressure decline stopped. In 2002, after receiving authorization to pump more water, developers are looking to increase production. As heating costs have risen over the past several years, more residents and businesses have begun to consider using geothermal heating. Kent Johnson, project manager of the City of Boise system, said that he used to receive one call a year about the system, but now receives about two calls a month. In some cases, the City of Boise has approached businesses about joining to the system. However, some new developments, including new condominiums being built adjacent to the system, rejected the idea of using geothermal, in part because they lack experience with the technology.

Re-injection issues

The Boise system has benefited from re-injection, with three of the four systems using re-injection. Only the BWSWD does not re-inject. The patrons of the BWSWD resist re-injection because it might lead to rate increases; however, several interviewees suggest that the BWSWD residents may drop their resistance if adequate incentives are applied to subsidize the additional costs associated with the re-injection wells.

Re-injection is a major issue for geothermal direct use facilities throughout Idaho. Most facility operators say they would re-inject if the economics were feasible. Resources have experienced reduced capacity at numerous sites, and re-injection could both stabilize resources and allow for expansion.

Twin Falls, another example where re-injection can make a difference, is a small city of 34,000 in south-central Idaho along the Snake River Plain. Two fish farms use geothermal heating, along with a high school, a swimming pool, and a church. A major user of geothermal direct use heating is the College of Southern Idaho (CSI), a two-year community college with a campus population of about 7,500 students. Using relatively low temperatures, about 100°F (38°C) from relatively shallow wells, CSI is able to make significant use of their resource. The geothermal heating system heats nearly 100 percent of the campus. However, withdrawals from the geothermal aquifers in the Twin Falls area may be exceeding recharge as indicated by progressive water level declines. This has prompted additional regulation of the use of the aquifer and a moratorium on development. Re-injection at these facilities currently using the geothermal aquifer could mitigate these problems, and alleviate concerns over re-opening the aquifer to further development.

Existing direct use facilities in Idaho appear to be at a crossroads. Direct use facility operators say that they are experiencing record energy savings, while at the same time some are constrained by costs of contending with the Snake River water adjudication process, water quality measures, and resources that experience reduced pressure because of operators' inability to afford re-injection wells. One suggestion is to establish a loan guarantee program that enables re-injection wells to be drilled. While the costs of such a program may be high, clean energy advocates suggest that such a program is win-win because it would both encourage geothermal development and water conservation at the same time. However, researchers warn that before a re-injection well is drilled, the design of the well is critical, and requires technical experience. This could provide business for companies who specialize in well drilling to expand and work on more projects.

Extending direct use to new business applications and new areas
In a March 2006 Utah Geothermal Working Group meeting in Salt Lake City, geothermal expert Jim Witcher, of Witcher and Associates, noted that in order for businesses to be successful using direct use applications, there needs to be a market to sell the product, a sound business plan, and an expert to manage the product (whether it be aquaculture, greenhouses, dairy processing, or other geothermal heat uses). According to the presentation, this includes the need for a good transportation route and year around product availability[67]. Idaho is a rural state, heavily forested in the north, where many potential geothermal resources are isolated from population centers, road and rail. However, in analyzing opportunities in Idaho, it is clear that plenty of resources exist near population, road, and rail and remain unused.

For example, as communities extend from Boise, and new residencies are built, an opportunity arises for geothermal heating systems to be installed beneath the homes before they are constructed. One example of where this was done successfully is at Givens Hot Springs (noted above) located 45 miles southwest of Boise and 25 miles south of Caldwell in Owyhee County. With the area already being used for a greenhouse, a spa, and an aquaculture facility, new homes built there in the mid-1990s utilized existing artesian wells for radiant heating. Another is example is the Castle Mountain Creek subdivision in Crouch where geothermal heating systems were installed in the 1980s and early 1990s for the construction of more than 50 permanent-resident homes and weekend cabins. A land developer in the area is selling a geothermal lot over an existing geothermal well and asserts that numerous homes in the area could be heated by geothermal if new wells are drilled. According to IDWR, the homes in Givens Hot Springs and Crouch use a method where the thermal energy is transferred from the water in the well bore to a closed-looping piping system that is filled with water[68]. Thus, there is no extraction of water from the well under this approach. Close-looped systems are an alternative to re-injection and work well for new construction.

These areas are not the only ones where homes using geothermal heating have recently been sold. Drillers of domestic water wells sometimes discover geothermal water suitable for home heating; however, there isn't always an interest in developing the resource if the economics are not favorable to do so. Over the past few years, however, developers throughout the Boise metro area have become more cognizant of the resource value, and have begun to offer geothermal-heated properties in Eagle, Idaho City, and Melba, where new homes and new developments are being built to accommodate new population moving into the area. Additional areas have been and are being considered for various geothermal direct use heating projects in the Treasure Valley region west of Boise, including in Nampa and Caldwell.

A challenge, according to land developers in these areas, is that there is little money available for drilling and exploring expressly for geothermal resources, and in their experience, finding geothermal water, even in areas where the resource is prevalent, is hit or miss. In the past, geothermal heating was usually developed only where availability was clearly demonstrated. This availability was often based on existing hot springs or serendipitous discoveries, rather than substantive exploration and planning. Several interviewees suggest that public-private partnerships, such as matching funds for drilling or resource assessment for new residential areas, would be valuable to encourage new projects. Land developers say there are no government financial incentives to own geothermal-heated homes.

Bruneau-Grandview-Castle Creek KGRA[69]

Down the road from Givens Hot Springs along Highway 78 are several promising geothermal resources areas near rural towns and agricultural areas south of the Snake River. This area, classified as the Bruneau-Grandview-Castle Creek KGRA, covers 1,100 square miles and has measured ground-water temperatures ranging from 59-176°F (15-80°C). Most of the water in this area is used for irrigation purposes; however, two geothermal aquaculture facilities exist near the Bruneau River. Near these facilities, there has been consideration to use geothermal heating for a new interpretive center at Bruneau Dunes State Park. However, as of yet, funds have not been allocated to construct the new building.

Parts of the Bruneau area, including Bruneau Canyon, have been restricted to development due to endangered snail species habitat. While this does not affect the two aquaculture facilities currently in operation, it restricts development in most of Bruneau and Hot Creek Valleys as well as Davis Hot Spring, east of the Bruneau River and the Indian Bathtub area, where a temperature of 230°F (110°C) has been suggested, but not verified[70]. Endangered habitat like this are not uncommon in warm and hot springs throughout the western U.S. and the possible presence of these species must be taken into account whenever a direct use geothermal project is considered.

Outside of the protected area, to the west of Bruneau, is the town of Grandview with a population of just under 500. Thermal wells in the vicinity of the community measure temperatures ranging from 77-181°F (25-83°C) and several homes utilize nearby wells for space heating. District heating had been considered to heat the entire community at one time; however, development efforts towards this goal never took place. Over the past few years rising heating costs have created renewed interest in such a project. Funding a feasibility study would be the next step.

Further west of Grandview is the Castle Creek KGRA; a thermal anomaly located just south of the small unincorporated town of Oreana. The Ward family, who operates a 3.5 acre geothermal-heated greenhouse at Garden Valley in Boise County, owns property and water rights in the Castle Creek KGRA, including property with existing greenhouses, not currently in operation. They are considering the construction of an 18-acre greenhouse to produce potted plants, flowers, and vegetables to sell to Boise and its surrounding communities. Geothermal heating would enable these plants to be grown all year long without enduring excess heating costs in winter. According to the developer, these products are sold mostly by out-of-state vendors, so building the project in this location would give them an advantage over their competition.

The greenhouses would use an existing artesian well, and the developer would consider using the water to irrigate alfalfa plants outside the greenhouse. He also says re-injection is a possibility if economical. While piping for the geothermal water exists, additional piping would need to be installed to complete the project. The greenhouse could employ people living in the surrounding counties. Although the area is rural, the existence of transmission and rural population could suit economic development in the area, and perhaps local housing if necessary. A feasibility study is underway through a grant from USDOE to evaluate the project in greater detail and to move forward with the next steps of development.

Valley County
Recently, Valley County and the City of Cascade have partnered with IDWR to evaluate resources in their area to utilize for heating and energy to benefit their community and create economic development. Valley County is located in west-central Idaho in the Idaho Batholith region and has a combined population of just over 8,300[71]. Most of the population in the area lives near the communities of Cascade and McCall.

IDWR, along with stakeholders in the area, have written a Strategic Plan to guide actions to be taken to utilize the resource. Valley County has a multitude of low-temperature geothermal wells and springs, and a few of them have been used for direct use applications, including a small aquaculture facility and three commercial recreation facilities. While it is uncertain at this time what projects will emerge from these efforts, most agree that regardless of what happens, the level of coordination and the commitment to identify and examine potential resource uses should serve as a model for other counties in the state.

Agricultural industries

Alligators raised in Buhl. Without geothermal heat they could not survive in Idaho. Photo by Bruce Green – National Renewable Energy Lab (NREL): http://www.nrel.gov/docs/fy04osti/36316.pdf (page 14)

What is clear from the examples above is that geothermal resources not only provide an opportunity for energy savings, they provide an opportunity for profit. Businesses can make money and add to Idaho's economy. In his presentation at the "Using the Earth's Energy: Arizona Geothermal Direct Use Conference" in Tempe, Arizona in May of 2006, Leo Ray of the Fish Breeders of Idaho, Inc. discussed his business; where he uses geothermal resources to raise catfish, tilapia, sturgeon, and alligators. He noted that the major barrier to these projects is that those interested in such a project have generally had to do all the work themselves[72].

As noted earlier, there is no coherent direct use industry that provides geothermal direct use systems readily available to businesses in the state. Furthermore, because direct use applications are generally a small part of any business, there are limits on time and money for small businesses to dedicate to developing the resource.

According to Leo Ray, creating markets requires government and other institutions working with the communities and businesses where the resources can be put to good use. Many of the developable low-temperature geothermal resources in Idaho are on private land owned by small farmers and ranchers.[73] There is seldom communication between the government, the research community and the farmers and ranchers. This results in many of Idaho's agricultural industries to sit on resources that go unused. Leo Ray suggests that agricultural extension programs and demonstration projects can help bridge this vital gap. Numerous interviewees stress the importance of investment in agricultural extension programs operated by land-grant universities, like the University of Idaho. These programs can employ staff familiar with geothermal resource development and can be a resource for farmers and ranchers. The University of Idaho has a major aquaculture center in Hagerman; however its activity towards geothermal development is minimal.

Demonstration projects can be included in extension programs, along with university programs or federal and state grant programs. These projects can test new technology for exploration or drilling, particularly of re-injection wells. For example, a project through the University of Idaho that included drilling for a geothermal resource along with a re-injection well was scrapped due to lack of funds. While there is currently little access to money for research programs, proponents of these projects suggest they should be initiated by small businesses, since large companies will not invest in direct use unless they can see a large profit or mass production. Researchers say that if funding is made available through larger institutions such as the Western Regional Aquaculture Consortium, the USDOE, or the USDA, there may be more potential for development. In fact, the USDA is offering grants for renewable energy projects in agricultural areas that could include demonstration projects like these.

If universities are involved, researchers suggest that students could work on small projects focused on technological development. Larger companies could eventually buy out these projects once the demonstrations are complete. The benefits to Idaho can be significant. Researchers say that due to the abundance of the resource and the ability to breed tropical fish at temperatures below 100°F (38°C) there is an opportunity to get new developments completed in the near term. In fact, according to Leo Ray, the project that was scrapped may have potential in nearby installations, including a nearby geothermal greenhouse.

Incentives

In his presentation at the March 2006 Utah Geothermal Working Group meeting, Washington State University (WSU) professor Gordon Bloomquist noted that costs and risks (particularly to prove a geothermal resource) play a large part in determining the decision to pursue a direct use project[74]. As the costs of drilling has increased, even for direct use wells, it has become risky to take on projects without first being assured that the costs will not rise significantly during the course of construction.

As discussed above, financial incentives alone are not sufficient to develop projects. Technical knowledge and other business considerations may complicate project development. For example, the IDWR Energy Division administers a low-interest loan program to finance the development of energy conservation measures or energy generation facilities that utilize renewable energy resources. However, since its inception in 1987, only two geothermal projects have received funding. The loans are offered at four percent interest rate and must be repaid in five years. The program provides residential loans from $1,000 to $10,000 and up to $100,000 for other sectors, including agricultural loans. To be eligible for financing, the savings from reduced usage of conventional fuel must be sufficient to pay for the project within 15 years. Although the number of loans that can be given out each year is not specified, most agree that loans for geothermal projects should be given out more than once per decade[75].

According to the Strategic Plan, in addition to an active extension program, other useful policies and programs include: conducting feasibility studies; developing educational programs at all levels for farmers, teachers and other related groups; and guaranteeing government assistance and government loans. Another suggestion, note several interviewees, is to set a minimum standard of energy efficiency for commercial and residential buildings. Standards like these exist in many American cities. Because land developers do not pay the energy bill once they sell a property, they may avoid installations that would increase their bottom line costs. Therefore, proponents of these policies suggest that minimum standards could correct this market failure, while at the same time make geothermal direct use systems more attractive by letting them compete with other sustainable options.

The need to close the information gap

The opportunities described in the previous section are just some of the many that are possible if the state invests time, money, and energy into getting them developed. More projects generate more interest, and help lead to more development. However, beyond expanding existing projects, building new projects, and providing incentives, most agree that an information gap remains to be addressed before these policies can truly create a boom in development.

According to resource maps, a majority of Idaho's population lives in the vicinity of low-to intermediate temperature geothermal resources that could potentially be used for direct use applications. In 1994, the Geo-Heat Center at the Oregon Institute of Technology (OIT) identified 51 communities in Idaho (including Boise) in 23 of Idaho's 44 counties that could potentially utilize, or increase their utilization of geothermal resources for district heating and other direct use applications. These communities included Caldwell, Hailey, Ketchum, Preston, Stanley, and Weiser[76] and subsequent studies have identified near-term project potential in Cascade, Mountain Home, Nampa, Pocatello, and Rexburg. All of these communities have had direct use projects proposed in the past, but abandoned them because they weren't cost effective at the time. This is in addition to numerous small towns in Idaho that have potential or have had projects considered and scrapped.

While many communities throughout Idaho could potentially benefit from the utilization of direct use applications, there is a concern that these applications are not being considered and community leaders and businesses do not understand how to pursue a direct use project, even if they are interested. In the Strategic Plan, seven out of the 10 specific barriers related to the expansion of direct use applications in Idaho dealt with information issues (See Table I)

Resource assessments are one of the most critical needs outlined in the Strategic Plan. Exploration technology is limited, and the cost of drilling new wells can be prohibitive, leaving most discoveries of geothermal water to serendipity, as noted earlier. While the IDWR received some funding to update the state's geothermal database, the Strategic Plan suggests that there needs to be a comprehensive program involving state, university, and federal institutions to cover all the research needs necessary to realize Idaho's development potential[77].

One component lacking in Idaho is expertise on resource development. Most agree that the research and business communities have not been adequately linked, leaving geological studies to generally not consider business opportunities and economic development as key components of their research. In order to bring more projects into the mainstream, state and federal agencies have been reaching out to those who have successfully developed direct use projects -- including businesses, companies, consultants, and contractors -- and encouraging them to share their knowledge. Clean energy advocates say this should continue and expand. Several interviews suggest that experienced entities could be encouraged to report on geothermal direct use projects in industry trade magazines, such as greenhouse and aquaculture industry publications that provide visibility about geothermal technology to a broader audience.

The Strategic Plan suggests that the state government should "coordinate with the Idaho Department of Commerce, Regional Economic Development Districts and others in conducting studies that document the rural economic impacts of developing geothermal [resources]." It also suggests that the state should develop and make available a "one-stop shopping" document for those interested in developing and using geothermal resources for direct use applications including for those in the financing community[78]. However, before such a document is created, most agree that the quality of information must be assured. For instance, while there are numerous users of geothermal resources in Idaho the actual numbers and locations of these installations are undetermined. The last comprehensive update of known resources was performed in the mid-1990s[79] and data on existing facilities vary from source to source. Such an update may include traveling to the locations themselves, and/or checking with regulators and local chambers of commerce.

TABLE I: Direct use Applications Needs and Barriers

Need for education and outreach to users on efficient and alternative uses of geothermal resources, such as aquaculture (e.g. tropical fish), greenhouses (e.g. flower production, seeds), home and building heating and crop drying.
Need to fund training and education on geothermal direct use to change aquaculture genetic issues including warm species genetic pool research. A geothermal well at the UI Hagerman Aquaculture Research Station is needed for education and research. This can also be done at Raft River using the Raft River geothermal wells.
Some ground water resources are fully appropriated.
Inability to expand or develop new geothermal resources due to moratorium in critical groundwater areas. Better understanding of the geothermal reservoir capacity and use of more conservation could allow greater use of the resource.
Need to better assess geothermal resources using new techniques, geologic, geophysical and geochemical models, and new drilling technology.
Not a long enough track record on geothermal production so financing industry is skeptical and reluctant to risk funding geothermal energy projects.
Lack of data and understanding on existing resources to support additional development.
Need for funds to conduct resource assessments.
Need to update existing databases.
Need more geothermal energy technology transfer.

Source: Idaho Department of Water Resources, Energy Division, and the Idaho Geothermal Energy Working Group – Strategic Plan (2002): http://www.geothermal-biz.com/ID_strategic_plan.pdf (pages 5-6)

Raise public awareness

Residents of Idaho have used geothermal resources for many years. Some realize the benefit of these resources, but many still do not understand the many ways in which they can be used or how valuable they are. With energy prices rising, along with a growing appreciation for clean energy resources, geothermal direct use applications may become a preferred alternative for many communities and businesses. Developers say the lack of awareness about how to utilize the resource prevents the public from clamoring for more development. Researchers say that despite its usage, the public is still more aware of wind and solar resources, in part because wind turbines and solar panels are considerably more visible than geothermal applications.

Most agree that the technology used to tap the resource is still not at its technological tipping point. Advancements in technology may make possible the development of systems able to serve entire cities. For example, one Icelandic company is currently working with the Chinese government to develop a geothermal district heating system that would serve nearly half-a-million residents in one of China's largest cities. Another Icelandic company came to Boise in March of 2006 to discuss advancements in geothermal district heating systems and how these could help Boise residents make better use of their own resource. Meanwhile, the scope of prospects for geothermal development in Idaho is still unknown and most agree that the state should do all that it can to encourage development, education, and awareness to ensure that geothermal resources will serve Idaho for generations to come.

Web Resources with more information for Idaho

Battocletti, Liz. *The Economic, Environmental, and Social Benefits of Geothermal Use in Idaho.* Bob Lawrence and Associates (April 2006):
http://www.geothermal-biz.com/Docs/Idaho.pdf
Bloomquist, Gordon: "A Regulatory Guide to Geothermal Direct Use Development: Idaho". Washington State University Extension Energy Program, 2003:
http://www.energy.wsu.edu/documents/renewables/idaho.pdf
Boise State University – CGISS:
http://cgiss.boisestate.edu/
City of Boise Geothermal Heating District:
http://www.cityofboise.org/public_works/services/water/geothermal/
Database of State Incentives for Renewable Energy (DSIRE) – Idaho Incentives for Renewables and Efficiency:
http://www.dsireusa.org/library/includes/map2.cfm?CurrentPageID=1&State=ID&RE=1&EE=1
Energyatlas.org: Idaho Renewable Energy Resources:
http://www.energyatlas.org/PDFs/atlas_state_ID.pdf
GeoPowering the West (GPW) – Idaho State Fact Sheet:
http://www.eere.energy.gov/geothermal/gpw/pdfs/29213.pdf
Geothermal Energy Association (GEA) – "Geothermal Development Needs in Idaho" under GEA Publications/reports and information on developing projects and resources under Information at:
http://www.geo-energy.org/
Idaho Department of Water Resources Energy Division

- -"Examination and Evaluation of Geothermal Sites in the State of Idaho with Emphasis Given to Potential for Electrical Generation or Direct Use". (Sept. 2002): http://www.idwr.state.id.us/energy/alternative_fuels/geothermal/reports/exam_eval_200209.pdf
- -Idaho Geothermal Energy Resources: http://www.idahogeothermal.org/
- -Strategic Plan (Oct. 2002): http://www.geothermal-biz.com/ID_strategic_plan.pdf

Idaho Geological Survey:
http://www.idahogeology.com/
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http://www.idwr.idaho.gov/energy/alternative_fuels/geothermal/wg.htm
Idaho National Laboratory – Geothermal Energy:
http://geothermal.id.doe.gov/
Idaho Water Resources Research Institute (IWRRI) at the University of Idaho:
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http://www.nrel.gov/docs/fy04osti/36316.pdf
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http://www.idwr.state.id.us/energy/alternative_fuels/geothermal/reports/geo_impact_sm.pdf

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Endnotes

[1]Dunlop, Michelle. "Senate sends energy plan to governor", the Times-News, Twin Falls, Idaho. 3/29/06: http://powermarketers.netcontentinc.net/newsreader.asp?ppa=8knpp%5E%5Bgkquunr%5BVgb%216%3C%22bfel%5D%21

[2]This document does not consider geothermal heat-pumps which can utilize temperatures as low as 50°F (10°C) without requiring the use of deep underground aquifers, although there is a general agreement by researchers that geothermal heat pumps would be useful at creating energy savings for Idaho communities, businesses, and industries. In some cases, heat pumps can combine with direct use facilities. This type of installation is described in the direct use section of this report.

[3]Source: Geo-Heat Center, Oregon Institute of Technology (OIT): PTL idaho-direct.xls

[4]Source – Marie, Jim St., Mink, Leland, Mink L., and Neely, Kenneth W., Idaho Department of Water Resources. "Examination and Evaluation of Geothermal Sites in the State of Idaho with Emphasis Given to Potential for Electrical Generation or Direct Use". September 2002: http://www.idwr.state.id.us/energy/alternative_fuels/geothermal/reports/exam_eval_200209.pdf (page 5)

[5]Source – Geothermal Task Force of Western Governor's Association (WGA) – January 2006: http://www.westgov.org/wga/initiatives/cdeac/Geothermal-full.pdf (page 65)

[6]Source – Energy Information Agency (EIA): http://www.eia.doe.gov/cneaf/electricity/epa/fig7p2.html Take 90 percent availability for a geothermal power plant and the number is over 30.8 percent based on 2005 numbers for retail sales in Idaho.

[7]See USGS Circular 790 (1978) – pages 33, 50-51

[8]Sources – Yellowstone Volcano Observatory: http://volcanoes.usgs.gov/yvo/history.html & http://volcanoes.usgs.gov/yvo/figures/fig1.html

[9]See Excel file from the Geothermal Energy Association webpage on "Potential Use": http://www.geo-energy.org/aboutGE/potentialUse.asp#now

[10]The estimated hydrothermal resource base for undiscovered resources in Idaho is approximately 13,550 MW. This state estimate is based on estimates of geologic areas specified in USGS Circular 790 (1978). When considering the largest two regions with geothermal potential in Idaho: the Eastern Snake River Plain and the Western, Central and southwest Snake River Plain – the average ratio between identified and estimated undiscovered resources is just over 37:1. This leads to the calculation for undiscovered resources of 13,550 MW. When adding the 366 MW of identified resources, the total estimated resource base is 13,916. For more information, see USGS Circular 790 (1978) pages 32-33

[11]Source – Idaho Department of Water Resources (IDWR), Energy Division – Types of Geothermal Power Plants: http://www.idwr.idaho.gov/energy/alternative_fuels/geothermal/detailed_power.htm

[12]Source – Chena Hot Springs: http://www.yourownpower.com/Power/

[13]For more information see the USDOE – "Enhanced Geothermal Systems": http://www.eere.energy.gov/geothermal/pdfs/egs.pdf

[14]Source – Brown, Don & Duchane, Dave. "Hot Dry Rock (HDR) Geothermal Energy Research and Development at Fenton Hill, New Mexico." GHC Bulletin, Geo-heat Center, Oregon Institute of Technology (OIT), December 2002: http://geoheat.oit.edu/bulletin/bull23-4/art4.pdf

[15]Major sources for this section:
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Idaho Water Resources Research Institute (IWRRI) at the University of Idaho. "Overview of Geothermal Investigations 1980 to 1993". (December 1994): http://boise.uidaho.edu/documents/GeothermalSiteReport.pdf&pid=33484&doc=1
Marie, Jim St., Mink, Leland, Mink L., and Neely, Kenneth W., Idaho Department of Water Resources. "Examination and Evaluation of Geothermal Sites in the State of Idaho with Emphasis Given to Potential

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http://www.ngdc.noaa.gov/nndc/struts/results?op_0=eq&v_0=ID&op_1=l&v_1=&op_2=l&v_2=&t=100006&s=1&d=1
Supply of Geothermal Power from Hydrothermal Sources: A Study of the Cost of Power in 20 and 40 Years, (Petty S., Livesay B., Long W. & Geyer J., 1992). Sandia National Laboratories:
http://www.prod.sandia.gov/cgi-bin/techlib/access-control.pl/1992/927302.pdf (Appendix D, pgs. 115-116)
Western Governors Association (WGA) Geothermal Taskforce Report (January 2006):
http://www.westgov.org/wga/initiatives/cdeac/Geothermal-full.pdf (page 66)

[16]Additional Sources:
Arney, B.H., Goff, F., and Harding Lawson Ass., Evaluation of the Hot-Dry-Rock geothermal potential of an area near Mountain Home, Idaho, Los Alamos National Lab Report LA-9365-HDR, 1982:
http://www.osti.gov/energycitations/servlets/purl/5350339-H7VT3K/native/5350339.pdf & Summary of "Geologic Mapping in the Central Mountain Bennett Hills: Volcanism Associated with the North-Central Boundary of the Snake River Plain". Guarisco, Peter, Matthews, Scott, and Vetter, Scott, Dept. of Geology, Centenary College (May 2004):
http://gsa.confex.com/gsa/2004RM/finalprogram/abstract_72280.htm

[17]Source – Embree, Glenn F. and Prostka, Harold J., "Geology and geothermal resources of the Rexburg Area, eastern Idaho". U.S. Geological Survey, Denver, Colorado. January, 1978:
http://www.osti.gov/energycitations/servlets/purl/6369347-hucS2s/6369347.PDF (page 1)

[18]Additional sources: US Geothermal – "The Project": http://www.usgeothermal.com/start.html & Applegate, J.K. & Moens, T.A., "Geophysical Logging Case History of the Raft River Geothermal System, Idaho." Los Alamos Scientific Lab & Boise State University. April 1980:
http://www.osti.gov/bridge/servlets/purl/5490655-e6VVGL/native/5490655.pdf

[19]Source – Geothermal Energy Association: http://www.geo-energy.org/information/developing/Idaho/WillowSprings.asp

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http://www.geologynet.com/granite1.htm

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[23]Sources: National Geophysical Data Center – Idaho Thermal Springs List:
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[24]"Northern Boundary of the Snake River Plain" – Gladwell, J.S.; Moore, B.; Savage, N.; Warnick, C.C. "Resource use: a summary of the assessments of geothermal resource use limitations of Bruneau KGRA, Castle Creek KGRA, Crane Creek KGRA, Mountain Home KGRA, Vulcan KGRA," Idaho Water Resources Research Institute (IWRRI) at the University of Idaho (Feb 1979):
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[25]Additional drilling has been done that has not been documented by state well data. However, that number is likely small. Sources – INL Geothermal Program: Idaho-collocated_Keller_revised.xls; Idaho Deep Wells.xls & Idaho Department of Water Resources, Energy Division: geothermal_snapshot.xls

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[27]Source: Geothermal Energy Association (GEA) – August 2005: http://www.geo-energy.org/publications/reports/Factors%20Affecting%20Cost%20of%20Geothermal%20Power%20Development%20-%20August%202005.pdf (page 18)

[28]Idaho Department of Water Resources Energy Division and the Idaho Geothermal Energy Working Group – Strategic Plan (2002): http://www.geothermal-biz.com/ID_strategic_plan.pdf (page 5)
[29]Idaho Department of Water Resources Energy Division and the Idaho Geothermal Energy Working Group – Strategic Plan (2002): http://www.geothermal-biz.com/ID_strategic_plan.pdf (page 10)
[30]Idaho Department of Water Resources Energy Division and the Idaho Geothermal Energy Working Group – Strategic Plan (2002): http://www.geothermal-biz.com/ID_strategic_plan.pdf (pages 7-10)
[31]Source: Statement of Walter S. Snyder. Director, Intermountain West Geothermal Consortium, Before the Energy and Natural Resources Committee U.S. Senate, July 11, 2006:
http://energy.senate.gov/public/index.cfm?FuseAction=Hearings.Testimony&Hearing_ID=1576&Witness_ID=4455&SuppressLayouts=True
[32]The reason I refer to these resources as "being considered over the next five years" is based on the 3-5 years it takes to develop a project once the project is underway (i.e. further exploration, drilling, etc.). The 67 percent estimate is based on the "Update on US Geothermal Power Production and Development: November 10, 2006" – Geothermal Energy Association (GEA).
[33]These are calculations based on the annual appropriations for the USDOE Geothermal Technologies Program from 1990 to 1999. The average appropriation during the 1990s was $27.75 million as compared to $23.299 million for FY 2006. When considering inflation (real dollars), the 2006 appropriations are more than 16% lower than the average appropriations from 1990 through 1999. Source of budget: USDOE.
[34]Idaho Department of Water Resources Energy Division and the Idaho Geothermal Energy Working Group – Strategic Plan (2002): http://www.geothermal-biz.com/ID_strategic_plan.pdf (page 7)
[35]Bloomquist, Gordon: "A Regulatory Guide to Geothermal Direct Use Development: Idaho". Washington State University Extension Energy Program, 2003:
http://www.energy.wsu.edu/documents/renewables/idaho.pdf (page 2)
[36] Source: Idaho Department of Water Resources, Energy Division, and the Idaho Geothermal Energy Working Group – Strategic Plan (2002): http://www.geothermal-biz.com/ID_strategic_plan.pdf (page 8)
[37]Source: http://www.id.blm.gov/publications/02update/state5_10.pdf
However BLM land is currently greater than in 2002 at 12,001,817 acres:
http://www.id.blm.gov/blmfacts/index.htm
Total federal mineral acreage in Idaho: Bureau of Land Management (BLM) (2002): Mineral and Surface Acres Administered by the Bureau of Land Management: http://www.blm.gov/natacq/pls02/pls1-3_02.pdf
[38]For more information on new regulations see the U.S. Department of Interior:
http://www.doi.gov/iepa/2005_results.pdf (Section 222-224)
[39]See U.S. Bureau of Land Management (BLM) – Wind Energy Development Final Programmatic EIS:
http://windeis.anl.gov/eis/index.cfm
[40]"*Avoided costs*" – Electronic Code of Federal Regulations (e-CFR) – Title 18: Conservation of Power and Water Resources: http://ecfr.gpoaccess.gov/
[41]In fact, based on 2005 numbers of electricity demand in Idaho, less than 300 MW of base-load renewable energy (i.e. operating at 90%) would suffice for Idaho to reach 10 percent at its current level of consumption. Given additional generation potential from biomass, solar, and wind production, reaching 10 percent is very possible in the near term. See EIA:
http://www.eia.doe.gov/cneaf/electricity/epa/fig7p2.html
[42]Source – Database of State Incentives for Renewable Energy (DSIRE):
http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=ID08F&state=ID&CurrentPageID=1&RE=1&EE=1
[43]Source – Dunlop, Michelle. "Senate sends energy plan to governor", the Times-News, Twin Falls, Idaho. 3/29/06:
http://powermarketers.netcontentinc.net/newsreader.asp?ppa=8knpp%5E%5Bgkquunr%5BVgb%216%3C%22bfel%5D%21
[44]The Idaho Energy Resources Authority issues revenue bonds, like a bank, into the bond market. The investor, not the state, has the liability. The Authority will not get paid until projects get financed. The Authority deals with two types of projects: 1) Utilities – generation facilities or transmission projects; and 2) Independent (non-utility) developers of renewable energy projects in Idaho, for transmission or generation. For utilities, the Authority focuses on rural co-ops and municipal utilities, although they do not exclude IOUs. These projects do not have to be for renewable energy. The Renewable Energy Bond Program does only allow renewable energy projects, but only affects developers. For more information,

see the Database of State Incentives for Renewable Energy (DSIRE): http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=ID06F&state=ID&CurrentPageID=1&RE=1&EE=1

[45]For more information on the State Energy Plan, see – Dunlop, Michelle. "Senate sends energy plan to governor", the Times-News, Twin Falls, Idaho. 3/29/06: http://powermarketers.netcontentinc.net/newsreader.asp?ppa=8knpp%5E%5Bgkquunr%5BVgb%216%3C%22bfel%5D%21 & Geothermal-biz.com Newsletter (October 2006): http://www.geothermal-biz.com/newsletter/Oct-2006.htm & House Concurrent Resolution No. 62: http://www3.state.id.us/oasis/2006/HCR062.html

[46]Source – Marie, Jim St., Mink, Leland, Mink L., and Neely, Kenneth W., Idaho Department of Water Resources. "Examination and Evaluation of Geothermal Sites in the State of Idaho with Emphasis Given to Potential for Electrical Generation or Direct Use". September 2002: http://www.idwr.state.id.us/energy/alternative_fuels/geothermal/reports/exam_eval_200209.pdf (page 12)

[47]Source – Energy Information Agency (EIA) – 2004: http://www.eia.doe.gov/cneaf/electricity/st_profiles/idaho.pdf

[48]Sources – Idaho Power:
Idaho Power 2004 Draft RFP: http://www.idahopower.com/pdfs/aboutus/business/rfp/geothermal_draftRFP.pdf
Idaho Power 2004 IRP: http://www.idahopower.com/energycenter/irp/2004/
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[49]Idaho Power 2004 Draft RFP: http://www.idahopower.com/pdfs/aboutus/business/rfp/geothermal_draftRFP.pdf
Avista RFP: http://www.puc.state.id.us/internet/press/010906_AVUIRP.htm

[50]Avista "Buck a Block" Program: http://www.avistautilities.com/products/windpower.asp
Idaho Power "Green Power" Program: http://www.idahopower.com/choiceSwitch.asp?p=/energycenter/greenpower/
PacifiCorp "Blue Sky" Program: http://www.pacificpower.net/Homepage/Homepage35816.html

[51]Several mining and industrial operations exist in Idaho which requires small power generation to operate. Sometimes these facilities use existing power lines from IOUs, sometimes from municipal power or rural cooperatives, and sometimes from their own generation. However, these entities can benefit from small electric power production from geothermal resources, and geothermal prospects for these operations can be studied further.

[52]Source: Idaho Power IRP: http://www.idahopower.com/pdfs/energycenter/irp/2004/2004_IRP_final.pdf (page 50 - Figure 14)

[53]Citizens' Utility Board of Oregon – Grid West RTO and Columbia RTO: http://oregoncub.org/archives/2006/08/transmission_10_1.php

[54]For example, according to research performed by Iowa State University, one estimate says Iowa's annual production of more than one billion gallons of ethanol accounts for about 16 percent of the state's demand for natural gas: http://www.pollutiononline.com/content/news/article.asp?docid={FD009FED-93C2-4CCB-81F5-CD67463C2F19}&VNETCOOKIE=NO (9/27/2006)

[55]Source: Battocletti, Liz. *The Economic, Environmental, and Social Benefits of Geothermal Use in Idaho.* Bob Lawrence and Associates (April 2006): http://www.geothermal-biz.com/Docs/Idaho.pdf (page 4)

[56]Source: Statement of Walter S. Snyder. Director, Intermountain West Geothermal Consortium, Before the Energy and Natural Resources Committee U.S. Senate, July 11, 2006: http://energy.senate.gov/public/index.cfm?FuseAction=Hearings.Testimony&Hearing_ID=1576&Witness_ID=4455

[57]Source: Bloomquist, Gordon: "A Regulatory Guide to Geothermal Direct Use Development: Idaho". Washington State University Extension Energy Program, 2003: http://www.energy.wsu.edu/documents/renewables/idaho.pdf

[58]In the report, it is referred to as the "Snake River Basin". Source: Government Accountability Office (GAO) – "Increased Geothermal Development Will Depend on Overcoming Many Challenges". May 2006 Report to the Ranking Minority Member, Committee on Energy and Natural Resources, U.S. Senate: http://www.gao.gov/new.items/d06629.pdf (page 26)

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[60]Source: Bloomquist, Gordon: "A Regulatory Guide to Geothermal Direct Use Development: Idaho". Washington State University Extension Energy Program, 2003: http://www.energy.wsu.edu/documents/renewables/idaho.pdf
[61]Idaho Department of Water Resources Energy Division and the Idaho Geothermal Energy Working Group – Strategic Plan (2002): http://www.geothermal-biz.com/ID_strategic_plan.pdf (page 22)
[62]For a map of land ownership see the Idaho National Laboratory: http://geothermal.inel.gov/maps/id.pdf
[63]Sources: Idaho Mountain Express and Guide. "Ketchum considers cutting cord with Idaho Power". Rebecca Meany, 8/30/2006: http://www.mtexpress.com/index2.php?issue_date=08-30-2006&ID=2005112020 & Idaho Water Resources Research Institute (IWRRI) at the University of Idaho. "Overview of Geothermal Investigations 1980 to 1993". (December 1994): http://boise.uidaho.edu/documents/GeothermalSiteReport.pdf&pid=33484&doc=1 (pages 17-18)
[64]Sources: History: http://www.haileycityhall.org/historicPreservation/index_files/Page373.htm & Resource studies: Idaho Water Resources Research Institute (IWRRI) at the University of Idaho. "Overview of Geothermal Investigations 1980 to 1993". (December 1994): http://boise.uidaho.edu/documents/GeothermalSiteReport.pdf&pid=33484&doc=1 (page 17)
[65]Source – IDWR Energy Division: http://www.idwr.idaho.gov/energy/alternative_fuels/geothermal/detailed_history.htm
[66]Idaho Water Resources Research Institute (IWRRI) at the University of Idaho. "Investigation of Hydrogeologic Conditions and Ground Water Flow in the Boise Front Geothermal Aquifer" (October 2003): http://boise.uidaho.edu/default.aspx?pid=33453
[67]Source – Jim Witcher (March 2006): http://geology.utah.gov/emp/geothermal/ugwg/workshop0306/ppt/Witcher0306_1.ppt
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[69]Major Source for this section – Idaho Water Resources Research Institute (IWRRI) at the University of Idaho. "Overview of Geothermal Investigations 1980 to 1993". (December 1994): http://boise.uidaho.edu/documents/GeothermalSiteReport.pdf&pid=33484&doc=1 (pages 49-52)
[70]Davis Hot Spring: Idaho Department of Water Resources, Energy Division: geothermal_snapshot.xls
[71]U.S. Census – 2005 estimates: http://quickfacts.census.gov/qfd/states/16/16085.html
[72]Sources:
Ray, Leo. "Geothermal: Our Most Underutilized Natural Resource". Presentation given on 5/18/2006 at the Using the Earth's Energy: Arizona Geothermal Direct Use Conference in Tempe, Arizona & Geo-Heat Center at the Oregon Institute of Technology (OIT) – GHC Bulletin, March 2004: http://geoheat.oit.edu/bulletin/bull25-1/art6.pdf
[73]They are "developable" because they are near agricultural areas with existing developments or populations in the area.
[74]Source, Gordon Bloomquist (March 2006): http://geology.utah.gov/emp/geothermal/ugwg/workshop0306/ppt/Bloomquist0306_3.ppt
[75]One loan went to the College of Southern Idaho in Twin Falls and another added a new user in Boise to the district heating system. See Idaho Department of Water Resources Energy Division – Low-interest energy loans: http://www.idwr.state.id.us/energy/loans/ & Database of State Incentives for Renewable Energy (DSIRE): http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=ID02F&state=ID&CurrentPageID=1&RE=1&EE=1
[76]Geo-Heat Center at the Oregon Institute of Technology (OIT): http://geoheat.oit.edu/idaho.htm
[77]Idaho Department of Water Resources Energy Division and the Idaho Geothermal Energy Working Group – Strategic Plan (2002): http://www.geothermal-biz.com/ID_strategic_plan.pdf (page 22)
[78]Idaho Department of Water Resources Energy Division and the Idaho Geothermal Energy Working Group – Strategic Plan (2002): http://www.geothermal-biz.com/ID_strategic_plan.pdf (pages 7-9, 22)
[79]This refers to research performed by the Geo-Heat Center at the Oregon Institute of Technology (OIT): http://geoheat.oit.edu/state/id/all.htm