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GAO

Report to the Ranking Minority Member, Committee on Energy and Natural Resources, U.S. Senate

May 2006

RENEWABLE ENERGY

Increased Geothermal Development Will Depend on Overcoming Many Challenges

GAO-06-629

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Highlights

Highlights of GAO-06-629, a report to the Ranking Minority Member, Committee on Energy and Natural Resources, U.S. Senate

Why GAO Did This Study

The Energy Policy Act of 2005 (Act) contains provisions that address a variety of challenges that face the geothermal industry, including the high risk and uncertainty of developing geothermal power plants, lack of sufficient transmission capacity, and delays in federal leasing. Among the provisions are means to simplify federal royalties on geothermal resources while overall collecting the same level of royalty revenue. The Act also changes how these royalties are to be shared with local governments (disbursements). This report describes: (1) the current extent of and potential for geothermal development; (2) challenges faced by developers of geothermal resources; (3) federal, state, and local government actions to address these challenges; and (4) how provisions of the Act are likely to affect federal geothermal royalty disbursement and collections.

What GAO Recommends

GAO found that it will be difficult for the Department of the Interior to demonstrate that it intends to collect the same level of royalties as called for in the Act because the Minerals Management Service (MMS) does not systematically collect the necessary revenue data from electricity sales. Therefore, GAO recommends that the Secretary of the Interior instruct the appropriate managers within MMS to systematically collect future sales revenues for electricity, and Interior agreed.

www.gao.gov/cgi-bin/getrpt?GAO-06-629.

To view the full product, including the scope and methodology, click on the link above. For more information, contact Jim Wells at (202) 512-3841 or wellsj@gao.gov.

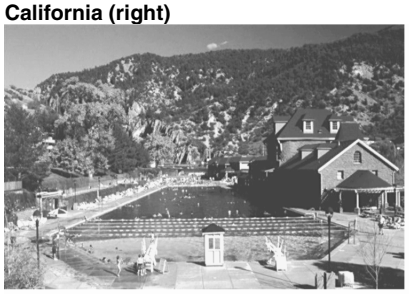
What GAO Found

Geothermal resources currently produce about 0.3 percent of our nation's total electricity and heating needs and supply heat and hot water to about 2,300 direct use businesses, such as district heating systems, fish farms, greenhouses, food-drying plants, spas, and resorts. Recent assessments conclude that future electricity production from geothermal resources could increase by 25 to 367 percent by 2017. The potential for additional direct use businesses is largely unknown because the lower temperature geothermal resources that they exploit are abundant and commercial applications are diverse. One study has identified at least 400 undeveloped wells and hot springs that have the potential for development. In addition, the sales of geothermal heat pumps are increasing.

Developers of geothermal electricity plants face many challenges including a capital intensive and risky business environment, developing technology, insufficient transmission capacity, lengthy federal review processes for approving permits and applications, and a complex federal royalty system. Direct use businesses face unique business challenges, remote locations, water rights issues, and high federal royalties. The Act addresses many of these challenges through tax credits for geothermal production, new authorities for the Federal Energy Regulatory Commission, and measures that streamline federal leasing and that simplify federal royalties, which totaled $12.3 million in 2005. In addition, the Department of Energy and the state of California provide grants for addressing technology challenges. Furthermore, some state governments offer financial incentives, including investment tax credits, property tax exclusions, sales tax exemptions, and mandates that certain percentages of the electricity within the state be generated from renewable resources.

Under the Act, federal royalty disbursement will significantly change because half of the federal government's share will now go to the counties where leases are located. Although the Act directs the Secretary of the Interior to seek to maintain the same level of royalty collections, GAO's analysis suggests this will be difficult because changing electricity prices could significantly affect royalty revenues. Also, MMS does not collect sales data that are necessary to monitor these royalty collections.

Glenwood Hot Springs, Colorado (left) and Geothermal Power Plant at The Geysers, California (right)



Source: GAO.

Contents

Abbreviations

BLM	Bureau of Land Management
DOE	Department of Energy
DOI	Department of the Interior
EA	environmental assessment
EIS	environmental impact statement
FERC	Federal Energy Regulatory Commission
KGRA	known geothermal resource areas
MMS	Minerals Management Service
NEPA	National Environmental Policy Act of 1969
RPS	Renewable Portfolio Standard
USGS	U.S. Geological Survey

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United States Government Accountability Office
Washington, D.C. 20548

May 24, 2006

The Honorable Jeff Bingaman
Ranking Minority Member
Committee on Energy and Natural Resources
United States Senate

Dear Senator Bingaman:

American families and businesses rely heavily on electricity and natural gas to heat and light homes and buildings, to power appliances, to manufacture goods, and to supply services. Increasing demand and rising prices for electricity and natural gas have increased interest in alternative forms of energy, including geothermal energy. Geothermal energy is a unique type of renewable resource in that it can provide power that is independent of weather and climate, thereby enabling a consistent and uninterrupted supply of heat and electricity. Geothermal energy also creates fewer environmental impacts than the production of natural gas and other conventional fossil fuels that are used to generate electricity. Because many areas that have the potential to produce additional geothermal energy are located on federal lands, the federal government is a major participant in the future development of geothermal energy.

Geothermal energy is literally the heat of the earth. This heat is abnormally high where hot and molten rocks exist at shallow depths below the earth's surface. Water, brines, and steam circulating within these hot rocks are collectively referred to as geothermal resources. Geothermal resources often rise to the surface naturally along fractures to form hot springs, geysers, and fumaroles. For centuries, people have used naturally occurring hot springs as places to bathe, swim, and relax. More recently, some individuals have constructed buildings over these springs, transforming them into elaborate spas and resorts, thereby establishing the first direct use of geothermal resources for business purposes. Businesses have also established other direct uses of geothermal resources by drilling wells into the earth to tap the hot water for heating buildings, drying food, raising fish, and growing plants. Where the earth's temperature is not high enough to supply businesses with geothermal resources for direct use, people have made use of the ground's heat by installing geothermal heat pumps. Geothermal heat pumps consist of a heat exchanger and a loop of pipe extending into the ground to draw on the relatively constant temperature there for heat in the winter and air conditioning in the summer.

Geothermal resources can also generate electricity, and this is their most economically valuable use today. Only the highest temperature geothermal resources, generally above 200 degrees Fahrenheit, are suitable for electricity generation. When companies are satisfied that sufficient quantities of geothermal resources are present below the surface at a specific location, they will drill wells to bring the geothermal fluids and steam to the surface. Upon reaching the surface, steam separates from the fluids as their pressure drops, and the steam is used to spin the blades of a turbine that generates electricity. The electricity is then sold to utilities in a manner similar to sales of electricity generated by hydroelectric, coal-fired, and gas-fired power plants.

Geothermal resources are found throughout the world. In the United States, geothermal resources are concentrated in Alaska, Hawaii, and the western half of the country, primarily on public lands managed by the Bureau of Land Management (BLM). The Congress set forth procedures in the Geothermal Steam Act of 1970 for leasing these public lands, developing the geothermal resources, and collecting federal royalties. Today, BLM leases these lands and sets the royalty rate, and the Minerals Management Service (MMS)—another agency within the Department of the Interior (DOI)—collects the federal geothermal royalties and disburses to the state governments its share of these royalties as required by law.[1] In 2005, the most recent year for which data are available, MMS collected $12.3 million in geothermal royalties, almost all of which was derived from the production of electricity.

Since 1970, determining the amount of royalty payments has become increasingly complex due to restructuring in the geothermal industry and changing economic conditions. Government and industry representatives formed a task force in late 2004 to devise a simpler royalty system that would address these changes. During deliberations on the Energy Policy Act of 2005 (Act), we briefed you on the findings of this task force and on challenges facing geothermal development. Shortly thereafter, the Congress passed the Act, which contains provisions to simplify the federal royalties on electricity generation and reduce royalties on direct use. The

[1]Beginning in 1978, the Congress passed laws that also gave the Secretary of each military department the authority to develop geothermal resources on lands under his jurisdiction. A comparison of BLM's system for geothermal leasing and the Department of the Navy's system for geothermal leasing at China Lake appears in GAO, *Geothermal Energy: Information on the Navy's Geothermal Program*, GAO-04-513 (Washington, D.C.: June 4, 2004).

Act also contains other provisions designed to encourage the development of geothermal resources. This report formalizes the content of our briefings and our work since then, including: (1) the current extent of and potential for geothermal development; (2) challenges faced by developers of geothermal resources; (3) federal, state, and local government actions to address these challenges; and (4) how provisions of the Act are likely to affect federal geothermal royalty disbursements and collections.

In responding to these objectives, we reviewed key studies on the extent and potential of geothermal development and interviewed BLM and industry officials in California, Nevada, and Utah. To identify the challenges facing geothermal developers and to assess actions taken by federal, state, and local governments, we interviewed a variety of government and industry officials, reviewed substantial supporting documentation and the Act, and toured geothermal electricity plants in California and Nevada and direct use facilities in Idaho, Nevada, and Oregon. To assess how provisions within the Act will affect federal geothermal royalties, we interviewed MMS and BLM employees; reviewed a report authored by the Royalty Policy Committee;[2] and analyzed geothermal royalty, production, and sales data from January 2000 through December 2004. We performed our work between May 2005 and May 2006 in accordance with generally accepted government auditing standards. A more detailed description of our objectives, scope, and methodology is provided in appendix I.

Results in Brief

Although locally important in Hawaii, California, and Nevada, geothermal resources produce a very small portion of our nation's total electricity and heating needs, and estimates of the potential for additional development vary. In 2004, geothermal resources generated about 0.3 percent of the nation's total electricity and supplied heat and hot water directly to about 2,300 businesses and organizations, including district heating systems, fish farms, greenhouses, food drying plants, spas, and resorts. In addition, the Geothermal Heat Pump Consortium estimates that 1 million geothermal heat pumps are installed in the 50 states, tapping the shallow heat of the earth to both heat and cool individual homes and businesses. Estimates of future electricity generation from geothermal resources vary widely based on methodology, sites considered, development costs, and future electricity

[2]The Royalty Policy Committee is a group of state, tribal, federal, corporate, and public representatives that provide advice on royalty management and mineral policies to the Secretary of the Interior.

prices. The most recent assessments suggest that the current production of 2,500 megawatts of electricity—enough to supply 2.5 million homes—could increase to between about 3,100 and 12,000 megawatts in 11 years. The future potential of using geothermal resources in direct use applications is less known because of the wide variety of applications and the widespread occurrence of suitable geothermal resources. However, the Geo-Heat Center at the Oregon Institute of Technology estimates that about 400 undeveloped geothermal wells and hot springs have the potential to supply heat and hot water directly to a variety of businesses and other organizations. The potential for geothermal heat pumps, however, is almost unlimited in the United States. Heat pumps are the fastest growing sector of the geothermal industry, with about an 11 percent increase in units added each year. Finally, the potential for geothermal development is, to some extent, dependent on the federal government. Whereas nearly all direct use applications of geothermal resources are on private lands, geothermal power plants depend upon resources located on federal lands for about 50 percent of the electricity they generate.

Businesses and individuals face significant financial, technical, and logistical challenges when trying to develop geothermal resources. Developers of electric power plants that use geothermal resources face a capital intensive and risky business environment in which obtaining financing and securing a contract with a utility are difficult and where recouping the initial investment takes many years. Geothermal power plant developers must also use exploration and drilling technologies that are inadequate because of the unique attributes and high temperatures associated with geothermal reservoirs. Furthermore, because portions of the electrical grid lack adequate transmission capacity and because geothermal resources are often in remote locations, new geothermal power plants may face costly transmission expenses. Developers of electric power plants on federal lands face additional challenges, including: (1) lengthy administrative/regulatory reviews of lease and permit applications that can become complicated by lawsuits involving environmental and/or Native American issues, (2) scattered federal leases that make it difficult to develop an economically viable project, and (3) a complicated royalty payment system. Businesses and individuals trying to tap geothermal resources for direct use face unique marketing, financing, and technical challenges characteristic of their industry, as well as challenges that are unique to the site that they hope to develop. In some cases, these businesses and individuals must also contend with remote locations and state water rights that may restrict the use of geothermal resources. In addition, the developers of direct use facilities face higher federal royalties

because royalty payments are based on the price of natural gas, which has recently risen to levels that substantially reduce profit margins.

To address the many challenges of developing geothermal resources, federal, state, and local governments have implemented a number of incentives and initiatives, including tax credits, technology grants, requirements to use renewable energy, and leasing and royalty simplification. Many of these efforts show promise, but it is too early to assess their overall effectiveness. To address the capital intensive and risky business environment facing the developers of geothermal power plants, the Act grants developers a federal tax credit that allows them to recoup their investments more quickly. The Act also seeks to lower exploration risk by directing that the Secretary of the Interior update the U.S. Geological Survey's 1978 assessment of geothermal resources. Some state governments are addressing the capital intensive and risky business nature of geothermal development by granting various tax credits for the production of electricity from renewable energy and for the construction of renewable energy facilities and systems. Twenty-two states and the District of Columbia have further encouraged the production of electricity from renewable resources with laws or policies containing renewable portfolio standards. Most of these standards mandate that public utilities provide a minimum percentage of their electricity from renewable energy such as geothermal resources. To address technological challenges, the federal government and the state of California have awarded grants for research and development efforts through the Department of Energy's Geothermal Technologies Program and the California Energy Commission, respectively. To address transmission challenges, the Act gives the Federal Energy Regulatory Commission (FERC) new authorities to issue permits for transmission facilities in the national interest, increase their capacity, and develop incentives. Some states and local governments have also developed several planning initiatives aimed at transmission challenges. Finally, the Act contains provisions designed to improve the efficiency of the federal geothermal program, including simplifying the federal leasing process, improving coordination between leasing responsibilities of BLM and the Forest Service, consolidating small federal leases, and simplifying or reducing federal royalty rates on electricity generation and direct use facilities.

How federal geothermal royalties are to be shared with local governments will change significantly after passage of the Act, and the total amount of royalties collected could change significantly if electricity prices also change. Prior to passage of the Act, half of federal geothermal royalties

were disbursed to the states, and half were retained by the federal government. Now, half of the federal government's share will be disbursed to the counties in which the geothermal resources are located, leaving the federal government with 25 percent of the total royalty revenue, instead of the original 50 percent. While, for most leases, the Act directs that the Secretary of the Interior seek to maintain the same level of royalty revenues as before the Act, our analysis suggests that this will be difficult because changing electricity prices could significantly affect the percentage of royalty revenues collected in the future. Furthermore, it will be difficult for MMS to show that it plans to collect the same level of royalty revenues from electricity generation because it does not routinely collect revenue data from electricity sales, and these data are necessary to calculate and achieve the royalty percentages prescribed in the Act. Finally, while a provision within the Act lowers the royalties on direct use applications in order to encourage additional development, the monetary impact on collections is likely to be small because total royalty revenues from direct use applications on federal lands are already minimal.

To demonstrate their attempt to collect the same level of royalty revenues as prior to passage of the Act, we are recommending that the Secretary of the Interior instruct the appropriate managers within MMS to routinely collect future sales revenues for electricity when royalty payments are due.

Background

The temperature of geothermal resources generally dictates their use. Low temperatures from 40 to 70 degrees Fahrenheit (F) that occur in the ground at shallow depths are best used for geothermal heat pumps. Geothermal heat pumps, also known as ground-source heat pumps, are devices that take advantage of the relatively constant temperature immediately beneath the earth's surface to provide heat in the winter and air conditioning in the summer. During the winter, a heat pump transfers the heat of the ground to a fluid filled set of coils and then pumps this fluid to the building. A heat exchanger then transfers the heat to another set of coils filled with a refrigerant that boils. The resulting gas is then compressed and pumped to a condenser, where it gives up its heat as a fan blows over the condenser coils. During the summer, heat pumps work in reverse, extracting heat from the building and transferring it to the ground. Although heat pumps run on electricity, they produce three to four times the energy that they consume. As a result, they can reduce energy consumption by 20 to 70 percent relative to conventional electrical heating and cooling systems. They also can produce hot water for free during the summer and for about half price during the winter.

Direct use applications begin with geothermal resources that have temperatures as low as 70 degrees F and can include geothermal resources as hot as 300 degrees F. Geothermal waters can be mixed with groundwater or surface water to achieve the most desirable temperature for the specific application. Geothermal waters with temperatures between about 70 and 125 degrees F are best used in spas and resorts for recreational swimming and bathing, in aquaculture operations for raising fish and other aquatic animals (fig. 1), and within sidewalks and roads for melting snow. Geothermal resources between about 125 and 300 degrees F can be used for various applications, each of which has optimal temperature ranges. Specific applications include food processing; fruit and vegetable drying; space and district heating; raising flowers, plants, and trees in greenhouses; processing pulp and paper; drying lumber, cement, and aggregate; curing concrete blocks; pasteurizing milk; dyeing fabric; making ice; and providing refrigeration.

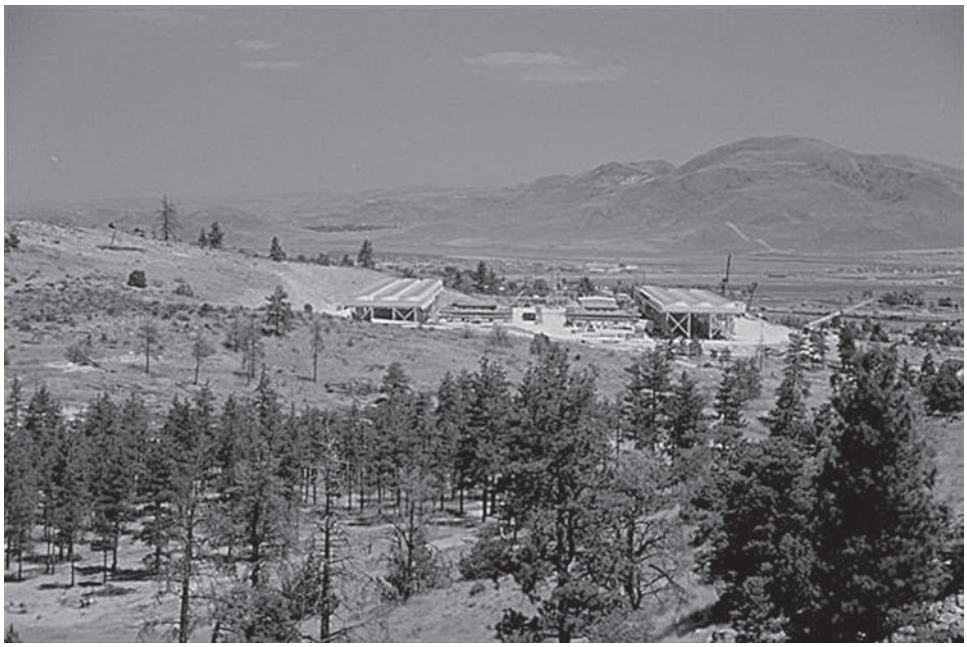
Figure 1: Tropical Fish Raised in Oregon with Geothermal Water

Source: GAO.

Electricity generation requires geothermal resources of at least 200 degrees F, with higher generation capacity coming from temperatures above 350

degrees F. Geothermal power plants extract geothermal fluids—hot water, brines, and steam—from the earth by drilling wells to depths of up to 10,000 feet (fig. 2). The geothermal resources are then used, in lieu of running water or the burning of fossil fuels, to produce a vapor that turns the blades of a turbine that spins a generator to produce electricity. Geothermal resources with temperatures from about 200 to 350 degrees F are best suited for binary power plants. In a binary plant, the geothermal fluids are passed through a heat exchanger to heat a secondary fluid, like isopentane, that vaporizes at a lower temperature than water and spins the power-producing turbines. The fluid is then condensed back into a gas and recycled, and the geothermal resources are injected back into the reservoir. When geothermal resources have temperatures over about 350 degrees F, flash plants are most appropriate. In flash power plants, highly pressurized hot water is brought to the surface, where the pressure decreases and part of the water explosively boils, or "flashes," into steam. The steam is then separated from the remaining hot water and used to turn the turbines. Residual water is injected back into the reservoir. In some rare geothermal systems with temperatures above 455 degrees F, as at an area known as The Geysers Geothermal Field (The Geysers) in northern California, the geothermal resources may consist entirely of steam within the reservoir. Dry steam power plants use the steam directly to spin the turbines. Although some of the steam condenses back to water that can be injected back into the reservoir, much water is lost to evaporation in this process. Flash and binary power plants can also be combined in sequence for the most efficient generation of electricity. In these hybrid power plants, hot water is first flashed within a flash plant and then the steam is condensed, combined with the lower temperature water, and routed to a binary plant for further generation of electricity.

Figure 2: Geothermal Power Plant near Reno, Nevada



Source: GAO.

The leasing of federal lands for geothermal resources is governed by the Geothermal Steam Act of 1970, as amended.[3] To explore and develop geothermal resources on federal lands, developers must first obtain a federal lease from BLM. The lease is a contract between the federal government and the lessee that specifies certain terms for development and payment of rents and royalties. Regardless of the federal agency managing the lands where the geothermal resources are located, BLM has responsibility for issuing these leases after obtaining concurrence from the federal land managing agency. Before passage of the Act, BLM designated certain areas that it believed to have a reasonable potential for the commercial development of geothermal resources as "known geothermal resource areas (KGRA)." Within a KGRA, BLM was required to lease lands to the highest qualified bidder under a formal competitive bidding process, as long as the highest bid equaled or exceeded fair market value.[4] For land

[3]30 U.S.C. §§ 1001-1027.

[4]Fair market value is the price agreed to by a willing buyer and a willing seller.

outside of a KGRA, BLM was required to issue a lease noncompetitively to the first qualified buyer applying for the lease. Under provisions of the Act, BLM no longer establishes KRGAs, but instead accepts nominations from parties interested in leasing available lands and holds a competitive auction at least once every 2 years. If bids are not received for lands offered in the sale, the Secretary is to make them available for 2 years for noncompetitive leasing. BLM issues geothermal leases for 10 years and requires lessees to pay an annual rental of at least $1 per acre until commercial production is established. Thereafter, lessees pay a royalty from 10 to 15 percent of the value of production.

BLM will not issue federal geothermal leases until the federal land management agency completes an extensive environmental review process. The leasing and development of these lands must be consistent with the management objectives for the lands as documented in the appropriate resource or forest management plan. Should these plans not adequately address exploration and development of geothermal resources, the appropriate agency personnel may need to amend or rewrite the plans. Prior to leasing, agency officials must also comply with provisions of the National Environmental Policy Act of 1969, as amended (NEPA). NEPA requires federal agencies to prepare an environmental impact statement (EIS) for major federal actions that may have a significant affect on the quality of the human environment. When an agency is not sure whether an activity will have significant impact on the environment, the agency prepares a less detailed environmental assessment (EA). If an EA determines that the activity will significantly affect the environment, the agency then prepares an EIS. During these analyses, agency personnel analyze potential impacts of geothermal leasing to various resources such as air and water quality, vegetation, wildlife, threatened and endangered species, and visual and cultural resources. In California, state laws also require a similar environmental review. Agency personnel may also need to comply with provisions of other federal legislation, such as the Endangered Species Act of 1973, as amended, and the National Historic Preservation Act, as amended.

Under the Geothermal Steam Act of 1970, as amended, calculating geothermal royalties was relatively simple because the developers of the geothermal fields sold steam and hot water to power plants, establishing a sales price upon which royalties could be based. The statutory royalty rate specified in the lease, which was from 10 to 15 percent, was multiplied by the sales value of the geothermal resource each month to yield royalties due. In the 1980s, the developers sold the fields to the power plants, and

this basis for valuing the geothermal resource was lost. In 1991, MMS issued new regulations that were in effect until passage of the Act. These regulations established the value of the geothermal resource based on the value of the electricity sold. The regulations called for subtracting, or "netting back" from the electricity's sales revenues, the costs of generation and transmission. Formulas for netting back these costs were complex due to different methods of accounting for depreciation, uncertainty over which costs qualified for deduction, and commingling of federal and nonfederal resources. The Act contains provisions aimed at simplifying this process by allowing lessees the option on existing leases to pay royalties based on a percentage of gross sales revenue and by prescribing a set schedule of royalty rates for future leases. In addition, royalties due on direct use facilities prior to passage of the Act were based on the price of natural gas, which has risen substantially in recent years, making the direct use of federal geothermal resources unattractive. The Act provides for replacing this system of direct use royalties with a schedule of fees that encourages the development of geothermal resources.

Current Geothermal Development Is Limited, and Estimated Potential for Additional Development Varies

Electricity generated from geothermal resources is small, about 0.3 percent of the total electricity produced in the United States, with about half of this amount coming from federal resources. Recent estimates of the potential for additional electricity generated from geothermal resources vary from an increase of about 25 percent by 2015 to 367 percent by 2017. There were over 2,300 businesses and heating districts that used geothermal resources for heat and hot water in the United States in 2005, with only two businesses using federal geothermal resources. The total potential for direct use applications is largely unknown because of the widespread occurrence of lower temperature geothermal resources and the many diverse applications.

Electricity Generation from Geothermal Resources Is Small and Relies on Federal Resources

Geothermal resources currently produce about 0.3 percent of the annual electricity in the United States, or 2,534 megawatts—enough electricity to supply 2.5 million homes. Even though the percentage of electricity generated from geothermal resources is small nationwide, it is locally important. For example, geothermal resources provide about 25 percent of the Island of Hawaii's electricity, 5 percent of California's electricity, and 9 percent of northern Nevada's electricity. As of January 2006, companies were constructing geothermal power plants in California, Nevada, and Idaho that collectively will produce another 390 megawatts of electricity.

Table 1 shows the number, location, and capacity of geothermal power plants that currently produce electricity or are under construction.

Table 1: States with Power Plants and Their Capacity

State	Number of existing geothermal power plants	Total capacity	Number of power plants under construction	Additional capacity
California	41	2,239	2	285
Hawaii	1	30	0	0
Idaho	0	0	1	10
Nevada	10	239	3	95
Utah	2	26	0	0
Total	**54**	**2,534**	**6**	**390**

Source: The Geo-Heat Center, the Department of Energy (DOE), and BLM.

Note: Each unit of capacity is a megawatt.

Over half of the nation's electricity generated from geothermal resources, about 1,275 megawatts, comes from geothermal resources located on federal lands. Of the 54 geothermal power plants, 26 are located on federal lands managed by BLM, and 28 are located on private or state lands. As of January 2006, there were 50 federal geothermal leases from which electricity was produced—48 on BLM lands, and 2 on Forest Service lands. Twelve of these leases are located in The Geysers in northern California, and they account for over one-third of the electricity produced from federal geothermal resources. The other 44 producing federal geothermal leases are located in and near the Sierra Nevada Mountains of eastern California, near the Salton Sea in the southern California desert, in southwestern Utah, and scattered throughout Nevada.

Estimates of the Potential for Additional Electricity Generation from Geothermal Resources Vary Widely

Industry and government estimates of the potential for electricity generation from geothermal resources vary widely, due to differences in the date by which forecasters believe the electricity will be generated, the methodology used to make the forecast, assumptions about electricity prices, and the emphasis placed on different factors that can affect electricity generation. Five estimates published since 1999 indicate that the potential for electrical generation from known geothermal resources over the next 9 to 11 years is from about 3,100 to almost 12,000 megawatts. By 2025, two of these sources estimate that electrical generation from these

known resources will increase to between 6,800 and 13,000 megawatts. The difference in estimates could also be due to the different methodologies used to make the forecasts, such as surveys of experts in the geothermal industry and/or detailed economic modeling. Placing different emphasis on geothermal development costs, electricity prices, natural gas prices, and/or reservoir characteristics also probably led to differences in the estimates. Table 2 summarizes the estimates of potential electricity generation from geothermal resources.

Table 2: Estimates of Potential Electricity Generation from Geothermal Resources

Source and date of estimate	Estimate of electricity generation
U.S. DOE, Energy Information Administration's Annual Energy Outlook, 2004	6,800 megawatts by 2025 for known geothermal areas based on stable natural gas prices. This estimate does not take into account Enhanced Geothermal Systems, which is a DOE program to create man-made geothermal reservoirs.
California Energy Commission, 2005	11,822 megawatts by 2017 in California, Nevada, Arizona, Idaho, Utah, Oregon, and New Mexico from known geothermal resource areas based on amount of heat in place, reservoir characteristics, economic factors, and a Monte Carlo simulation.
Oregon Institute of Technology, Geo-Heat Center, 2005	3,160 megawatts based on all planned capacity at known geothermal areas coming on line by 2015.
Western Governor's Association, 2005	5,600 megawatts by 2015 and up to 13,000 megawatts by 2025, based on consensus of professional opinions for known geothermal resource areas and economic modeling of costs and electricity prices.
Geothermal Energy Association, 1999	Between 6,340 megawatts and 11,700 megawatts using 1999 technology and between 15,080 megawatts and 25,390 megawatts using enhanced technology, based on a survey of expert opinions and known geothermal areas.
U.S. Geological Survey, 1978	23,000 megawatts from known geothermal areas and an additional 72,000 to 127,000 megawatts from undiscovered resources based on amount of heat in place, reservoir characteristics, 1978 technology, and a Monte Carlo simulation.

Source: GAO.

A detailed comprehensive study of electricity generation from all geothermal resources in the United States has not been undertaken since 1978, when the U.S. Geological Survey (USGS) published Circular 790, "Assessment of Geothermal Resources of the United States—1978." This assessment, based on the amount of thermal energy in place, estimated that known geothermal resources could generate 23,000 megawatts if all of them were developed, significantly more than that estimated by the five other studies. The other five estimates in table 2 differ from the USGS estimate in that they attempt to estimate how much electricity could be economically produced from known resources, given competing commercial sources of electricity, and they are based on more extensive reservoir, production, and economic data. In addition, none of the five

estimates include undiscovered resources; the USGS estimated that undiscovered resources could generate an additional 72,000 to 127,000 megawatts.

Direct Use Applications Are Numerous and Diverse, and Few Are Located on Federal Land

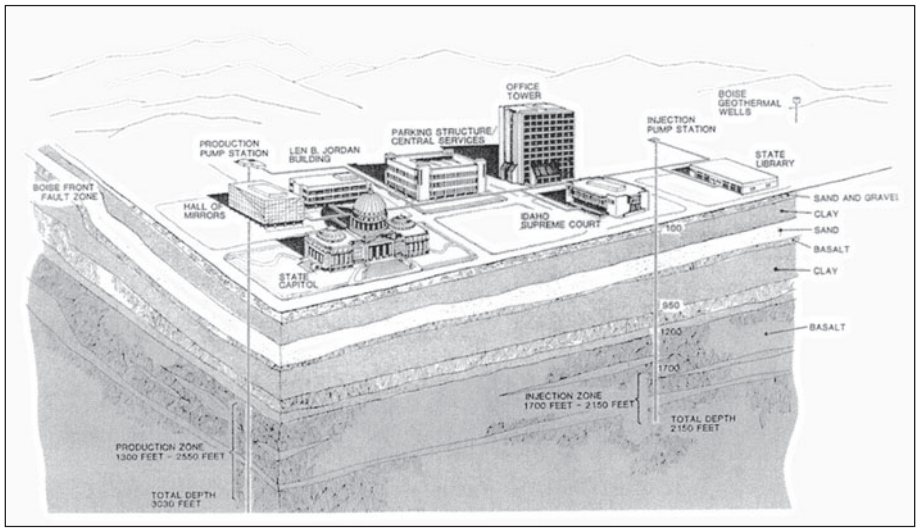
Over 2,300 businesses and heating districts in 21 states used geothermal resources directly for heat and hot water in 2005. About 85 percent of these users are employing geothermal resources to heat homes, businesses, and government buildings (table 3). While most users heat one or several buildings, some users have formally organized heating districts that pipe hot water from geothermal wells to a central facility that then distributes it to heat many buildings more economically than other available sources of energy. The largest concentration of geothermal heating districts occurs in Boise, Idaho, where four heating districts distribute geothermal waters to over 50 buildings, including the Capitol and City Hall (fig. 3). Geothermal heating districts supply heat to about 20 commercial and government buildings in Klamath Falls, Oregon, and to 400 homes in Reno, Nevada. The next most plentiful direct use applications are resorts and spas, accounting for over 10 percent of sites. About 244 geothermal resorts and spas offer relaxation and therapeutic treatments to customers in 19 states. Spas and resorts can be as primitive as an unsheltered hot spring in the backcountry to an elaborate resort with multiple soaking pools, an Olympic-sized swimming pool, a 100-room hotel, and gourmet restaurants. Two percent of geothermal direct use applications consist of heated greenhouses in which flowers, bedding plants, and trees are grown. Idaho leads the nation with the most geothermally heated greenhouses—13, and New Mexico leads the nation with the largest geothermally heated greenhouse—covering 32 acres. Another 2 percent of geothermal direct use applications are for aquaculture operations that heat water for raising aquarium fishes for pet shops; catfish, tilapia, freshwater shrimp and crayfish for human consumption; and alligators for leather products and food (fig. 4). Other direct use geothermal applications include dehydrating vegetables, like onions and garlic, and melting snow on city streets and sidewalks. Geothermal direct use applications are summarized in table 3.

Table 3: U.S. Geothermal Direct Use Applications as of 2005

Application	Number of sites
Space heating	1,976
District heating	20
Resorts and spas	244
Aquaculture	48
Greenhouses	44
Snow melting	6
Agricultural drying	3
Other industrial	3
Total	**2,344**

Source: The Geo-Heat Center at the Oregon Institute of Technology.

Figure 3: District Heating in Boise, Idaho



Source: GAO.

Nearly all direct use businesses and heating districts are currently located on private lands. Only two direct use businesses that use federal geothermal resources are currently in operation. One of these businesses, located at Honey Lake in northern California, uses geothermal resources to preheat a boiler in which biomass is burned to create electricity. Four additional businesses—a nursery, a food processing plant, and two mines—

have also used federal resources at one time in direct use applications. A nursery in New Mexico used federal geothermal resources for heating greenhouses, but the owner reported that he stopped using the federal geothermal resources because he considered the federal royalties to be excessive. Two gold and silver mines also used geothermal waters from BLM lands in Nevada to enhance their cyanide heap leeching operations but suspended these operations, due in part, to high federal royalties. The owner of the food processing plant, which dried garlic, reported being forced out of business by lower priced imports from China.

Figure 4: Raising Tropical Fish with Geothermal Resources in Idaho

Source: GAO.

The Potential for Developing Additional Direct Use Is Uncertain

The potential for additional direct use of geothermal resources in the United States is uncertain due to the geographically widespread nature of low-temperature geothermal resources and the many different types of applications. The USGS performed the first national study of low-

temperature geothermal sites in 1982[5] and estimated the amount of heat in-place that could be available for direct use applications across the United States. However, this study was neither specific enough to identify individual sites for development, nor did it estimate the amount of heat that could be recovered and converted into energy savings for homes or businesses. In 2005, the Geo-Heat Center at the Oregon Institute of Technology identified 2,211 geothermal wells and springs with temperatures appropriate for direct use. The Geo-Heat Center estimated that 404 of these wells and springs might be commercially developed because they are within 5 miles of communities. The study estimated the minimum amount of heat that could be produced at each site but did not assess the economics or business climate of the various direct use applications.

Geothermal Heat Pumps Show Increasing Use

Geothermal heat pumps have become a major growth segment of the geothermal industry by making use of the earth's warmer temperature in the winter to heat buildings and using the earth's cooler temperature in the summer for air conditioning. The Geothermal Heat Pump Consortium estimated that 1 million units were in operation in all 50 states as of January 2006. The number of geothermal heat pumps has steadily increased over the past 10 years. Because geothermal heat pumps are effective where ground temperatures are between 40 and 70 degrees F, they can be installed in almost any location in the United States and, therefore, are the most widespread geothermal application and have the greatest potential.

Until 1999, few geothermal heat pumps were installed in federal facilities. The annual federal investment in geothermal heat pumps has increased substantially since then, from $6 million in 1999 to $74 million in 2001—the latest year for which data are available. As of November 2005, federal facilities had installed over 25,000 individual heat pumps—over 24,000 of them in military bases. The other 1,000 heat pumps were installed by the Department of Housing and Urban Development, DOI, the U.S. Postal Service, and the Environmental Protection Agency.

[5]U.S. Geological Survey, *Assessment of Low-Temperature Geothermal Resources of the United States*, 1982.

Geothermal Development Faces Many Challenges

The development of geothermal resources for electricity production faces major challenges, including high risk and financial uncertainty, inadequate technology, and insufficient transmission capacity. Developers of geothermal power plants face additional challenges when operating on federal lands. These challenges include: (1) a lengthy review process for the approval of leases and permits,(2) insufficient resources at BLM to conduct the necessary reviews, (3) different priorities between the BLM and the Forest Service when lands under their jurisdiction occur within a project area, (4) fragmented lease holdings that make it difficult to develop an economically viable project, and (5) a complex federal royalty system. Developers of geothermal resources for direct uses also face a variety of other business challenges, remote locations, water rights issues, and higher federal royalties over the past few years. The recently passed Act addresses some of these challenges and is discussed in the next section of this report.

Geothermal Power Plants Face High Risk, Financial Uncertainty, and Technological Impediments

Geothermal development for the production of electricity is a risky, expensive, and lengthy process. Geothermal groups reported that most attempts to develop geothermal resources are unsuccessful, that costs to develop geothermal power plants can surpass $100 million, and it can take 3 to 5 years for plants to first produce and sell electricity. The development of geothermal resources for electricity generation follows a series of phases, starting with finding the geothermal resources through exploration, then confirming the magnitude and extent of the resource, and ending with full field development and power plant installation. Although some resources are easy to find because they produce telltale signs such as hot springs or fumaroles, most resources are buried deep within the earth—at depths sometimes exceeding 10,000 feet—and finding them often requires an in-depth knowledge of the area's geology, geophysical surveys, remote sensing techniques, and at least one test well. The Geothermal Energy Association estimates that average wells cost from $2 million to $5 million and that only about 25 percent of the initial test wells are successful in finding commercial geothermal fields. Companies must then drill additional wells to assess the extent, temperature, pressure, and productivity of the reservoir, thereby allowing companies to confirm the magnitude and extent of the resource and decide whether it is economically viable. Estimates of failure rates for wells drilled during this phase run as high as 60 percent. According to the Geothermal Energy Association, developers typically spend about 10 percent of the total cost for this phase. It costs $75 million to develop a typical 25 megawatt power plant. Such a plant can produce enough electricity for 19,000 homes. The

drilling of additional wells to produce and manage the reservoir, installing the power plant, and connecting the wells to the plant with pipes generally account for another 23 percent, 54 percent, and 7 percent of the total costs of the plant, respectively. In addition, operating and maintenance costs for a plant of this size could be about another $5 million per year.

The risks and high initial costs associated with geothermal development limit financing and make financing more difficult. Energy consultants told us that few companies, including venture capitalists, are willing to provide funding for geothermal projects, particularly for the initial phases of exploration and confirmation. Industry officials who do provide funding for geothermal development told us that they would only fund projects that are either fully confirmed or are in areas of well-known geothermal potential. Even when fully confirmed, moreover, few lenders will finance a geothermal project until a contract has been signed by a utility or energy marketer to purchase the expected electricity. Geothermal industry officials describe the process of securing a contract as complicated and costly, especially for small geothermal developers who are generally unfamiliar with the various bidding mechanisms that utilities use to establish electricity prices. Officials with a large utility expressed their reluctance to purchase more costly electricity from geothermal plants and cited an inability to pass on the additional cost to ratepayers. Electricity from geothermal resources may also be unavailable during time frames specified by the contract because of delays due to environmental litigation or lack of available transmission. In addition, an energy consultant told us that most utilities are unfamiliar with geothermal resources, and they are unlikely to invest the necessary time to assess geothermal projects because geothermal electricity would make up a small percentage of their total energy portfolio.

Inadequate technology adds to the high costs and risky nature of geothermal development. Since geothermal systems are geologically more complex than oil and gas systems, exploration tools commonly used in the oil and gas industry, such as geophysical surveys, are less effective. In general, geothermal reservoirs are located in very hard and fractured rocks that make drilling difficult. Operators often experience difficulty in drilling because drill bits wear quickly and because the medium used to lubricate the borehole and remove rock fragments, called drilling fluid, is commonly lost into the many fractures in the rock. Compared with oil and gas wells, the temperatures encountered when drilling are considerably higher and the geothermal resources are more corrosive, resulting in corrosion of drilling equipment and production casing and the failure of electronic

components. Geothermal wells are also larger in diameter than oil and gas wells drilled to the same depth, which drives up drilling costs. The recent boom in oil and gas drilling has added to the scarcity and higher costs for drilling rigs and equipment.

Lack of Adequate Electrical Transmission Hinders Geothermal Development

Lack of available transmission creates a significant impediment to the development of geothermal resources for electricity production. To send electricity produced at geothermal power plants to utilities, geothermal companies often need to construct new transmission lines from their plant to existing lines. In the West, however, many geothermal resources are located far from existing transmission lines, making the construction of additional lines economically prohibitive, according to federal, state, and industry officials. For example, there are no significant transmission lines between the geothermal resources in northern Nevada and the populated area of Las Vegas in southern Nevada. In California, there is a need for new or upgraded transmission to access renewable resources in Nevada and in the Imperial Valley of southern California, which has significant geothermal potential. Even when geothermal resources are near major transmission lines or developers can fund the construction of an additional transmission line, adequate transmission capacity may still be unavailable. Many existing transmission lines are operating at or near capacity and may not be able to transmit electricity without significant upgrades.

Paramount among transmission concerns is who will pay for the needed transmission capacity. Transmission costs can be very large. In Nevada, a BLM official told us that transmission lines there cost over $500,000 per mile. The California Energy Commission said in a June 2005 report that new transmission lines with interconnections cost between $375,000 and $3.3 million per mile for single circuit lines, depending on their voltage. In the summer of 2005, FERC denied a request from a utility to pass the costs for transmission lines on to ratepayers. According to utility officials, this reaffirms that developers must pay for the costs since utilities will not voluntarily absorb the costs directly. Under current rules, when a developer requests new transmission capacity, the bulk of the costs are assigned to the project that first pushes the transmission system beyond its existing capacity. In addition, federal, state, and industry officials note that small geothermal plants are discouraged from connecting to these large transmission lines because utilities do not want to bother with the small amounts of electricity unless there are many of them in the same area.

Cumbersome planning and permitting processes have hindered the addition of necessary transmission capacity. In a July 2005 report, a consultant for the Edison Electric Institute noted that nationally the task of getting a transmission project planned, approved, permitted, and financed remained daunting. The authors stated that the investment climate for transmission remained fragmented by different procedures, incentives, and constraints from one region of the country to another. The California Energy Commission noted in a November 2005 report that the state's inefficient transmission planning and permitting processes were contributing to worsening the state's transmission problems. Addressing the same issue, an official of a large California utility told us that obtaining agreement on where to construct transmission lines, addressing environmental issues, obtaining approvals, and a "not in my backyard" philosophy, contributed to the uncertainty and long lead times in building additional transmission capacity. In addition, a geothermal developer complained about extensive hearings and an inability to determine jurisdictions between the state and the federal government and between agencies within California.

Geothermal Power Plants on Federal Lands Face Delays in Processing Applications, Fragmented Lease Holdings, and a Complex Royalty System

Geothermal developers state that the process for approving leases and issuing permits to drill wells and construct power plants has become excessively bureaucratic. BLM and Forest Service officials often have to amend or rewrite resource or forest management plans, which can add up to 3 years to the approval process, depending upon the complexity of the proposal and when the last plan was written. Delays in finalizing resource and forest management plans and in conducting environmental reviews have resulted in a backlog of 31 lease applications in California, with an average age of 7.4 years, and 136 lease applications in Nevada, with an average age of about 2 years. Despite the high backlog in Nevada, BLM officials noted that they processed 177 lease applications from January 2001 through June 2005. In contrast, during the same period, BLM did not process any lease applications in California. Nevada BLM officials reported that they can generally make decisions on whether to allow leasing and development faster because the public raises fewer issues and BLM documents its decision within a shorter document known as an EA. In California, however, the public raises more environmental issues and concerns involving Native American spirituality so BLM often prepares a more detailed document called an EIS, which typically takes 2 years to complete. While geothermal developers told us that they support environmental analyses, they complained about the duplication of federal and state documentation in California and of the appeals and lawsuits filed

by groups opposing the federal and state decisions, citing that it often takes years for their resolution. The California Energy Commission reported in a June 2005 report that the entire process from exploration to the first production of electricity can take more than a decade and that it was not unusual to redo environmental documents because they became outdated.

Geothermal applications, permits, and environmental reviews are also delayed because of a lack of staff and budgetary resources at the BLM state and field offices that conduct the necessary work. Nevada and California BLM officials noted that lack of funding and dedicated staff to work on lease applications was a constant problem. Lack of funding in California has slowed completion of BLM resource management plans and EISs necessary for lease approvals and drilling permits. BLM officials noted in California that they received only $90,000 to conduct two extensive EISs for which staff had requested $1.2 million while Nevada BLM received a one-time allocation of $700,000 for processing a backlog of lease applications and writing several less extensive EAs, which generally cost $80,000 to $90,000 each.

Approvals for leases and permits may also be delayed when BLM must coordinate with the Forest Service, which manages land in some project areas. The Forest Service manages significant lands on geothermal projects in Oregon, Washington, California, and Nevada. Although BLM is the lead federal agency for geothermal development, the Forest Service must concur with leasing and development, and it has its own permitting process. BLM and industry officials report that there can be a lack of coordination between the Forest Service and BLM because of differing objectives and directives. While both agencies manage their lands according to the multiple use doctrine, they may have different priorities for land use and the public often submits more negative comments concerning geothermal development on Forest Service lands. A Forest Service official noted that it is important to balance the competing issue of geothermal development with other land uses such as preservation and recreation. He cited a limited budget for updating forest management plans, which can lead to delays, and noted that since geothermal development generates far less revenue than logging and coal mining on Forest Service Lands, geothermal development receives less priority.

Companies may also encounter difficulties in developing geothermal resources for electricity production due to a patchwork of lease ownership. Geothermal resources within a project area may be owned by the federal government, state government, or private entities. Even when all resources

within a project are under federal lease, several lessees with competing interests and objectives may own these leases. Some BLM officials noted that some developers have reported difficulty in consolidating the various geothermal leases into an economically viable project that can recover the costs of the power plant and transmission line. These developers, according to these BLM officials, say that speculators often lease geothermal resources not for development purposes but rather to resell the leases at a significant profit, running up the cost of the project.

Geothermal developers, BLM officials, and MMS officials concur that the complex federal royalty system in effect before passage of the Act was a challenge to the development of geothermal electricity plants. While developers did not consider this royalty system to be a major obstacle in constructing a geothermal power plant, some described calculating royalty payments as burdensome and reported expending considerable time and expense on royalty audits. Several industry officials cited the complex royalty system as a reason for advocating revisions to the Geothermal Steam Act of 1970, as amended.

Direct Uses of Geothermal Resources Face Business Challenges, Remote Locations, Water Rights, and Royalty Issues

The small business owners, operators of heating districts, and individuals who commonly develop geothermal resources for direct use face a variety of business challenges. Foremost among these challenges are obtaining capital, overcoming specific challenges unique to their industry, containing costs, and securing a competitive advantage. While the amount of capital to start a business that relies on geothermal resource is small compared with the amount of capital necessary to build a geothermal power plant, this capital can be large relative to the financial assets of the small business owner or individual. Unforeseen problems in well construction, piping, and water disposal can also increase original funding estimates. Obtaining funding is difficult as commercial banks are often reluctant to loan money for unproven projects and ideas that appear risky. Even district heating systems that are operated by municipalities have encountered financing difficulties as city or state legislatures may be reluctant to provide funding or customers may be reluctant to pay for modifications that are necessary to use geothermal resources in their current heating systems. We observed a number of business challenges unique to various industries that the successful owners of direct use businesses were able to overcome. They used their extensive knowledge of their respective industries to combat diseases in fish farms; to combat corrosive waters used in space heating; and to control temperature, humidity, and light according to the specifications of the various plant species they grew in nurseries.

Escalating costs also pose a challenge to direct use operations. Rising labor costs and cheaper imports closed a food processing plant in Nevada. Greenhouses in Idaho and Oregon remained profitable by shifting from high-cost natural gas to cheaper geothermal resources for heating. Successful operators of direct use businesses have secured competitive advantages by entering specialty niches (see figs. 5 and 6). For example, the operators of two aquaculture facilities in Idaho and Oregon sell alligator meat, tilapia, and freshwater shrimp to restaurants. Also, a resort operator in Alaska that relies on geothermal resources constructed and markets an "ice museum" where guests can spend the night with interior furnishings sculptured from ice. We noticed that some greenhouse operators gained a marketing advantage by selling from their retail outlet rather than selling at a lower price to wholesalers.

Figure 5: Alligator Farm Using Geothermal Resources in Idaho

Source: GAO.

The remote location of many geothermal resources hampers their development for direct use. Geothermal direct use is constrained because the geothermal waters cannot be economically transported over long distances without a significant loss of heat. An official with the Geo-Heat

Center noted that for space heating, spas, and resorts, the geothermal resources should be located within 5 miles of the location where they will be used. While some greenhouses, aquaculture operations, and food processors that rely on geothermal resources have successfully produced their products far from consumers, they still need access to adequate transportation and a cheap labor market, both of which are generally dependent on proximity to population centers. The distant location from major population centers of geothermal resources on federal lands contributes to their unattractiveness for direct use applications.

Figure 6: Nursery Heated with Geothermal Resources in Idaho

Source: GAO.

Obtaining water rights can be a significant challenge to direct use development. Western states are not uniform in classifying geothermal resources, considering them legally to be mineral, water, or having characteristics of both minerals and water. Depending sometimes on the depth and/or the temperature at which they occur, geothermal resources can be subject to state water laws in the western states and are then managed by the state agency responsible for protecting groundwater. Even when not legally classified as water, the production of geothermal

resources for direct use applications may still fall under regulations enforced by a state agency responsible for groundwater protection. In areas of high groundwater use, the western states generally regulate geothermal water according to some form of the doctrine of prior appropriations, under which specific amounts of water are appropriated to users in the order when they first made beneficial use of the water. Additional amounts, if available, are appropriated in the future to applicants on a first-come basis. Those that have more senior rights have priority in using the water when use exceeds supply, such as during a drought. Western states that generally follow the prior appropriations doctrine when managing the production of geothermal water for direct use include Utah, Idaho, Oregon, New Mexico, and Nevada.[6] Developers of geothermal resources for direct use would face problems obtaining appropriations in the Snake River Basin of Idaho, which consists of much of the state below the panhandle, because groundwater is fully appropriated there and used predominantly for irrigation. Over half of the state of Utah also includes areas in which geothermal resources for direct use would be excluded or restricted due to prior appropriations, and the state water engineers in Nevada and New Mexico may also restrict appropriations in some areas of their states. In addition, applications for development of geothermal resources for direct use on federal lands may also be subject to state water laws. Unless the federal government has reserved water rights on land in which a geothermal developer is interested and the geothermal development fulfills the specific purpose of the federal reservation, the development may still be subject to restrictions under state water laws.

Developers interested in using federal geothermal resources for direct use were concerned about high federal royalties prior to passage of the Energy Policy Act of 2005. Royalties were computed according to a formula that relies on the amount of heat extracted from the resource and the cost of a reasonably available alternative form of energy. Since most inquiries into the use of federal resources have been by operators of greenhouses, this alternative form of energy—natural gas—has been the source generally used to heat greenhouses. Average wellhead natural gas prices in recent years have increased about two and a half times from $3.68 per million British thermal units in 2000 to $9.50 in September 2005. Operators of greenhouses have told us that heating greenhouses with natural gas is no

[6]California treats geothermal resources as minerals, and they are managed by the California Division of Oil, Gas, and Geothermal Resources.

longer economically feasible as the costs of raising plants would exceed the price they obtain for these plants. During meetings between BLM, MMS, state, and industry officials, general consensus was reached that natural gas was too expensive an energy source upon which to base royalties, and a working group was formed to propose an alternative energy source. In the report they drafted,[7] the group proposed Powder River Basin coal, which averages about 30 cents per million British thermal units—a fraction of the price of natural gas. The report states that lower royalties on direct use may encourage development and result in higher royalty revenues in the long run. However, based on other challenges facing the development of direct use applications, the lowering of federal royalties alone is unlikely to stimulate the direct use of federal geothermal resources.

Efforts by Federal, State, and Local Governments to Address Challenges Show Promise

The Act includes a variety of provisions designed to help the geothermal industry address numerous challenges, including the high risk and financial uncertainty of developing renewable energy projects, lack of sufficient transmission capacity, delays in federal leasing, and complex federal royalties. Although these efforts show promise, it is too early to assess their effectiveness. Through the Department of Energy (DOE) and the California Energy Commission, the federal government and the state of California are attempting to overcome technical challenges by awarding cost-share grants for research and development. State and local governments have also made efforts to address challenges to geothermal development. Chief among these efforts are financial incentives, such as tax credits for production from renewable energy sources, sales and property tax exemptions, and mandates that certain percentages of the electricity generated within the state come from renewable energy sources, such as geothermal resources.

Financial Incentives Are Used to Address the High Risk and Uncertainty of Geothermal Development

Provisions within the Act address the high risk and financial uncertainty of producing renewable energy by providing tax credits and other incentives for renewable energy producers, including the producers of geothermal electricity. Starting on January 1, 2005, section 1301 of the Act extends for 10 years a tax credit on the production of electricity from geothermal resources for already existing plants and for any new plants producing by December 31, 2007. The credit is now 1.9 cents per kilowatt-hour and has future adjustments for inflation. Although government and industry

[7]Royalty Policy Committee, Geothermal Valuation Subcommittee Report, May 2005.

officials praised this provision, they told us that for the credit to be more effective, the date by which plants must produce electricity needs to be extended. They explained that since it can take 3 years or longer for the construction of geothermal electricity plants, plants probably will not qualify unless they are ready to break ground immediately. The Act also provides a financial incentive for tax-exempt entities that cannot take advantage of the production tax credit. Section 1303 of the Act permits the issuance of clean renewable energy bonds by tax-exempt entities, such as municipalities and rural electric cooperatives, for the construction of certain renewable energy projects, including geothermal electricity plants. Investors can purchase the bonds, which pay back the original principal and also provide a federal tax credit instead of an interest payment. The Department of the Treasury will manage the issuance of these bonds and the setting of credit rates. The total issuance of bonds cannot exceed $800 million, and the bonds are to be issued between December 31, 2005, and December 31, 2007.

The Act also extends the federal government's Renewable Energy Production Incentive, which expired on September 30, 2003. This incentive entitled eligible electric production facilities, including not-for-profit cooperatives, public utilities, and various government entities who sell renewable electricity, including that generated from geothermal resources, annual financial incentive payments from the federal government. Additionally, section 1333 of the Act makes a $300 tax credit available to purchasers of geothermal heat pumps who place them in service in 2006 and 2007.

Another provision in the Act may decrease the uncertainty inherent in geothermal exploration. The Act directs the Secretary of the Interior, acting through the USGS, to update the 1978 Assessment of Geothermal Resources made by the USGS. This assessment, published as Circular 790, is widely considered to be out of date and in need of revision. USGS officials reported that, since 1978, there have been significant advancements in technology that are not reflected in Circular 790. Now, electricity can be generated from lower temperature resources and from resources located deeper within the earth. Today, according to USGS officials, scientists and engineers can make more accurate resource estimates because they are more knowledgeable of reservoir characteristics and have benefited from the knowledge gained during the 27 years of exploration and development that has occurred since the original study.

State governments are also offering financial incentives to the geothermal industry by creating additional markets for their electricity through Renewable Portfolio Standards (RPS). An RPS is a state policy directed at electricity retailers, including utilities, that either mandates or encourages them to provide a specific amount of electricity from renewable energy sources, which may include geothermal resources. To date, 22 states plus the District of Columbia have RPSs, and three other states have set RPS targets. Requirements for the program vary by state as each RPS is unique, and not all states have significant geothermal resources. California and Nevada, which have large geothermal production and potential, have each established an ambitious RPS. California law mandates that retailers must supply 20 percent of their electrical energy from renewable energy by 2017, and the state is currently seeking to move this date up to 2010. Nevada requires certain percentages of its electricity to be generated from renewable energy each year, with 20 percent by 2015. Since California and Nevada requirements were implemented, one 20 megawatt-geothermal plant in Nevada, which has gone on line, and geothermal developers have signed contracts for three plants in California for as much as 260 megawatts of future geothermal power, which can be attributed to RPSs. Nevada utilities currently are not meeting their annual RPS requirements. Officials from two large California utilities told us that they are interested in purchasing electricity generated from geothermal resources specifically because of RPS and noted that the RPS may be instrumental in constructing a new transmission line from the Imperial Valley to utilities in southern California.

Additional state programs also provide tax credits and other financial incentives for renewable energy development, including electricity generation from geothermal resources. These incentives include property tax incentives, sales tax incentives, and business tax credits. For example in California, eligible geothermal developers can be awarded supplemental energy payments from the state if they have a contract for electricity at above market costs with one of California's three investor-owner utilities. In Nevada, state law exempts from local sales and use taxes the sale, storage, and consumption of products or systems designed to generate electricity from renewable resources. In Utah, the purchases of equipment to generate electricity from renewable resources are excluded from state sales tax. Both Nevada and Oregon do not count the value added by renewable energy systems when assessing property taxes. Oregon also offers a business energy tax credit of up to 35 percent of the cost of certain renewable energy projects, including geothermal systems.

Federal and State Grants Are Addressing Technology Challenges

DOE and the state of California provide financial assistance and grants to the geothermal industry in trying to overcome technical challenges. At DOE, the Geothermal Technologies Program's mission is to work in partnership with U.S. industry to establish geothermal energy as an economically competitive contributor to the U.S. energy supply. Several goals of the program include reducing the cost of geothermal development to 5 cents per kilowatt-hour by 2010 and increasing electrical capacity from geothermal resources to 40,000 megawatts by 2040. The program seeks to accomplish these goals by competitively awarding cost-shared grants to industry for research and development. The program's budget was $25.3 million in fiscal year 2005. In the past, program funds have been used to pioneer new drill bits, demonstrate the large scale use of binary technology, produce new seismic interpretation methods, commercialize geothermal heat pumps, develop slimhole (reduced diameter) drilling for exploration, and produce a strategy for reinjection at The Geysers. Within the program, an initiative called GeoPowering the West provides technical and institutional knowledge on opportunities to use geothermal resources and on how to overcome challenges. Goals of this initiative are to increase the number of homes using geothermal energy to 7 million by 2010 and to double the number of states producing geothermal electricity to eight by 2006.

California provides financial and technical support for geothermal development through grants under two programs administered by the California Energy Commission. Under the Geothermal Resources Development Account, grants are competitively awarded to promote research, development, demonstration, and commercialization of geothermal resources in California. Funding is provided from a portion of the federal geothermal royalties disbursed to the state. The program's costs are shared with awardees. One noteworthy project funded by the program was the piping of treated wastewater from Santa Rosa, California, to The Geysers, where it was injected into the geothermal reservoir, increasing reservoir pressure and boosting electricity production by an estimated 10 percent. For California's fiscal year 2006, $3.9 million in funding is available for 12 to 15 projects. The state's Public Interest Energy Research Program also funds awards for renewable resource projects, including geothermal projects. Money comes from a surcharge on California residents' electricity bills. Of the $62 million collected by the state in 2005, $2 million was available for geothermal projects.

Expanded FERC Authority and Planning Initiatives Are Aimed at Transmission Challenges

The Act may also address transmission challenges by providing FERC with new authorities in permitting transmission facilities and in developing incentive-based rates for electricity transmission in interstate commerce. FERC can now approve new transmission lines in certain instances in a "national interest electric corridor" when a state fails to issue a permit within 1 year of a company's filing of an application. The Act also authorizes companies that obtain FERC permits for transmission facilities to acquire rights of way through eminent domain proceedings. In addition, the Act directed FERC to develop incentive-based rates for transmission of electricity in interstate commerce to promote increased investments in transmission. Within 1 year of passage of the Act, FERC is to issue a rule establishing incentive based rates. In November 2005, FERC initiated the rulemaking process for establishing these rates.

Several planning initiatives are aimed at addressing challenges to transmission. In the West, a number of regional entities composed of state public utility commissions, local governments, utilities, and others are working on transmission planning. These entities include Southwest Transmission Expansion Planning, the Northwest Transmission Assessment Committee, and the Rocky Mountain Area Transmission Study. Certain utilities are also being proactive. The Los Angeles Water and Power District is proposing that the City of Los Angeles spend $240 million to help construct or upgrade a transmission line from the Salton Sea, an area rich in geothermal resources near the Mexican border, to the Los Angeles area. Similarly, San Diego Gas and Electric is proposing a new transmission line from the Imperial Valley to its service area.

Provisions within the Energy Policy Act and BLM Planning Efforts May Address Leasing and Royalty Issues

Provisions within the Act are aimed at streamlining or simplifying the federal leasing system, principally by mandating competitive geothermal lease sales every 2 years, by combining prospective federal lands into a single lease, and by improving coordination between DOI and the Department of Agriculture, which manages lands in the National Forest System. Since companies can nominate tracks of federal land for sale, some geothermal companies see the competitive sale provision as a mechanism to jump start leasing in areas where it has stalled in recent years. BLM officials speak positively of both this provision and the provision that allows combining prospective lands into a single lease, saying that these provisions make it more likely that companies with the financial resources to develop the lands can do so. The Act also requires the Secretary of the Interior and the Secretary of Agriculture to enter into a

memorandum of understanding that establishes an administrative procedure for processing geothermal lease applications and that establishes a 5-year program for leasing of Forest Service lands and reducing its backlog of lease applications, as well as establishing a joint data retrieval system for tracking lease and permit applications. A senior official with the Forest Service's Geothermal Program said that, since the Forest Service already has a memorandum of understanding with BLM, drafting the new memorandum should not be difficult.

The Act also contains provisions that simplify federal geothermal royalties on resources that generate electricity and simplify and or reduce royalties on resources put to direct use. For electricity production, the Act defines three types of leases and provides different incentives for each. For the first type—leases that currently produce electricity—the Act allows lessees to negotiate a royalty rate equal to a percentage of gross sales revenues, instead of using the significantly more complex process known as "netback." For the second type of lease—those that were issued prior to the Act and will first produce electricity within 6 years following the Act's passage—lessees can elect for the first 4 years of production to pay 50 percent of the royalties that would have been due. For the third type of lease—those that have not yet been issued—lessees will pay according to a schedule in which royalties are equal to certain percentages of gross sales revenues. In addition, the Act significantly changes royalties due in the future on direct use applications. The Act directs the Secretary of the Interior to establish a schedule of fees, in lieu of the current complicated system, that encourages the development of direct use resources.

BLM's 5-year strategic plan for its geothermal program also attempts to address some challenges to federal leasing. The plan calls for annual workforce planning documents to reflect the skills and staffing necessary to implement an active geothermal program. A BLM official within the Geothermal Program said that this provision will allow the state and field offices to identify current budgetary needs so that they can process geothermal applications and permits in a timely manner. The strategic plan also calls for BLM to develop an inspection and enforcement plan, which it currently does not have. Such a program could help in ensuring that the federal government collects the correct royalty revenues from the sale of electricity generated from geothermal resources.

Geothermal Royalty Disbursements Will Change Significantly, and Changes in Electricity Prices Could Alter Total Royalty Collections

Under provisions of the Act, geothermal royalties retained by the federal government will be cut in half because half of the royalties that originally were retained by the federal government will now have to be disbursed to the counties in which the federal leases are located. Although provisions within the Act may change the royalties due on specific types of leases, the overall revenue impact of these provisions should be minor if electricity prices remain relatively stable and if the Secretary of the Interior relies on past royalty histories in determining future royalties. However, it is not possible to predict with reasonable assurance how electricity prices will change in the future, and price changes could significantly impact future royalty collections if they are not accounted for in royalty calculations.

The Energy Policy Act Redistributes a Greater Portion of Federal Royalties

A royalty provision of the Act redistributes the federal royalties collected from geothermal resources—cutting in half the overall geothermal royalties previously retained by the federal government. Set by the Geothermal Steam Act of 1970, as amended, the prior distribution provided for 50 percent of geothermal royalties to be retained by the federal government and the other 50 percent to be disbursed to the states in which the federal leases are located.[8] The Act changes this disbursement. While the Act provided that 50 percent of federal geothermal royalties will continue to be disbursed to the states in which the federal leases are located, an additional 25 percent will now be disbursed to the counties in which the leases are located, leaving only 25 percent to the federal government.

The Act also changes how the federal government's share of geothermal royalties can be used. Prior to passage of the Act, 40 percent of the federal government's share was deposited into the reclamation fund created by the Reclamation Act of 1902, and 10 percent was deposited into the general fund of the Department of the Treasury. For the first 5 fiscal years after passage of the Act, the federal government's share is now to be deposited into a separate account within the Department of the Treasury that the Secretary of the Interior can use without further appropriation and fiscal year limitation to implement both the Geothermal Steam Act and the Act. DOI officials explained that some of these funds could be used for activities

[8]30 U.S.C. § 191 (a). The state of Alaska is an exception to this provision, receiving 90 percent.

such as issuing geothermal leases, conducting environmental reviews, collecting geothermal royalties, and inspecting geothermal leases.

Provisions of the Energy Policy Act Are Likely to Have Little Impact on Overall Royalty Revenues Only if Electricity Prices Remain Relatively Constant

Despite several provisions of the Act that alter the amount of royalties due on both the generation of electricity and direct use operations, federal geothermal royalties could remain about the same, but only if electricity prices remain stable. However, electricity prices are not possible to predict with certainty, and price changes could significantly impact royalty revenues on electricity sales, which account for about 99 percent of total geothermal royalty revenues. The Act contains provisions for each of three specific types of leases that generate electricity: (1) leases that currently produce electricity, (2) leases that were issued prior to passage of the Act and will first produce electricity within 6 years following the Act's passage, and (3) leases that have not yet been issued. There is also a provision in the Act that replaces the current method of calculating royalties due on direct use operations with a schedule of fees that shall encourage the development of geothermal resources. Since direct use royalties accounted for less than 1 percent of total geothermal royalties from 2000 through 2004, the financial impact of the switch to a schedule of fees is likely to be minimal.

For leases that currently produce electricity, the Secretary of the Interior is to seek to collect the same level of royalties over the next 10 years but under a simpler process. Prior to passage of the Act, lessees of 13 of the 15 geothermal electricity projects paid federal royalties according to a provision within MMS's geothermal valuation regulations referred to as the "netback process." To arrive at royalties due under this process, lessees are to first subtract from the electricity's gross sales revenue[9] their expenses for generation and transmission and then multiply that figure by the royalty rate specified in the geothermal lease, which is from 10 to 15 percent.[10] The Act simplifies the process by stating that within the 18 months after the effective date of the final regulations issued by DOI, lessees who were

[9]The valuation regulations 30 C.F.R. § 206.352 (c) (1) (ii) actually call for using gross proceeds, not sales revenue, in this calculation. The Act also refers to the term gross proceeds. Gross proceeds are all financial compensation accruing to the lessee from the sales of electricity. Since sales revenues are generally the largest component of gross proceeds, we use the two terms synonymously in this report for simplicity.

[10]Deductions are estimates that are to be recalculated at the beginning of each year. Prior year's deductions are to be adjusted based on actual costs during that year.

producing electricity prior to passage of the Act have the option to request a modification to their royalty terms. This modification allows for royalties to be computed as a percentage of the gross sales revenues from the electricity so long as this percentage is expected to yield total royalty payments equal to what would have been received for comparable production under the royalty rate in effect before passage of the Act. MMS has already implemented a procedure similar to this provision for the two projects that produce electricity at The Geysers, setting their future royalties equal to a percentage of gross sales revenues based largely on past royalty histories and future projections.

Royalty revenues from a geothermal lease currently producing electricity will remain the same if the lessee elects not to convert to the new provision within the Energy Policy Act. In this case, the lessee will continue to calculate and pay royalties just as the lessee did before passage of the Act. Royalty revenues from a geothermal lease currently producing electricity should also remain about the same if the lessee does convert to the simpler method of calculating royalties in the Act, provided that DOI negotiates with the lessee a future royalty percentage based on past royalty history and provided that electricity prices remain relatively constant. This situation is illustrated in table 4, which uses data based on actual royalty data from a geothermal project on federal lands. According to table 4, the lessee pays royalties equal to $20,000 under the netback process. Royalties are equal to the production of 8,000 megawatt hours times the sales price of $100 per megawatt hour less $600,000 in expenses times the statutory royalty rate of 10 percent. Figures in table 4 represent averages over a 5-year period and show that royalties are equal to 2.5 percent of gross sales revenue. If production remains the same and if electricity prices average $100 per megawatt hour, future royalty revenues will remain the same whether royalties are calculated under the netback process or if royalties are calculated at 2.5 percent of gross sales revenues.

Table 4: Example of Royalties Due under the Netback Process

Production	Sales price	Gross sales revenue	Expenses	Net sales revenue	Statutory royalty rate	Royalties due	Royalties as a percent of gross sales revenues
8,000	$100	$800,000	$600,000	$200,000	10%	$20,000	2.5%

Source: GAO.

Note: Production is in megawatt hours, and sales price is dollars per megawatt hour.

However, if electricity prices increase and royalties are based on historic percentages of gross sales revenues, royalty revenues will actually decrease relative to what the federal government would have collected prior to passage of the Act. More revenue would have been received under the netback process because expenses for generation and transmission do not increase when electricity prices increase and the higher 10 percent statutory royalty rate would have applied to all of the increase in sales revenues. This impact is illustrated in table 5. Using the historic average of 2.5 percent computed in table 4, the royalties will actually be $12,000 less than what would have been collected under the netback process when the average price increases by $20 per megawatt hour. On the other hand, if average electricity prices drop by $20 per megawatt hour, royalty revenues will increase by $12,000 relative to what would have been collected under the netback process.

Table 5: Impact of Changing Electricity Prices on Royalties Due under the Energy Policy Act and the Netback Process

Sales price	Change in sales price	Gross sales revenue	Royalties due under the Act	Royalties due under netback	Change in royalties due
$100	$0	$800,000	$20,000	$20,000	$ 0
$120	+$20	$960,000	$24,000	$36,000	- $12,000
$80	-$20	$640,000	$16,000	$4,000	+$12,000

Source: GAO.

Note: This example is for currently producing leases for which the lessee elects to change royalty to a percentage of gross sales revenue. The sales price is per megawatt hour. The example assumes constant production of 8,000 megawatt hours, constant expenses of $600,000, royalty rate equal to 2.5% of gross sales revenue under the Act, and 10% under netback.

For the second type of lease—leases that were issued before the Act and that will first produce electricity within 6 years after the Act's passage—royalty revenues are likely to drop somewhat because lessees are likely to take advantage of an incentive within the Act. The Act allows for a 50 percent decrease in royalties for the first 4 years of production so long as the lessee does not elect to pay royalties based on a percentage of gross sales revenues and continues to use the netback process.[11] Because of the substantial reduction in royalties, it is likely that lessees owning leases

[11]Pub. L. No. 109-58 § 224 (2005).

issued before passage of the Act will elect to pay only 50 percent of the royalties due on new production for the 4-year period allowed by the Act. This incentive also applies to sales revenues from the expansion of a geothermal electricity plant that exceeds 10 percent. Owners of geothermal electricity plants currently paying royalties under the netback process may elect to take the production incentive for new plant expansions if they perceive that the royalty reduction is worth the additional effort and expense in calculating payments under the netback process and worth the possibility of being audited. BLM officials said that leases in Utah, California, and Nevada may become subject to the royalty reduction provisions within the Act for new production and new plant expansions.

It is difficult to predict exactly how royalty revenue from the third type of lease—leases that have not yet been issued—will change, but it appears that revenue impacts are likely to be minor, based on our review of historic royalty data. The Act specifies that the Secretary of the Interior should seek to collect the same level of royalty revenues over a 10-year period as before passage of the Act, but it will be difficult for DOI to compare an estimate of what royalty revenue would have been without the Act with royalty revenues after the Act because the production and expenses of future plants could vary substantially due to their unique geological, engineering, and economic attributes. The Act provides that, for future leases, royalties on electricity produced from federal geothermal resources should be not less than 1 percent and not greater than 2.5 percent of the sales revenue from the electricity generated in the first 10 years of production. After 10 years, royalties should be not less than 2 percent and not greater than 5 percent of the sales revenue from the electricity.

We attempted to analyze the revenue impact on future leases by using historic royalty data maintained by MMS and sales revenue data maintained by BLM. A detailed description of our methodology is in appendix II. First, we attempted to analyze revenue impacts on the first 10 years of electricity production, but we had difficulty obtaining relevant royalty data so we could not complete this analysis. Next, we examined the impact on royalties after the first 10 years of production by analyzing data for seven geothermal projects from 2000 through 2004. In analyzing royalty data, we found that MMS did not maintain gross sales revenue data so we used data that BLM supplied to MMS. We also found that 40 percent of the royalty data maintained by MMS was erroneous or missing so we corrected or obtained these data as necessary. We then calculated royalties paid as a percentage of gross sales revenues for each project. This analysis showed that lessees were paying a wide range of percentages—from 0.2 to 6.3

percent. Three of the seven projects paid under the minimum 2 percent royalty rate prescribed in the Act, suggesting that some projects in the future could pay more under the Act's new provisions than they would otherwise have paid. On the other hand, one project paid greater than the maximum 5 percent prescribed in the Act, suggesting that it is possible for a plant to pay less in the future than it would otherwise have paid. However, both the royalty revenue that the one plant would have overpaid and the total of the royalty revenues that the three plants would have underpaid are small—about 0.2 percent and 0.01 percent, respectively, of all geothermal royalties reportedly paid during the period of our analysis.

Even though provisions within the Act may decrease royalties on direct use applications, the impact of these provisions is likely to be small because total royalty collections from direct use applications are minimal. In fiscal years 2000 through 2004, MMS reported collecting annually about $79,000 from two direct use projects, or less than 1 percent of total geothermal royalties. In addition, MMS reported collecting an additional $222,000 during this period in settlement for royalties owed on a direct use project from 1987 through 2003. While a provision within the Act may encourage the use of federal geothermal resources for direct use by lowering the federal royalty rate, we believe based on challenges facing developers that it is unlikely that this royalty incentive alone will stimulate substantial new revenues to compensate for the loss in revenue due to the lower royalty rate. We believe that, in order to substantially increase the development of federal direct use applications, developers must overcome the relatively high capital costs for investors, unique business challenges, and water rights issues.

MMS Does Not Routinely Collect the Royalty Data Necessary to Maintain the Same Level of Royalty Collections

MMS does not routinely collect meaningful data on the revenue from electricity sales. Since the Act requires the Secretary of the Interior to seek to achieve the same level of royalty revenues when issuing new royalty regulations, these data are necessary to know how future royalties will compare with what would have been collected before passage of the Act. To make these comparisons, MMS needs to calculate the percentage of gross sales revenues that lessees pay in royalties. MMS requires royalty payors to record sales revenue data on Form MMS-2014 under the data field "sales value." MMS's *Geothermal Payor Handbook* instructs royalty payors using the netback method to record in this field its net sales revenue, which is equal to gross sales revenues less deductions for expenses such as generation and transmission. As such, this sales value cannot be used as

one of the factors to calculate the percent of gross sales revenues paid in royalties.

In preparing an analysis for the Royalty Policy Committee, MMS obtained gross sales revenue data from BLM for many of the geothermal projects. While BLM regulations require geothermal plant operators to report to BLM the amount of electricity produced, these regulations do not require the reporting of gross sales revenues. Nevertheless, BLM officials said that they collect the sales revenue data. BLM officials in Nevada and southern California reported examining the production and gross sales revenue data for reasonableness and patterns in order to check on the accuracy of royalty reporting. A BLM official also reported collecting sales revenue and production data at The Geysers in northern California, but he said that BLM lacked the resources to examine these data and was unable to compile these data either for MMS or for us. These data from The Geysers are important because they represent about 61 percent of total federal geothermal royalties. Some royalty data from The Geysers were obtained and audited by the state of California, but an MMS official said that it would be more efficient and timely if MMS collects gross sales revenue data directly, rather than having to ask BLM or the states for these data. The official also said that MMS could use the gross sales revenue data in the future to conduct general compliance audits by comparing the percent of gross sales revenue paid in royalties with percentages prescribed within the Act and by examining trends in the data, without having to undertake lengthy and expensive on-site visits to the geothermal plants.

Conclusions

The Energy Policy Act of 2005 addresses a wide variety of challenges facing developers of geothermal resources. The Act incorporates many of the lessons learned by state governments and federal agencies in an attempt to make federal processes more efficient and provide financial incentives for further development. However, the Act is new and insufficient time has passed to assess its effectiveness. Several of the Act's major provisions will be left to the federal agencies within DOI for implementation, and the drafting and public comment period for regulations that implement these provisions will take time. Agencies will also need to spend considerable time and effort in working out the details for implementation and securing the necessary budgets to implement the new system. To assist in these efforts, the Congress has authorized the agencies to use the federal government's share of royalty collections to implement the geothermal program for 5 years.

All the while, the Act directs the Secretary of the Interior to seek to maintain the same level of geothermal royalty revenues over the next 10 years as would have been collected prior to the Act. This is a tall mandate, as one of the factors that can most affect geothermal royalty revenue—the price of electricity—is outside the control of the managing agencies. Although it is impossible to predict with reasonable assurance how these prices will change in the future, the federal agencies must make their best effort to mitigate the impact of changing prices if federal royalty revenue are to remain the same. This mitigation can only be achieved if there is timely and accurate knowledge of the revenues that lessees collect when they sell electricity. Without such knowledge, MMS will have difficulty collecting the same level of royalties from lessees that elect to use the new royalty process.

Recommendation for Executive Action

To assist in achieving the same level of geothermal royalties as would have been collected prior to the Energy Policy Act of 2005, we recommend that the Secretary of the Department of the Interior instruct the appropriate managers within the Minerals Management Service to take the following two actions:

- Correct erroneous and missing royalty data, when necessary, so that it will have an accurate baseline of royalty collections for each payor; and

- Routinely collect from royalty payors the gross sales revenues for electricity sold in order to compare these revenues with past royalty collections and to verify compliance with the percentages prescribed within the Act for leases to be issued in the future.

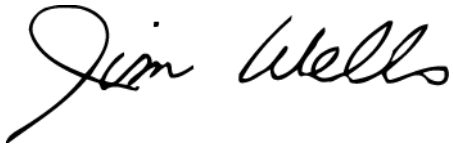
Agency Comments and Our Evaluation

We provided a draft of this report to the Department of the Interior for review and comment. DOI provided written comments, which are presented in appendix II. DOI agreed with our recommendations and emphasized the importance of correct and relevant data in fulfilling the requirement to collect the same level of geothermal royalties as would have been collected prior to the Energy Policy Act of 2005. Specifically, DOI stated that MMS plans to take steps to correct erroneous and missing royalty data, including initiating an audit and directing payors to correct data. DOI also stated that MMS is drafting new geothermal regulations as part of implementing the Act and that these regulations will refer to instructions that require payors to report to MMS the gross sales revenues

for electricity sold. MMS also provided several technical comments that we have incorporated in the report.

As agreed with your office, unless you publicly announce the contents of this report earlier, we plan no further distribution until 15 days from the report date. At that time, we will send copies to other interested congressional committees. In addition, we will send copies of this report to the Secretary of the Interior, the Director of BLM, the Director of the Minerals Management Service, the Secretary of the Department of Agriculture, the Chief of the Forest Service, and the Secretary of Energy. We also will make copies available to others upon request. In addition, the report will be available at no charge on the GAO Web site at http://www.gao.gov.

If you or your staff have any questions about this report, please contact me at (202) 512-3841 or WellsJ@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Key contributors to this report are listed in appendix III.



Jim Wells
Director, Natural Resources
and Environment

Objectives, Scope, and Methodology

In this report, we discuss (1) the current extent and potential for geothermal development; (2) challenges faced by developers of geothermal resources; (3) federal, state, and local government actions to address these challenges; and (4) how provisions of the Energy Policy Act of 2005 (Act) are likely to affect federal geothermal royalty collections.

To describe the current extent and potential for geothermal development, we reviewed key studies on the extent and potential of geothermal development that were published by the Department of Energy, the California Energy Commission, the U.S. Geological Survey, the Western Governors' Association, the Geo-Heat Center at the Oregon Institute of Technology, the Geothermal Energy Association, and the state of Utah. We contacted and visited the authors of the studies prepared by the Department of Energy in Golden, Colorado; the California Energy Commission in Sacramento, California; and the Geo-Heat Center in Klamath Falls, Oregon. We also visited the Geothermal Resources Council in Davis, California. We obtained statistics on federal geothermal leases from the Bureau of Land Management (BLM) and data on geothermal heat pumps from the Geothermal Heat Pump Consortium, the Department of Energy's Geothermal Technologies Program, and the General Services Administration.

To identify the challenges facing geothermal developers and to assess actions taken by federal, state, and local governments, we interviewed a variety of government and industry officials, reviewed substantial supporting documentation and the Act, and visited geothermal facilities. We interviewed BLM officials in Washington, D.C.; California; Nevada; and Utah, as well as Forest Service officials in Washington, D.C.; Minerals Management Service (MMS) officials in Lakewood, Colorado; and Department of Energy officials in Washington, D.C.; and Golden, Colorado. We contacted state officials in California, Nevada, and Idaho. We also interviewed geothermal industry representatives in Washington, D.C.; California; Nevada; and New Mexico and toured geothermal electricity plants in California and Nevada and direct use facilities, including heating districts, food processing plants, greenhouses, aquaculture operations, and a spa in Idaho, Nevada, Oregon, and Colorado. Specifically to assess financial challenges faced by the geothermal industry, we also interviewed officials with public utilities and officials who specialize in arranging financing for geothermal plants. In assessing challenges specific to federal lands, we also reviewed processes for approving lease applications and conducting environmental analyses under the National Environmental Policy Act of 1969; examined federal regulations addressing leasing,

geothermal operations, and royalty valuation for both electricity production and direct use; and read the 148-page *Geothermal Valuation Handbook*.

To assess how provisions within the Act will affect federal geothermal royalties, we interviewed MMS employees in Lakewood, Colorado, and BLM employees in California, Utah, and Nevada and reviewed a report authored by the Royalty Policy Committee. We reviewed in detail how provisions of the Act address the disbursement of federal geothermal royalties and specifications for geothermal royalty collections from leases that are currently producing electricity, leases that will first start to produce electricity within the 6 years following passage of the Act, and leases that have not yet been issued.

To assess how provisions of the Act could impact royalty revenue from the sale of electricity, we started by trying to obtain monthly geothermal royalty data and sales revenue data from MMS for January 2000 through December 2004 for 10 geothermal projects paying royalties according to the netback process. We discovered that MMS does not require payors to submit gross sales revenue data but instead collects these data from BLM. We assessed whether MMS's royalty data and BLM's sales revenue data were complete enough and accurate enough for MMS to determine what percentage of gross sales revenues is equivalent to the current level of royalties being paid, should lessees elect to convert to paying a percentage of gross sales revenues, as allowed by the Act. We reviewed MMS's and BLM's data for reasonableness and completeness. While we found BLM's data to be reasonably complete and accurate for the 10 geothermal projects, we found that BLM could not furnish us with sales revenue data for the 2 steam projects at The Geysers Geothermal Field in northern California. We also found that about 40 percent of the monthly royalty data maintained by MMS for the 10 projects was missing or erroneous. The most common error, accounting for 73 percent of erroneous and missing data, was not paying the 0.1 percent minimum royalty required by MMS regulations. This error did not result in significant monetary underpayments; monthly underpayments for this type of error generally amounted to less than $500. After assuming that the correct royalty due was 0.1 percent of net sales revenue for those months in which underpayments were less than the minimum royalty calculation, we determined that royalty data was reasonably accurate and complete for January 2000 through December 2004 for 6 of the projects and for January 2003 through December 2004 for one additional project.

In assessing revenue impacts from leases that were currently issued and producing electricity, we considered MMS's past history of approving royalty calculations based on a percentage of gross sales revenues at The Geysers. We also reviewed MMS's calculations of the percentages of gross sales revenues that appear in the report to the Royalty Policy Committee. Based on these considerations, we assumed that MMS could determine a percentage of gross sales revenues equal to what would have been collected prior to the Act if electricity prices do not change. We also determined the impact of changing prices on royalty revenues as illustrated in table 5. In assessing revenue impacts from leases that were currently issued and not producing, we contacted BLM officials to ascertain the likelihood for these leases to first start producing in the next 6 years and the likelihood of producing leases to expand their production by more than 10 percent. We also discussed with industry officials their opinions on paying royalties according to the netback process.

To assess how royalty collections from future leases could be impacted, we began to examine royalty data from the first 10 years for the 15 federal geothermal projects, all of which first started producing prior to 1987. We abandoned this attempt after conversing with MMS officials. MMS officials noted that contracts for the sale of electricity prior to 2000 were different and would probably not be representative of future situations. In addition, sales in the 1980s often involved the sale of geothermal resources such as steam and hot water rather than electricity, complicating the use of MMS's royalty data. Although some industry officials said that their projections suggest that royalties during the first 10 years of a project's life are substantially less than the royalties during the remainder of the project's life, we could not verify this estimate without actual royalty data.

To assess how royalty collections from future leases could be impacted 10 years after they first produce, we proceed with examining royalty data for 7 of the projects from our original sample of 10 geothermal projects. We calculated royalties as a percentage of gross sales revenues from January 2000 through December 2004 and compared their range with the range of percentages prescribed within the Act for production after the first 10 years. We also compared royalties as the percentages of gross sales revenues for five of the flash plants with royalties as a percentage of gross

sales revenues for two of the binary plants.[1] We found that flash plants paid royalties from 0.6 to 6.3 percent of gross sales revenues while binary plants paid from 0.2 to 2.6 percent of gross sales revenues. It appeared to us that each project, whether flash or binary, faces unique geological, economic, and engineering situations that can combine to yield different percentages of gross sales revenues. In addition, the small number of observations and the significant overlap in range of the data indicated to us that generalizations about the difference in percentages between the two types of plants would be inaccurate.

To determine the impact of the Act on royalties from direct use of geothermal resources, we obtained direct use royalty data from MMS and reviewed the calculations on an alternative to the current calculation of direct use royalties that appears in the report to the Royalty Policy Committee.

[1]Of the 15 geothermal projects on federal lands, two other geothermal projects pay royalties on a negotiated percentage of gross sales revenues and three other projects have both binary and flash operations—one of which has produced electricity intermittently and is currently shut down.

Comments from the Department of the Interior

United States Department of the Interior

OFFICE OF THE SECRETARY
Washington, DC 20240

MAY - 9 2006

Mr. Jim Wells
Director, Natural Resources and Environment
U.S. Government Accountability Office
441 G St., N.W.
Washington, DC 20548

Dear Mr. Wells:

Thank you for the opportunity to comment on the draft report entitled "Renewable Energy: Increased Geothermal Development Will Depend on Overcoming Many Challenges," (GAO-06-629).

In general, we concur with the report's recommendations. The Department of the Interior understands the requirement to achieve the same level of geothermal royalties as would have been collected prior to the Energy Policy Act, and is taking steps to support that requirement. The MMS agrees that an accurate baseline of royalty collections is important, and that gross sales revenue figures should accompany future royalty payments on geothermal-related electrical production. We will take the following actions to implement these two recommendations:

Recommendation 1. Correct erroneous and missing royalty data to form an accurate baseline of royalty collections for each payor.

1. MMS concurs.

   During 2006, MMS plans to audit the one geothermal property with significant royalty revenue problems. (Page 51 of your report defines "significant" as greater than $500.) The company uses the netback royalty method and has admitted to us that they reported royalty incorrectly for a period. In addition, BLM has informed us that the company operating this property is under-reporting its electricity sales revenues. The other incorrect or missing royalty data is relatively minor, according to the GAO. The MMS will direct the applicable companies to correct this data. We will complete the audit of the one geothermal property and notify the other companies by December 2006.

Recommendation 2. Routinely collect from royalty payors the gross sales revenue for electricity sold in order to compare these revenues with past royalty collections and to verify compliance with the percentages prescribed within the Act for leases to be issued in the future.

2. MMS concurs.

MMS is drafting a new geothermal regulation as part of the implementation of the Energy Policy Act of 2005. The draft proposed regulation will refer to the Oil and Gas Payor Handbook for Reporting Instructions (210.355). MMS will revise the geothermal chapter (Chapter 7) of the Oil and Gas Payor Handbook to instruct payors who use the percent-of-gross-proceeds method would be required to report their gross proceeds from electricity sales as the "Sales Value" on Form MMS-2014.

As indicated in the Draft Report, two payors represent the bulk of the geothermal-derived electricity royalties. The MMS will instruct the two payors, who are currently under a percent-of-gross-proceeds royalty method, by letter to include their gross proceeds from electricity sales as the "Sales Value" on Form MMS-2014.

It will be a simple compliance procedure for percent of gross proceeds payors for MMS to divide the royalties paid by the reported gross sales value to derive their percentage of gross proceeds paid. This calculated percentage can then easily be compared to what their percentage is expected to be under the Energy Policy Act. These royalty and gross sales data will require periodic audits or compliance reviews to ensure accuracy of reporting under the projects' sales contracts. This new reporting procedure will be in the revised Oil and Gas Payor Handbook, Chapter 7. This Handbook will be revised after the new geothermal rule is published, scheduled for December, 2006.

Again, thank you for providing the opportunity to review and comment on this report. If you have any questions regarding this response, please contact Mr. James Witkop, MMS's Audit Liaison Officer, at (202) 208-3236.

Sincerely,

R. M. "Johnnie" Burton
Acting Assistant Secretary
Land and Minerals Management

Enclosure

GAO Contact and Staff Acknowledgments

GAO Contact

Jim Wells (202) 512-3841

Staff Acknowledgments

In addition to the individual named above, Dan Haas, Assistant Director; Jeanne Barger; Ron Belak; John Delicath; Randy Jones; Frank Rusco; Anne Stevens; and Barbara Timmerman made key contributions to this report.

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